

Investigation of Air Quality in Medical Centers in Different Places in Basra Province, South of Iraq

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Abstract— To prevent nosocomial infection in patients, maintaining acceptable indoor air quality (IAQ) in medical centers (MCs) is crucial. The properties of IAQ in several medical centers were investigated in this study. The aim of this was to focus on some indoor air pollutants in different medical clinics. Models of air samples were measured inside several medical clinics in Basra province. The results of TVOC, CH₂O, and PM_{2.5} were distributed between exceeding the standard limits and others within the standard. The results in the urban (center of Basra city) were within the legal limits for TVOC and CH₂O, but the rural areas were above the legal limits in those areas. PM_{2.5} were above legal limits but urban sites had the highest. Healthcare workers and patients are exposed to a variety of chemicals that vary with the activities and products used. The presence and exposure of VOCs, CH₂O, and PM_{2.5} may lead to health effects on the patient people. Variation between rural and urban sites in pollutants concentration was clear.

Keywords— clinics indoor air, particulate matter, carbon dioxide, contamination.

I. INTRODUCTION

The concept "indoor air quality" (IAQ) is frequently used to refer to the air quality inside a building. Human exposure to air contaminants in enclosed spaces can harm occupant health. Carbon dioxide (CO₂), carbon monoxide (CO), formaldehyde (HCHO), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), total volatile organic compounds (TVOCs), and particulate matter are common air pollutants that decrease IAQ (Abdul-Wahab et al., 2015). As air pollution, whether indoor or outdoor, is considered a significant cause of environmental health problems, poor indoor air lies due to the lack of clarity of the sources, where the sources of outdoor air pollution such as traffic, industry, construction, combustion sources, etc. In addition, the human being in his natural state spends most of the time in indoor environments, so indoor air quality should be taken care of and more attention, in addition to the emergence of a new risk which is the presence of a disease, for example, Covid – 19 virus, so there are many auditors inside private medical clinics made them vulnerable to its spread to many of patients and touching, because the virus remains for hours on the surfaces, which contributed significantly to the bad and poor air through the use of disinfection, spraying clinics with chlorine and the use of alcohol to sterilize hands, as well as the excessive use of sterile materials, increased the presence of many pollutants, including formaldehyde, small suspended particles, and volatile organic compounds (Caabay, 2020).

Formaldehyde (HCHO) is a colorless, reactive, strong-smelling gas at room temperature. It is one of a large family of chemical compounds called volatile organic compounds VOCs, it is a common constituent of adhesives used in particle boards, carpeting, household cleaners, paints, personal care products, and furniture, it is considered a carcinogenic that causes cancer of the nasal cavity in workers exposed in their jobs at a remarkably high level of exposure (thousands of ppb or higher). Formaldehyde is just one of several gasses present indoors that may cause adverse health effects and illnesses. Exposure to moderate levels of HCHO (hundreds of ppb or greater) can cause several irritant symptoms, including temporary burning of the eyes or nose and a sore throat (Salthammer et al., 2010; U.S CPSC, 2013).

It is frequently used as a guide to assess whether chemical levels are elevated in air samples to calculate the total of all individual VOCs, or TVOCs. These levels usually represent the potential of occupant irritation and discomfort. TVOCs can cause symptoms that range from minor irritability to levels of toxicity that ultimately result in death (Manisalidis et al., 2020).

VOCs, as categorized by WHO, are compounds with a boiling point less than 250° C. Volatile compounds with boiling points between 0 – 100 C°, are gases, whereas the compounds with boiling points



between 100 – 250 °C distributed between air and water body surfaces or solid surfaces (WHO, 1989; U.S EPA, 2011).

