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Assessment of pollutants emitted by automobile exhaust on some physiological variables of the exposed people in the city of Kirkuk

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***Abstract*---**The current study was conducted in the city of Kirkuk. Five areas are selected: the check point of entrance to Kirkuk, June 1st, the beginning of the Al-Shuhada Bridge, the Citadel, the Old Doctors Street, the Old Inzibat, and the New Tissen where the movement of vehicles is high because these areas are residential, service and commercial and compared to Yayci due to its lack of vehicle movement. The study aimed to measure the concentrations of some pollutants such as carbon monoxide and hydrocarbons emitted from car exhaust in four seasons (fall, winter and spring). It also aims to identify their effects on some exposed smoker and non-smoker people in the work environment (traffic men, security services, drivers and shop owners) and compared them with the control group and from by measuring the concentration of lead and the percentage of carbon monoxide (carboxyhemoglobin in the blood) in the blood of the groups. Moreover, it identifies the effect of these pollutants on the blood components (WBCs and RBCs) by the use of SAS and SPSS to statistically analyze the data and by the use of ANOVA to show the variance. The study also uses the F test to examine the significant or non-significant study groups identified for smokers alone and non-smokers separately at 0.01probability level. The arithmetic means were compared according to Duncan multiple range tests. The standard error was used to determine the extent to which the values deviated from the mean(K. M. Al-Rawi, 2000). While the hydrocarbons exceeded the values of the Iraqi and international environmental determinants, and the concentration of pollutants in the blood of smoker and non-smoker groups. In comparison with the control group, lead, $p \leq 0.01$, and carboxyhemoglobin compound, blood carboxyhemoglobin $p \leq 0.05$ increased significantly. The exposure of

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the smoking and non-smoking groups to pollutants causes the increases and significant differences (p≤0.05) in the number of WBCs and RBCs in comparison with the control group.

***Keywords*---**air pollutants, carbon monoxide, hydrocarbons, lead.

Introduction

The problem of pollution has attracted a great attention for its harmful effects on human health and the environment, and because air is necessary to preserve human life and other creatures on the globe(Shahsavari-Pour, Bahador, Heydari, & Fekih, 2022), as air pollution reduces renewable and non-renewable natural resources and poses a danger to the future generations(Ashour & Wahab, 2016). Any imbalance in the air ecosystem as a result of releasing a large amount of gases and particles that exceeds the system's ability to self-purify causes a significant change in the properties and elements of the air(Majaji, 2018). Thus, air pollution has caused a change in the proportions of air components and harm human health and the ecosystem(Musa & Ahmed, 2019). Cars are a moveable source of air pollution due to the incomplete combustion of the fuel used inside the engines and the lack of periodic maintenance as they are released Various gases, including gases, carbon oxides and hydrocarbons(Barwari, 2021), and all types of cars are large sources of lead pollution to the environment, especially in the crowded areas(Schileo & Grancini, 2021).

Air pollution can be defined as the entry of chemical, biological or particulate matter into the atmosphere causing discomfort, illness, or death to humans, or harming other living organisms and natural environments. The substance in the air can be harmful to humans and environment; it is called an air pollutant in the form of liquid, solid, or gases droplets(Kumar et al., 2020). There are three main methods of exposure and entry into the body, depending on the exposure period, the concentration of the substance and its type(Schuhmacher, Nadal, & Domingo, 2009). One method is inhalation where the most common pollutants enter the human body through the lungs. The absorption methods are the most common ways for pollutants to enter through the skin and eyes(Al-Qurashi, 2012). In addition, ingestion through the mouth and access to the digestive system is another method(Yang & Massey, 2019). Because the environment is polluted with metal toxins such as lead, human exposure is inevitable(Ore & Adeola, 2021), and lead is a heavy element with high toxicity and high quantity in the environment due to its widespread use(Koki, Taqui, Shehu, & Kharisu, 2017). Occupational exposure to lead in the work environment and through inhalation with dust containing lead and smoking is caused by its rise in the workers' blood and depends on the period of exposure (Golpayegani & Khanjani, 2012).

