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The Effect of Environmental Pollutants Emitted from the Al-Samoud Refinery on the Health of its Workers

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Abstract

The current study dealt with knowing the effect of exposure to pollutants emitted from the Al-Sumoud refinery on the health of workers working in it, where blood samples were collected from these workers, and then some blood component tests were performed in addition to measuring their blood pressure and measuring the concentrations of both sodium ion and chloride and these results were compared with non-persons. exposed to such pollution as a control group. The results of the current study showed clear variations in the values and concentrations of these measurements in the blood of the workers in this refinery, where the percentage of workers who had low blood pressure was (65.11%), while the percentage of workers who appeared to have high blood pressure was (27.90%)), as the haemoglobin concentration showed a decrease in the blood of workers working on the study sites amounted to (29.0 ±.64 11), (63.0 ± 12.55) and (0.33 ± 13.27) in the liquid gas, refining and hydrogenation sites compared with the control group (0.28 ±. 93 14) respectively and in the study sites from the refinery, while the percentage of the packed cell volume and in the blood of workers in the liquid gas, refining and hydrogenation sites decreased in the refining and hydrogenation units (38.75 ± 0.98), (41.73 ± 2.02) and (44.20 ± 1.12)) compared with the packed cells volume in the blood of the control group ((49.66 ± 0.94), while the red blood cells showed an increase in their numbers, the percentages of increase reached (6, 8 and 11%) respectively and in the liquid gas site, while the percentage of increase in the serum of workers reached In the refining and hydrogenation units are (3, 6 and 8%) and (1, 4 and 6%) and during the exposure year from (4-10)) year and from (11-20) years and (more than 20) years, while the decrease in the concentrations of sodium and chloride reached and during the service year (more than 20 years) also in the location of liquid gas is (2, 3 and 4%), (2, 7 and 11%) respectively, compared with the percentages of decrease in the blood of administrators, which are (1, 1 and 1%), (1, 1 and 4%), respectively.

Keywords: blood pressure, concentrations of both sodium ion and chloride, Al-Samoud refinery, Environmental, blood lymphocytes.

Introduction

Environmental issues have become the first priority of the attention of modern societies, due to studies that indicate day after day the relationship of the manifestations of environmental pollution to the emergence of diseases in humans, and the deterioration of marine and wildlife on the planet, and with the development of life and industrial and technological progress, the environment has become With all its components of water, air and soil exposed to new pollutants that were not previously known, so the environment and its sciences have taken an important place among scientists, researchers, institutions and systems, and they have had a role to take care of environmental issues and the effects resulting from problems and dangers that threaten the entire world. There are tens of thousands of chemicals that make it more difficult to deal with the issue of industrial chemical pollutants in terms of research or treatment and the nature of these substances [1]. One of the most important of these problems is the risk of environmental pollution and the damage it leaves to all organisms living organisms in varying proportions and the risk of depleting nature's resources and energies. Therefore, pollution is a widespread global phenomenon, and it means causing harm and damage to the environment, its components, and resources through a group of pollutants, which leads to the disruption and disruption of nature, directly or indirectly, with all its components of soil, water, air, plants and animals [2-4].

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Industrial environmental waste is dangerous and varied, including solid, liquid, or gaseous, and some of it is inorganic and is not degradable and reusable, or part of it needs a long year for the purpose of decomposition, as it produces negative effects that affect the quality of air, water or agricultural crops. Or livestock that people feed on, and these negative effects appear in several forms of diseases, namely organic, psychological, and economic [5]. Air pollution leads to CO gas, carbon dioxide, CO2, sulfur dioxide, SO2, and other sulfur materials or nitrogen dioxide. NO2, suspended particles and dust lead to an increase in the incidence of respiratory diseases, including chronic bronchitis, asthma and emphysema, in addition to that it leads to a rise in the rates of chest injuries, allergies and cardiovascular diseases, which leads to a low level of human resistance to bacterial diseases [6], As for the gases rising from the iron and steel industry, if they are toxic and lead to immediate death, such as sulfur oxides, SOx or CO, or asphyxiating, such as CO2, as the danger of CO gas lies in as much as It has to combine with hemoglobin in the blood, which leads to a high death rate from respiratory diseases or increases heart diseases and blood pressure [7], and the poisoning of the heavy metal element lead leads to abdominal cramps, episodes of constipation and diarrhea, anemia, Liver and kidney failure, general weakness, paralysis of the feet or hands with visual impairment, insomnia, nervous seizures and convulsions, nervous irritability, coma, and this poisoning may be associated with miscarriage, fetal abnormalities, or infertility [8].

