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Original

Association between Occupational Exposure to Mineral Dust and Blood Lipid Parameters

Atefeh Roshanaee[1], Hamideh Mihanpour[2], Ali Dehghani[3], Abolfazl Barkhordari[4], Mohammad Hossein Davari[5], Mohammad Javad Zare Sakhvidi[6]*

[1] Occupational Health Research Center, Department of Occupational Health, School Of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran• [2] Department of Occupational Health, Instructor, School of Paramedicine Abarkouh, Genetic and Enviormental Advantures Research Center Shahid Sadoughi University of Medical Sciences, Yazd, Iran • [3] Epidemiologist Associated Professor Public Health School Department of Biostatistic and Epidemiology Shahid Sadoughi University of Medical Sciences, Yazd, Iran• [4] Occupational Health Research Center, Department of Occupational Health, School Of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran• [5] Assistant Professor of Occupational & Environmental Medicine Industrial Disease Research Center Department of Occupational Medicine, School of Medicine Shahid Sadoughi University of Medical Sciences Add: Shahid Rahnemoun Hospital, Farrokhi Ave, Yazd, Iran• [6] Occupational Health Research Center, Department of Occupational Health, School Of Public Health, Shahid Sadoughi University of Medical Sciences, Yazd, Iran• Corresponding author: Mohammad Javad Zare Sakhvidi, Email:mjzs63@gmail.com, Tel: +98-912-4481013

Abstract

Background: Epidemiological studies have shown a change in blood biochemical parameters due to short and long exposure to airborne particles. Long Exposure to airborne particles can increase the risk of blood lipid disorders through oxidative stress. Therefore, this study was conducted to evaluate the relationship between respiratory exposure with inhaled particles and blood lipid parameters in workers of a ceramic tile factory. **Methods:** In this descriptive-analytical study, a sample size based on similar studies and Cochran formula, 128 healthy workers (77 exposed and 51 unexposed) were estimated in the age range of 24-40 years and randomly selected from among the factory workers. Sampling of the breathing region of all individuals was performed to determine the concentration of respirable particles based on the NIOSH_0600 method. Blood lipid parameters of people having cholesterol, triglyceride, HDL, and LDL were measured using standard methods. The data were analyzed using SPSS version 20 software. **Results:** The Mean of exposure to respirable particles in different units were 73.29 ± 7.75 mg / m3 and lower than standard (3 mg / m3). In this study, the levels of triglyceride and HDL were higher in the exposed group and the mean of these two parameters were statistically different. There was no correlation between lipid parameters and density of respirable particles and work experience (P value> 0.05); however, the body mass index had a positive correlation with cholesterol, triglyceride and HDL. Moreover, cholesterol and triglycerides showed a positive correlation with systolic hypertension. **Conclusion:** Exposure to particles has relationship with levels of lipid-related markers factors and can change the level of some of the lipid parameters. Therefore, protecting workers in units with high levels of dust and constant efforts to train and supervise workers to enhance safety and monitoring the proper and consistent use of these equipment is essential.

Key words: Air pollution; Blood lipid parameters; Respirable particles; Tile industry

Introduction

Many developing countries in Asia suffer from extremely high levels of PM 2.5 with an annual average of 45 micrograms per cubic meter. In these countries, more than 99% of people are exposed to the pollution above the WHO standard. In some areas where pollution is high, the

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daily concentration is usually more than 150-500 µg / m^3.[1] In their studies in Philadelphia, Schwartz et al. found a significant relationship between daily mortality and the level of tiny airborne particles.[2] Many studies have shown that respiratory, cardiovascular diseases and mortality related illnesses have been associated with dust levels.[3,4]

It is anticipated that these diseases and mortality may be mainly due to PM2.5 dust particles or very fine particles PM0.1, as coarse particles are usually filtered through the nose or coughed up from the upper lung. However, PM10 particles can cause respiratory problems for some people.[5] Although most recent epidemiological studies focus on the effects of short-term exposure to air pollution, several studies have shown that long-term exposures may be more important with respect to public health.[6]

