Cancer Risk Assailments Due to Inhale Manganese (Mn) Fly Ash by People in Wasit Governorate – Iraq

https://doi.org/10.31185/wjps.VolX.IssX.XX

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Abstract—The concentration of the heavy metal Manganese (Mn) has been measured for more than one hundred indoor air samples of different locations in Wasit Governorate that is frequented by many people. The samples were taken from the air conditioners of these locations and then washed with distilled water. The Atomic Absorption Spectroscopy (AAS) has been used to measure Mn concentration. The results showed that the concentration of Mn, in general, is higher than the allowed international values. The minimum, maximum, and overall average values of Mn concentration (in\ mg\ m^{-3}) for the investigated samples were 1.13E-04, 2.05E-02 and 3.46 E-03, respectively. Finally, the cancer toxic risks and non-cancer toxic risks have been estimated, and its results were important and cannot be ignored.

Keywords—paper publishing, journals, styles, how-to

1 How to work with this template

2 Introduction

Recently, it is no secret to everyone, especially the Iraqis, about the extent of air pollution with dusty particles that content heavy metals, chemical materials and others pollutants. Many factors have led to an increase in air pollution in Iraq, especially in the cities of Wasit Governorate, the study area in the current study. One of these factors is the bulldozing of agricultural areas and their transformation into residential cities, and thus the loss of major cities to their green belt. The dependence of electricity production on diesel generators and even personal electric generators scattered in city alleys, it works with diesel, which causes a great pollution of air with ash that is saturated with toxic and dangerous Manganese (Mn) [1, 2]. In addition to all of this, the steadily increasing number of cars that use diesel fuel has led to an increase in the concentration of Manganese (Mn) in the atmosphere. Also, the population increase in cities, which is a result of the migration of agricultural village people to cities, is considered an important reason for increasing pollution.

The countries of the world were interested in measuring and treating the air pollution [3-5]. In Thailand (for example) [3], the effect of fireworks on increasing concentrations of minerals in the atmosphere, including lead, was studied. In Nigeria [4], the effect of soil dust on the health of school students was studied. In Iraq, great interest has been in studying radon gas concentrations in the atmosphere and in various cities of Iraq [6-8]. As for the presence of minerals in the air and studying their impact on people, we have not found studies in this direction, especially in Wasit Governorate.

In Iraq, the increase in the incidence probability of all kinds of cancer is a dangerous indicator. Statistics studies have shown a significant increase in the incidence of cancer in all governorate of Iraq, especially breast and lung cancer [9]. Therefore, this study aimed to measure the concentration of an important element, which is lead in the atmosphere of Wasit governorate cities, and internal measurements were adopted in governmental offices such as hospitals, health centers, police stations, etc. to determine the contamination percentage with lead and calculate the possibility of cancer probability incidence.

3 Research Methodology

Special filters were used that contained 10 to 20 μm holes. These filters were placed on the air conditioners in the studied places for different periods of time, and then these filters were removed and treated with distilled water for the purpose of collecting dust attached to it. The collected samples were up to 100 samples. A special calibration was made between what the air conditioner pulls from the amount of air and what a person breathes when resting from the air (which is 7 liters per minute), so the concentration of any metal can be calculated easily in units of mg/m3.

The atomic absorption spectrometry with flame method was used to measure the lead concentration in the study samples. The flame method of atomic absorption is used as a technique known to determine mineral concentrations in environmental samples. In this technique, the thermal energy is sufficient to isolate the chemical compounds into free atoms. Most of the atoms, within the correct flame conditions, remain in the lower state and are able to absorb light within the wavelength of the analysis. The ease and speed in determining element concentrations make atomic absorption technology one of the most common methods of mineral analysis. The steps described in reference [10] were approved in the preparation of samples for examination.

However, in order to estimate the health risk due to inhale of Manganese (Mn) minutes in air of the studied locations, the average exposure to selected metals by inhalation $\{(D\}_{inh})$ for both children and adults, based on individual's body weight during a given period, is computed using eq.(1) [5];

$$D_{inh} = \frac{C * i\,n\,h\,R * E\,F\,q * E\,D}{BW * A\,T}$$

where D_{inh} is exposure by respiratory inhalation $(mg\ kg^{-1} day^{-1})$; $InhR$ is inhalation rate (7.6 and 20 $m3day-1$ for children ($InhRchild$) and adults ($InhRadult$), respectively); EFq is exposure frequency ($day\ year-1$); ED is exposure duration (6 years for children ($EDchild$), 24 years for adults ($EDadult$), respectively); BW is average body weight (15 kg for children ($BWchild$), 70 kg for adults ($BWadult$); AT is the averaging time (for non-cancer toxic risks, $AT\ (days) = ED * 365$; for cancer risks, $AT\ (days) = 70 * 365$; C is exposure-point concentration ($mgm-3$). In this study, the lifetime average daily dose ($LADD$) of selected metals through inhalation is employed for evaluating health risk, as described in eq.(2) [4-5];

$$LADD = \frac{C * EFq}{AT} * \left(\frac{InhR_{child} * ED_{child}}{BW_{child}} + \frac{InhR_{adult} * ED_{adult}}{BW_{adult}}\right) \quad \dots\dots.. \quad 2$$