Materials and working methods

1 - Samples Collection

The current study included 150 blood samples from male workers exposed to pollutants only, non-smokers, non-alcoholics, and those who were healthy from chronic diseases in the Al-Samoud Refinery affiliated to the General Company for Northern Region Refineries within the liquid gas, refining, and hydrogenation unit, and their ages ranged from 23-60 years for the period from December 2021 to September 2021, where blood was collected at a rate of (6-5) ml using a medical syringe and without the use of Tourniquet, and 50 blood samples were collected from healthy males, non-smokers, non-alcoholic, not exposed to pollutants, and in the same age groups of workers, who work in the agricultural field from his residence in Rabia district (Uwainat village).) outside the city of Mosul as a control group

The workers were divided into three groups, depending on the year of service (the number of years of exposure to pollutants), as follows:

- The first group: includes workers from (4 - 10) years
- The second group: includes workers of (11-20) years
- The third group: includes workers of (more than 20) years.

2 - Collecting and preserving blood samples

Blood Sample Collection and Preservation

Elbow venous blood samples were collected from males working in the Al-Samoud refinery laboratory and the control group at a rate of (6-5) ml from each person, taking into account the exclusion of some hemolysis samples because they give a wrong result, and the blood was divided into two parts according to the type of examination.

1. Part One

Put 1 ml of the drawn venous blood into plastic tubes containing the anticoagulant substance ethylenediaminetetraacetic acid (EDTA), with tight-fitting caps, and use this portion of blood for the purpose of conducting a complete blood count (CBC).

2. Part Two

Put the remaining drawn blood (4-5) ml into Jell tubes with tight, dry covers, free of any anticoagulant, and leave the tubes for 20 minutes at room temperature, then separate the blood by centrifuge for 10 minutes at a speed of 5000 cycles per A minute, for the purpose of obtaining blood serum, as it was withdrawn by means of a micropipette, divided into parts and placed in dry, sterilized Eppendr of tubes, and keeping the serum in a deep freezer at a temperature of (-20) 5 m until all the tests required in the current study are performed. [9].

3- Hematological Tests

The blood tests were performed on the blood of the workers and the control, which included the concentration of hemoglobin (Hb) hemoglobin blood, the number of packed cells (%PCV) packed cell volume, the number of red blood cells (RBCs) red blood cells count, the number of white blood cells (WBCs).) White blood cells count, the number of lymphocytes (Lym) and granules (Gra). Blood samples were analyzed using an Auto hematology analyzer from Ray.

4- Measuring the sodium and chloride ions

Both ions were measured using a RADIOMETER device.

5 - Statistical Analysis

Statistical analysis of the results was carried out using a complete randomized design (CRD), as the differences between the studied groups and the control group were determined using Duncan's Multiple Range Test for the variables studied in the current study at a probability level ($p \leq 0.05$),

Significant difference was promised, using the ready-made SAS statistical program for the purpose of finding (mean ± standard error) [10].

