Original Article

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White Blood Cell Indices and Health Parameters of Workers in Industrial and Urban Areas

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ABSTRACT

Background. Working far from urban domains exposes workers to harsh environmental hazards like air pollutants and harmful byproduct emissions. Site workers often are exposed to harmful agents and may suffer from dangerous health disorders. The aim of this study is to estimate the hazard level posed by these conditions through clinical examination of assays taken at the State Company of Fertilizers, Southern Region, in the Basra governorate of the city of Iraq.

Methods. A study was conducted on 35 workers from both the State Company of Fertilizers (Southern Region) and Basrah University. The study involved an inquiry into the occupational history, chronic illnesses, and smoking habits of participants, along with a physical examination of arterial blood pressure, heart rate, body temperature, and oxygen saturation (SpO2). A complete blood picture (CBP) test was given to all study participants to obtain WBCs, while serum was assessed for liver (ALT) and (AST).

Results. The study showed a higher incidence of hypertension and diabetes among urban workers than among industrial workers, while 14% more industrial workers underwent surgical operations and 29% had fillings of dental caries and showed a non-significant rise in body temperature when compared with urban workers. Industrial employees had a highly significant increase ($P \leq 0.001$) in systolic blood pressure. Both groups of workers had uniformly decreased monocyte levels, while total WBCs and granulocytes were non-uniformly distributed, except for lymphocytes. Data showed a highly significant decrease ($p \leq 0.005$) in the monocytes of industrial workers, while a general decrease was present in all other WBC parameters, though with no statistical significance ($P \geq 0.05$). Liver function tests showed abnormalities in 42% of the industrial workers (ALT 36 U/L), while 92.8% were suggestive of chronic hepatitis or steatosis due to a ratio of less than 1 in AST : ALT levels.

Conclusion. Decreased WBCs (leukopenia) and health problems, along with markers of liver dysfunction, are potential health hazards faced by workers in the fertilizer industry. Maintenance and site equipment engineers had recurrent long-term exposure to ammonia gases and toxic environmental agents. The findings of this clinical surveillance are significant; however, studying the etiological factors and subsequent pathogenicity remains necessary.

Keywords: White blood cell indices, industrial, urban

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INTRODUCTION

Industrial workers are exposed to numerous dangerous chemicals, along with harsh climate changes and environmental hazards, such as air pollutants and harmful byproducts from factory emissions. Workers at industrial sites and office employees in their offices are constantly exposed to harmful agents while doing their jobs, and may develop serious health disorders, such as respiratory, hematological, hepatic, and renal problems.[1,2,3] The purpose of this study was to judge the risks to these workers by measuring some clinical data and health constraints alongside an evaluation of hematological and liver capacity tests done on workers at the State Company of Fertilizers, Southern Region, in the Basra governorate of the city of Iraq.

The liver function tests and the hematological data from both urban and industrial employees were encoded and analyzed statistically in a Microsoft Excel program using a student t-test and analysis of variance (ANOVA) to differentiate between the working divisions. A rise in plasma aminotransferase activities is a sensitive indicator of damage to cytoplasm and/ or mitochondrial membranes. Plasma enzyme activities rise when the membranes of only a very few cells are damaged. Liver cells contain more aspartate amino-transferase (AST) than alanine aminotransferase (ALT), but ALT is confined to the cytoplasm, in which its concentration is higher than that of AST. Raised plasma levels of both enzymes are indicative of hepatocyte damage. In inflammatory or infective conditions, such as hepatitis, leakage of cytoplasmic contents causes a relatively greater increase in plasma ALT than AST activities. On the other hand, in disseminated disorders, where there is damage to both mitochondria and cytoplasm organelles, there is a relatively more prominent increment in plasma AST than ALT activity. A plasma AST:ALT ratio of 2 is suggestive of intoxicative liver disease, and a ratio 1 suggests chronic hepatitis or hepatic steatosis.[4] Liver capacity irregularity was characterized as serum ALT 36 U/L, and serum AST 34 U/L.[5]

Materials and Methods

1. Clinical investigation

This study is part of a clinical investigation conducted on 30 workers from the State Company of Fertilizers and employees of Basrah University. Information was gathered concerning the occupational history, lifestyle (such as smoking habits), and health status (such as chronic illnesses, like hypertension and diabetes). A physical examination of arterial blood pressure and heart pulse rate were taken for each individual, along with body temperature and measurements of oxygen saturation (SpO2), using a fingertip pulse oximeter.

