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Risk Assessment of Occupational Exposure to Air Pollution in Baghdad City

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Abstract

Air pollution rates have increased in the city of Baghdad due to the spread of sources of fuel burning, car exhaust, electric power generators, and other industrial activities.Air pollution causing major global problems of public health especially occupational exposure for workers in street (traffic police, security workers,street vendors,etc).The aims of this study are to determine levels and nature of occupational exposure toair pollutants in Baghdad city.

Twenty stations for air sampling and 32 blood samples were collected from different areas of Baghdad city both Karkh and Rusafa sides. These samples were analyzed by an inductively coupled plasma- atomic emission spectrometer (ICP-AES) for Lead (Pb), Cadmium (Cd), Copper (Cu), Chromium (Cr), Zinc (Zn).

The mean value of Total Suspended Particles (TSP) in the air, was(825.244 µg/m3), which is higher than Iraqi standards and world international allowable limits.

The mean concentrations of CO and CO_2 in the air(1.61 and 440.4ppm) these are lying within national and world standard.

The air of study area considered good quality for CO and CO_2 health effect while considered hazardous for TSP with health risk.

The result showed that the air of the region containing high concentration of heavy elements (Pb, Cr, Zn) 0.72, 0.136 and31.95µg/m^3 respectivelyin the air exceeded the permissible limits globally and nationally, except (Cd, Cu)0.014, 0.150µg/m^3, respectivelywere lower than the world limits, Iraqi studies and MOE, Canada.

The mean concentrations of Heavy metals in the bloodof exposure group are significantly higher than those in the blood of control group.

The results showed no significant differences ($p < 0.05$) between the exposure and control groups, there is no correlation between the level of heavy elements in the blood ofexposure groupson the one hand, and age, smoking, and duration of work on the other hand. The comparison of the mean values of heavy metals with the Iraqi and International Studies it is noticed that they are lower than Iraqi and International Studies.

Key words :Health risk, Heavy metal, Occupational exposure , blood , air quality , Baghdad City

Introduction

Air pollution causing major global problems of publichealth(WHO, 2020). Traffic air pollution caused much of the ambient air pollution in cities, exhaust emissions alone represent up to 30% of all particulate matter that emitted in urban areas (Krzyżanowski., et al 2005).

Road dusts are created by atmospheric deposition of particulate matter by the effect of road surface gravity. Particulate matter come from many sources, likeconstruction processes, traffic emissions, industrialsources, etc. (Cao et al., 2017).

Persons that exposed to higher doses of trace elementsshownumerous diseases, like cardiovascular system diseases, tumors, skeletal, gastrointestinal and renal toxicity (Vardhan et al., 2019). There are 3 pathways for trace elements and heavy metalsto reach the human bodyeasily: ingestion,inhalation, and skin contact (Cook et al., 2005).

Emissions of the road vehicle consider one of the more important and worrying source of human exposures to pollutionin air, principallyoccurring as consequence of the large increases in the use and ownership of motor vehicles(Ghose et al., 2004; Huang et al., 2012). This increase in automobiles number has lead to high traffic density, which is aggregatedthrough peak hours (Kamal et al., 2016).

Heavy metals are high atomic weight elements that occur naturally in the earth's crust. They are releasedfrom both natural and anthropogenic activities. Their constant use in the industry, agriculture, medicineand technology lead to their prevalence in the environment, raising worry to human health andenvironmental safety (Bradl, 2005).

1.1 Study Area

Baghdad lies in the middle of Iraq within the Mesopotamia plain which represents the western part of the unstable shelf (Figure 1-1). It lies at the northern part of Mesopotamia between latitude (33˚ 44 – 33˚25) and longitude (44˚ 29 – 44˚ 16).

The study area characterized by the presence of industrial institutes, populated groups and agricultural lands. The area of the populated regions with its industrial institutes cover about 67%, while unpopulated lands including agricultural lands cover 33% (Al-Hitti, 1985).