Results and Discussion

1- Types of pollutants to which workers inside Al-Samoud Refinery are exposed:

Figure (1) shows the percentage of pollutants that workers inside the refinery are exposed to as a result of the various oil production processes, where the percentage of gases reached (31%), while the percentage of miscellaneous vapors reached (30%), while the percentage of smoke reached (22%) and finally it was The percentage of dust is (17%), as workers in such polluted sites are exposed to many multiple pollutants at the worksite as a result of exposure to gases, some of which are simple suffocating such as methane and carbon dioxide and some of them are suffocating gases such as carbon monoxide, in addition to The other part of it is irritating gases such as sulfur dioxide, in addition to exposure to dust, organic compounds, oil and its derivatives such as benzene and gas oil. Oil is a result of burning processes of fuel used inside oil sites or as a result of gas-burning processes associated with oil extraction and refining operations **[**7,11**]**.

2- The effect of environmental pollutants emitted from the Al-Samoud refinery on the workers' blood pressure.

Figure (2) shows that these pollutants have an effect on the blood pressure of workers in the Al-Samoud refinery affiliated with the General Company for Northern Region Refineries, where the percentage of workers who had low blood pressure was (65.11%), while the percentage of workers who had high blood pressure reached It is (27.90%). As for the percentage of workers who had normal blood pressure, it is (6.97%). Studies in this field have proven that the various pollutants emitted by various industries have an effect on blood pressure either to a decrease or to an increase, as many particles The result of this type of pollution leads to changes in the arteries, and there is usually a relationship between air pollution and blood pressure, even if the level of air pollution is very low **[**12,13**]**.

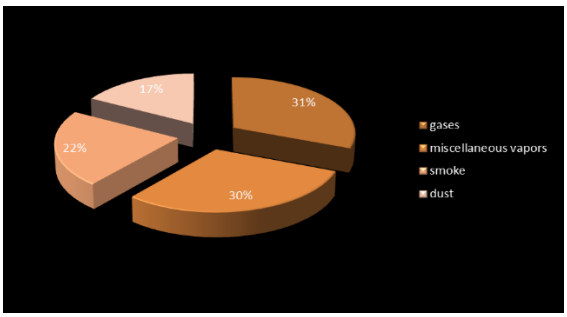

Fig.1. Percentages of gases to which workers are exposed.

Those workers working in the sites of this refinery usually work in open areas and are directly exposed to the sun's rays, and this will lead to the loss of quantities of salt through the process of sweating, and the daily work rate for them is for more than eight hours a day under the sun's rays **[**14**]** .

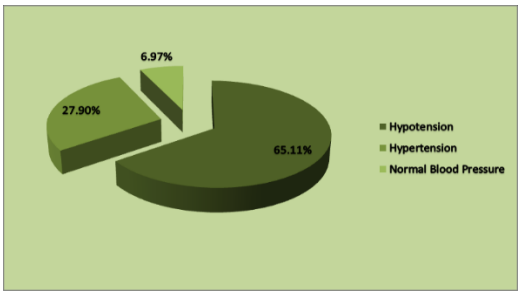

Fig.2. Blood pressure ratios (mm. Hg) for workers.

3- The effect of environmental pollutants on the numbers of white blood cells, granulocytes, and lymphocytes-3

The results shown in Table No. (1,2 and 3) showed that the total numbers of white blood cells, lymphocytes and granules, showed a clear increase in different work sites compared to the control group, where the highest number of white blood cells was (0.67 ± 11.40) and in the first site (the gas unit) liquid), while its lowest number was (1.4 ± 7.89) and in the third site (hydrogenation unit) compared with the control groups (2.11 ± 6.29), while its numbers in the blood of administrative persons reached (1.13 ± 7.02), while it reached The number of lymphocytes and granulocytes in the blood of workers working in the liquid gas unit reached (3.15 ± 33.38) and (68.40 ± 8.48), while in terms of the year of exposure, the highest number of white blood cells reached (0.06 ± 7.14) with an increase of (13%)) and in the hydrogenation unit, the lowest number of which reached (0.06 ± 6.87) and in the liquid gas unit, with an increase rate of (9%), while the percentage of increase in its numbers in the blood of administrative workers was (5%) and in the year of exposure from (4-10)) year, and the rates of increase in the numbers of lymphocytes and granulocytes were (17%) and (9, 11 and 11%) respectively. Wali in the hydrogenation unit and in the blood of working workers (for more than 20) years was exposed, as studies in this field have proven that the entry of pollutants into the human body and with different types of molecules may lead to overlap between them in terms of their impact on the response of the immune system in the body. An imbalance occurs in the proportions of the components of white blood cells in response to this, especially in the preparation of lymphocytes, which are one of the most important components of the immune system in the body, and these polluting factors and the interactions between them have a significant impact with the length of exposure periods **[**15-17**]**.