2. Hematological study

The EDTA anti-coagulated blood samples were kept in a cool box until arrival at the university campus for blood CBP assays. At that point, part of the blood was transferred to gel tubes and centrifuged for serum collection. All study subjects underwent a complete blood picture (CBP) test for hematology parameters concerning white blood cells, using an Automated Hematology Analyzer COUNT-60 (USA). The serum was collected using gel test tubes, and was then used for assessing liver enzyme function: alanine aminotransferase (ALT) and aspartate aminotransferase (AST).

3. Liver function tests

RANDOX ALT and AST enzyme kits were used for the colorimetric determination of the serum alanine aminotransferase and serum aspartate aminotransferase, respectively. According to Reitman and Frankel, the procedure involved measurement of optical density (OD) against a reagent blank using a spectrophotometer at a wavelength of 546 nm, and reconstruction of a calibration curve using a Pyruvate standard, as in Table 1.

Table 1. Preparation of standard curve solutions

Tube no.	Pyruvate standard (ml)	Redistilled water (ml)	Buffer solution (ml)
1	0.00	0.2	1.00
2	0.05	0.2	0.95
3	0.100	0.2	0.90
4	0.15	0.2	0.85
5	0.20	0.2	0.80
6	0.25	0.2	0.75
7	0.30	0.2	0.70
8	0.35	0.2	0.65
9	0.40	0.2	0.60
10	0.45	0.2	0.55

The procedure involved pipetting reagents into test tubes, as above, and then mixing and pipetting into each tube 1.0 ml of reagent 2,4-DNP solution, mixing and incubating for 20 minutes at 20°C. Afterwards, 10 ml of sodium hydroxide solution (0.4 Mol/L) was added to each tube.

Five minutes after mixing, absorbance was read against the blank (tube no. 1). The absorbance of the expanding measures of Pyruvate (0.05–0.45 ml Pyruvate standard) corresponded to the subsequent transaminase events in U/L, as in Table 2, below.

Table 2. The amount of Pyruvate corresponding to transaminase activity

Tube no.	ALT U/L	AST U/L
2	9	6
3	18	11
4	27	16
5	37	20
6	46	25
7	56	31
8	67	37
9	77	44
10	87	52

The calibration curve was obtained by plotting the deliberate absorbance corresponding to the transaminase activities in U/L (ordinate = absorbance, abscissa = activity) for the serum test, pipetted into test tubes, as in Table 3.

Table 3. Preparation for serum measurements against blank

	Reagent blank	Sample
Sample Buffer Distilled Water	--- 0.5 ml 0.1 ml	0.1 ml 0.5 ml ---
Mix incubate 30 min at 37°C		
Reagent 2,4-DNP solution	0.5 ml	0.5 m
Mix, allow to stand for exactly 20 min. at 25°C		
Sodium hydroxide	5.0 ml	5.0 ml

Five minutes after mixing, the value of the sample absorbance was measured against the reagent blank.

Hematology reports were classified according to urban and industrial groups, and a statistical comparison between averages was done using a student's t-test.

Results

1. Clinical investigation

The health parameters mean ± SD error and clinical investigations for urban workers are presented in Figures 3 and 4, below.