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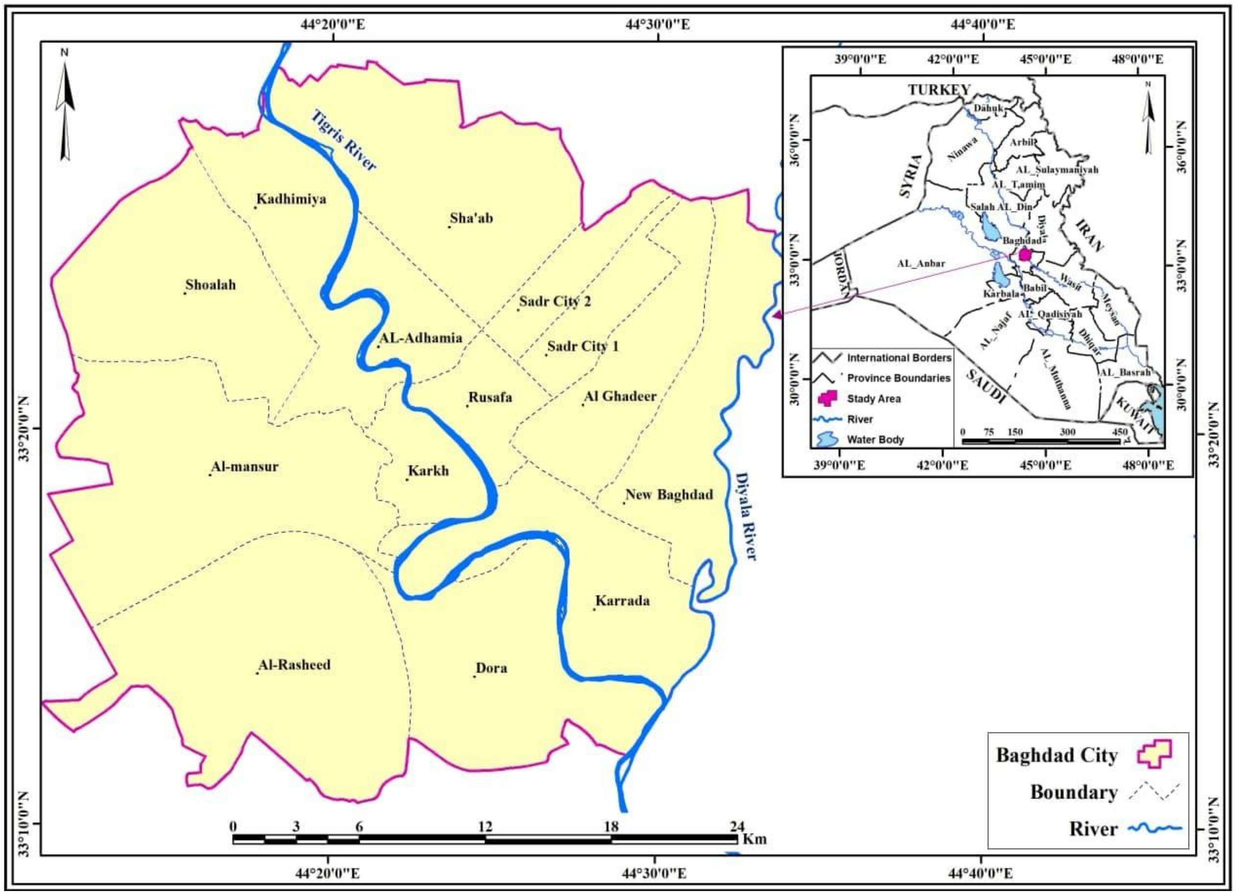

Figure 1:Location map of the study area

1. Materials and Methods

Samples are collected from selected areas in Baghdad city in both Karkh and Rusafa sides that include 20 air and 32 blood .Fieldwork started in December 2019 and ended in July2020 . The practical steps included an operation to analyze some of the heavy elements in (air and blood), measuring TSP as well as measuring the concentrations of some gases (CO, CO_2) in air. All analyses of heavy elements have been examined by an inductively coupled plasma- atomic emission spectrometer (ICP-AES) .Visual measurements for air were described in the field , CO and CO_2, gases concentration for air were measured by portable devices. Twenty stations distributed over different areas of Baghdad. were selected for the measurements of the concentrations of air pollutants. The stations were distributed on a regular basis in order tocover most areas of Baghdad city, where emphasis was placed on the type of each area to be traffic overcrowded.A total 32 blood samples in Karkh and Rasafa in Baghdad city (20 adult male

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volunteers from thepolice men and street vendors with 12 non exposed persons aged 18-60 years old) were investigated. were 5 ml of venous blood sample (whole blood) taken by using sterilized syringes from each volunteer, stored at 5°C until reach to laboratory.After the collection of the samples from (air and blood) they are taken to the laboratory for measuring the concentrations of different pollutants (heavy metals)