4- Effect of environmental pollutants on hemoglobin concentrations and the volume of packed cells:

The results shown in Tables No. (4 and 5) showed that hemoglobin concentrations in the blood of workers and administrators showed clear variations according to the different study sites and years of work compared with the control groups. The hemoglobin concentration showed a decrease in the blood of workers working in the study sites amounted to (29.0 ±.64 11), (63.0 ± 12.55) and (0.33 ± 13.27) in the liquid gas, refining and hydrogenation sites compared with the control group (0.28 ± .93 14) respectively and in the study sites from the refinery, while the percentages of decrease in hemoglobin concentrations reached in The blood of workers in this refinery and according to the various years of work (22, 16, 11 and 3%), respectively, in the blood of administrative workers and workers in liquid gas, refining and hydrogenation units, and at the work year (10-4) years in the refinery, while the proportion of the volume of compacted blood cells reached The decrease in the refining and hydrogenation units was (38.75 ± 0.98), (41.73 ± 2.02) and (44.20 ± 1.12) compared with the volume of concentrated blood electrolytes in the blood of the control group (49.66 ± 0.94), while the proportions reached (49.66 ± 0.94) Increase in the volume of compacted blood cells (22, 16, and 1 1 and 3%) in the blood of administrative workers and workers in liquid gas, refining and hydrogenation units, respectively, where studies in this field indicated that continuous exposure to gaseous pollutants affects blood cells and destroys these cells in the bone marrow and spleen as a result of the poisoning they cause, and leads to infection Anemia and a low concentration of hemoglobin, or it may be due to a deficiency of copper in the blood, which leads to a defect in blood formation and thus affects the concentration of hemoglobin because it participates in its construction**[**18,21**]**.

Table 1: The effect of gaseous pollutants emitted from the Al-Samoud refinery on the total number of white blood cells WBCs (*10^9/L) in the workers' blood and for different exposure periods.

	exposure periods			(4-10)) year			(11-20) years			(more than 20 years)		
Parameter	Total WBCs(*10^9/L)			WBCs(*10^9/L)			WBCs(*10^9/L)			WBCs(*10^9/L)		
Study group	Av ± St error	Number%	Increas%	Av ± St error	Number%	Increas%	Av ± St error	Number%	Increas%	Av ± St error	Number%	Increas%
Control	1.30±6.29c	100	-	0.03±6.31h	100	-	0.03±6.31h	100	-	0.03±6.31h	100	-
Administrative units	1.13±7.02 bc	112	12	0.05±6.65g	105	5	0.08±6.72g	106	6	0.08±6.82f	108	8
liquid gas units	0.67 ±11.40a	181	81	0.06±6.87ef	109	9	0.04±6.94de	110	10	0.08±7.00d	111	11
hydrogenation units	1.39 ±8.99b	143	43	0.02±6.90de	109	9	0.01±6.97d	110	10	0.01±6.99d	111	11
Refining units	1.40±7.89 bc	125	25	0.06±7.14c	113	13	0.06±7.24b	115	15	0.13±7.36a	117	17

* Numbers followed by different letters vertically indicate the presence of significant differences between them at the level of probability (p≤0.05), and vice versa, according to Duncan's test.