The intensity of exposure to pollutant particles and the toxicity of these particles in working environments are generally more common than public and outdoor environments. Several studies have shown changes in biochemical parameters and blood hematology due to short-term and long-term exposure to airborne particles that changes in blood parameters is significantly related to the concentration of PM2.5 particles.[7] For example, due to exposure to these particles, the serum levels of biomarkers such as CRP and fibrinogen increase.[8,9] Several epidemiological studies have shown the relationship between exposure to pollutant airborne particles and human mortality, [10]pulmonary inflammation,[11] the incidence of severe respiratory complications, lung cancer, and chronic respiratory and cardiovascular diseases.[12,13] Long-term exposure to airborne particles can increase the risk of atherosclerotic plaques by increasing oxidation of LDL. Other possible mechanisms are short-term effects, such as increased viscosity of the blood due to pulmonary inflammation.[14]

The study of Kumar, et al.in India showed that in smokers the level of blood lipid parameters, including triglycerides, cholesterol and LDL increased, while HDL levels in smokers were lower than non-smokers.[15] However, few studies have discussed the relationship between workers' short-term and long-term exposure to these particles and changes in their blood-vessel and cardiovascular parameters. In ceramic and tile industries, exposure to particles such as silica, mica, kaolin, quartz and tridimite is common. Diseases caused by inhalation of these particles include silicosis, lung cancer, and chronic obstructive pulmonary disease.[16] The review of literature shows that few studies have been conducted on the effects of air pollution on fat parameters, and in Iran, there was no study on the effect of exposure to inorganic pollutants in working environments on lipid parameters. Therefore, this study aimed to determine the relationship between exposure to respirable particles on fat parameters of the workers in one of the tile factories.

Methods

This cross-sectional study was carried out in Yazd in 2004 on 128 people (77 people from different working units in ceramic and tile factories; the units included packaging, stone grinding, ball mill spray, pressing, glazing line as exposed group and 51 people from administrative units as unexposed group) were randomly selected. In order to determine the relationship between long-term exposure to air pollution and workers' blood lipid parameters, having at least one year of work experience in these units was the criterion to participate in the study. Furthermore, based on the review of the medical records since recruitment, those with a history of lipid, or a particular medication or diet were excluded from the research. Socioeconomically, everyone was similar, based on their own statements. Therefore, it was assumed that they all had the same lifestyle and eating habits. Demographic data, history of environmental exposures and lifestyle (smoking cigarette, smoking hookah, respiratory protection) were collected using a demographic questionnaire. This study was approved by the Ethics Committee of Shahid Sadoughi University of Medical

Sciences (approved by the IR Committee on Ethics, IRS.UA.SPH.REC.1395.23). Prior to collecting data, each participant gave their verbal and written consent.

Sampling and Measuring Blood Biomarkers

In this study, 1 cc blood sample was taken intravenously early in the morning before breakfast for blood lipid tests after obtaining the informed consent by blood sampling officer. Samples were transferred to a laboratory in a cold box with a temperature of less than 3 ° C in less than 2 hours. Cholesterol, triglyceride, HDL and LDL tests were performed by a medical lab science expert after serum isolation in Shahid Sadoughi department of Health in Yazd. The samples were kept at -20 ° C for the required tests to be used at the right time. After taking the serum samples out of the freezer, they were placed in a bin Marie to reach a degree between 25 and 30 degrees Celsius. Then, the tests were performed on sera with the AutoCAD Echo Analyzer E-model made in Germany. Cholesterol and triglyceride, HDL and LDL tests were performed completely automatically, and based on the kit used in pars Azmoun Company. The solutions required for the above tests were prepared by the Auto Analyzer Selectra Model E from Pars Azmoun Company (Iran). To calibrate the machine, Lipid calibrator from Pars Azmoun was used and we calibrated the machine.

Assessment of Respiratory Exposure

In this study, the samples were taken from the air in the respiratory area of the exposed group who were 77 people (30 cm in diameter around the mouth and nose of the worker (7)) in a 4-hour interval representing all the activities of the individual. Sampling of respirable particles was done based on the NIOSH_0600 method with a PVC membrane filter with 25 mm diameter and a 5-micrometer pore size made by SKC from UK, SKC Aluminum Cyclone, UK, Individual sampling pump SKC with a mass flow of 7.1 liters per minute (Calibrated using the recommended Rotameter in accordance with the recommended mass flow.

