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The Domino Effect: Air Pollution And Human Health In Iraq, Sources And Effects.

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Abstract
This investigation focuses on clarifying air pollution in the diverse regions of Iraq giving a strong attention towards the gaseous emissions of many types which are released into the atmosphere. Outstanding gases which have been noted carbon dioxide, carbon monoxide, nitric oxide gases, ozone and Sulphur oxide gases. In addition to that, there are also suspended particles, heavy metals and polycyclic aromatic hydrocarbons. This investigation reveals that the critical sources of these pollutants comprise of the oil industry, vehicles, fossil fuel combustion dust storms and the brick and cement production industry. The volumes of these emissions are currently exceeding the International Standard Criteria and the effects has been exhibited on human health where the population is developing respiratory and cardiovascular complications due to these gases. The implications of air pollution are felt by public health and there is need to explore the relationship between socio-economic factors with air pollution rate. This is very critical when the goal is to reduce the rate of pollution in Iraq. Gaseous chemicals recorded to be noxious have been noted to affect the health of humans and the chemicals include sulfur dioxide, nitrogen oxides, particulate matter and carbon monoxide. Making use of quantitative analysis results show that carbon monoxide, lead and particulate matter are high in cities like Basra, Al-Najaf and Basra, respectively. The highest level of copper has been detected in Duhok with 2710ppm in 2020 and Lead has a concentration of 95.21 ug/m3 in 2017 in Basra. In addition to that carbon monoxide has been staged at 9.127ppm in Karbala whilst particulate matter in Al-Najaf is staged at 9480.17Ug/m3 in 2015. There is also need to apply the right interventions for the purpose of mitigating the impacts of air pollution. In a nutshell, the focus of this analogy is exposing the nexus between air pollution and health-care in Iraq. Simultaneously, there is need for concerted efforts from all stakeholders to manage the pollutants in the atmosphere.

Keywords: Air pollution, Health complications, respiratory complications, cardiovascular complications, aromatic hydrocarbons, ozone, heavy metals.

1Introduction

Air comprises of a mixture of gases and suspended particles and the balanced concentrations sustains life. Critical gases include Oxygen, Carbon dioxide and Nitrogen. These gases and particles exist in different forms and sizes. The compositions of these gases are not stationary rather it is dynamic depending on time and location. Industrial activity is considered to be the major determinant in several chemical reactions (1). Air remains the largest atmospheric transport media which ferries gases and particles from point A to B therefore influencing the contents of regions. This implies that regions of high industrial activity fueled by hydrocarbons tend to have more hydrocarbon gases and particulates than opposite ones (2).

The rising gases in Iraq due to heavy industrial activity, that is, oil extraction and processing, cement production, fossil fuel combustion and the energy production is contributing the public health concern where majority of the population is battling with respiratory challenges due to these noxious and toxic gases (3). The main causes of the exponential rise of air pollution in Iraq and the world at large are a rapid rise in economic and industrial development, infrastructure developments, population growth and an increase in traffic in these recent years. This implies that pollutants are on a rise and therefore population health is compromised (4).

Iraq is no different from many other countries who are struggling with air pollution such as China and India with booming industrial activities. PM2.5 has been recorded in these countries in 2020. The main causatives being rapid industrialization and urbanization. By exploring the sources and the effects, we are capable of curbing the rapid destruction which is currently being experienced. There is need for urgency in dealing with air pollution looking at the gravity of challenges it poses. Of most importance is human health which should be protected diligently. There are many sources of industrial emissions in Iraq which include industrial emissions, vehicle Exhaust, and agriculture practices. All these sources of pollution can be categorized into anthropogenic and natural ones. They shall be discussed in detail below.

The deposition of unwanted materials in the atmosphere is connected to air pollution and this reduces the quality of air which subsequently affects human health. This comprises of human beings, plants and animals which inter-relate in the ecosystem. Air pollution is exhibited through the presence of a hazy or brown color in the atmosphere in the morning or evening. During working hours, facilities such as industries, oil companies as well as cement manufacturing companies produce dusty or black emissions which pollute the air. Smoking being a cultural norm in the country, has been on the rise especially in the young population inducing cancers of the lung passively. In addition to that, these gases have annoying odors which shows how toxic and noxious they are (5).