Table 2: The effect of gaseous pollutants emitted from the Al-Samoud refinery on the percentage of white blood lymphocytes (%) among workers and for different exposure periods.

	exposure periods			(4-10)) year			(11-20) years			(more than 20 years)		
Parameter	Total Lymphocyts%			Lymphocyts%			Lymphocyts%			Lymphocyts%		
Control	6.75±25.66 b	100	-	0.01±27.28i	100	-	0.01±27.28i	100	-	0.01±27.28i	100	-
Administrative units	1.42±27.26ab	106	6	0.07±28.14h	103	3	0.18±29.26g	107	7	0.07±29.69de	108	8
liquid gas units	3.15 ±33.83a	132	32	0.02±29.42f	107	7	0.07±29.57e	108	8	0.16±29.77d	109	9
hydrogenation units	4.59 ±29.30ab	114	14	0.02±30.38c	111	11	0.18±30.67b	112	12	0.06±30.74b	113	13
Refining units	7.67 ±28.40ab	111	11	0.08±31.76a	116	16	0.04±31.86a	117	17	0.06±32.93a	120	20

* Numbers followed by different letters vertically indicate the presence of significant differences between them at the level of probability (p≤0.05), and vice versa, according to Duncan's test.

Table 3: The effect of gaseous pollutants emitted from the Al-Samoud refinery on the percentage of granulated white blood cells (%) among workers and for different exposure periods.

	exposure periods			(4-10)) year			(11-20) years			(more than 20 years)		
Parameter	Total Granules%			Granules%			Granules%			Granules%		
Study group	Av ± St error	%	Increase%	Av ± St error	%	Increase%	Av ± St error	%	Increase%	Av ± St error	%	Increas%
Control	4.01 ±61.40 a	100	-	0.03±60.27g	100	-	0.03±60.27g	100	-	0.03±60.27g	100	-
Administrative units	1.10 ±65.31a	106	6	0.06±61.30f	102	2	0.06 ±61.40ef	102	2	0.06±61.50ef	102	2
liquid gas units	8.48 ±68.40a	111	11	0.05±62.18e	103	3	0.10±63.22d	105	5	0.14±63.42d	105	5
hydrogenation units	5.59 ±65.95a	108	8	0.03±65.16c	108	8	0.02±66.16ab	110	10	1.74±66.86bc	111	11
Refining units	2.65 ±65.41a	107	7	0.02±65.52bc	109	9	0.12±66.63a	111	11	0.08±66.80a	111	11

* Numbers followed by different letters vertically indicate the presence of significant differences between them at the level of probability ($p \leq 0.05$), and vice versa, according to Duncan's test.

Table 4: The effect of gaseous pollutants emitted from the Al-Samoud refinery on the concentration of haemoglobin (g/l) among workers and for different exposure periods.

	exposure periods			(4-10)) year			(11-20) years			(more than 20 years)		
Parameter	Total Hb(g/l)			Hb(g/l)			Hb(g/l)			Hb(mg/dl)		
Study group	Av ± St error	Co n %	Decrease %	Av ± St error	Co n %	Decrease %	Av ± St error	Co n %	Decreas e%	Av ± St error	Co n %	Decrease %
Control	0.28 ±14.93a	100	-	0.18 ±14.91a	100	-	0.18 ±14.91a	100	-	0.18 ±14.91a	100	-
Administrativ e units	0.14 ±14.49a	97	3	0.06 ±14.73ab	99	1	0.07 ±14.28±cd	96	4	0.15 ±13.93±d	93	7
liquid gas units	0.29 ±11.64d	78	22	0.10 ±14.11cd	95	5	0.04±12.1 4 g	81	19	0.15 ±11.59h	78	22
Hydrogenatio n units	0.63±12.55 c	84	16	0.06 ±14.28cd	96	4	0.08 ±12.98e	87	13	0.43 ±11.86gh	80	20
Refining units	0.33 ±13.27b	89	11	0.08±14.4 8 bc	97	3	0.49 ±12.81e	86	14	0.22 ±12.34f	83	17

* Numbers followed by different letters vertically indicate the presence of significant differences between them at the level of probability ($p \leq 0.05$), and vice versa, according to Duncan's test.