Numerous indoor VOCs may worsen IAQ by causing sensory reactions such as odor discomfort and eye and airway irritation (Berglund and Lindvall, 1990, WHO, 1989)

A wide range of different emission sources, such as building-related materials including furniture and equipment (Levin, 1992), consumer and domestic products, and other items, is the source of VOCs. Depending on spatial and temporal patterns, some sources, including human activities (Hernandez et al., 2020; Chaudhuri et al., 2022). Particles (PM) are classified as PM₁₀ (respirable particles with a diameter of 10 $\mu\text{g. m}^{-3}$ or less) and PM_{2.5} (particulates having a diameter of 2.5 $\mu\text{g. m}^{-3}$ or less). According to WHO, the inhalation of particles causes the deaths of more than 2 million people worldwide (WHO, 2005). Lung cancer and heart failure are likely to increase with continued exposure to respiratory particles (Pope et al., 2002). The risk of an unexpected heart attack increases with particle exposure in some cases (Borrega et al., 2006) Particles can contain dangerous and toxic compounds such as fluoride, lead, nickel, zinc, iron, and copper (Kermani, 2002; Dobaradaran et al., 2009).

It is important to compare air quality values with legal values. It is recommended that the threshold limit of TVOCs value is 0.1 ppm TLV-TWA* and 0.3 ppm TLV-STEL and 0.3 to 0.5 mg/m³ is Acceptable for formaldehyde, while the threshold limit value is 25 $\mu\text{g}/\text{m}^3$, based on 24-hour data for PM_{2.5}.

Jonah (2020) Studied the determination of some air pollutants and meteorological parameters in Abattoir in Nigeria. The result is an indication of the presence of possible air pollutants in the study area which may result in many health problems.

There is a lack in this kind of research, some studies included the ambient air of the city focusing on outdoor activities. The study of Shehabalden&Azeez (2017) on the air quality of Basra province and Mashkhol et al. (2021) on monitoring of total hydrocarbons and particulate matters in AL Nasiriya City, South of Iraq. The aim of this was to focus on some indoor air pollutants in different medical clinics.

II. MATERIAL AND METHODS

The study included the collection of air samples from specialized medical clinics in Basrah governorate and some districts. The study covered several areas, Bariha, Al – Abbasiya, Al – Ashar, Old Basrah, Al – Jumhuriya, Al – Zubair, and Al – Hayyania, for a period that exceeded six months, with three clinics in each medical complex, two days a week. The measurement period was for half an hour in each clinic, noting that the measurements are carried out in medical clinics where the number of patients ranges from 10 to 25 patients. The ventilation system in clinics is a vacuum in addition to the air conditioner.

The concentrations of several pollutants in the indoor air of the clinics, which are formaldehyde, volatile organic compounds, and suspended particles, were measured using an Air detector, picture 1.

The patient waiting room area in which the measurement was made inside the clinic ranges from 3 x 4 to 5 x 6 square meters; sterilization was carried out using chlorine and ethyl alcohol 70%, in addition to the hand sanitizer gel and adherence to safety and security measures at the time of the pandemic, such as the spacing between patient chairs and making sure to wear a mask, the number of patients ranges from 10 – 25.

The measurements were done in nearly the same circumstances (average temperature $35\pm 3^\circ\text{C}$ and relative humidity $40\pm 6\%$).



Picture 1: Air monitoring device

The working period in the clinics was three hours per day, and the number of visits to medical clinics according to the specialty was the following (Table 1):

Table 1: Number of visits to different medical clinics during the study

Clinic specialty	No. of visits
Gynecological diseases	10
Surgery	10
Dermatology diseases	10
Esoteric diseases	17
Respiratory diseases	5
Joints and fractures	10
Pediatric	10

Statistical Analysis

All data were collected and grouped using MS-Excel 2021. The statistical analyses were performed using SPSS software with a 95% confidence level.

III. RESULTS

The results of indoor air quality during this study showed a variation of indoor air pollutants among 124 sites distributed between urban and rural sites. Table 2 showed that TVOC ranged from 0 to 0.1 ppm in urban sites, while it was from 0 to 5.631 ppm in rural sites. The other pollutant CH₂O ranged from 0 to 0.013 ppm in urban sites, while it was from 0.009 to 0.8441 ppm in rural sites. Particulate matter showed variation also ranging from 4 to 154 $\mu\text{g}/\text{m}^3$ in urban sites, while it ranged from 8 to 41 $\mu\text{g}/\text{m}^3$ in rural sites.