The most exposed people to it are of different professions such as drivers of vehicles, street vendors, industrial workers, gas station workers and workers on dirt roads, that is, people who live in urban areas because the soil is contaminated and due to the inhalation of dust containing lead(Laidlaw et al., 2016). Furthermore, there is a correlation between the levels of lead in the blood and the risk of mortality due to cardiovascular disease(Cook, Zhang, & Wei, 2022). It causes poor sperm quality and oxidative stress, (Xie et al., 2022). Incomplete combustion of carbon fuels such as gasoline, quercene, coal and wood causes the emission of carbon monoxide (CO) mix freely with air and is slightly soluble in water, blood serum and plasma in the human body and interacts with hemoglobin to form carboxyhemoglobin in the blood(Penney et al., 2010). The symptoms of poisoning begin with the appearance of a bright cherry red color in the face and trunk, at the base of the nails, lips, and oral mucosal tissues (Jarvis, 2012)and poisoning with small quantities of this gas leads to a monopoly of red blood cells and prevents them from transporting oxygen to all parts of the body causing symptoms of poisoning and metabolic defects(Nielsen et al., 2021).

The poisoning affects many organs and systems in the body. It leads to coma and death in severe cases. Carboxyhemoglobin blood (COHb)% is used as a marker to detect CO poisoning(Grieb et al., 2011). Incomplete combustion of benzene and petrochemical by-products plastics and solvents) cause the emission of hydrocarbons and some types of volatile aromatic compounds (VOC), which have a strong odor. Gasoline and diesel fumes are among the dangerous components that are emitted from vehicle exhausts and are carcinogenic compounds that cause leukemia and their high concentrations are fatal and are characterized by the ability to accumulate within the food chain, becoming toxic. Hydrocarbons have global environmental impacts(Al-Ziyadi, 2019), and are organic compounds in nature in three gaseous, liquid and solid states depending on the carbon atoms in the compound. When four carbon atoms or less are gaseous, and when five to ten atoms are liquid and more, they are solid(A. K. Al-Rawi, 2013). It consists of carbon and hydrogen atoms in different forms, and the aromatic species are more dangerous and lie in their interactions with other pollutants(Matar, Al-Hashemi, & Al-Huwais, 2020).

Materials and working methods

First: The concentration of carbon monoxide and hydrocarbons for the study locations are measured, by taking samples from each location of the air using the Ac Electric Air pump (HT-196) through which the American-made BAG TEDLAR bags from the RESTEK company are filled with a capacity of (5) for each site which has has a bag that has been closed after that. The HORIBA process & Enivronmental (AP-370series) device is used. It a device manufactured by a Japanese company, approved by European agencies. The device is operated an hour and a half before the start of the measurement, and when the device is stable, the bags are emptied inside the device and directly gives the reading of carbon monoxide ppm concentration and hydrocarbon ppm concentration("US. EPA reference equivaient nmber eqsa-0506-156.," 2006).

Second: Blood samples were collected from (150) smokers and non-smokers exposed to pollutants in their work environment. Five ml were taken, and divided into two parts: Section One: To calculate the concentration of lead in the blood, (3) ml of the drawn blood were placed in test tubes(EDTA Tube). The tubes were placed in a KAHN-SHAKER hemolysis machine (TKA-226) for 30 minutes. Then, the blood was emptied from the test tube and placed in a regular tube called a plane. 2.5 ml of Trichloroacetic acid (TCA) were added and mixed well. The tube is inserted into the German-made UNIVERSAL 16 A centrifuge to separate the blood components for 10 minutes at a speed of RPM3000, i.e. Round Per Munit, followed by obtaining a clear transparent solution read directly when inserted into the atomic absorption spectrophotometry (FAAS) Flame type(Pfeil, 1993).

