

Understanding Air Pollution in Karbala: A Community-Based Study on Awareness, Sources, and Impacts

(A Graduation Project as Part of The Requirements for Obtaining a Bachelor's Degree in Pharmaceutical Sciences from Al-Zahrawi University College in Karbala)

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Abstract

Background: Air pollution poses a significant threat to public health globally, leading to millions of premature deaths each year. In Karbala, Iraq, the unique demographic and geographic characteristics, coupled with large population influxes during religious events, exacerbate air pollution levels. This study investigates the awareness, sources, and impacts of air pollution in Karbala.

Objective: The study aims to assess the level of awareness among Karbala residents regarding air pollution and its health impacts, identify primary sources of air pollution, and evaluate the environmental and health impacts on the local population.

Methods: A community-based survey with 494 participants was conducted from January to February 2025. The survey included a structured questionnaire with sections on demographics, sources of pollution, awareness and perception, and impacts. Data were analyzed using descriptive statistics, cross-tabulation, chi-square tests, and thematic analysis for qualitative data.

Results: Significant associations were found between awareness levels and perception of health impacts, sources of pollution, and demographic characteristics. Transportation and industrial activities were identified as the primary sources of air pollution. Residents living in urban areas and using private vehicles reported higher awareness and concern.

Conclusions: The study highlights the high awareness of air pollution among Karbala residents and identifies transportation and industrial activities as major pollution sources. Tailored interventions, public awareness campaigns, emission reduction initiatives, and improved urban planning and transportation policies are recommended to mitigate air pollution and improve public health in Karbala.

Keywords (Air pollution, Environmental Impact, Awareness, Karbala, Community Survey)

1. Introduction

Background

Air pollution is a significant environmental and public health issue that affects both developed and developing countries. It is caused by the presence of harmful substances in the atmosphere, such as particulate matter (PM), nitrogen dioxide (NO₂), sulfur dioxide (SO₂), carbon monoxide (CO), and ozone (O₃). These pollutants originate from various sources, including industrial activities, transportation, residential energy use, and natural events like wildfires. ⁽¹⁾

Globally, air pollution is responsible for millions of premature deaths each year and contributes to a wide range of health problems, including respiratory infections, heart disease, stroke, lung cancer, and chronic obstructive pulmonary disease (COPD). ⁽²⁾

The World Health Organization (WHO) estimates that around 99% of the global population breathes air that exceeds WHO guideline limits, with low- and middle-income countries suffering from the highest exposures. Additionally, air pollution is closely linked to climate change, as many of the drivers of air pollution, such as the combustion of fossil fuels, are also sources of greenhouse gas emissions. ⁽¹⁾

Air pollution has significant health impacts, affecting millions of people worldwide. Here are some of the key health consequences:

- Respiratory Issues: Exposure to air pollution can cause or exacerbate respiratory conditions such as asthma, bronchitis, and chronic obstructive pulmonary disease (COPD). Fine particulate matter (PM_{2.5}) can penetrate deep into the lungs and even enter the bloodstream, leading to inflammation and respiratory infections. ⁽²⁾
- Cardiovascular Diseases: Air pollution is linked to an increased risk of heart disease, stroke, and hypertension. Pollutants like PM_{2.5} and nitrogen dioxide (NO₂) can cause inflammation and oxidative stress, which can damage blood vessels and the heart. ⁽²⁾

- Lung Cancer: Long-term exposure to air pollution, particularly to pollutants like PM_{2.5} and polycyclic aromatic hydrocarbons (PAHs), is associated with an increased risk of lung cancer. ^{(2) (3)}
- Neurological Effects: Emerging research suggests that air pollution may have adverse effects on the brain, potentially contributing to cognitive decline, dementia, and other neurological conditions. ⁽¹⁾
- Adverse Pregnancy Outcomes: Pregnant women exposed to high levels of air pollution are at a higher risk of adverse pregnancy outcomes, including low birth weight, preterm birth, and stillbirth. ⁽¹⁾
- Increased Mortality: Air pollution is a leading cause of premature death globally. It is estimated that air pollution contributes to millions of deaths each year, with a significant proportion of these deaths attributable to noncommunicable diseases (NCDs) such as heart disease, stroke, lung cancer, and COPD. ⁽⁴⁾

Aim of the Study

The purpose of this study is to investigate the awareness, sources, and impacts of air pollution in Karbala, Iraq. Karbala is a relevant location for this research due to its unique demographic and geographic characteristics, as well as its cultural and religious significance. The city experiences significant population influxes during religious events, such as the Arbaeen pilgrimage, which can exacerbate air pollution levels. ⁽⁵⁾

By conducting a community-based study, this research aims to:

- Assess the level of awareness among Karbala residents regarding air pollution and its health impacts.
- Identify the primary sources of air pollution in the city.
- Evaluate the environmental and health impacts of air pollution on the local population.