The accumulation of chemicals such as ozone (O3) in the atmosphere have the potential to destroy the ozone layer which is very important in the insulation of the earth from dangerous rays. In addition to that, an oversupply of chemical gases such as Sulphur destabilize important cycles such as nitrogen and carbon cycles. To a greater extend, the huge and progressive deposit of gases into the atmosphere by anthropogenic and natural factors have the ability to endanger environmental and human health (6). Natural sources of pollution include earthquakes, floods, wild fires and volcanic activities. The Middle East region has been experiencing volcanic activities and wild fires due to an exponential increase in temperatures.

As noted earlier on, health complications are a direct effect of air pollution and complications which have been seen in Iraq include a sudden rise in respiratory and cardiovascular complications. Diseases such as asthma, Bronchitis, lung cancer and chronic obstructive pulmonary disease (COPD) are on the rise. The depletion of the ozone layer is directly connected to the deposit of Carbon monoxide which is catalytic to the production of free radicals which dismantle ozone (O3) and therefore cause an exponential rise in temperature which potentiates skin cancer. Other health conditions which are emanating from air pollution include liver disease, kidney disease and neurological disorders.

Human intake of oxygen per day is estimated to be around 20m3/day (7) which services the human body systems with critical organs being the brain, heart and the kidneys. Air pollution reduces the amount of oxygen which is available for breathing and this will end up affecting human health negatively (8). Studies carried across the world indicate that human exposure to gaseous pollutants is connected to respiratory, and cardiovascular cancer as well as lung and skin cancers (9). The negative impact of air pollution is widespread due to the capacity of the pollutants to travel very long distances hence efforts to thwart the rise of pollutants by cutting carbon production is global (10).

To add, some of the suspended materials and heavy metals such as Lead (Pb) , Arsenic (Ar) and other aromatic hydrocarbons such as benzene have the potential to be transported by water for long distances affected biodiversity in other places which are far. Through the water cycle and energy chains (food chains and webs), these particles are recycled into the atmosphere again thereby continuously damaging the standard atmospheric conditions (11). Effects caused by air pollution are not only connected to the reduction of air quality but also affect the quality and productivity of plants, animals and human life (12).

Iraq has witnessed a deterioration of air quality in recent years and this was mainly caused by an increase in electric power plants which are driven by crude oil. As noted before, the passion for development by the country as well as the exponential rise of the population causes these industries to fully depend on industrial carbon compounds like oil. To thwart this, innovation is needed which can factor in clean and smart and clean technologies such as the zero emission cars (Electric Vehicles) and others. The excessive use of crude oil driven domestic and public generators has also caused a sudden rise in air pollution. Below are the most identified pollutants in Iraq (13)

Gaseous Pollutants: Due to an increase in human population in Iraq together with a rise in industrial development, there has been a sudden increase in the concentrations of emissions which has a negative impact towards human and environmental health (14). In addition to that, we have identified that human activities are the main drivers of air pollution in Iraq especially in urban areas (15) and the main gaseous pollutants are carbon monoxide, carbon dioxide, nitrogen oxides, Sulphur oxides compounds and ozone (16).

1.1 Air pollution in Iraq-Sources.

The quality of air in Iraq has suffered from a diverse of pollutants. One of the prominent sources is dust storms which is quite recurring in the country and these dust storms comes from arid lands. They blanket the city reducing the visibility together with compromising the quality of air (1). Other courses of these dust storms include deforestation and overgrazing of land which increases the frequency and the intensity of these dust storms. Industrial activity is also considered to be one of the greatest sources of pollutants in Iraq. Power plants, oil refineries and other industrial processing contribute to the increase in pollutants in the atmosphere. These harmful pollutants include sulfur dioxide, particulate matter, and nitrogen oxides (3). The effect of these compounds is seen in the health of citizens.

Another source of pollutants is vehicle emissions as the automotive industry continue to burn hydrocarbons. The growing number of trucks and cars in Iraqi has got the potential to affect the air quality significantly especially in urban areas where the traffic is high. Incomplete combustion is another challenge which deposits highly toxic gases into the atmosphere. These gases include carbon monoxide, hydrocarbons and nitrogen oxides and these gases poses a negative impact on the health of citizens (4).

1.2 Health Effects

There is extensive evidence of the negative impact which is caused by toxic gases on humans and biodiversity in Iraq. The polluted air causes a domino effect which generates many afflictions on human beings. The health impacts manifests in form of respiratory complications which is quite pronounced. The diseases which are associated with that include asthma, COPD which is fully known as Chronic Obstructive Pulmonary Disease (5). These afflictions reduce the quality of life of citizens causing early death, indeed, statistics show a high level of mortalities and morbidities in Iraq due to these diseases.