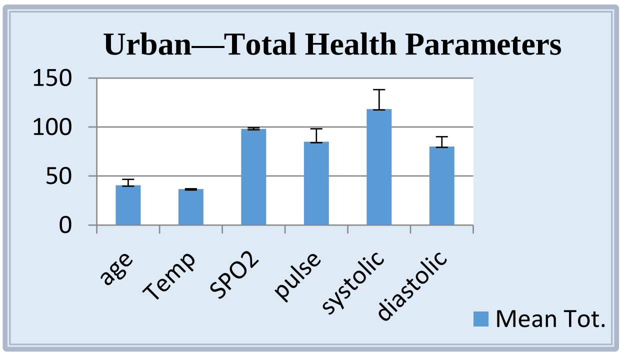

Fig. 3. Urban workers' health parameters, presented as mean ± SD

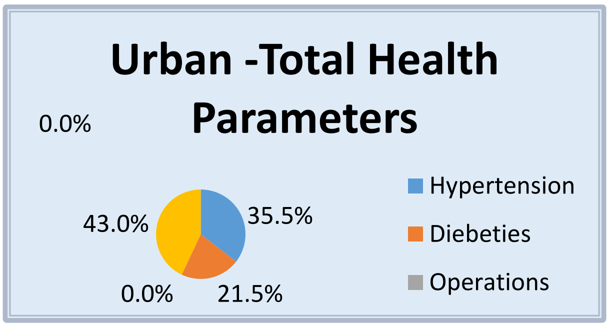

Fig. 4. Urban workers' clinical investigations in percentages

The health parameters mean ± SD error and clinical investigations for industrial workers are presented in Figures 5 and 6, below.

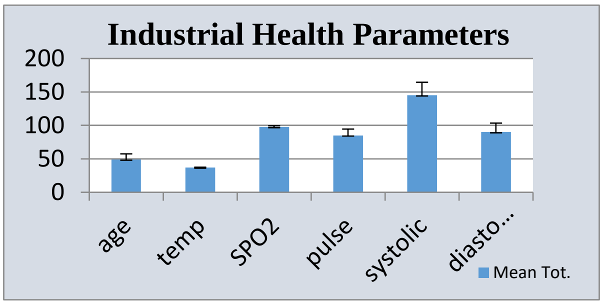

Fig. 5. Industrial workers' health parameters, presented as mean ± SD

Table 4. Urban and industrial workers' health parameters, presented as mean ±SD

The study showed a higher incidence of chronic diseases, like hypertension and diabetes, among urban workers than among industrial workers, while more industrial workers underwent surgical operations, had dental caries filled, and smoked less.

Urban and industrial workers' health parameters were calculated and the means ± SD are presented in Table 4, below. In Table 4, a significant difference in the age of workers is evident, such that industry employees with longer exposure to toxic chemicals and physical agents showed a highly significant increase (P<0.001) in systolic blood pressure.

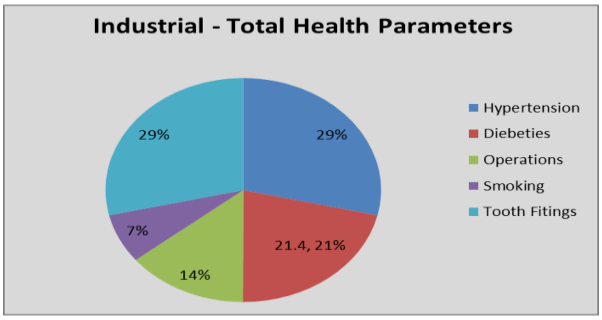

Fig. 6. Industrial workers' clinical investigations, in percentages

n=35	Age	Temp	SPO2	Pulse	Systolic	Diastolic
Urban mean	40.73	36.82	98.27	85.12	118.54	80.31
SD±	5.94	0.28	1.00	13.15	19.72	9.90
Industrial mean	48.93	37.00	97.57	85.07	145.00	89.93
SD±	8.53	0.46	1.91	9.42	19.48	13.49
P=	0.016	0.260	0.151	0.344	0.001	0.106
(P<0.05)*	*	-	-	-	**	-
(P<0.01)**						

No significant difference was observed in the rest of the health parameters investigated.

2. Hematological study

The distribution of industrial and urban WBCs is presented in Figures 7 and 8.

