

**EVALUATION OF LIPID PARAMETERS IN OUTDOOR AND INDOOR WORKERS:
PRELIMINARY RESULTS**

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ABSTRACT

Introduction: Some categories of outdoor workers are more exposed to certain pollutants in relation to the working hours in open air and to the potential chemicals used in their activity. The purpose of the study is to evaluate the lipid parameters in environment technicians exposed and in indoor workers (control group).

Materials and Methods: We studied the lipid parameters (Total cholesterol, HDL, LDL and triglycerides) comparing mean and standard deviation in 129 male indoor administrative workers and 129 male environment technician outdoor workers. The two groups have been made comparable by age, working age, alcohol consumption and smoking habits. We eliminated all the workers that presented confounding factors.

Results: we found a significative increase of LDL values and a significative decrease of HDL values in the outdoor worker group.

Discussion: the results suggests that some pollutants present in the air can influence HDL and LDL values.

Key Words: chemical risk, environment pollution, indoor workers, lipid profile, outdoor workers.

INTRODUCTION

Air pollution is one of the major risks for human health according to the World Health Organization (WHO). Air pollution is defined as: " every modification of atmospheric air, due to the introduction in the same of one or more substances in a quantity and with characteristics such as to prejudice or to be a danger for human health or for the environment quality or such as to prejudice physical assets or compromise the legitimate uses of the environment (Art. 268 of Decree No. 152/2006). "

Some categories of workers are more exposed to certain pollutants in relation to the working hours in the open air and to the types of chemicals used (1). The main pollutants responsible for about 98% of air pollution are Carbon Monoxide CO (52% of pollution) Sulphur dioxide SO₂ (14%) Hydrocarbons (14%) particles (around 4%) Nitrogen dioxide NO₂ (14%) (2).

Polycyclic aromatic hydrocarbons and heavy metals such as arsenic (As) are inclined to bind the particulate matter present in the air. The particulate seems to be an important route of exposure to these pollutants. Arsenic is adsorbed to particles of PM and it is usually present as a mixture of arsenite and arsenate (3). It can cause acute or chronic poisoning for workers who conduct their activities in the open air. Its toxicity, observed after exposure, has been associated with a number of negative effects on human health also on metabolic functions (IARC 2004) (4).

Among the most important gases there are carbon monoxide, sulfur dioxide, nitrogen dioxide and monoxide, polycyclic aromatic hydrocarbons, halogenated compounds. CO is surely the most present one and it is produced by the incomplete combustion of carbonaceous substances. Human exposure comes mainly from the exhaust, industrial fumes and cigarette smoke. Various studies have been conducted on both human and animal models on the capability to change the lipid profile and on the resulting atherogenic effect of chronic exposure to carbon monoxide and benzene. In 1969 Wanstrup et al. (5) had already studied the effects of CO on the vessels of rabbits causing quantitative alterations of lipid metabolism. They demonstrated that the exposure to carbon monoxide causes degenerative and reparative alteration of atheromatous nature with accumulation of lipids in the intima of the aorta, as a result of hypoxia induced by exposure. McGill (6) and Tomao (7) in particular showed that chronic exposure to this pollutant causes an increase in the values of LDL cholesterol and a decrease of HDL cholesterol.

Benzene is among the most studied pollutants in urban environment for its established role in some human diseases in various organs and systems (8-10).

Among the various compounds of the gasolines and oils combustion, the monochlorobenzene, the chlorobenzene and the 1,2-dichlorobenzene were studied for their toxic properties. They can induce liver damage and alteration of the metabolic functions of this organ (11). Few studies in the literature have dealt with the issue of workers exposed to residues of combustion engines. The composition of this pollutants includes both a toxic gas phase and a particulate phase. The extracts of the particulate contain nitro and dinitropireni and are carcinogenic, as well as volatile compounds. The latter, in particular those of diesel engines, have the highest rate of polycyclic aromatic hydrocarbons and toxic substances (12).

The presence of benzene in the atmosphere is mainly due to various human activities which, by themselves, are responsible for over 90% of total emissions, reaching a value of $110\mu\text{g}/\text{m}^3$ in large Western cities (13). Among these activities, those related to the fuel cycle are the most indicted. . Not to forget is however also the presence of benzene in cigarettes whose quantity depends on the type and the number of cigarettes smoked a day. Several authors have highlighted the mechanisms through which benzene and CO can cause an alteration in the lipid values of individuals chronically exposed (14, 15).