3.Results and discussion

3.1 Air pollution

The concentrations of TSP , CO ,CO_2 and heavy metals are shown in tables 1,3 and figures 2,3.The mean value of Total Suspended Particles (TSP) in the air is (825.244 $\mu g/m^3$), which is higher than Iraqi standards and world international allowable limits. The high TSP in the air is most probably comes from different sources of air pollution in the site of traffic in which the samples were collected. The results of the current study showed that the concentrations were high and exceeded the Iraqi study (Ali, 2013; Abed, 2015 and Mohamed, 2016) .(Table 4).The maximum TSP value was recorded in Shoalah in Karkh zone with (1915.11$\mu g/m^3$) this may be due to overcrowding of cars in this traffic as well as present of another sources of air pollution, while the minimum value of TSP was recorded also in Karkhzone at Al-mansur site with (89.02$\mu g/m^3$).

The mean concentrations of CO and CO_2 in the air are (1.61 and 440.4) ppm, respectively the CO levels lying within national and world standards, and CO_2 is higher than national and world limits. The air of study area considered good quality for CO health effect while considered hazardous for TSP and CO_2 with health risk.the mean values of lead in air is (0.72$\mu g/m^3$) , it is higher than WHO and EPA, but it is lower than National and MOE, Canada. The concentration of Cd (0.014$\mu g/m^3$) and Cu (0.150$\mu g/m^3$) were lower than the world limits, Iraqi studies and MOE, Canada . The decrease of the concentration at July was due to the meteorological conditions. While our result of Zn(31.95$\mu g/m^3$) was higher than WHO MOE, Canada and Iraqi studies, Increasing of Zn concentration belongs to high traffic density and fuel combustion operations . Cr concentration(0.136$\mu g/m^3$) is less than Iraqi studies and higher than WHO, while their concentration coinciding with MOE, Canada.

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High level concentrations of trace elements in the air are due to high traffic density and fuel combustion operation.

The mean and range of results are compared with the mean concentrations of (Abed, 2015; Ali, 2013; Abdullah, 2010 and Mohamed, 2016), (Table 4).The results show significant variations of TSP that is much higher than (Abed, 2015) and lower than Ali, (2013) and Mohamed, (2016).

While our result of Co higher than Abed, (2015) and lower than results of other local studies. Trace elements (Cd, Cr,Cu Pb and Zn) are higher than local studies.

From the data obtained in current study, relating the airborne lead (Pb) and the other heavy metals concentrations, we can generallyconcluded that pollution in air by Pb, Cr, Cd, Cu and Zn are remain low, in comparison to another big cities .While the founded values, in fact display the presence of air pollution by lead (Pb) and the other heavy metals, no threatening levels have been reached yet.

Table 1: Range and Mean of TSP, CO and CO_2 in Compare with (IQS) , (WHO) and (EPA)

Stations		***TSP ($\mu g/m^3$)***	***CO ppm***	***CO_2 ppm***
Rusafa	Jadriya	1098.9	0.01	410
	Za'faraniya	1084.24	0	492
	New Baghdad	693.58	0	481
	Mashtal	761.90	0	456
	Zayoona	358.73	4	463
	SadrCity	1036.81	10	463
	Palestine street	730.15	1	444
	Al-Bab Al sharqi	498.41	1.8	444
	Sha'ab	442.41	0	435
	AL-Adhamia	269.84	1	417
	BabAlMo'adham	800	0	416
Karkh	Qdisiah	459.77	0	342
	Saydeyah	1413.37	0	350
	Shoalah	1915.11	3	534
	Kadhimiya	1676.79	1.5	260
	Amiriah	525.87	3	445
	Hay aljihad	1246.37	2	516
	Dora\ abodsheer	523.80	1	420

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	Hay aljamiaah	879.81	2	540
	Al-mansur	89.02	2	480
	Range (μg/m3)	89.02-1915.11	0-10	260-540
	mean	825.244	1.61	440.4
	Iraqi standards , 2008 (μg/m3)	350	35	250
	WHO, 1996(μg/m3)	60-90	9	250
	EPA,2000	150	35	