The spatial variation was significant ($P \leq 0.5$) between urban and rural sites, and the data of urban sites were within the range of data reviewed by WHO (150-230 $\mu\text{g}/\text{m}^3$).

The non-attainment can be attributed to re-suspended dust, photocopier and vehicular movement, the use of rug and carpet in offices, air fresheners, and printers.

Table 2: The median, standard deviation, range, minimum, and maximum of the indoor air pollution

		Median	±Standard Deviation	Range	Minimum	Maximum
URBAN	Tvoc	0	0.00277	0.1	0	0.1
	CH ₂ O	0	0.002	0.013	0	0.013
	PM _{2.5}	23.5	25.289	150	4	154
RURAL	Tvoc	0.1025	1.404883	5.631	0	5.631
	CH ₂ O	0.053	0.26511	0.835	0.009	0.844
	PM _{2.5}	15	6.69	33	8	41

Figures 1 to 3 showed spatial variation between rural and urban sites as the average of VOCs and $PM_{2.5}$ were 1.05 ppm and $30.37 \mu\text{g}/\text{m}^3$ respectively higher in urban than rural sites. The average concentration of CH_2O was 0.16 ppm higher in rural than urban sites.

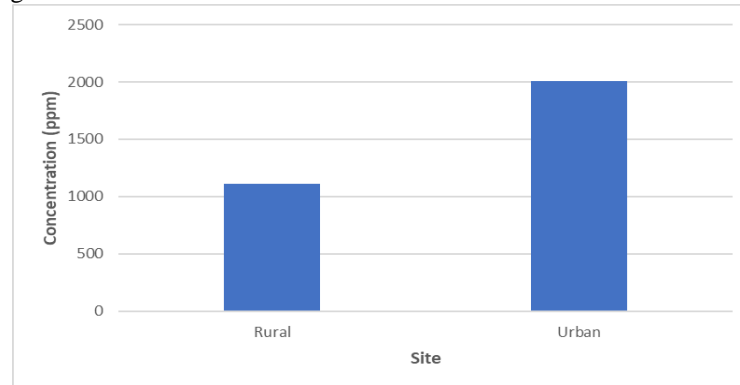


Figure 1: Concentration of VOCs in rural and urban sites of Basra province

Figure 1: Concentration of CH_2O in rural and urban sites of Basra province

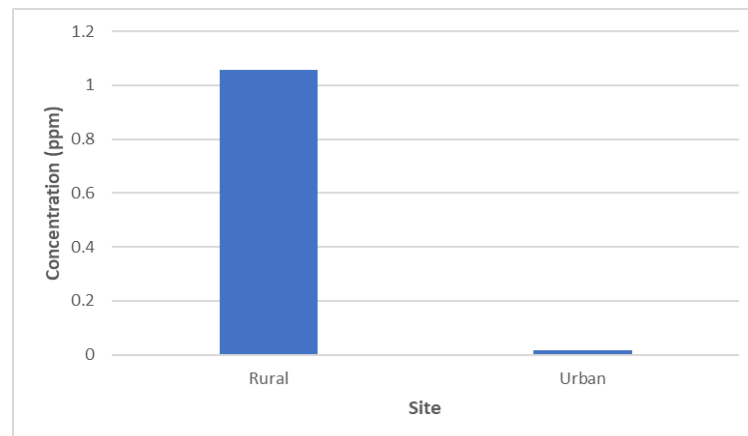


Figure 2: Concentration of CH_2O in rural and urban sites of Basra province

Figure 2: Concentration of VOCs in rural and urban sites of Basra province

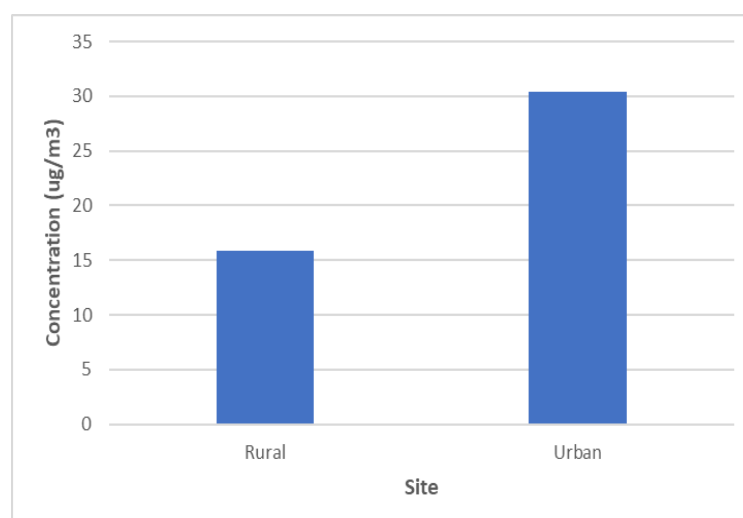


Figure 3: Concentration of $PM_{2.5}$ in rural and urban sites of Basra province

Figure 3: Concentration of $PM_{2.5}$ in rural and urban sites of Basra province

IV. DISCUSSION

The existence of a pollution source, as in buildings, is an essential element in determining indoor air quality. Many clinic buildings have different Environmental tobacco smoke, formaldehyde from furniture, and various organics from other sources are common office contaminants. Cleaning materials and activities, air fresheners, building materials, carpet. Pesticides used in pest management are another source of contamination.

Models of air samples were measured inside several medical clinics in Basra province. The results of TVOC, CH₂O, and PM_{2.5} were Distributed between exceeding the standard limits and others within the standard. The results in the urban (center of Basra city) were within the legal limits for TVOC and CH₂O, but the rural areas were above the legal limits in those areas. PM_{2.5} were above legal limits but urban sites had the highest.

The concentrations of CH₂O were high due to the use of disinfectants significantly (Ghasemkhani et al., 2005). The presence of laboratories in those sites that use this substance for various purposes, in addition to the lack of commitment of satisfied people and escorts for smokers who smoke in places close to the clinic and this, leads to the high concentration of CH₂O as well as the presence of traffic congestion and the lack of suitable parking in addition to the proximity of medical clinics to the main roads, which led to high concentrations (Wang et al., 2018).