As to the particulate pollutants, it includes the small solid particles classified according to their size. Atmospheric particles are usually measured in TSP (Total Suspended Particulate): PM10 when the average aerodynamic diameter is less than 10 microns (they can reach the lungs), PM2.5 when their mean aerodynamic diameter is less than 2.5 microns (more harmful because they can pass through the filters of the upper respiratory airways). Attention is now focusing on the impact on health of even smaller particles, PM0.1 and the so-called nanoparticles (even finer), which penetrate further in depth. They are considered even more harmful. Chuang et al. (16), Sancini et al. (2), Tomei (17) showed with their studies as these particles may alter lipid metabolism and in particular the values of LDL and HDL.

There are many categories of workers that for time of exposure to pollutants of chemical nature can be considered at risk. Among these we chose to study the environment technicians also exposed to chemicals in their work and we compared their lipid profile with that of a control group of indoor workers. Few studies have been conducted on the correlation between pollution and lipid profile in outdoor workers (6, 7, 16, 18).

The purpose of the study is to evaluate if the outdoor workers have significant differences compared to indoor workers in terms of lipid values (COL TOT, HDL, LDL and triglycerides).

MATERIALS AND METHODS

We examined a population of 627 indoor and outdoor male workers (370 administrative workers + 257 environment technicians employed to the "service gardens" of a large Italian city). Indoor workers are the ones who make an office work and who are not exposed to dangerous pollutants or hepatotoxic substances. The subjects employed to the "Service gardens" are technicians or environment technicians of the gardens, which play many of their activities outside, especially outdoor and in urban areas. Because of their employment this working population is exposed to chemicals present in urban air and uses chemicals in their activity for the use of machines and tools to the motor and therefore containing petrol. The study sample consists of workers involved in the maintenance of gardens, parks, greenhouses and tree-lined streets, involved in the collection and removal of waste dumped in the green areas, of resulting materials of the maintenance (pruning, mowing, etc.) and involved in restoring avenues and squares with pruning and squaring of hedges or trees with use of lifting equipment. We included in the study only subjects between 35 and 60 years. Subjects younger than 35 years do not have a work seniority sufficient to have suffered over the years the influence of the contaminants studied. Subjects over 60 years were not present in the group of indoor workers but only in the group of environment technicians (7).

Through information obtained from anamnesis and medical examination all those workers with confounding factors that could alter the lipid profile were excluded from the study (65 for consumption of more than two glasses at day of wine or consumption of super alcohol (19, 20), 70 for the consumption of more than 20 cigarettes per day (21), 55 for previous and current liver diseases (22), 17 for diabetes (23), 21 for genetic dyslipidemia (24), 12 for hypothyroidism (25), 5 for BMI > 25 (22), 4 for drugs that can affect the lipid profile (26-29). The subjects in the study are comparable for age, seniority, BMI, alcohol consumption, and smoking. The values of triglycerides (TG), total cholesterol (COL TOT), HDL and LDL cholesterol (high and low density lipoproteins) were dosed for every subject studied. The reference values for the tests were those commonly used for our laboratory: total

cholesterol vn <200 mg/dl; LDL v.n. <130 mg/dl; HDL v.n. >35 mg/dl; TG v.n. 65-165 mg/dl.

The characteristics of the studied population are reported in Table 1.

The blood samples were run for each worker in the morning between 6.45 and 9.30 before the normal course of activity and fasting. The blood samples were stored at a temperature of -4 ° C until they were transported to the laboratory where they were immediately centrifuged and once obtained this serum was kept at -20 ° C until their analysis occurred within 3 days of collection .

We calculated was how many employees of the case group and how many employees of the control group had lipid values above the norm. The resulting frequencies were compared.

The characteristics of the studied population are reported in Table 1.

All subjects consented to the processing of their personal data for the purpose of scientific study and have been well informed about it in accordance with the principles of the Declaration of Helsinki.

Statistical analysis

The results were expressed as mean, standard deviation (SD) and frequencies. The individual variables of frequency were compared with the chi-square test with Yates correction. The differences between the means were compared with the t-test of Student for paired data.

The differences were considered significant when the p value was <0.05.

The data were processed and analyzed using the programs Microsoft Excel and SPSS 19 ©.Statistical analysis of the data was based on the calculation of means, relative standard deviation (SD), range, frequencies of different variables under study. We used the statistical program SPSS.

Characterization of exposure to urban pollutants in the studied city

We acquired data for PM10. CO and benzene in the period 2004-2014 from the environmental monitoring carried out by 13 fixed stations ARPA Lazio, located in different areas of the city (30) (in order to represent different territorial urban), appointed to the detection of environmental concentration of pollutants standards for the characterization of the quality of air from the European and Italian regulations (31). The units are located in sites with high traffic (stations therefore represent important critical conditions with some of the highest levels of pollution), in some intermediate traffic areas and in other areas with limited traffic. Samples representative of workers for each area were selected.