2. Materials and Methods

Data Collection

A community-based survey was conducted to assess the awareness, sources, and impacts of air pollution in Karbala, Iraq. The survey included a total of 494 participants, selected through a combination of convenience and random sampling methods to ensure a representative sample of the population. Data collection was carried out over a period of two months, from January to February 2025.

Survey Design

The survey instrument consisted of a structured questionnaire with closed-ended questions. The questions were in Arabic Language, so Iraqi people can understand them.

ضع دائرة او علامة صح حول الإجابة			
العمر	40-16 سنة	60-40 سنة	أكثر من 60
الجنس	ذكر	انثى	
مكان العيش	مدينة	ريف	
التحصيل الدراسي	اعدادية	جامعة	لا يوجد
وسيلة النقل التي تستخدمها	مركبة خاصة	نقل عام	
تعتقد بوجود مشكلة تلوث هواء في منطقتك؟	نعم	كلا	لا اعرف
درجة تلوث الهواء في منطقتك؟	بسيطة	متوسطة	شديدة
تلبس الكمامة إذا شعرت بتلوث الهواء؟	نعم	كلا	
هناك علاقة بين تلوث الهواء وحرق النفايات من البلدية؟	نعم	كلا	لا اعرف
هناك علاقة بين تلوث الهواء وعدد السيارات والدراجات؟	نعم	كلا	لا اعرف
هناك علاقة بين تلوث الهواء ومولدات الكاز؟	نعم	كلا	لا اعرف
الحكومة تبذل جهود كبيرة لحل مشكلة تلوث الهواء؟	نعم	كلا	لا اعرف
هناك علاقة بين تلوث الهواء وسرطان الرئة؟	نعم	كلا	لا اعرف
انت مستعد لاستبدال سيارتك بسيارة كهربائية اقل كفاءة من اجل الحفاظ على البيئة؟	نعم	كلا	
انت مستعد لترك وسيلة نقلك الخاصة السريعة وركوب وسيلة نقل عامة بطيئة من اجل الحفاظ على البيئة؟	نعم	كلا	
اعادة تدوير النفايات سيحل مشكلة تلوث الهواء؟	نعم	كلا	لا اعرف
انت مع منع الأطفال من الذهاب للمدرسة إذا ارتفع تلوث الهواء عن الحد الطبيعي؟	نعم	كلا	
انت تعلم بالضبط ارقام قياسات مصطلح AQI وتحفظ ماذا يعني مصطلح درجة نقاوة الهواء؟	نعم	كلا	
هناك اهمال متعمد من اعلام وزارة الصحة لهذا الموضوع؟	نعم	كلا	لا اعرف
هناك كبريت ومواد صناعية سامة في هواء منطقتك؟	نعم	كلا	لا اعرف
انت مع فرض غرامات قاسية على السيارات والدراجات النارية التي تنفث الدخان؟	نعم	كلا	
هناك علاقة بين تلوث الهواء وعمر الانسان؟	نعم	كلا	لا اعرف
العراق من ضمن اسوء دول العالم في درجة نقاوة الهواء؟	نعم	كلا	لا اعرف
بغداد من ضمن اسوء مدن العالم في درجة نقاوة الهواء؟	نعم	كلا	لا اعرف

3. Results

Data Analysis

The survey responses were entered into a Microsoft Excel Database and analyzed using statistical software (Prism, version 10.4.1). Descriptive statistics, such as frequencies and percentages, were calculated to summarize the demographic characteristics and awareness levels of the participants. Cross-tabulation and chi-square tests were used to explore associations between demographic variables and awareness/perception of air pollution.

For the qualitative data from closed-ended questions, thematic analysis was conducted to identify common themes and patterns in the participants' responses. The findings were organized into categories based on the sources of pollution, awareness and perception, and health/environmental impacts.