In addition to that, the tiny particles have the potential of causing cardiovascular diseases as they enter into the blood stream. The is a direct correlation between the particles which enters into the blood and the emergence of heart complications. These complications include heart attack, high blood pressure, stroke, and myocardial infarction (6). These burdens do not affect individuals only but rather affect the collective health-care system.
Implications manifest in as neurological impacts, cardiovascular disorders and respiratory disorders. These diseases give a burden to the government in form of morbidities and mortalities. Loss of lives due to health complications caused by air pollution is preventable. Going Green is the way to go (43).

1.2.1 Cardiovascular impact

Air pollution is Iraq has been connected to extensive cardiovascular challenges. These include elevated heart attack and stroke cases across Iraq mainly caused by air pollutants. Other cardiovascular related health challenges include coronary heart attack, and hypertension. In addition to that, it's imperative to note that pollutants and particulate matter induce systemic inflammation, endothelial dysfunction, oxidative stress thereby exposing people to cardiovascular events. This implies that, eliminating the pollutants solve the greater part of the health challenges. The synergistic impact of air pollution effects and other risk factors such as smoking, poor diet increase burden on the cardiovascular symptoms in Iraq (17).

1.2.2 Neurological Effects

Current research shows air pollution poses neuro-toxic effects on the human body. These effects contribute to neuro-developmental disorders as well as cognitive collapse to the victims. The best way out is to clean the air using preventive approaches as well as technological ones. Prenatal exposure to pollutants has been associated with birth defects such as low birth weight and neurological challenges. In addition to that, the chronic exposure to substances such as manganese and lead which are mainly produced from industrial areas causes neurodegenerative disorders which have an effect on cognitive performance (17)

1.2.3 Respiratory Effects

Airborne pollutants such as sulfur dioxide, nitrogen oxides, and nitrogen oxides. These compounds are associated with respiratory challenges such as asthma, chronic obstructive pulmonary disease and several other respiratory disorders. Children and the geriatrics are the population groups which are at great risk therefore they have to be protected. In any given population children and the old population are vulnerable to sicknesses (17).

1.3 Potential Solutions to break the cycle

To combat the challenges which are currently being faced in Iraq, there is need for a multi-pronged approach. Areas to attend to include, government policies which restrict the application of harmful compounds. Vehicles and industries should be controlled in terms of their emissions. Without these restrictions, air pollution will remain a big challenge to the country and as noted above, the cascade effect of high emissions is seen on health of people and animals. Cardiovascular diseases, cancer and other diseases will start to emerge in the community. In addition to that, there is need for the government in collaboration with the private sector to invest into cleaner sources of energy. These include, wind, hydro power and solar power. By opting for this route, the effects which are caused by fossil fuels will be reduced.
The promotion of public transportation as well as encouraging people to use bicycles and walking on foot can potentially reduce pollution levels. There is also need for an upgrade of power plants which produces clean energy with low environmental contamination. This is part of targeting infrastructure and modernize it. Old infrastructure causes more environmental damage than the modern one. Other approaches the community can take include planting trees so as to reduce carbon in the atmosphere. It is quite important that sustainable land management practices are put into practice to reduce the rate of pollution.
Finally, it is quite imperative to note down that public awareness is needed to give awareness to citizens on safe handling of materials with the goal of reducing emissions. The general public should also know the effects of different kinds of pollutions and the implications they cause. To clean the air, collective effort is required. This implies that every citizen should play a role to alleviate the effects of pollutions.

1.4 The oil Boom

One of the big sources of air pollution in Iraq are the rich oil fields which promote oil extraction as well as its processing in Iraq. The oil fields are found both in the North and South parts of Iraq. The Iraqi embassy in Washington has declared that oil operations account for nearly 95% of foreign exchange earnings from the year 1927 to the present day. Iraqi is the fifth largest producer of oil globally with a 5-million-barrel production per day. The operations which are involved in the extraction and processing of the hydrocarbons contaminates the air. Critical processes which cause air pollution include gas flaring which involves the burning of methane gas whilst drilling for the oil (18).