The second section is prepared by putting (2 (ml) of the blood into glass tubes containing EDTA tubes (K2) anticoagulant. The tubes were slightly shaken and placed in the Swelab Alfa device manufactured by Boulle Medical AB. The WBC (109/l) and RBC (1012/l)C were calculated using the solutions supplied by the company, as the existing blood samples (EDTA) were inserted into the device that withdraws $0.5cm^3$ of blood through a special needle in the device and gives the results of the examination in a record time less than a minute. The percentage of carbon monoxide in the blood is measured (carboxyhemoglobin in the blood) by preparing a medical syringe and filling it with HEPARINE SODIQUE, Then heparin was completely emptied from the syringe inserting it into a device (ABL800Flex analyzer) made by the Radoimeter MedicalDeenmark company(Krzeminski, 1992).

Results and Discussion

Carbon monoxide concentration in the air

The results shown in Table (1) revealed that there is a discrepancy in the concentrations of carbon monoxide and for the three seasons, and all sites recorded an increase compared to Yayci. The variation in the values of carbon monoxide concentrations during the three seasons between the sites confirms the findings of other studies (Al-Hassan, 2011a, 2011b; Al-Kalabi, 2013; Ayed, 2012).

Table 1
Carbon Monoxide Concentrations (ppm)

Locations	Autumn	Winter	Spring	average	Environmental determinants			
					Iraq		WHO	
					One hour	8 hours	One hour	8 hours
The entrance to check point Kirkuk June 1	1.81 ppm	1.24 ppm	2.25 ppm	1.766	did not exceed	did not exceed	did not exceed	did not exceed
The beginning of the Martyrs' Bridge (the Citadel)	1.82 ppm	3.69 ppm	11.2 ppm	5.570	did not exceed	did not exceed	did not exceed	did not exceed
Street doctors old discipline	4.93 ppm	2.93 ppm	3.5 ppm	3.787	did not exceed	did not exceed	did not exceed	did not exceed
Tiseen	3.14 ppm	2.2 ppm	1.6 ppm	2.313	did not exceed	did not exceed	did not exceed	did not exceed
Yayci	1.02 ppm	1.08 ppm	0.36 ppm	0.82	did not exceed	did not exceed	did not exceed	did not exceed

The highest spatial rate was recorded at the site of the beginning of the Shuhada Bridge (the castle) with a concentration of (5.570) ppm, due to the dense movement of vehicles, intersections in the movement of vehicles, their slow movement and stopping their engines. There are other different sources of gas emissions, including ovens, restaurants, bakeries, smoke of public, private generators, and populace market, which increased the number of passing vehicles, and these factors helped to rise the concentration of pollutants in crowded areas. This confirms the studies of Al-Maliki (2005); Sriea (2014); Wu (2014). Also, the concentrations of air pollutants increase in some locations but not others due to the height of buildings And their agglutination as an indicator of the environmental capacity around pollutants sequestration in some study sites (Beck, 2010). Yet, the lowest spatial rate of gas concentration (CO) in the Yayci site was (0.82) ppm because it is an agricultural area with wide open areas that allow the dispersal of pollutants(Al-Ajrash, 2020). What happened in Iraq after 2003 caused an increase in vehicles importing (Al-Ziyadi, 2010) which has a role in air pollution and the effect on air quality (Hülsmann, 2014)). So, the level of pollution emitted from vehicle exhaust gases has effects on human health and the environment Bateebe (2012) causing asthma and myocardial infarction(Jacquemin Leonard, 2007), especially the gases associated with traffic and bus routes (Saltos, 2018). When comparing the concentrations of the spatial rates of the locations under consideration with the Iraqi and global environmental determinants (WHO)) Table (3), it was found that they did not exceed the Iraqi environmental determinants and the World Health Organization for concentrations (8) Hours and one hour.

The concentration of hydrocarbons in the air

The results of Table (2) showed that the concentrations of hydrocarbons recorded a temporal and spatial variation for the three seasons for the five areas increased compared to the location of Yayci confirming Utang and Peterside (2011), who showed different levels of hydrocarbons. The highest spatial rates were recorded at the Kirkuk entrance check point, June 1, with a concentration of (15.187) ppm, because the site is the focus of hydrocarbon pollution due to the increase in the number of passing vehicles. Also the dissemination of air pollutants, and the phenomenon of atmospheric dispersal are the sum of the effect of transmission in addition to the movement of pollutants with the direction of the winds, and spread.