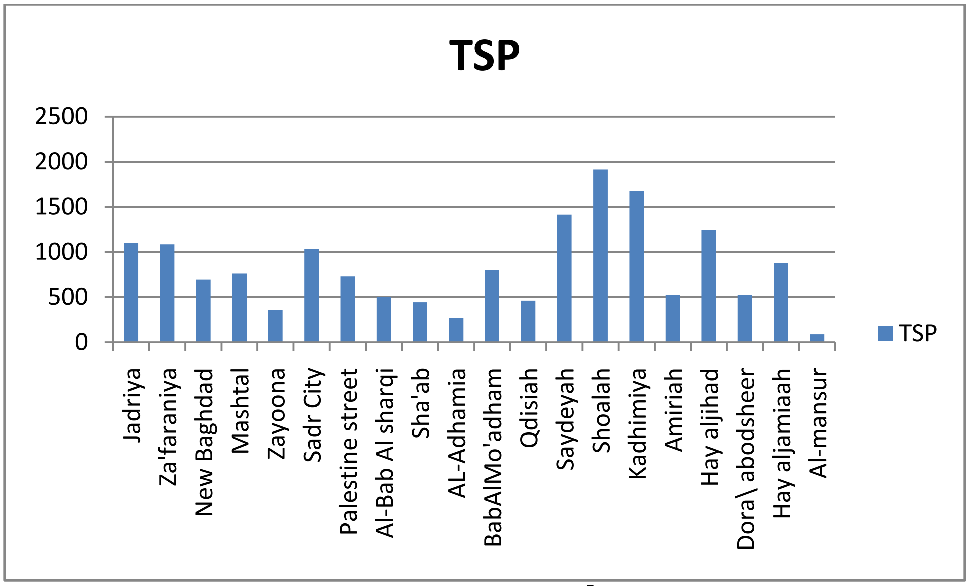
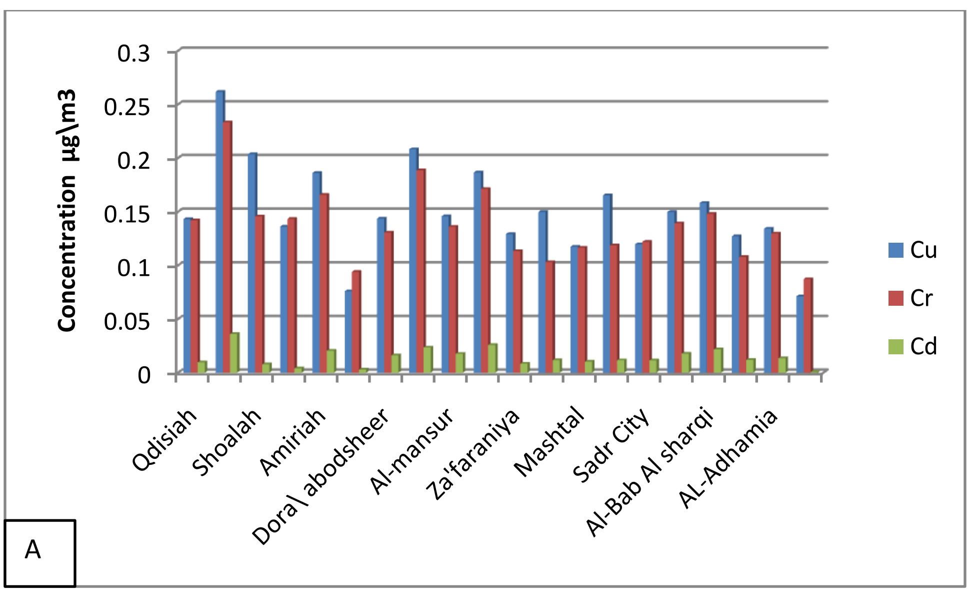


Figure 2: Concentrations of TSP (μg/m^3) in air in Baghdad city.