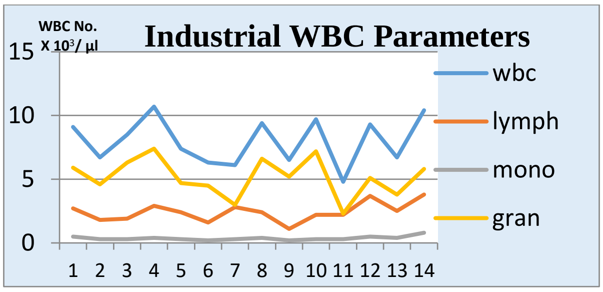

Fig. 7. Distribution of industrial workers' WBCs parameters

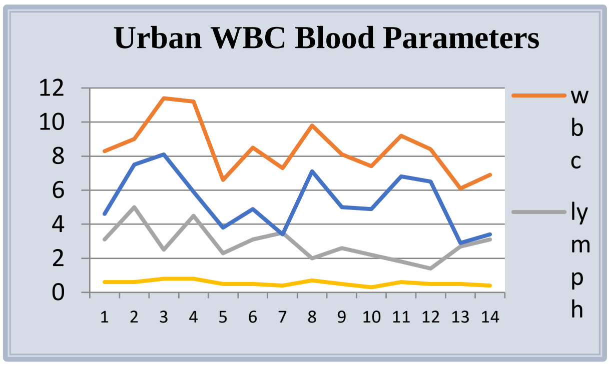

Fig. 8. Distribution of urban workers' WBC parameters

This study revealed that both sets of workers had uniform decreased monocyte levels, while total WBCs and granulocytes followed similar zigzag patterns and were uniformly distributed. Lymphocytes in both urban and industrial workers' groups were evenly distributed. Urban and industrial workers' WBC parameters were calculated for mean ± SD, and are presented in Figure 9, below.

Statistical analysis showed that a highly significant decrease (P=0.005) is evident in the industrial workers' monocytes, as compared with those of the urban workers. A general trend of decrease is present in all other WBC parameters of the industrial workers, but with no statistical significance (P>0.05).

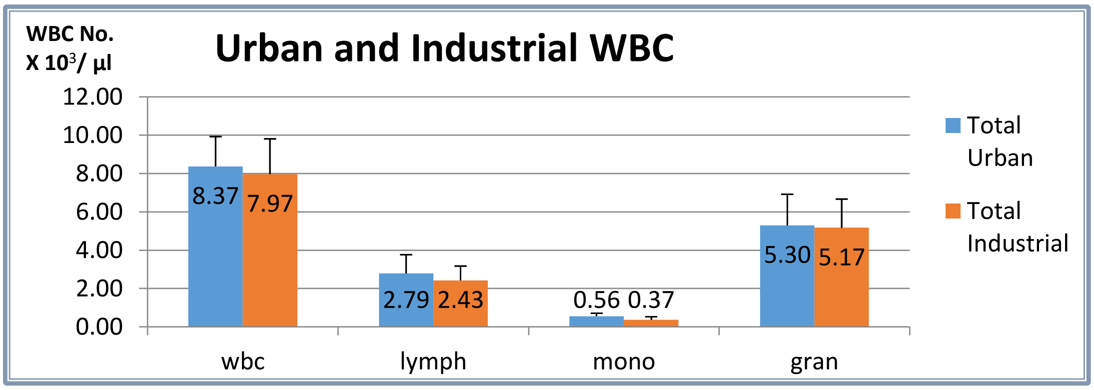

Fig. 9. Urban and industrial workers' WBC parameters, mean ±SD

3. Liver function tests

The absorbance values at 546 nm of the expanding measures of Pyruvate corresponding to the alanine transaminase activities in U/L are shown in Table 5.

Table 5. Optical densities according to transaminase activity levels

ALT U/L	Optical Density (OD)
9	0.001
18	0.087
27	0.135
37	0.2
46	0.231
56	0.306
67	0.321
77	0.35
87	0.395

The reconstructed calibration curve is shown here in Figure 10.