The process of gas flaring produces huge flames which produce toxic and noxious gases such as benzene. These compounds can affect the overall respiratory system. Exposure to some of these hydrocarbons lead to the loss of white blood cells in the body. This certainly destroys the human defense mechanism thereby exposing the body to many illnesses. Exposure to high concentration of these gases can lead to death. Another important aspect is the issue of laws and regulations. Iraqi prohibits oil companies to operate 10Km closer to residential areas for the sake of safeguarding human health. In addition to that, Iraqi is currently implementing tree planting initiative which aims to plant 5 million trees in the entire country (19).

As noted above, oil mining is at the center of economic activities in Iraq as it contributes extensively to the economic and social welfare of the country. It is quite unfortunate that there is a direct correlation between oil mining and air pollution. The burning of aromatic hydrocarbons puts human health at great risk. Below are the sources of air pollution in oil extraction:

1.4.1 Flaring and Venting

The flaring and venting of natural gas have been connected to air contamination. The process of flaring as mentioned above involves the burning of excess gas in the process of oil extraction. The process release greenhouse gases such as methane (CH4) and carbon dioxide (CO2). On the other hand, venting involves the intentional release of gases into the atmosphere. The emission of volatile compounds in the atmosphere 8VOCs) and (HAPs) also known as hazardous air pollutants. The overall effect manifests on biodiversity, that is, on animals, human beings and plants (18).

1.4.2 Equipment and Machinery related emissions

The usage of heavy machinery during drilling process emits particulate matter which is known as PM. In addition to that, sulfur dioxide and nitrogen Oxides (NOx)are generated in the process. In addition to that, the diesel-powered engines which are used in the process of power generation, drilling and transportation produces pollutants that affect the air quality causing health risks to human population (19).

1.4.3 Leaks and oil spills

During extraction, transportation, and storage of oil there is a probability that oil can leak or spill and when this happens, there is a risk of the destruction of biodiversity. Spilled oil emits toxic compounds into the atmosphere, water and the soil. This directly contaminates the ecosystem. Other harmful pollutants which are released include benzene and methyl-benzene which are noxious. Polycyclic aromatic hydrocarbons (PAH) are also dangerous to the ecosystem as they are known to be having, teratogenic, carcinogenic and mutagenic effects (20).

1.4.4 Air pollution and health impacts in the town of Basra, Karbala and Baghdad.

The town of Basra is located in the Southern part of Iraq and it houses many oil production companies. The air quality in Basra, a city that is highly impacted by the oil industry, is seriously threatened by emissions from the extraction and processing of oil. High volumes of nitrogen oxides, particulate matter and sulfur dioxide are produced during manufacturing, extraction and processing of different raw materials. These pollutants have shown to affect the cardiovascular and respiratory systems within the local population. Other chronic respiratory conditions which have been noted in Basra include asthma and Chronic obstructive pulmonary disease (COPD) due to poor quality of air and heavy dust storms.

Heavy construction and vehicle emissions significantly contributes to elevated air pollution in Karbala. During the busiest ours of the day, high levels of carbon monoxide, nitrogen dioxide and sulfur dioxide. Karbala is a religious city hence during festive seasons, the volume of traffic is significantly high. Locals are prone to risk of allergic responses, respiratory diseases or death. There are many cases of people who succumb to respiratory sicknesses in Karbala especially in seasons associated with heavy pollution.

Baghdad being the capital city, the city faces high levels of pollution and its quite complex to deal with the air pollution challenges in Baghdad. There is high traffic level, industrial operations, as well as rubbish burning in the city and this attribute to high level of air pollution in the city. There is high level of SO2, NO and particulate matter in the city. Vulnerable population groups like children and the geriatric population are at great risk. Statistics show that Baghdad inhabitants are at great risk of developing lung cancer and heart complications due to exponential increase in gaseous pollutants (19).

To reduce the total health effects on human beings, there should be comprehensive strategies to combat productions of pollutants. Other strategies include, the use of public transportation, conducting public awareness campaigns as well as tightening emissions volumes. This will preserve the health of people living in the cities of Karbala, Baghdad and Basra.

2 Materials and Methods

Karbala, Baghdad and Basra have shown record high of pollution and the sources are quite a lot such as industrial emissions as well as rapid urbanization. The effects are seen on human health and Basra being an oil producing city, there

air quality is not good. There are high levels oF sulfur dioxide (SO2), particulate matter and nitrogen oxides (NO). The pollutants concentrations are shown in Tables which are below and they show a sharp increase of pollutants with time (20). 18 parts per million of CO was recorded in 2013 yet in 2015 CO concentration became 40.23 million parts per million. In addition to that, air pollution has the potential of increasing bacterial viral diseases incidence rates (21).