Table 2
Values of hydrocarbon concentrations (ppm)

Locations	Autumn	Winter	Spring	Average	Environmental determinants	
					Iraqi	WHO
					3 hours	One hour
The entrance to	30.13 ppm	10.83 ppm	4.602 ppm	15.187 ppm	More than	More than

check point Kirkuk June 1						
The beginning of the Martyrs' Bridge (the Citadel)	22.42 ppm	8.41 ppm	8.16 ppm	12.997 ppm	More than	More than
Street doctors old discipline	19.13 ppm	10.35 ppm	4.051 ppm	11.177 ppm	More than	More than
Tiseen	20.12 ppm	8.99 ppm	4.308 ppm	11.140 ppm	More than	More than
Yayci	14.7 ppm	7.63 ppm	3.308 ppm	8.547 ppm	More than	More than

In addition, the difference in concentrations in streets and intersections is due to the dissemination of pollutants by vehicles along the street(Al-Shbani, 2019). The lowest spatial average was recorded in Yayci with a concentration (8.547) ppm due to the lack of sources of hydrocarbon emissions in this site. The values of the spatial average concentrations of the studied sites exceeded the Iraqi and international national environmental determinants (WHO) Table (3) for concentrations (3) hours.

Table 3
The Iraqi and global environmental determinants of air pollutant concentrations(Al-Ajrash, 2020; " Iraqi environmental determinants (determinants of exposure to gases)," 2012)

NO	pollutant	exposure period	environmental determinants	
			Iraqi (2012)	WHO (2020)
1	CO	8 hours (ppm)	9 35	9 25
2	hydrocarbons	1 hour (ppm)	0.24	0.24

Lead concentrations in the study groups

The results of Table (4) concentrations of lead pb in the blood of the smoking groups indicate a significant increase ($p \leq 0.01$)), traffic records (29.75±1.49), security services (30.00±1.58), drivers (30.00±1.47) and shop owners (29.00±1.68). This is a significant increase in comparison with the control group (25.50 ± 1.84) mg/100 ml. The current study showed an increase in lead concentrations among people exposed to lead in the work environment and smokers. These results are consistent with Mahdi (2019) who stated that individuals who smoke and who work in environments containing sources of lead emissions have more lead in their blood because it is one of the cumulative environmental pollutants. It has a positive correlation with the number of years of exposure. Heavy metals enter the human body through cigarette smoke, which is a prominent source of many heavy metal pollutants, including lead(Ashraf, 2011). The blood transports lead element to all parts of the body, and its level in the blood of smokers varies according to the types of cigarettes, and 2.46 micrograms/g is the average concentration of lead in various Saudi cigarettes. Blood samples are used as part of the environmental pollutant control program(Gajek, Barley, & She, 2013), as smoking causes an increase in lead concentrations in smokers(Alrobaian & Arida, 2019). Additionally, the number of cigarettes and smoking duration have a role in increasing lead concentrations(Hassan, Modawe, & Abdrabo, 2015; Rhainds & Levallois, 1997).

The results of Table (4) show the concentrations of lead in the blood form of the non-smoking groups, showing a significant increase for the groups ($p \leq 0.01$), as the traffic records (28.75 ± 1.10), the security services (29.5 ± 2.17), the drivers (28.75 ± 1.31) and the shop owners (28.5) ±2.25). This shows significant differences compared with the control group (22.00 ± 1.08) mg/100 ml. f Al-Shammari (2002) confirmed this finding indicating an increase in the concentration of lead in the blood of workers in industrial environments and a cumulative increase with the increase in the years of exposure. He also stated that lead is an essential element that enters into various industries. Similarly pavement dust contains different amounts of heavy metals at different levels that fall under the influence of environmental factors, especially air currents and automatic transport through different means of transportation(Al-Salman, Issa, & Al-Thuwaini, 2012). On the presence and level of heavy metals in the streets of cities(Alhassan et al., 2012; Ali, 2008)the movement of transportation and exhaust vehicle has a role in raising the element of lead on the roads and its presence in the Blood causes health damage because of its toxicity and direct effect on the body's organs (Jain et al., 2005).