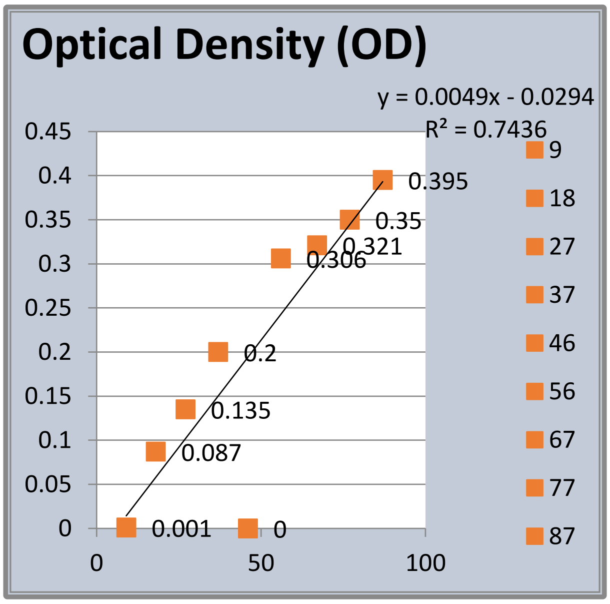

Fig. 10. ALT Enzyme level in Accordance to Absorbance values

The absorbance values at 546 nm of the increasing amounts of Pyruvate corresponding to the aspartate transaminase activities in U/L are shown in Table 6.

Table 6. Optical densities according to transaminase activity levels

AST U/L	Optical Density (OD)
6	0.001
11	0.001
16	0.016
20	0.027
25	0.044
31	0.057
37	0.073
44	0.084
52	0.086

The reconstructed calibration curve is shown here in Figure 11.

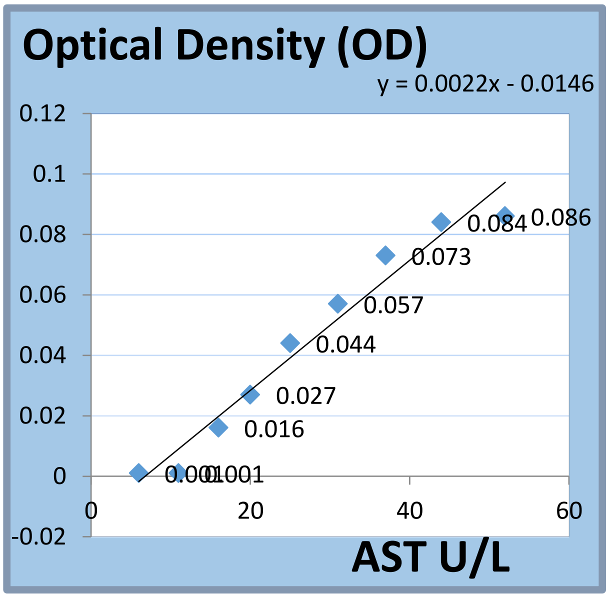

Fig. 11. AST Enzyme level in Accordance to Absorbance values

Industrial employees' ALT enzyme levels, according to the standard curve fittings, are shown in Table 7.

Table 7. Industrial employees ALT enzyme levels obtained from standard curve

No.	Blood Sample O.D.	Reagent Blank O.D.	Calculated O.D.	ALT (U/L)
1	0.461	0.359	0.102	27
2	0.463	0.359	0.104	27
3	0.461	0.359	0.102	27
4	0.445	0.359	0.086	24
5	0.570	0.359	0.211	49
6	0.556	0.359	0.196	46
7	0.585	0.360	0.225	52
8	0.484	0.360	0.123	31
9	0.433	0.361	0.076	22
10	0.393	0.357	0.034	13
11	0.525	0.358	0.166	40
12	0.515	0.359	0.155	38
13	0.422	0.360	0.062	19
14	0.584	0.360	0.225	52

Industrial employees' ALT enzyme levels, according to the standard curve fittings, are shown here in Table 8.

Table 8. Industrial employees' AST enzyme levels obtained from standard curve

No.	Blood Sample O.D.	Reagent Blank O.D.	Calculated O.D.	AST U/L
1	0.290	0.287	0.003	8
2	0.284	0.289	0.000	7
3	0.301	0.289	0.012	12
4	0.315	0.290	0.025	18
5	0.311	0.290	0.021	16
6	0.314	0.291	0.023	17
7	0.341	0.291	0.050	29
8	0.292	0.291	0.001	7
9	0.315	0.291	0.024	18
10	0.306	0.292	0.014	13
11	0.309	0.292	0.017	14
12	0.308	0.292	0.016	14
13	0.294	0.293	0.001	7
14	0.320	0.293	0.027	19

Liver function tests showed abnormalities in 42% of the industrial workers (ALT 36 U/L), while 92.8% were suggestive of chronic hepatitis or steatosis due to AST:ALT level ratios of less than 1. Urban and industrial employees' ALT and AST enzyme levels, according to the standard curve fittings, were tabulated and calculated for mean and standard error, and are presented in Table 9.