For the collection of this data, making use of air quality monitoring stations stationed in towns like Basra, Baghdad and Karbala working with sensors and instruments which are capable to measure gaseous emissions and particulate matter. In addition to that. This data was collected over multiple years and statistically analyzed whilst more data was obtained from secondary data sources
The table below exhibits the concentrations of gaseous pollutants in the different cities of Iraq and noted is the fact that the highest sources of these pollutants are transportation (22), industrial activities, oil combustion (23), diesel generators (24), brick factories (24), petroleum and oil refinery and agricultural fires (25).

Table 1: Concentration of gaseous emissions in Iraq.

CO	NOx	SOx	O3	Measuring Unit	Site	Year
18	1.3	0.9	-	ppm	Basra	2013
13	0.16	0.1	0.09	ppm	Karbala	2013-
40.23	4.25	10.23	0.23	ppm	Basra	2015
15	0.33	0.7	0.09	ppm	Al-Najaf	2015
20	0.339	0.33	0.926	ppm	Baghdad	2016
-	0.682	0.479	-	ppm	Baghdad	2016
-	0.827	0.76	-	ppm	Baghdad	2018
9.127	0.942	0.546	0.015	ppm	Karbala	2018
1.42	1.7	0.45	-	ppm	Babylon	2019
4.4	4	-	-	ppm	Kirkuk	2019
2.632	-	0.4984	-	ppm	Duhok	2020
-	22.5	98.07	-	Ug/m3	Wasit	2020
1.2	26.8	0.6	38.6	ppm	Erbil	2021

2.1The suspended particles

Suspended particles have got the ability of affecting climate, energy balance as well as human and environmental health, the reason being that these materials are toxic and can interfere with the physiological processes, deactivating and activating internal systems (26). Suspended particles which are released from both anthropogenic and natural sources are categorized into primary and secondary sources (27). Primary particles are the substances which are released directly from the source whilst secondary forms are the products of reactions which can happen to the primary particulates. The suspended particles sizes ranges from 0.001 to 100um (28).
From a health care perspective, particles which are lesser than 10um are quite inhalable and therefore can penetrate the respiratory system to cause different kinds of health complications such as lung cancers and COPD (29). Also, continuous exposure to the suspended particles can lead to death especially in the infancy and geriatric populations (30). Another side effect is the contraction of human life expectancy due to an increase of morbidities which paralyze the immune system. Table 2 below shows the total concentrations of suspended particles in different cities of Iraq.

Table 2: Total suspended particles concentrations in Iraq.

TSP	Measuring Unit	Site	Year
3555.6	Ug/m3	Kirkuk	2012
2241.37	Ug/m3	Baghdad	2012
3223.24	Ug/m3	Daura	2014
1400	Ug/m3	Baghdad	2015
9480.17	Ug/m3	Al-Najaf	2015
3985	Ug/m3	Baiji	2016
4000	Ug/m3	Baiji	2016
317	Ug/m3	Baghdad	2016
510.2	Ug/m3	Maysan	2018
2098	Ug/m3	Baghdad	2018
4397.57	Ug/m3	Karbala	2018
6609.68	Ug/m3	Baghdad	2018
1807.28	Ug/m3	Al Diwaniyah	2018

114.94	Ug/m3	Karbala	2018
757.02	Ug/m3	Babylon	2019
1798.1	Ug/m3	Al Najaf	2020
4787.6	Ug/m3	Wasit	2020
55.25	Ug/m3	Erbil	2020

2.2 Heavy Metals

Heavy metals have weight which is above 24 and their density is above 4.5 gm per cm3 Heavy metals such as lead mercury, and arsenic contribute to air pollution in Iraq. The main sources of these heavy metals comprise of industrial effluent, Oil refinery industry, mining, auto-mobile industry, infrastructure engineering and the sea (31) . These materials enter into the biosphere via energy cycles as they are transferred either by water or heat into the atmosphere (32). In as much as heavy materials are beneficial when they are in small quantities (33), it should be noted that large quantities of heavy materials have got a negative implication on the health of biodiversity, they are toxic (34).