In order to increase the accuracy of the sampling, the filters to be used for 24 hours were placed in a silica gel containing desiccator for their possible moisture to be absorbed. After weighing, the dried filters were placed inside special holders. To eliminate the factors that cause the sampling and decomposition error during sampling, for each 10 samples, two control samples were taken (based on the sampling method standard of the respirable particles (NIOSH_0600 method). After the sampling is finished, the filters were again placed in the desiccator for 24 hours. And the filter was weighed three times and the average weight of the filter with the collected dust was determined. To weigh the filters, the GR-200 digital calibrated scale was used. At the end, the concentration of the respirable dust collected from the filters was calculated using the relationship provided in the NIOSH_0600 protocol.

The general questionnaire was given to the participants and after the interview, the necessary information was obtained; being in traffic in the past week, distance from the street, previous job, mass body index, and cigarette smoking status. Using the instruments of scale, measuring tape, and using blood pressure machine, information such as weight, height, abdominal circumference and blood pressure were measured. After completing the general questionnaire, the International Physical Activity Questionnaire (IPAQ) was handed out to the individuals. The researcher completed the questionnaire by asking questions about physical activity during the last 7 days and explaining each question.

Statistical Analysis

After sampling and collecting data and entering the data into SPSS 20, to describe the data, the mean, standard deviation, and minimum and maximum were used. Kolmogorov-Smirnov test was used to measure the normality of the data and p value less than 0.05 was considered significant. Spearman test was used to investigate the correlation between blood lipid parameters and respirable dusts concentration and Mann-Whitney and Kruskal-Wallis tests were used to investigate the relationship between abnormal quantitative and qualitative data.

Results

The present study was conducted in 2016 with the aim of assessing occupational exposure to mineral dust and its relationship with blood parameters in workers in one of the tile and ceramic industries of Yazd. In this study, 100% of the subjects were male who were selected randomly from among workers working at different units of tile industries for at least one year. Descriptive statistics (mean, standard deviation, maximum and minimum) of demographic data, the history of exposure (work history and the distance from the main street) and the exposure to respirable dust are reported in Table 1. In this study, 72 people worked in shifts. In terms of the use of respirator, 23 workers always used them, 33 workers sometimes wore filter respirator masks, and 21 workers never used masks. Of 128 participants, 8 (6.25%) were smokers and 120 (93.5%) were non-smokers.

The average of exposure to respirable particles in different units was 73.29 (7.75) mg /m^3 and lower than the standard level (3 mg /m^3). The results of the evaluation of exposure to respirable particles showed that the exposure of 91.25% of the participants (73) was recommended to be below the standard level. The level of exposure to respirable particles in the Ball mill unit was 19.3 unit and the stone crushing was 15.62 mg /m^3, which is higher than the authorized amount.

Table 1. Frequency Distribution of Demographic Variables and Particles Density

variable	group	Mean(SD)	Min-Max
Age(year)	Exposed	29.45(4.78)	22-40
	Unexposed	31.27(6.75)	21-48
Distance from the main street (meter)	Exposed	238.53(259.86)	2-1500
	Unexposed	176.49(183.26)	5-1000
The level of exposure to traffic pollution in a week (day)	Exposed	1.86(4.66)	0-30
	Unexposed	5.33(5.47)	0-20
Work experience in the present unit(year)	Exposed	3.81(1.57)	1-7
	Unexposed	4.73(3.65)	1.16
Work experience(year)	Exposed	7.36(4.06)	1-18
	Unexposed	6.45(4.4)	1-22
Body Mass Index(BMI)	Exposed	25.88(4.68)	16.14-41.65
	Unexposed	26.39(3.72)	17.82-34.86
Cytolysis blood pressure	Exposed	111.95(11.5)	80-140
	Unexposed	114.9(7.58)	100-130
Diastolic blood pressure	Exposed	73.83(7.86)	60-90
	Unexposed	74.12(8.29)	60-90
Physical activity	Exposed	8043.61(13186.85)	198-106400
	Unexposed	2573.67(2733.82)	66-15975
Concentration of respirable particles		2.73(9.55)	0.25-82.84