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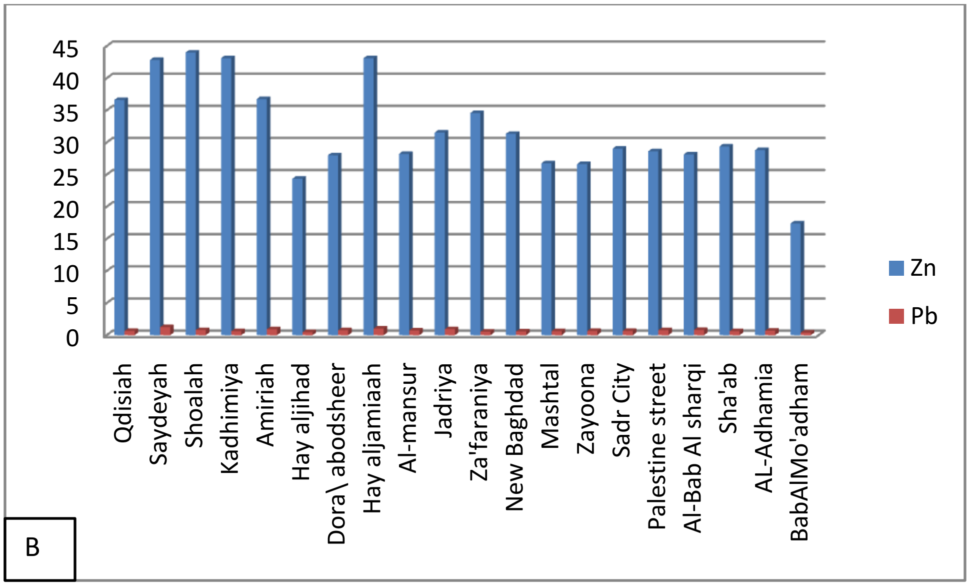

Figure (3 a, b): Concentrations of heavy metals (µg/m^3) in air in Baghdad city

Table 2:heavy elementsconcentrations in the atmosphere of the study area

Sample Station	Pb µg/m^3	Cd µg/m^3	Cu µg/m^3	Cr µg/m^3	Zn µg/m^3
Qdisiah	**0.64**	**0.009**	**0.143**	**0.141**	**36.60**
Saydeyah	**1.24**	**0.036**	**0.261**	**0.233**	**42.83**
Shoalah	**0.78**	**0.007**	**0.203**	**0.145**	**43.98**
Kadhimiya	**0.62**	**0.004**	**0.136**	**0.143**	**43.12**
Amiriah	**0.93**	**0.020**	**0.186**	**0.165**	**36.75**
Hay aljihad	**0.45**	**0.002**	**0.075**	**0.093**	**24.34**
Dora\ abodsheer	**0.75**	**0.016**	**0.143**	**0.130**	**28**
Hay aljamiaah	**1.03**	**0.023**	**0.208**	**0.188**	**43.11**
Al-mansur	**0.73**	**0.017**	**0.145**	**0.136**	**28.22**
Jadriya	**0.93**	**0.025**	**0.186**	**0.171**	**31.53**
Za'faraniya	**0.54**	**0.008**	**0.129**	**0.113**	**34.56**

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New Baghdad	**0.57**	**0.011**	**0.149**	**0.103**	**31.33**
Mashtal	**0.63**	**0.010**	**0.117**	**0.116**	**26.75**
Zayoona	**0.64**	**0.011**	**0.165**	**0.118**	**26.62**
Sadr City	**0.67**	**0.011**	**0.119**	**0.121**	**29.03**
Palestine street	**0.77**	**0.017**	**0.149**	**0.139**	**28.62**
Al-Bab Al sharqi	**0.80**	**0.021**	**0.158**	**0.148**	**28.13**
Sha'ab	**0.60**	**0.011**	**0.127**	**0.107**	**29.36**
AL-Adhamia	**0.69**	**0.013**	**0.134**	**0.129**	**28.8**
BabAlMo'adham	**0.39**	**0.0006**	**0.071**	**0.087**	**17.37**
Range	**0.39 - 1.24**	**0.0006-0.036**	**0.071-0.261**	**0.087-0.233**	**17.37-43.98**
Mean	**0.72**	**0.014**	**0.150**	**0.136**	**31.95**
Iraqi standards	**3µg/m^3**				
WHO 1996	**0.5µg/m^3**	**0.05µg/m^3**	**0.25 µg/m^3**	**0.04µg/m^3**	**6µg/m^3**
WHO ,2000	**0.15-0.5**	**0.2**			
WHO ,2001	**0.5 µg /m^3**				
EPA,2005	**0.15µg/m^3**				
MOE, Canada 1989	**2.5**	**0.3**	**2.5**	**0.1**	**2.5**
Abdullah, (2010)	**1.684**	**0.440**	**2.472**	**0.266**	**3.764**
Al- Saadi,(1999)	**9.6**	**0.42**	**1.25**	**11.9**	**21.8**

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Table 3: Mean and range of the present results were compared with the meanconcentrations of the previous local studies.