RESULTS

We have obtained a sample of 129 indoor workers and 129 outdoor workers (Table 1).

	environment technicians (n=129)	indoor workers (n=129)	statistical analysis result
Age (years) RANGE 35-60	48±6 **	48±6 **	n.s.*
Seniority (years) RANGE 5-32	20,3±6,6**	20,1±6,3**	n.s.*
Smoking habits (N°cigarettes/die) RANGE <20/die	5,5±7,8**	5,3±7,4**	n.s.*
N°smokers /Total number	48/129 37%	40/129 31%	n.s.*
BMI (kg/m ²) RANGE 20-24	22,3±2**	22,5±2**	n.s.*
Alcohol habits N° of glasses of wine at day RANGE <2 glasses/die	1,3±0,5**	1,1±0,8**	n.s.*

*n.s.= not significative (p<0,05) ** mean±SD

Table1: characteristics of the environment technicians group and of the indoor workers group

The subjects in study are comparable for age (mean age of the group indoor workers 48 ± 6 mean age of the group outdoor workers 48 ± 6), seniority (mean of years of employment in indoor group 20.1 ± 6.3 and outdoor group 20.3 ± 6.6), BMI (between 20 and 24), alcohol consumption (less than two glasses of wine at day), and smoking (mean of number of cigarettes at day 5.3 ± 7.4 in the group of workers with administrative job and 5.5 ± 7.8 in the one environment technicians).

We acquired data for PM₁₀, CO and benzene in the period 2004-2014 from the environmental monitoring carried out by 13 fixed stations ARPA Lazio, located in different areas of the city (30) (in order to represent different territorial urban), appointed to the detection of environmental concentration of pollutants standards for

the characterization of the quality of air from the European and Italian regulations (31).

The average annual concentration of PM₁₀ is calculated as average over a calendar year equal to 1.0 ng/m³. The D.M. 60/02 provides the daily limit of 50 g/m³ not to be exceeded more than 35 times a year. No unit exceeds the limit imposed by DM mentioned above.

For carbon monoxide the legislation imposes a limit of 10 mg/m³ for maximum concentrations of eight hours in a year, this limit is never exceeded in the city in study for the years 2008 to 2014 as observed by fixed stations of ARPA Lazio.

The values of benzene concentrations measured in the period 2008-2014 from fixed stations ARPA Lazio were below the limits (ACGIH 2014).

The results of the studied parameters are showed in Table 2.

	environment technicians (n=129)	Indoor workers (n=129)	statistical analysis result
Triglycerides (mg/dl) n.v. 65-165 mg/dl)	122,21±76,96**	128,28±94,54**	n.s.*
Total Cholesterol (mg/dl) n.v. <200mg/dl	204,79±40,1**	198,66± 9,63**	n.s.*
LDL (mg/dl) n.v. <130 mg/dl	131,61±32,8**	122,35±37,4**	P=0,04
HDL (mg/dl) n.v. >35 mg/dl	46,79±12,58**	50,65±15,03**	P=0,02

N° of cases out of range for cholesterol values (col tot >200 mg/dl)	66/129 51%	46/129 35,6%	n.s.*
N° of cases out of range for HDL values (HDL <35 mg/dl)	11/129 8,5%	9/129 7%	n.s.*
N° of cases out of range for LDL values (LDL>130 mg/dl)	65/129 50%	52/129 40,3%	n.s.*
N° of cases out of range for triglycerides values (TG>165 mg/dl)	30/129 23%	25/129 19,3%	n.s.*

*n.s.= not significative

**mean±SD

Table 2: statistical analysis of the parameters studied in group environment technicians and in the group indoor workers.

It is highlighted a non significant difference between control group and group of outdoor workers for the mean value of total cholesterol and for the triglycerides. As for LDL cholesterol the outdoor group presents a significant increase of the mean value compared to the group of indoor workers. Even the analysis of the values of HDL cholesterol shows a significant result between the two groups: the group of outdoor workers presents a significant decrease of HDL values compared to the group of indoor workers.

There were no statistically significant differences between the frequencies of total cholesterol (51% vs. 35.6%; $p = 0.1$) HDL (8.5% vs. 7%, $p = 0.8$), LDL (50% vs. 40.3%; $p = 0.3$) and TG (23% vs. 19.3%; $p = 0.6$) between the group of the exposed and non-exposed workers.