2.3 Effects of heavy materials

Effects of heavy materials ranges from neurotoxicity, nephrotoxicity, hepatotoxicity and some have got the potential of inducing cancer or sudden death (35). Congenital abnormalities such as autism and immunotoxicity are exhibited extensively in infants (36). Heavy metals when recklessly disposed enter carried by water enters into the water cycle and distributed into the atmosphere by energy cycles generating acid rain which have potential of damaging plants, animals as well as infrastructure. Heavy metals have got potential of affecting the nervous system (36).

The main sources of heavy metals comprise of the brick industry, oil refinery, industrial activities, road traffic, power plants and home and public generators. The table below outlines the concentrations of heavy metals in the various cities of Iraqi (37). It is also critical to note that these heavy metals have been contributing extensively towards air pollution and subsequently the poor health in Iraq. As noted above Heavy metals have got the capacity of inhibiting receptor sites and enzymatic reactions leading to severe health complications or death (38).

Table 3: The concentration of heavy metals in the cities of Iraq (29).

Pb	Cr	Cd	Cu	Ni	Co	Hg	Measuring Unit	Site	Year
9.08	2.49	0.18	0.22	0.86	-	-	Ug/m3	Kirkuk	2012
24.05	-	0.75	1750	55.50	-	-	Ug/m3	Baghdad	2012
6.50	48.60	0.40	-	26.50	-	-	Ug/m3	Baghdad	2015
1.50	16.51	3.13	5.53	-	6.57	-	Ug/m3	Al-Najaf	2015
-	-	0.14	-	0.63	0.38	-	Ug/m3	Baiji	2016
4.90	0.90	0.13		0.65	0.35	-	ppm	Baiji	2016
95.21	22.99	0.79	--	43.55	-	-	Ug/m3	Basra	2017
45.00	-	1.10	27.10	-	-	-	ppm	Duhok	2018
4.99	-	2.01	7.73	4.93	-	1.82	ppm	Maysan	2018
6.39	1.55	1.58	-	1.39	-	-	Ug/m3	Karbala	2018
94.00	2.02	53.00	3.10	38.70	11.1	-	Ug/m3	Baghdad	2018
3.19	0.33	0.06	5.25	-	-	-	Ug/m3	Al-Diwaniyah	2018
11.23	-	-	-	2.51	3.07	-	Ug/m3	Babylon	2029
0.56	-	1.29	-		--	-	Ug/m3	Al -Najaf	2020
45.00	-	-	2710	-	-	-	ppm	Duhok	2020
4.46	5.554.	0.86	4.16	2.48	-	-	Ug/m3	Wasit	2020
3.85	5.04	1.11	11.25	5.46	2.05	0.08	Ug/m3	Erbil	2022

3 Results and Discussion

The findings exhibited by this study show that air pollution in Iraq comes from different sources with significant contributions coming from both natural and anthropogenic factors. As shown, above, the primary human-induced causes of pollution include industrial activities, energy production-power plants and oil refineries, farming, vehicular emissions. Poor sewer reticulation also contributes to heavy metals pollution. In addition to that, natural factors which contribute to pollution include dust storms and earthquakes which always happen in the region.

The information provides a study of the quantities of heavy metals, total suspended particles (TSP), and gaseous emissions in different Iraqi cities between 2012 and 2022. Carbon monoxide (CO) concentrations varied significantly, with Basra recording the highest levels in 2015 (40.23 ppm) and Babylon recording the lowest (1.42 ppm) in 2019. Significant

variations were also seen in the levels of sulfur oxides (SOx) and nitrogen oxides (NOx), with Basra and Wasit recording particularly high amounts. Wasit in the year 2020 showed high levels of pollution looking on the values of nitrogen oxides, and sulfur dioxide which were 22.5 µg/m³ and 98 µg/m, respectively. Industrial operations, and vehicle emissions contribute significantly to these results.

From the analysis which have been conducted the carbon dioxide concentration has shown variations. In the year 2015, Basra had the highest concentration of carbon dioxide which is 40.2 µg/m³ and in the 2019 the city of Babylon showed the least concentration of 1.4 µg/m³. From the heavy metal analysis which have been carried in Basra and Baghdad, high concentrations of nickel, chromium and lead have been detected. Lead levels was found to be 95 µg/m³ in year 2017 and such amount can potentially affect human health. In the year 2015, chromium concentration was 48.60 µg/m³ and such concentrations show the need to intervene in the industrial production by applying rules and standards which cut emissions. A comprehensive approach to deal with air pollution in every particular city is needed to save public health and the environment.