Variables	Range	Mean	Abdullah, (2010)	Ali, (2013)	Abed, (2015)	Mohamed, (2016)
TSP (µg/m³)	89.02-1915.11	825.244		824.415	357.3	3064.19
CO ppm	0-10	1.61		2.325	0.68	4.2
CO_2 ppm	260-540	440.4		339.22	239.6	125.37
Cdµg/m³	0.0006 - 0.036	0.014	0.440	0.0955	0.0622	0.612
Crµg/m³	0.087 - 0.233	0.136	0.266	0.489	0.0266	0.52625
Cuµg/m³	0.071 - 0.261	0.150	2.472	0.0725	0.0129	0.83875
Pbµg/m³	0.39 - 1.24	0.72	1.684	2.6025	0.2258	5.16375
Znµg/m³	17.37- 43.98	31.95	3.764		0.0396	

3.2 Blood analysis

Environmental heavy metals pollution remain to cause several health defects in humans. Because of the use of leaded gasoline continuously in Iraq and numerous other developing countries, emissions from vehicles are the primary source of heavy metals pollutionin environment. Policemen in traffic are the persons mostly affected by heavy metals pollution from exhaustof automobiles.

Heavy metal concentration levels in blood were used to assess traffic air exposure and were used as diagnostic tool for their toxicity. This study was planned to assess heavy metals levels as a measure for traffic pollutants exposure and heavy metals poisoning among Iraqi traffic policemen and street vendors in Baghdad.

The results revealed high concentration of Cr, Cu, Pb and Zn of exposure comparing with the control with difference significant between the control and exposures groups (Table10),Figure 4and 5, as well as Smokers are slightly higher than non-smokers in both exposures and control groups (Table 5 and 6).

These results agreed with (Azize, 2018 and Mortada., et al 2001) who found there are significanthigh differences between the levels ofheavy metals(Pb and Cd) in the blood of control and workers group.

Also our results agree with Al-Saadi, (2011) who detect the level of Pb, Zn in sera of industrial workers and their results showed highly increase significantly in the concentration

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ofzinc and leadof workers in comparing with the control group, and agree with results of this study in age factor as there in slightly higher significant difference among different age groups, smokers and non-smokers and effect of period ofworks on heavy metals levels.

These results may be due to non-use of facial masks during work that increases the level of heavy metals in blood due to inhalation of (Pb, Cd, Cr, Cu and Zn) present in air and neglect use protective clothing and body wash after work , also this increase may be due to dermal absorption.