5- The effect of environmental pollutants on the total number of Red blood cells

The total number of red blood cells, as shown in Table (6), showed an increase in their total numbers in the blood of workers working in the refinery sites and the year of service, where their numbers reached (4.63 ± 0.31), (4.59 ± 0.40), (4.55 ± 0.44) and (4.51). ± 0.09), respectively, and in the liquid gas site, refining, hydrogenation, and the blood of administrative workers compared with the numbers in the blood of the control group (4.25 ± 0.10), while the highest numbers of it in the liquid gas site reached (4.68 ± 0.38), (4.69 ± 0.28), (4.83 ± 0.19) and during a service year from 4-10 years and from 11-20 years and more than 20 years of exposure in this refinery compared with the second in the control group (4.31 ± 0.13), (4.15 ± 0.15) and (4.42 ± 0.33) Respectively, as for the refining unit, the percentages of increase in their numbers reached (3, 6 and 8%) respectively and during the above work year, while the percentages of increase in the numbers of red blood cells and in the blood of workers working in the hydrogenation unit are (1, 4 and 6%).) respectively and according to the working year from 4-10 years and from 11-20 years and more than 20 years of exposure. The lungs and thus affected the breathing process of the workers exposed to it, and this, in turn, will affect the gas exchange process, as the blood works as an adaptive measure to increase the numbers of red blood cells in such cases in order to avoid the decrease in the amount of oxygen transported in the blood **[**22-24**]**.

6-Effect of environmental pollutants on platelet count

The results are shown in Table (7) showed a clear increase in the number of platelets in the blood of workers working in the various refinery sites and in the different years of work.(186.66 ± 14.57) and (185.86 ± 38.66), which are liquid gas, refining, hydrogenation and administrative workers compared to their numbers in the blood of the control group (153.33 ± 7.23), but in terms of the year of work, their numbers reached in the blood of the working people and according to the three years of work and in the location of liquid gas To (189 ± 16.52), (194.66 ± 36.55) and (214.66 ± 51.81) compared with the control groups (156 ± 17.08), (170 ± 20.95), (143.33 ± 15.27), while the percentages of increase in their numbers and in the blood of the working workers reached At the refining and hydrogenation site, they are (7, 8, and 10%) and (2, 4 and 5%) compared to the rates of increase in the blood of administrative workers (1, 2, and 4%), respectively, and during the work year from 4-10 years and from

11-20 years and more From 20 years it has been exposed, as studies have shown that any defect in the blood formation process as a result of the influence of such gaseous pollutants and continuous exposure to them, it eventually affects all components of the blood, including Red blood cell count, platelet count, and hemoglobin concentration **[**25,26**]**.

7- Effect of environmental pollutants on sodium and chloride concentrations

The concentrations of both sodium and chloride in the blood of these workers in the different refinery sites and during the work year showed a decrease in their concentrations compared with the control groups as shown in Tables (8 and 9), while the decrease in the concentration of sodium and chloride during the service year reached (10). - 4 years, (20-11) years and (more than 20 years) also, and in the liquid gas site, it is (2, 3 and 4%), (2, 7 and 11%), respectively, compared to the percentages of decrease in the blood of administrators, which are (1 and (1 and 1%), (1, 1 and 4%) respectively. As for the percentages of decrease in the concentration of both sodium and chloride, it reached (1, 3 and 3%) and (2, 6 and 8%), respectively, in the blood of workers working in The refining unit, as for the percentages of decrease in the concentration of sodium ion and chloride, it reached (1, 2 and 3%) and (2, 6 and 8%) respectively in the blood of workers working in the hydrogenation unit and according to the three years of service above. A polluted environment may lead to severe physiological changes and an imbalance in the hormonal and enzymatic regulation in the body, which results in physiological disorders, as these workers in such sites are subject to They were subjected to sweating as a result of working in high temperatures, which in turn leads to a loss of electrolytes through the loss of water in addition to an imbalance in the water content of the blood due to the loss of water and elements together **[**27-30**]**.