Table 9. Urban and industrial employees' ALT, AST enzyme levels: mean and ±SD

Urban	n=35	ALT (U/L)	AST (U/L)
	Mean	34.14	37.27
	±SD	7.63	4.58
Industrial	n=35	ALT (U/L)	AST (U/L)
	Mean	33.36	14.21
	±SD	12.8	6.09
* = (P<0.05) *** = (P<0.001)		Not Significant (N.S.)	***

Discussion:

This study explored how industrial specialists are, for the most part, exposed to remarkably higher dangers than urban workers. The responsibilities of male workers, maintenance employees, and apparatus engineers expose them to the dangers of discontinuous long-term top exposure to toxic gases like ammonia (the principal pollutant in the fertilizer plant site), leading them to suffer hematological toxicity. This is the same finding as reported by Cullen et al. and Weeks et al.[6,7] Industrial workers' health parameters showed a decreased mean SPO2 and a pulse rate with high body temperature, due to inhalation of ammonia gas, which is exceptionally irritating, dry, and extremely dissolvable. The earlier study of Close et al. showed that the problem occurs in absorption in the upper part of the breathing path, where the gas causes pathological and pathohistological changes.

The observed fluctuation (decrease) of respiratory and pulse rate may be related to an ammonia-induced change in blood pH.[9] Respiratory compensation has been reported to correlate with changes in pH.[10] The pH of the blood is maintained within a very narrow range during exposure to ammonia, and fluctuates, along with partial pressure of CO2 and O2.[9]

Aleemuddin et al. reported the chronic exposure of workers to petroleum fumes like benzene (an aromatic hydrocarbon which is considered to be a natural constituent of unfinished oil and natural gas), which is highly present in the plant atmosphere. These fumes are poisonous to the blood and blood-creating organs, leading to adverse effects on the human hematopoietic system, like bone marrow depression and resultant pancytopenia. The same results were obtained in this study, where the total WBCs, lymphocytes, and granulocytes means of industrial workers decreased, with an extremely significant decrease of monocytes ($P < 0.01$).[11]

Trond et al. reported that chronic toxic effects on blood due to benzene exposure, including reduced lymphocyte, neutrophil, and platelet cell numbers in peripheral blood, have been recognized at local exposures below a level that had previously been considered not to cause any health issues, but whether these irregularities represent hematopoietic damage and/or early events in the progress of a true neoplastic disease is still unclear.[12]

Another study done in Nigeria on fuel attendants showed similar results, with a global reduction in the mean values of total leucocyte counts, red blood cell counts, packed cell volume, and other red blood cell indices in unprotected workers.[13]

This study's results were also parallel to those of Luo et al., who found that there were lower mean WBC counts at highly significant levels in male industrial workers (mean=5870/mm3, SD=1190) when compared with urban workers (mean=7350 /mm3, SD= 1660), p=0.003).[14]

The industrial work classifications included tidying up compound spills and breaks, cleaning hardware, blending chemical mixtures, changing strong sources and oil pumps, applying preventive supports on devices, carrying out crisis reactions on various apparatuses, and manipulating or filling holders for substances on machines.

Male specialists, more often than not, wore cotton covers and cartridge or air masks during these operations. The absence of sufficient respiratory insurance may enable laborers to be exposed to hematological poisons.

One earlier study demonstrated that architects may be exposed to a high convergence of dangerous chemicals amid preventive support.[15] This study corresponds with the conclusions reached by Luo et al., where the results of sub-chronic impacts demonstrated that the assignments of modern laborers may put them in danger of long-term hematological and hepatic variations from the norm.

The present study showed an extremely significant decrease in liver function tests in the industrial workers (mean=37.2, SD= ± 4.58) as compared to the urban workers (mean= 14.2, SD= ± 6.09). This finding coincides with the results of Muslim et al., which showed chronic hepatitis resulting from hepatocyte intoxication with air pollutants and harmful factory by-products.[5]

Conclusion.