Also, for VOCs, the areas of rural are high due to the use of different materials for cleaning and the use of disinfectants within clinics (Hytinen et al., 2021), as well as the presence of many insects and mosquitoes in the areas surrounding the medical clinics, which leads to the use of insecticides significantly as they are areas of an agricultural nature in the first place as well as the frequent use of generators in times of power outages and working long hours makes them one of the most important reasons for the increase of these compounds as well as the presence of restaurants that use barbecue operations have a role In the spread of fumes and also "the company of several cafes frequented by people and the progress of hooka frequently and the spread of its smoke (Zhou et al., 2017), which leads to the high concentration of these compounds within medical clinics where the place is located in a crowded market containing a lot of different commercial events.

As for PM_{2.5} So, their rates are high due to the work of generators when the power outages, as well as traffic congestion as well as the movement of cars on roads that are not paved or with bad paving, be one of the reasons that lead to high rates of short minutes (White et al., 2005). Still, inside the clinic, it is possible that the minutes resulting from the large dust that enters the clinic through the cooling devices (split air conditioner) and the lack of clear air inside the clinic, so the machines must be continuously and work periodic maintenance due to the large dust resulting from the A/C devices (and the lack of clear air inside the clinic, so the machines must be continuously and work periodic maintenance due to a large amount of dust resulting from the large dust resulting from the A/C and the lack of clear atmosphere inside the clinic. From the external air and lack of vegetation in particular, "the weather in Basra is where dust storms are a common condition at present" due to the transformation of agricultural land into residential land in most areas of the outskirts of Basra, the lack of interest in tree planting, the creeping desertification towards Basra areas and the drought of rain in Basra are all reasons why the minutes of dust type PM_{2.5} increase in concentrations in locations outside the city center.

V. CONCLUSIONS

Healthcare workers and patients are exposed to a variety of chemicals that vary with the activities and products used. The presence and exposure of VOCs, CH₂O, and PM_{2.5} may lead to health effects on the patient people. Variation between rural and urban sites in pollutants concentration was clear.

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