Table 5: The effect of emitted gaseous pollutants on the percentage of the volume of packed cells (%) for the study groups and for the different exposure periods.

	exposure periods			(4-10)) year			(11-20) years			(more than 20 years)		
Parameter	Total PCV%			PCV%			PCV%			PCV%		
Study group	Av ± St error	%	Decrease%	Av ± St error	%	Decrease%	Av ± St error	%	Decrease%	Av ± St error	%	Decrease%
Control	0.94±49.66 a	100	-	0.61 ± 49.66a	100	-	0.61 ± 49.66a	100	-	0.61 ± 49.66a	100	-
Administrative units	0.46 ±48.26a	97	3	0.20 ±49.04 ab	99	1	0.24 ±47.55cd	96	4	0.25 ±46.39e	93	7
liquid gas units	0.98±38.75d	78	22	0.33 ±46.98de	95	5	0.16 ±40.42g	81	19	0.51 ±38.59h	78	22
Hydrogenation units	2.02 ±41.73c	84	16	0.24 ±47.55cd	96	4	0.30 ±43.30f	87	13	1.45 ±39.49h	80	20
Refining units	1.12±44.20b	89	11	0.26 ±48.23bc	97	3	0.15 ±43.70f	88	12	0.73 ±41.10g	83	17

* Numbers followed by different letters vertically indicate the presence of significant differences between them at the level of probability ($p \leq 0.05$), and vice versa, according to Duncan's test.

Table 6: The effect of pollutants emitted from the Al-Samoud refinery on the number of Red blood cells ($*10^9$ /L) in the workers' blood and for the different exposure periods.

	exposure periods.			(4-10)) year			(11-20) years			(more than 20 years)		
Parameter	Total RBCs($*10^9$ /L)			RBCs($*10^9$ /L)			RBCs($*10^9$ /L)			RBCs($*10^9$ /L)		
Study group	Av ± St error	Number%	Increase %	Av ± St error	Number%	Increase%	Av ± St error	Number%	Increase%	Av ± St error	Number%	Increase%
Control	0.10 ±4.25a	100	-	0.02±4. 27g	100	-	0.02±4. 27g	100	-	0.02±4. 27g	100	-
Administrative units	0.09±4. 51a	106	6	0.03±4. 32fg	101	1	0.03±4. 36ef	102	2	0.03±4. 46cd	104	4
liquid gas units	0.31±4. 63 a	109	9	0.07±4. 51c	106	6	0.07±4. 63b	108	8	0.07±4. 73a	111	11
Hydrogenation units	0.40 ±4.59a	108	8	0.03±4. 41de	103	3	0.03±4. 51c	105	6	0.03±4. 61b	108	8
Refining units	0.44 ±4.55a	107	7	0.02±4. 36fg	102	2	0.02±4. 43d	104	4	0.02±4. 53c	106	6

* Numbers followed by different letters vertically indicate the presence of significant differences between them at the level of probability ($p \leq 0.05$), and vice versa, according to Duncan's test.

Table 7: The effect of gaseous pollutants emitted from the Al-Samoud refinery on the number of platelets (*10^9 /L) in the workers' blood and for the different exposure periods.