DISCUSSION

Our results suggest the possibility of lipid abnormalities in outdoor workers due to chronic occupational exposure to environmental pollution and chemicals present in mixtures of combustion and in gasoline present in the means used in their activities. Moreover, many epidemiological studies highlight that exposure to PM and environmental pollutants are positively correlated with the increase in human mortality from various causes, including metabolic diseases (32, 33). The exposure risk of the environmental technicians is related to their work environment (and so to air pollution) and to the equipment used such as chainsaws, lawnmowers, etc., and then smoke oils, mixtures of combustion and gasoline. Among the various compounds of the gasolines and oils combustion, the monochlorobenzene, the chlorobenzene and the 1,2-dichlorobenzene were studied for their toxic properties and the ability to induce liver damage and alteration of the metabolic functions of the liver including lipid homeostasis (34). Few studies in the literature have dealt with the issue of workers exposed to residues of combustion engines. The composition of this pollutants includes both a toxic gas phase and a particulate phase. The extracts of the particulate contain nitro and dinitropireni and are carcinogenic, as well as volatile compounds. The latter, in particular those of diesel engines, have the highest rate of polycyclic aromatic hydrocarbons and toxic substances (12).

Benzene is one of the most studied pollutant in the urban environment for its established role in certain diseases in various organs and systems. Benzene acts on lipid metabolism as already shown in several studies (35). It has been demonstrated in fact that benzene begins its biotransformation in the liver (36) and that the cytochrome P450 catalyzes the addition of a single oxygen atom of the benzene ring forming benzene oxide. Part of this is conjugated to glutathione through the way of the glutathione-S-transferase (37, 38) altering the function, generating oxygen radicals (39) and activating the lipid peroxidation (40). The CO and particulate air pollution appear to act more on set lipid in a quantitatively way going to increase the values of LDL cholesterol and causing a decline in the value of HDL cholesterol (8, 41) in subjects exposed according to various studies. McGill (6) and Tomao (7) have

suggested that the CO in the human is able to increase LDL cholesterol and decrease HDL and Roger et al. (18) showed the increase in the LDL/HDL ratio. Our study is consistent with the results mentioned above mentioned. In other studies in rabbits (42) it has been seen how exposure to CO did increase the levels of total cholesterol and decrease those of HDL. Studies on particulate air pollution resulting from combustion processes have finally shown the correlation between them and oxidative DNA damage and increased blood lipids caused by the action on insulin resistance and on lipid peroxidation with a result of metabolism moved on lipogenesis (43-45). Chuang et al. in 2010 in particular showed the decrease of HDL levels and the increase of apolipoproteinB in people with prolonged exposure to PM₁₀ (16). Chronic exposure to particulate seems associated with atherosclerosis progression with accumulation of oxidized LDL cholesterol and chronic hypertension (46, 47). Recent epidemiological studies (48) suggest the existence of a relation between UFPs air pollution and altered lipid metabolism with increases of LDL cholesterol in serum. Some possible mechanisms of action have been described in the literature to explain the changes induced by the particles on the cardiovascular system, such as the release into the bloodstream of pro-oxidative and pro-inflammatory mediators able to modify LDL cholesterol already present in the blood and such as the direct action on the heart and blood vessels of ultrafine particles translocated into the systemic circulation that would lead to a greater accumulation of LDL in the vessels (49, 50). Even Jacob et al. showed that the increase in serum levels of oxidized and not oxidized LDL is the effect of chronic exposure to ultrafine particles (51). We can hypothesize that benzene, going to act on lipid peroxidation (14, 15, 35) could have a synergistic role on the lipid metabolism together with the other chemical pollutants present in the atmosphere.

Arsenic appears to execute its damaging effects on lipid metabolism through alterations in the organ that determines its homeostasis, which is the liver. Tomei et al. and Casale et al. have suggested that some components of urban pollutants such as arsenic, in addition to accumulate in districts such as bone marrow, deposit themselves in the liver. This contributes to modifications of the hepatic functionality and therefore to alterations in the lipid metabolism (51, 52). Other authors have also shown that Arsenic can modify lipids parameters and this can lead to an increased cardiovascular risk (4).

The total cholesterol and triglyceride values show no significant differences between the two groups in contrast to HDL and LDL. This type of lipid profile is often found in the literature (54) .

In conclusion, the preliminary results of our study seem to indicate that some chemicals of gaseous or particulate type present in urban pollution could be responsible for alterations in lipid metabolism and parameters (55, 56).

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