Table 2. Frequency Distribution of Lipid Parameters Based on the Standard in the Exposed Group

Variable		Frequency	Percent%
Cholesterol	<200	61	79.2
	200-240	10	13
	>240	6	7.8
HDL	40>	77	100
	40-60	0	0
	60<	0	0
Tri glyceride	<200mg/dl	54	70.1
	200-400mg/dl	20	26
	>400mg/dl	3	3.9
LDL	155>	76	98.7
	155<	1	1.3
Total			

Table 3. Frequency Distribution of Density of the Lipid Parameters and Investigating Their Relationship with the Exposed Group

Variable	Group	Mean(SD)	Min-Max	*P*-Value
Cholesterol	Exposed Unexposed	172.78(40.72) 172.39(37.18)	81-308 98-267	0.957*
Triglyceride	Exposed Unexposed	176.79(118.41) 129.03(84.81)	46-764 0/8-508	0.013**
HDL	Exposed Unexposed	44.73(11.29) 40.59(9.66)	20-70 11-58	0.034*
LDL	Exposed unexposed	92.78(28.54) 103.36(31.76)	14.8-155.2 21.2-176/8	*0.052

**Mann-whithney U test
* Significance level 0/05
Significance level 0/01
T-test*

Table 4. Correlation of Fat Parameters with Quantitative Data in the Exposed Group

Variable		BMI	Work experience	Systolic blood pressure	Diastolic blood pressure	Inhalable particles	Respirable particles
Cholesterol	R	**0.389	0.032	*0.253	*0.248	0.049	-0.047
	P-value	0.000	0.784	0.027	0.03	0.67	0.682
Tri glyceride	R	**0.429	0.126	**0.293	0.183	0.104	-0.047
	P-value	0.000	0.275	0.01	0.11	0.37	0.682
HDL	R	**0.331	0.042	0.158	*0.236	0.043	0.061
	P-value	0.003	0.718	0.171	0.039	0.711	0.598
LDL	R	0.064	0.055	0.07	0.105	-0.012	-0.123
	P-value	0.579	0.637	0.546	0.365	0.919	0.287

Significance level 0/05
significance level 0/01

Table 5. Investigating the Relationship between Density of Lipid Parameters and Smoking in the Two Groups

Parameter Smoker	Number (%)	cholesterol (mean)standard (deviation)	Tri glyceride (mean)standard (deviation)	HDL (mean)standard (deviation)	LDL (mean)standard (deviation)
Yes	8(6.25)	174.87(20.23)	129.62(57.94)	38(8.94)	110.95(22.43)
No	120(93.75)	172.47(40.18)	159.63(110.95)	43.41(10.88)	96.06(30.48)
P-Value		0.87	0.63	0.17	0.18

As shown in Table 3, there is a significant statistical difference between triglyceride and HDL with exposed groups, and their mean is different between the two groups. No significant correlation was found between the fat parameters and the concentration of respirable particles and inhalable particles and the work history (*P*-value> 0.05); however, the BMI was correlated with the majority. Furthermore, cholesterol and triglycerides showed a positive correlation with systolic blood pressure Table 4. The results show that there is no significant relationship between the concentration of fat parameters and qualitative data in the exposed group. There was no significant statistical difference between smoking and blood lipid parameters.

Discussion

Ceramic tile is one of the industries in which there are many people are working who are susceptible to occupational diseases due to inhalation of dust particles. Due to the high risk of irreversible effects on workers' health in the industry, scientific studies are required to evaluate the magnitude of exposure to particulate matter in these industries. This study was conducted to investigate the hypothesis that particulate pollution of the air leading to blood lipids. Few studies have been conducted to investigate the effect of particulate contamination of air on lipid parameters, and this study measures the effects of exposure to inhalable particles in working environment on blood lipids. Previous studies examine the effect of air pollution on the population, based on measurements of pollution in a central point that covers everyone, while in the present study the air samples were taken from all participants of 4 hours of workers' breathing zone while working to determine the exposure to inhalable dust.