	exposure periods.			(4-10)) year			(11-20) years			(more than 20 years)		
Parameter	PLT (*10^9 /L) Total			PLT (*10^9 /L)			PLT (*10^9 /L)			PLT (*10^9 /L)		
Study group	Av ± St error	Numbe r%	Increa s%	Av ± St error	Numbe r%	Increa s%	Av ± St error	Numbe r%	Increa s%	Av ± St error	Numbe r%	Increa s%
Control	7.23 ±153.33 b	100	-	2.77±171.2 6h	100	-	171.26±2. 77h	100	-	171.26±2. 77h	100	-
Administra tive units	57.39±168. 66ab	110	10	0.98±173.1 6gh	101	1	1.11±175. 50fh	102	2	1.66±177. 83ef	104	4
liquid gas units	24.50±201. 66ab	132	32	1.26±177.7 3ef	104	4	0.83±180. 26de	105	5	1.55±182. 06cd	106	6
Hydrogena tion units	47.44±219. 00 a	143	43	2.25±183.3 0bc	107	7	2.25±185. 30ab	108	8	2.57±187. 63a	110	10
Refining units	14.57±186. 66ab	122	22	1.15±175.4 6fh	102	2	1.15±178. 46e	104	4	1.17±179. 83de	105	5

* Numbers followed by different letters vertically indicate the presence of significant differences between them at the level of probability (p≤0.05), and vice versa, according to Duncan's test.

Table 8: The effect of emitted gaseous pollutants on the sodium ion concentration in the blood of the studied groups and for the different exposure periods.

	exposure periods.			(4-10)) year			(11-20) years			(more than 20 years)		
Parameter	Sodium ions mmol/L Total			Sodium ions mmol/L			Sodium ions mmol/L			Sodium ions mmol/L		
Study group	Av ± St error	Con %	Decrease%	Av ± St error	Con %	Decrease%	Av ± St error	Con %	Decrease%	Av ± St error	Con %	Decrease%
Control	139.83 ±1.80a	100	-	139.33± 2.08a	100	-	139.33± 2.08a	100	-	139.33± 2.08a	100	-
Administrative units	138 ±2.50ab	99	1	138.56 ±1.52a	99.	1	138.00± 4.35a	99	1	137.33± 1.52ab	99	1
liquid gas units	135.05±1.62 c	97	3	136.50±0.50ab	98	2	135.33±0.57 ab	97	3	133.33± 1.52b	96	4
Hydrogenation units	135.94 ±3.16bc	97	3	137.50 ±1.80ab	99	1	135.34± 5.50ab	97	3	135.00± 1.00ab	97	3
Refining units	136.66 ±1.32bc	98	2	137.33±1.52 ab	99	1	136.66±1.52ab	98	2	136.00± 1.00ab	97	3

* Numbers followed by different letters vertically indicate the presence of significant differences between them at the level of probability (p≤0.05), and vice versa, according to Duncan's test.

Table 9: The effect of emitted gaseous pollutants on the concentration of chloride ions in the blood of the studied groups and for the different exposure periods.

	exposure periods.			(4-10)) year			(11-20) years			(more than 20 years)		
Parameter	Total chloride ions mmol/L			chloride ions mmol/L			chloride ions mmol/L			chloride ions mmol/L		
Study group	Av ± St error	Con %	Decrease%	Av ± St error	Con %	Decrease%	Av ± St error	Con %	Decrease%	Av ± St error	Con %	Decrease%
Control	106±4.82 a	100	-	105.00 ±1.0a	100	-	105.00 ±1.0a	100	-	105.00 ±1.0a	100	-
Administrative units	103.44 ±2.69ab	98	2	104.33 ±0.33a	99	1	104.33 ±0.79a	99	1	101.07± 6.03b	96	4
liquid gas units	101.44 ±2.28b	96	4	103.06± 1.00abc	98	2	97.88± 3.46bcd	93	7	93.77± 6.61d	89	11
Hydrogenation units	102.33 ±1.73ab	97	3	103.44 ±0.66ab	98	2	99.22± 2.33a-d	94	6	97.07± 6.15cd	92	8
Refining units	103.03 ±1.47ab	97	3	103.07± 0.04abc	98	2	99.22± 2.33a-d	94	6	97.10± 0.01cd	92	8

* Numbers followed by different letters vertically indicate the presence of significant differences between them at the level of probability (p≤0.05), and vice versa, according to Duncan's test.

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