It accumulates in soft tissues such as the liver, spleen, kidneys and lungs. The deposit of lead in the body is represented in the liver and kidneys and gathers in the bones and the nervous system and is absorbed through the digestive and respiratory systems(Youssef, 2007). It increases in those who are exposed to various professions of pollution in industrial areas (Zenad & Fadl, 2020)and the increase is double for workers in the crude oil fields (Saleh, Hamad, & Hama, 2021). Also, the exposure to lead is the main source of emissions from car exhaust from the increasing sources of pollution in the environment and affects the physiological variables of the blood of workers in industrial and traffic areas the longer the exposure period(Al-Azzawi, 2022).

The percentage of carbon monoxide gas

Table (4) shows the percentage of carboxyhemoglobin COHb% in the blood of the smoked groups, which indicates a significant increase ($p \leq 0.05$) for traffic groups (2.97±0.65), security services (3.50±0.62), drivers (4.10 ±0.88) and owners Stores (2.77 ± 0.66) in comparison with the control group (1.20 ± 0.15). According to the results of the current study, the percentage of carboxyhemoglobin is higher in the blood of the smoking groups exposed to pollution in the work environment of various professions N. H. Al-Fahadi (2019) in Table (4) showed that carboxyhemoglobin COHb% significantly increased in the blood of the non-smoking groups to an increase (0.05 p≤) in the traffic groups (1.55 ± 0.22), security services (3.20 ± 0.33), drivers (3.60) ±0.45) and stores (2.47 ± 0.29) in relation to the control group (0.65 ± 0.06)%. This increase is in the level of carboxyhemoglobin in the blood of the groups exposed to the influence of vehicle exhaust gases due to their direct contact with what they emit in the air. This proves N. H. A. Al-Fahadi (2002); Nicholson and Case (1983) who confirmed that running and standing near the movement of cars in an urban area raises levels of carboxyhemoglobin in the blood as a result of exposure to vehicle exhaust smokes and the content of carbon monoxide because it is a widely diffusible gas.

Table 4
Concentrations of lead pb and percentage of carbon monoxide (COHb)

groups	smoking status	Pb mg/ 100 ml	COHb %
the traffic	smoker	29.75±1.49 ab	2.97± 0.65 Cd
	non smoker	28.75±1.10 bc	1.55±0.22 Gh
security forces	smoker	30.00±1.58 a	3.50±0.62 B
	non smoker	29.5±2.17 ab	3.20±0.33 Bc
drivers	Smoker	30.00±1.47 a	4.10±0.88 A
	non smoker	28.75±1.31 bc	3.60±0.45 b
shop owners	Smoker	29.00±1.68 ab	2.77±0.66 De
	non smoker	28.5±2.25 bc	2.47±0.29 Ef
control	Smoker	25.50±1.84 ef	1.20±0.15 Hi
	non smoker	22.00±1.08 h	0.65±0.06 J

Different letters mean there are significant difference

The total number of WBCs in the study groups

Table (5) shows the total number of white blood cells in the blood of smoked groups with a significant increase (0.05 p≤), in the traffic staff (8.62 ± 0.73), security services (9.10 ± 0.59), drivers (8.92 ± 0.56) and shop owners (8.10 ± 0.60) when compared to the control group (6.12±0.24) 10^9/L. This means an increase in the total number of white blood cells in smokers and in the work environment. Smoking has an effect on hematological variables, including white blood cells, and is responsible for the increase in their number, consistent with what (Hameed, Mehdi, & Mehde, 2019)indicated. Herath, Wimalasekera, Amarasekara, Fernando, and Turale (2021)indicated that the intensity of smoking is measured from exhaled air, carbon monoxide, and levels of COHb formation in the blood. Inflammation of the bronchial mucosa increasing the white blood cell count is a risk factor for atherosclerosis and thickening of the vascular wall(Açık, Suyani, Aygün, & Bankir, 2020). Exposure to lead and smoking in the work environment has a role in increasing the numbers of white blood cells(Al-Aqeedi, 2020).