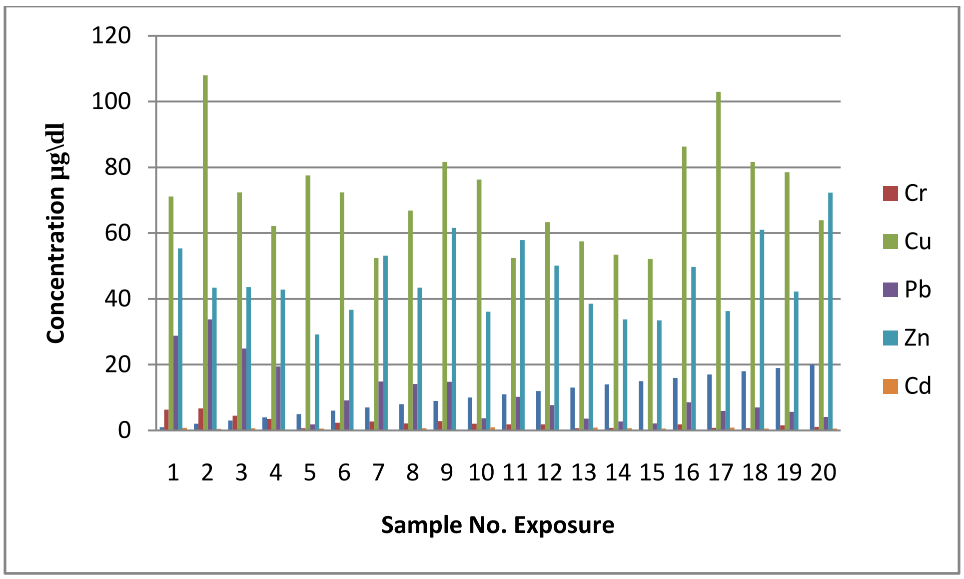

Figure (4) metal concentration in human blood of exposed

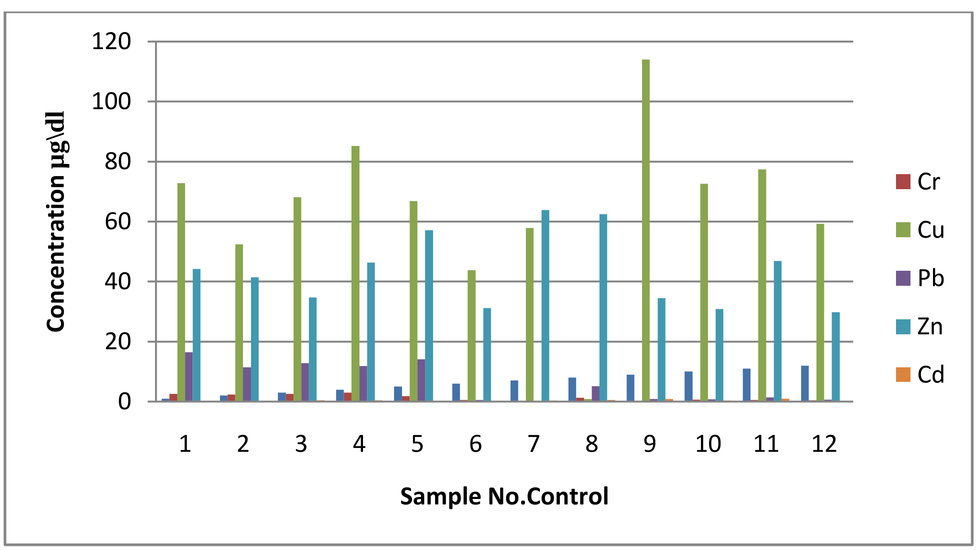

Figure (5) metal concentration in human blood of control

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Table 4 :Metal Concentration (µg/dl) in exposures and controls Blood

Element	exposures (n=20), mean±SE	SD	Min	Max	controls (n=12), mean±SE	SD	Min	Max
Cd	0.504 ± 0.065	0.292	0.1	1	0.355 ±0.076	0.265	0.07	0.9
Cr	2.23 ± 0.405	1.812	0.104	6.71	1.30 ±0.317	1.099	0.236	3.01
Cu	71.67 ±3.521	15.746	52.2	108	64.25 ±7.734	26.792	0.841	114
Pb	11.15 ±2.063	9.230	1.81	33.8	6.35 ±1.841	6.378	0.25	16.4
Zn	46.03 ±2.532	11.325	29.2	72.3	43.60 ±3.523	12.204	29.8	63.8

No significant difference at p< 0.05

Table 5 :Metal Concentration (µg/dl) in Smoker and Non-smoker Blood for exposure

Element	Smokers (n=16), mean±SE	SD	Min	Max	Nonsmokers (n=4), mean±SE	SD	Min	Max
Cd	0.54 ±0.062	0.248	0.12	0.9	0.56 ± 0.202	0.404	0.14	1
Cr	2.15 ± 0.501	2.004	0.104	6.71	2.54 ± 0.374	0.748	1.87	3.54
Cu	73.69 ± 4.132	16.53	52.2	108	63.6 ± 4.886	9.772	52.5	76.3
Pb	11.08 ± 2.473	9.892	1.81	33.8	11.45 ± 3.541	7.083	3.72	19.5
Zn	46.15 ± 3.069	12.27	29.2	72.3	45.52 ± 3.814	7.628	36.1	53.1

No significant difference at p< 0.05

Table 6 : metal concentration (µg/dl) in Smoker and Non-smoker Blood for controls.

Element	Smokers (n=4), mean±SE	SD	Min	Max	Nonsmokers (n=8), mean±SE	SD	Min	Max
Cd	0.26 ±0.070	0.141	0.1	0.42	0.39 ±0.109	0.308	0.07	0.9
Cr	1.96 ±0.558	1.116	0.456	3.01	0.95±0.354	1.003	0.236	2.56
Cu	69.82 ±5.487	10.975	59.2	85.2	61.46 ±11.455	32.400	0.841	114

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Pb	9.84 ±3.091	6.182	0.679	14.1	4.60 ±2.159	6.107	0.25	16.4
Zn	41.97 ±6.114	12.228	29.8	57.1	44.42 ± 4.578	12.949	30.9	63.8

No significant difference at p< 0.05

When the exposures and control persons were categorized according to their age in 2 groups, (19-30) years and (31-48) years, the results revealed no significant differences (p <0.05) between the two studies groups (Table 7 and 8),also there is no significant differences between the two groups accordingto the period of works (1-5, 6-15 years) ,(Table 9).