It is also important to introduce the concept of a hazard quotient. Theoretically, a hazard quotient (HQ) is the ratio of the potential exposure to a selected metal, relative to the level at which no adverse effects is expected. After $Dinh$ is computed, HQ can be obtained using eq. (3) [4-6];

$$HQ = \frac{D_{inh}}{RfD} \quad \dots\dots\dots\dots\dots\dots \quad 3$$

RfD is the reference dose $(mg\ kg^{-1}\ day^{-1})$, which is value $3.52 \times 10-3$ for Pb [6]. If the calculated HQ is < 1, then no adverse health effects are expected because of exposure. Conversely, if HQ is >1, then negative health impacts are possible.

3. Results and Discussions

In this paper, the lead concentration was measured in samples collected from the air of different places in Wasit governorate. Table (1) shows the details of the places from which the samples were collected, which are different places, including governmental places, personal homes, super markets, mobile centers, and etc. These places were chosen on one basis, which is the large number of people who occupy them.

Figure (1) illustrates the histograms of Mn concentrations measured in the examined samples. From this figure, one can note the great variation in measured manganese concentrations, which can be due to many reasons, such as distance from the street, cigarette smoking, proximity to emissions of personal electricity generators, and other reasons. Also, the maximum, minimum, and overall average values of Mn concentrations $(in\ mg\ m^{-3}\ unit)$ have been shown in Table (2), which are (2.05E-02, 1.49E-02), (1.13E-04, 1.16E-04), and (3.46E-03), respectively. The minimum value belongs to S47 sample while the maximum value belongs to S37 sample. However, the results of measuring manganese concentrations were compared with the values of international organizations [11- 13] such as the World Health Organization (WHO) and others, which indicated that most of the measurements were greater than the permissible international measurements and even the overall average of measurements of this paper was much greater, but when comparing these results with the results conducted in other countries such as China [6], the results of this research were approximately close to it, as shown in Table (1). In addition, the children and adults average exposure to Mn by inhalation $\{(D\}_{inh})$ $(in\ mg\ kg^{-1} day^{-1}\ unit)$, and children and adults hazard quotient (HQ) for both non-cancer toxic risks and cancer toxic risks have been calculated and illustrated in Table (1). Although the results of HQ were less than one, it is considered dangerous for non-cancer toxic risks and cancer toxic risks. This can attribute to the fact that the HQ parameter must be calculated for all measured heavy elements but in this paper was estimated for Mn only. Furthermore, the lifetime average daily dose (LADD) of Mn through inhalation has, also, calculated for the investigated samples. As expected, the values of LADD are consistent with the values of the measured concentration, because when calculating LADD parameter, it depends on the

measurements of the concentration. Table (2) shows the minimum, maximum, and overall average values of $LADD_{child}$, which are (900.22, 653.38), (4.97, 5.090) and 152.07, respectively. And the minimum, maximum, and overall average values of $LADD_{adult}$ which are (225.06, 163.34), (1.24, 1.273) and 38.02, respectively. As for Lifetime Average Daily Dose (LADD for adults, LADD for children) in Figure (3.27), it was found that LADD for children is four times the main risk for adults in non-cancer toxic ricks, this shows that children are more exposed to these effects with respect to adults due to the volume of inhalation and the rate of gastrointestinal absorption relatively larger and immature enzyme systems responsible for detoxification and relatively lower excretion rates of toxic substances. As for adults, they are more sensitive because of the history of exposure or the long period of exposure and the increase in the body's stock of some foreign vital substances, and this leads to a decrease in the rate of detoxification and elimination. In addition, LADD for adults is equal to LADD for adults for cancer toxic risks