In this study, a statistically significant difference between the mean of triglyceride and HDL were observed between the exposed and unexposed group. The HDL levels in the exposed group were more than the control group, which may be because of more physical activity in the exposed. This study is consistent with the study of Mr. Durstine et al. in which with increased physical activity the levels of HDL also increased.[17] Tomei also observed lipid abnormalities in outdoor workers, due to exposure to environmental pollutants and chemicals found in combustion and gasoline mixtures in equipment used in their activities.[18] Most epidemiological studies show that exposure to environmental pollutants has positive correlation with an increase in human mortality with various causes, including metabolic diseases [19,20]and cardiovascular diseases.[21]

Studies on particle contamination caused by combustion processes indicate a correlation between them and DNA damage and increased blood lipids due to the effect of insulin resistance and lipid peroxidation.[22,23] Chuang et al., in 2010, specifically demonstrated a decrease in HDL and an increase in apolipoprotein B in people with long-term exposure to PM10.[24] A study by Jacobs et al. showed that elevated serum levels of oxidized and non-oxidized LDLs are because of chronic exposure to very small particles.[25] Therefore, the nature of pollutant particles can also affect the results. In various studies, it has been observed that some of the chemicals or gases present in urban pollution may be responsible for changing fat metabolism and its parameters.[26] Urban air pollution is due to traffic and fossil fuels and chemical compounds such as heavy metals and poly-aromatic hydrocarbons.[12] While in tile factory the main pollutants are from dust and mineral particles and kaolinite, feldspar and silica, which are different from those in previous studies in urban areas. In the present study, there was no relationship between cigarette and lipid parameters; however, in the study by abdul-razaq et al., the results showed that level of total cholesterol, triglyceride and LDL were higher in the smoker group, while the level of HDL serum in them compared to non-smokers was significantly lower.[27]Lipid changes in smokers may be due to nicotine, which stimulates the secretion of catecholamine’s, which increases lipolysis and the concentration of plasma free lipid acid, thereby increasing the release of free lipid acids and liver triglyceride.[28]

The findings of Kumar et al. in India showed that cholesterol, triglyceride, LDL, malondialdehyde and CPR increased, while their HDL and serum protein level were lower than non-smokers .[15]There are several reasons why smokers are expected to have a higher level of lipid peroxidation than non-smokers, one of which is that smokers, by inhalation of a large amount of gas and other radicals, increase oxidative damage that is susceptible to oxidation.[29] Another reason is the discharge of plasma antioxidants to protect against oxidative damages and is frequent among smokers. Ultimately, smoking stimulates NADPH-smoking causing oxidative stress and reducing antioxidant defense, resulting in lipid peroxidation.[28]The Kumar study confirms the findings of Alsalhen et al., which showed a significant increase in cholesterol, triglyceride levels. Different mechanisms that lead to changes in lipid due to smoking include 1- nicotine, an increase in the adrenal gland synaptic system that leads to increased secretion of catecholamine's and leads to increased lipolysis and increased concentration of plasma free lipid acid and this leads to an increase in the release of free lipid acids and liver triglycerides. 2- The excess of plasma insulin in smokers increases the activity of lipoprotein, which leads to an increase in the level of lipid in smokers.[30]

In this study, gender was not studied because all the samples were from males; however, in the Yin study, the relationship between PM2.5 and HDL-P and the relationship between black carbon and HDL-C changed by gender. In both cases, the relationship between air pollution and HDL was more severe in women. Women generally have higher HDL-P and HDL-C levels than men, which is associated with higher estrogen production in women.[31] In this study, the participants were examined by a physician and none of them had a history of disease and assessment of the exposure of individuals was performed by personal sampling pump, as well as particle sampling for all units and in all shifts. Moreover, it was observed that exposure to particles is associated with lipoprotein and triglyceride levels and may change the level of some of the lipid parameters. Therefore, we respiratory mask in units with high levels of dust can be provided to protect workers. Constant efforts to train and supervise workers are necessary to enhance employees' safety and monitor the proper and continuous use of this equipment. Further research is needed to assess occupational exposure hazards with airborne pollutants.

Conflict of interest

There is no conflict of interest between authors.

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