This study suggests that decreased WBCs (leukopenia) and moderate problems in health parameters, along with markers of liver dysfunction, are potential health hazards faced by industrial workers in the fertilizer industry. The responsibilities of the processing, maintenance, and site equipment engineers put them in danger of repeated long-term exposure to ammonia gases, toxic agents, and other environmental hazards.

The findings of this clinical investigation are significant. Still, further exploration of the etiological influences and subsequent pathogenicity is necessary.

Abbreviations.

(ALT) Alanine Aminotransferase
(ANOVA) Analysis of variance
(AST) Aspartate Aminotransferase
(CBP) Complete Blood Picture
(EDTA)Ethylene Diamine Tetra Acidic Acid
(Mol/L) Mole per Liter
(OD) Optical Density
(SD) Standard Error
(SpO2) Oxygen Saturation
(Temp) Temperature
(U/L) Unit per Liter
(USA) United States of America
(WBCs) White Blood Cells
(nm) Nano Meter

References.

1. Wald PH, Jones JR. Semiconductor manufacturing: an introduction to processes and hazards. Am J Ind Med. 1987;11(2):203-21.
2. Sullivan Jr JB, Krieger GB, Thomas RJ. Hazardous materials toxicology: clinical principles of environmental health. J Occup Environ Med. 1992 Apr 1;34(4):365-71.
3. Teitelbaum DT. Photoactive chemicals used in photoresist systems. Occup Med. 1986;1(1):59-68.
4. Luo JC, Hsu KH, Hsieh LL, Wong CJ, Chang MJ. Lung function and general illness symptoms in a semiconductor manufacturing facility. J Occup and Environ Med. 1998 Oct 1;40(10):895-900.
5. Muslim AS, AL-azzawi RH. Prevalence of Hepatitis E Virus in AL-Muthanna Province (Iraq) patients. Iraqi J Sci. 2015;56(2A):965-71.

6. Cullen MR, Rado T, Waldron JA, Sparer J, Welch LS. Bone marrow injury in lithographers exposed to glycol ethers and organic solvents used in multicolor offset and ultraviolet curing printing processes. Arch Environ Health. 1983 Nov 1;38(6):347-54.

7. Weeks JL, Levy BS, Wagner GR, eds. Aplastic anemia: preventing occupational diseases and injury. Washington, DC: American Public Health Association; 1991:1059.

8. Close LG, Catlin FI, Cohn AM. Acute and chronic effects of ammonia burns of the respiratory tract. Arch Otolaryngol. 1980 Mar 1;106(3):151-8.

9. Olanrewaju HA, Thaxton JP, Dozier III WA, Purswell J, Collier SD, Branton SL. Interactive effects of ammonia and light intensity on hematochemical variables in broiler chickens. Poult Sci. 2008 Jul 1;87(7):1407-14.

10. Roller MH. The effects of acute ammonia toxicity on certain blood parameters in cattle. Diss Abstr: B. 1966;27.

11. Aleemuddin M, Babu MG, Manjunath ML, Quadri SS. Effect of chronic inhalation of petroleum products on hematological parameters. Int J Curr Res. 2015;3(4):196-201.

12. Kirkeleit J, Riise T, Gjertsen BT, Moen BE, Bråtveit M, Bruserud Ø. Effects of benzene on human hematopoiesis. Open Hematol J. 2008 July;2(1):87-102.

13. Okoro AM, Ani EJ, Ibu JO, Akpogomeh BA. Effect of petroleum products inhalation on some haematological indices of fuel attendants in Calabar metropolis, Nigeria. Niger J Physiol Sci. 2006;21(1-2).

14. Luo JJ, Hsieh LL, Chang MJ, Hsu KH. Decreased white blood cell counts in semiconductor manufacturing workers in Taiwan. Occup Environ Med. 2002 Jan 1;59(1):44-8.

15. Strang Cr, Levine Sp, Herget Wf. A preliminary evaluation of the Fourier transform infrared (FTIR) spectrometer as a quantitative air monitor for semiconductor manufacturing process emissions. Am Ind Hyg Assoc J. 1989 Feb 1;50(2):70-7.