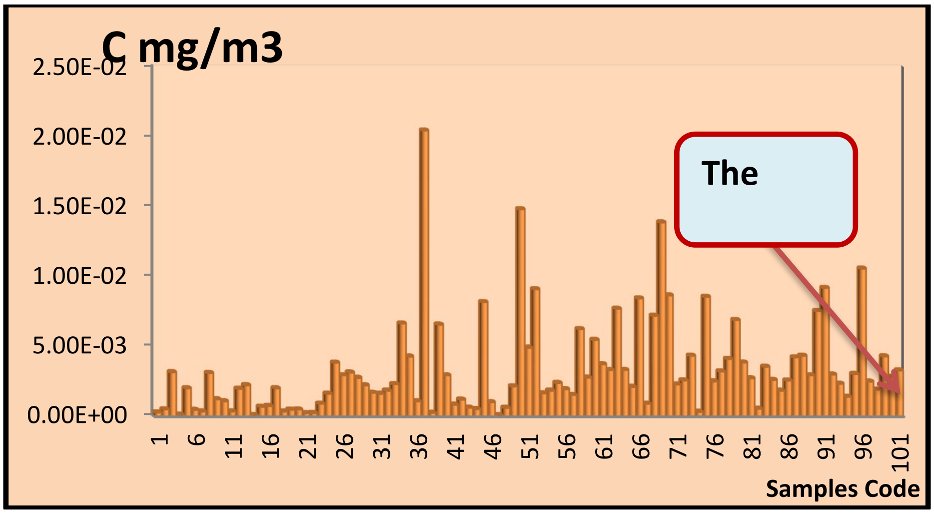

Fig. 1. The manganese concentrations of the measured samples

Table 1. The detailed locations of investigated samples

Samples locations	City Name	Code
Health center of Sheik Saad /Baby care lobby	Sheik Saad	S1
Health center of Sheik Saad /Consulting room	Sheik Saad	S2
Health center of Sheik Saad /Reception	Sheik Saad	S3

Directorate of Education in Wasit /Files room	Al-Kut	S4
Wasit health directorate /Department of individuals	Al-Kut	S5
Gym	Sheik Saad	S6
Coffee Shop	Sheik Saad	S7
Pharmacy	Sheik Saad	S8
Personal house	Sheik Saad	S9
Personal house	Al-Hawrah	S10
Wasit Governorate/ reception	Al-Kut	S11
Wasit Governorate / Inspection of women	Al-Kut	S12
Wasit Governorate / Cadre room	Al-Kut	S13
Medical Clinic	Al-Hoora	S14
Noor Al-Mujtaba School /Class room	Al-Hoora	S15
Noor Al-Mujtaba School /Cafeteria	Al-Hoora	S16
Appellate Court of Wasit /Contracts room	Al-Kut	S17
Appellate Court of Wasit /Social researcher room	Al-Kut	S18
Appellate Court of Wasit /Store	Al-Kut	S19
Zahra Teaching hospital /Pharmacy	Al-Kut	S20
Zahra Teaching hospital /X-ray room	Al-Kut	S21
Zahra Teaching hospital /X-ray room	Al-Kut	S22
Vegetable store	Sheik Saad	S23
Motorcycle shop	Sheik Saad	S24
Riadh Cafeteria	Al-Mashroo	S25
Al-Isnad Company	Al-Mashroo	S26
Drug store	Al-Mashroo	S27
Filling station	Hai Al-Hakeem	S28
Super Market	Hai Al-Hakeem	S29
Super Market	Hai Al-Hakeem	S30
Al-Kut Parking lot /Automotive oils store	Al-Kut	S31
Elsoosn Cafeteria	Al-Mashroo	S32
Kitchens Workshop	Al-Mashroo	S33
Coffee shop	Al-Zahra	S34
Al-Chef Restaurant	Al-Zahra	S35
Coffee shop	Al-Shohada	S36
Gym	Al-Shohada	S37
Exchange port	Al-Shohada	S38
Super market	Al-Khajia	S39
Coffee shop	Al-Khajia	S40
Jassan District directorate	Jassan	S41
Jassan Restaurant	Jassan	S42
Jassan Electricity directorate	Jassan	S43
Jassan Health Center	Jassan	S44
Badra Health Center	Badra	S45

Badra Court	Badra	S46
Badra District council	Badra	S47
Badra Police station	Badra	S48
Filling station	Badra	S49
Air Conditions Workshop	Al-Numaniya	S50
Al-Numaniya General Hospital/ Emergency hall	Al-Numaniya	S51
The Directorate of National Card Affairs in Al-Numaniya	Al-Numaniya	S52
Super Market	Al-Numaniya	S53
Al-Husseiniya health Center	Al-Husseiniya	S54
The Directorate of National Card Affairs in Al-Husseiniya	Al-Husseiniya	S55
Ali Shakir Restaurant	Al-Husseiniya	S56
Personal house	Sheik Saad	S57
The Directorate of National Card Affairs in Sheik Saad	Sheik Saad	S58
Courthouse in Sheik Saad	Sheik Saad	S59
Super Market	Al-Dubuni	S60
Al-Dubuni Health Center	Al-Dubuni	S61
Filling station	Al-Dubuni	S62
Al-Zubaydiya Health Center	Al-Zubaydiya	S63
The Directorate of National Card Affairs in Al-Zubaydiya	Al-Zubaydiya	S64
Directorate of municipalities of Al-Zubaydiya	Al-Zubaydiya	S65
Al-Aziziya Health Center	Al-Aziziya	S66
Al-Aziziya District Directorate	Al-Aziziya	S67
The Directorate of National Card Affairs in Al-Aziziya	Al-Aziziya	S68
Al-Assal Restaurant	Al-Aziziya	S69
Super Market	Hai Al-Kafaat	S70
Hai Al-Jihad health center/ Maintenance room	Hai Al-Jihad	S71
Hai Al-Jihad health center/ Consulting room	Hai Al-Jihad	S72
Health Center	Zain Al-Qaws	S73
Real estate registration	Al-Jaafari	S74
School	Al-Jaafari	S75
Health Center/ X-ray room	District of Al-Dujaili	S76
Health Center/ Men's emergency hall	District of Al-Dujaili	S77
District of Al-Dujaili Municipality	District of Al-Dujaili	S78