Table 7: Metal Concentration (µg/dl) in exposures Blood according to ages

Element	Ages from19-30(n=14) mean±SE	SD	Min	Max	Ages from31-48 (n=6), mean±SE	SD	Min	Max
Cd	0.52 ±0.068	0.256	0.12	0.9	0.59 ±0.134	0.330	0.14	1
Cr	2.49 ±0.526	1.971	0.636	6.71	1.64 ± 0.544	1.333	0.104	3.54
Cu	71.82 ±3.901	14.599	52.5	108	71.31 ± 8.039	19.693	52.2	103
Pb	12.13 ±2.714	10.157	1.81	33.8	8.87 ± 2.786	6.826	2.14	19.5
Zn	46.98 ±3.135	11.732	29.2	72.3	43.8 ±4.490	10.999	33.5	61

No significant difference at p< 0.05

Table 8 :Metal Concentration (µg/dl) in controls Blood for ages

Element	Ages from19-30(n=9) mean±SE	SD	Min	Max	Ages from31-48 (n=3), mean±SE	SD	Min	Max
Cd	0.31 ±0.087	0.263	0.07	0.09	0.48 ±0.160	0.277	0.3	0.8
Cr	1.34 ± 0.378	1.136	0.456	3.01	1.15 ±0.719	1.245	0.236	2.57
Cu	57.37 ± 8.258	24.776	0.841	85.2	84.9 ± 14.607	25.301	68.1	114
Pb	6.85 ± 2.189	6.568	0.25	16.4	4.82 ± 3.986	6.905	0.80	12.8
Zn	47.02 ±4.098	12.296	29.8	63.8	33.36 ±1.234	2.138	30.9	34.7

No significant difference at p< 0.05

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Table 9 :Metal Concentration (µg/dl) in exposures Blood for Period of working

Element	Exposure (Yrs)/(1-5) (n=9)mean±SE	SD	Min	Max	Exposure (Yrs)/(6-15) (n=11) mean±SE	SD	Min	Max
Cd	0.58 ±0.089	0.269	0.12	0.9	0.50 ±0.085	0.283	0.14	1
Cr	3.04 ± 0.758	2.274	0.636	6.71	1.54 ± 0.314	1.042	0.104	3.54
Cu	72.34 ± 5.415	16.247	52.5	108	74.68 ± 5.573	18.484	52.2	103
Pb	15.52 ± 3.765	11.297	1.81	33.8	7.76 ± 1.583	5.250	2.14	19.5
Zn	47.01 ± 3.413	10.239	29.2	61.6	41.95 ± 2.71	9.008	33.5	61

No significant difference at $p< 0.05$

Table10: comparison among results of present study and previous studies for exposures

Reference	Pbµg/dl	Cdµg/dl	Cuµg/dl	Znµg/dl	Crµg/dl
Mean	11.15	0.504	71.67	46.03	2.23
Alfaraji, (2018)	1486				
Wąsowicz et al.,(2001)	50.44	1.52	122	50	
Agha et al., (2005)	27.27		93.49		
Kushwaha et al., (2018)	3.47				
Azize (2018)	69	3.5	26.1	53.2	
Al-Shamri et al., (2010)	50		162.4	716.03	
Tayrab et al., (2014)	33.6				
ACGIH (2008)	20	0.5			0.05
OSHA				300	

4.Conclusion

The results of the current study showed that the concentrations of suspended particles in the air of the city of Baghdad were high and exceeded the permitted national and international limits, and that there was an increase in their concentrations during the current year compared to previous years .

Depending on the results of mean concentrations of heavy minerals in air and compared them with World International limits WHO It was found that these heavy metals have on as:

Zn>Cr> Pb > Cu > Cd

When the exposures and control persons were categorized according to their age in 2 groups, (19-30) years and (31-48) years, for detection of heavy metals in blood samples the results revealed no significant differences ($p < 0.05$) between the two studies groups. also there is no significant differences between the two groups according to the period of works.

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