The results of Table (5) indicate a significant increase ($p \leq 0.05$) in the non-smoking groups in traffic people (8.45 ± 0.58), security services (8.95 ± 0.59), drivers (8.87 ± 0.56) and shop owners (7.95 ± 0.60) when compared with the control group (4.30±0.15) 10^9/L. This means that the number of white blood cells increased in the work environment and in the non-smokers compared to the control group in agreement with Andjelkovic et al. (2019) who revealed a rise in the total number of WBCs for non-smokers in the work environment due to inflammatory conditions as a result of exposure to lead. So. as the immune system is activated in the body with defense mechanism(Sharma, Panwar, & Mogra, 2012). Huang et al. (2022)showed the association of heavy metal accumulations in the body with a rise in the immune response by measuring some metals, including lead, in the blood, where a significant increase in the number of WBCs was observed. In addition, lead poisoning causes peripheral and central nervous disorders, encephalopathy and poor coordination. Inhaling some gases in the atmosphere, including carbon monoxide, raises the number of WBCs(Mohammed Shaheed AL-Maraashi & Makki Mohammed AL-Hakkak, 2022).

The total number of RBCs

In Table (5), the results show the number of RBCs (10^12/L) in the blood of the smoking groups and indicate a rise ($p \leq 0.05$) as the smoking groups recorded increases in the traffic staff (5.78 ± 0.18), security services (6.37 ± 0.19) and drivers (6.76 ± 0.41) and shop owners (5.52 ± 0.50) compared to the control group (4.84 ± 0.61). Smoking causes blood diseases, reduces lung capacity, and increases red blood cell counts, as explained by Naseem, Mansha, Triq, and Thomson (2022). Continuous smoking causes harmful effects on the blood and is one of the main causes of death and has an acute and chronic effect(Malenica et al., 2017). The non-smoking groups were as follows traffic (5.36±0.38), security services (5.64±0.33), drivers (5.78±0.31), shop owners (5.44±0.29) entailing a significant increase compared to the control group (3.71±0.25). 10^12/L. The rise in the number of red blood cells in non-smoking groups is caused by continuous exposure to vehicle exhaust, especially people working in an atmosphere characterized by a lot of crowded traffic and the resulting burning of fuel containing lead, which causes pollution in the surrounding environment(Al-Aqeedi, 2020). Air containing heavy metals and hypoxia increase in HIF-1 factor, which in turn enhances in erythropoietin. This hormone stimulates the stem cell in the bone marrow to produce RBCs (Khaddam, 2015). Also, the exposure to monooxide gas Carbon reduces oxygen gas, which stimulates the process of blood formation as a compensatory way to enhance the body with oxygen(Agoro, Wankasi, Zebedee, & Agoro, 2019).

Table 5
The total number of white blood cells and red blood cells

Groups	smoking status	WBCs (10^9/L)	RBCs (10^12/L)
the traffic	smoked	8.62±0.73 Ab	5.78± 0.18 bcd
	non smoker	8.45±0.58 Ab	5.36±0.38 cde
security devices	smoker	9.10±0.59 A	6.37± 0.19 ab
	non smoker	8.95±0.59 A	5.64±0.33 bcd
Drivers	smoker	8.92±0.56 A	6.76±0.41 a
	non smoker	8.87±0.56 A	5.78±0.31 bcd
shop owners	Smoker	8.10±0.60 Abc	5.52±0.50 bcd
	non smoker	7.95±0.60 Bc	5.44±0.29 cde
Control	Smoker	6.12±0.24 Fg	4.84± 0.61 ef
	non smoker	4.30±0.15 I	3.71±0.25 g

Different letters mean there are significant differences

Conclusion

The study concluded that the security services and drivers are the most exposed and vulnerable to pollutants, followed by traffic staff and shop owners.

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