Super Market	District of Al-Dujaili	S79
Filling station	Al-Hayy	S80
Al-Salam health center	Al-Hayy	S81
The Directorate of National Card Affairs in Al-Hayy	Al-Hayy	S82
Al-Hayy Health Center	Al-Hayy	S83
Super market	Al-Hayy	S84
Personal house	Al-Hayy	S85
Cell phones shop	Al-Muwafaqiya	S86
Coffee shop	Al-Muwafaqiya	S87
Al-Suwayra General hospital/ Emergency hall	Al-Suwayra	S88
Al-Suwayra General hospital/ Emergency hall	Al-Suwayra	S89
The Directorate of National Card Affairs in Al-Suwayra	Al-Suwayra	S90
Cell phones shop	Al-Suwayra	S91
Super Market	Al-Suwayra	S92
Super Market	Al-Khajia	S93
Personal house	Al-Khajia	S94
Grocery store	Al-khajia	S95
Al-Omal Restaurant	Al-Zahra	S96
Super Market	Damok	S97
Super Market	Damok	S98
Super Market	Tammoz	S99
Super Market	Zain Al-Qaws	S100
Photography Studio	Al-Hoora	S101

Table 2. The minimum, maximum, and overall average values of the concentration ($\boldsymbol{C}$) ($\boldsymbol{mg}$ $\boldsymbol{m}{-}\boldsymbol{3}$), the children and adults average exposure to Manganese (Mn) by inhalation ($\boldsymbol{Dinh}$) ($\boldsymbol{mg}$ $\boldsymbol{kg}{-}\boldsymbol{1}\boldsymbol{day}{-}\boldsymbol{1}$), and children and adults hazard quotient ($\boldsymbol{HQ}$) for both non--cancer toxic risks and cancer toxic risks

Non-cancer toxic risks

Sample Code	C mg/m^3	Dinh children	Dinh adult	HQ children	HQ adult	LADD chield	LADD adult
Maximum in S37	2.05E-02	2.08E-03	1.17E-03	148.25	83.57	900.22	225.06
Maximum in S50	1.49E-02	1.51E-03	8.49E-04	107.602	6.1E+01	653.38	163.34
Minimum in S47	1.13E-04	1.15E-05	6.46E-06	0.82	0.46	4.97	1.24

Minimum in S14	1.16E-04	1.17E-05	6.62E-06	0.839	4.73E-01	5.092	1.273
The overall average	3.46E-03	3.51E-04	1.98E-04	25.04	14.12	152.07	38.02

Cancer toxic risks

Sample Code	C mg/m^3	Dinh children	Dinh adult	HQ children	HQ adult	LADD chield	LADD adult
Maximum in S37	2.05E-02	1.78E-04	4.01E-04	12.707	28.663	77.162	77.162
Maximum in S50	1.49E-02	1.29E-04	2.91E-04	9.223	2.1E+01	56.01	56.01
Minimum in S47	1.13E-04	9.83E-07	2.22E-06	0.070	0.158	0.426	0.426
Minimum in S14	1.16E-04	1.01E-06	2.27E-06	0.072	1.62E-01	0.44	0.44
The overall average	3.46E-03	3.01E-05	6.78E-05	2.147	4.842	13.035	13.035

4 Conclusions

The results obtained in this work strongly support the hypothesis of large air pollution in Wasit Governorate, which can be generalized to all governorates of Iraq due to the great similarity in their environments. This pollution is considered very dangerous as it is caused by heavy manganese, which has a high chemical toxicity, as well as the danger resulting from its large mass when inhaled. This conclusion can be confirmed by the results of this research, which are much higher than what is internationally permissible.

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Article submitted 2 December 2021. Published as resubmitted by the authors 29 March 2022.