3.1 Air pollution Effects on Health in Iraq.

The effect of air pollution on Iraq s public health is extensive and multifaceted. This investigation has proved that there is a positive correlation between exposure to atmospheric pollutants and many health outcomes such as respiratory illnesses which comprises of COPD, asthma, and several other respiratory infections. Some of the cardiovascular infections which have been detected in the elderly population is connected to heavy metals pollutants and poor air quality. some of the health implications which have been observed include preterm birth and low birth weight and this stress the impact the effects of atmospheric pollutants on maternal and child health.

3.2 The dominant air pollutants and their health impacts

Common gases, emitted from vehicles and industrial plants, which has been seen to affect the respiratory system include sulfur dioxide SO2 and nitrogen dioxide.

NO2 and SO2 are the common gases which are linked to terrible respiratory complications in Iraq. In addition to that, the effect of these gases is also exhibited in the reduction of lung efficiency in the Iraq population. Sulphur dioxide has been connected to respiratory irritation and the worsening of asthma and COPD. Volatile compounds and ozone (O3) have been detected too and they contribute to the development of secondary pollutants which put public health at great risk. Further investigations have shown that there is a correlation between high air pollution and the incidence of cancer in the human population.

3.3 Prevention ways and effects of current policies

With the current concentrations, the government of Iraq should prioritize strategies which reduce the emission of noxious and toxic gases in the environment. The urgent application of a multi-faceted approach in dealing with the current gases is needed. These approaches include, public awareness, a building of solid regulatory framework and its enforcement. In addition to that, some of the critical approaches include, international cooperation and the application of technology in dealing with pollution. Emissions standard should be applied to control the volume of gases produced per year in Iraq. Clean energy should be promoted and these include solar and hydro-electricity. Above all, close monitoring and surveillance is needed to keep the gases under check.

4 Conclusions:

From an analysis which has been carried from the year 2012 to year 2022, data shows that many cities are bracing with the challenge gaseous emissions, heavy metals and TSP (Total Suspended Particles). Basra and Wasit showed the highest concentrations of sulfur dioxide, nitrogen dioxide and carbon monoxide. The main sources of these gases include vehicle emissions and industries in these cities. High level of TSP was seen in Al-Najaf and Wasit and this was attributed to desert dust as well as industrial activities. Baghdad and Basra exhibited high concentrations of heavy metals such as Nicle, Chromium, and lead which threaten human health.

The application of immediate action is required combined with a variety of strategies to combat the air pollution problem. There is need for the government to design and apply strict rules and regulations which have capacity to control industrial emissions and those which promote greener energy sources. In addition to that, for the purpose of raising awareness, campaigns should be conducted. It is imperative to take into consideration proper land management techniques to reduce the effects of air pollution. Furthermore, clean technologies should be opted for instead of fossil fuels for example electric vehicles and renewable energy sources.

Ultimately, reducing the negative effects of air pollution on human health and the environment requires cooperation between the public, business, and governmental sectors. Through analyzing and reviewing many investigations conducted on air pollution and its health implications in Iraq, here are my deductions: There is an increase in suspended particles in Iraq thereby causing an increase in air pollution. The sources of pollution are fossil fuels combustion, oil refinery, fuel stations and power generation industries. Investigations show that most of the respiratory and cardiovascular infections

are caused by the noxious and toxic pollutants which are rising exponentially in Iraq. There is need for government to put quotas and regulations on industries and big operations regarding carbon volumes as well as industrial effluent discharge. This thorough analysis highlights the variation and intensity of air pollution in Iraqi cities, highlighting the regional origins of pollution and emphasizing the necessity of specialized intervention tactics. The conclusions urge quick action to improve air quality monitoring, impose more stringent emission regulations, and put sustainable urban design techniques into effect. It is imperative that these environmental issues are addressed in order to protect public health, advance sustainable development, and enhance Iraqi citizens' quality of life in general.

In summary, the data emphasizes how urgently Iraqi air quality control needs to be approached in a coordinated and proactive manner. Policymakers may lessen the negative effects of air pollution and clear the path for a healthier and more sustainable future by placing a high priority on environmental health and funding pollution control technologies.

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