Table1: Association Analysis Between Categorical Variables

	Q1 vs Q15	Q1 vs Q16	Q1 vs Q21	Q1 vs Q22
P-value	<0.0001	<0.0001	<0.0001	<0.0001
	Q2 vs Q8	Q2 vs Q9	Q2 vs Q17	Q2 vs Q18
P-value	0.0014	<0.0001	<0.0001	0.0003
	Q3 vs Q6	Q3 vs Q7	Q3 vs Q12	Q3 vs Q20
P-value	<0.0001	<0.0001	<0.0001	<0.0001
	Q4 vs Q10	Q4 vs Q11	Q4 vs Q13	Q4 vs Q14
P-value	<0.0001	<0.0001	<0.0001	<0.0001

Categorical variables were described as frequency and percentage. Association between these variables was assessed by using Chi-square test, the cut-off limit of significance was set to < 0.05 .

The survey responses were entered into a Microsoft Excel Database and analyzed using statistical software (XLSTAT 2019).

Figure 1: Age of Participants

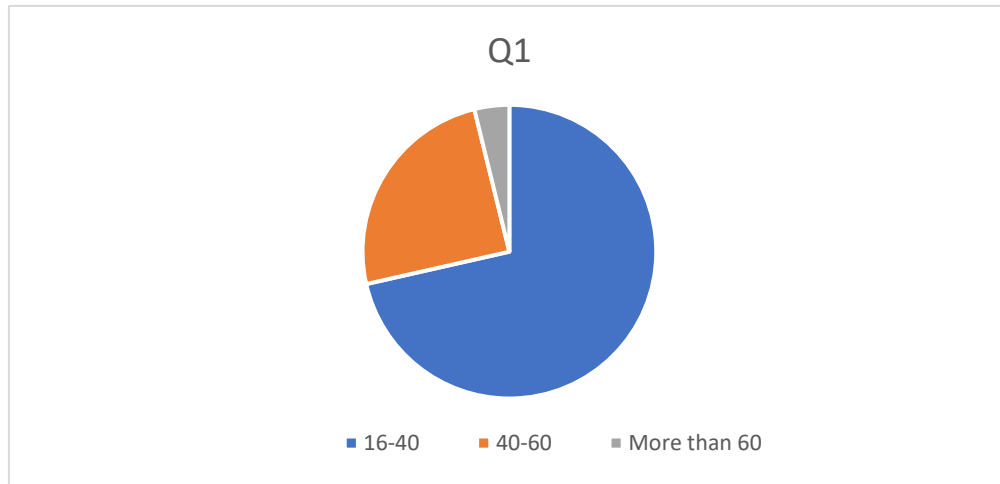


Figure 2: Gender of Participants

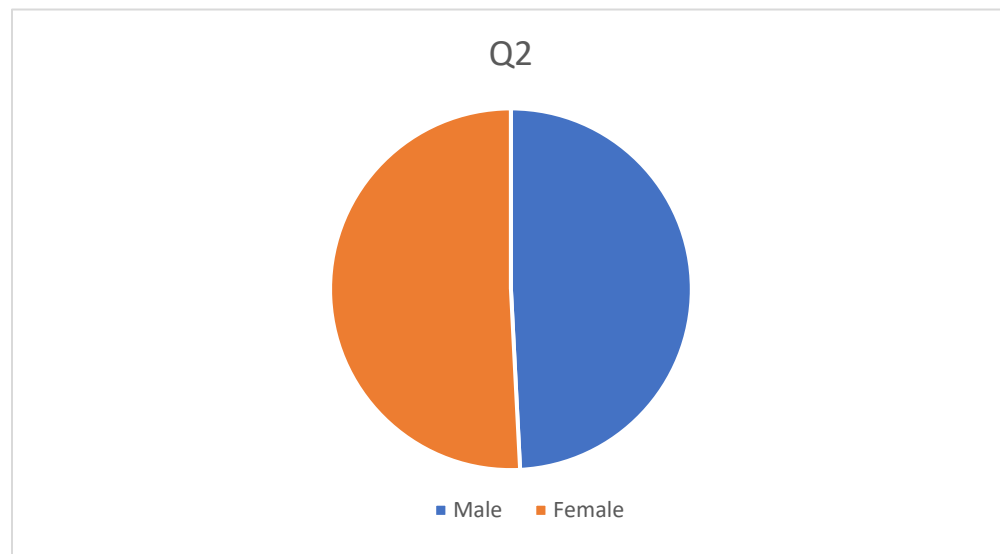


Figure 3: Living Place of Participants

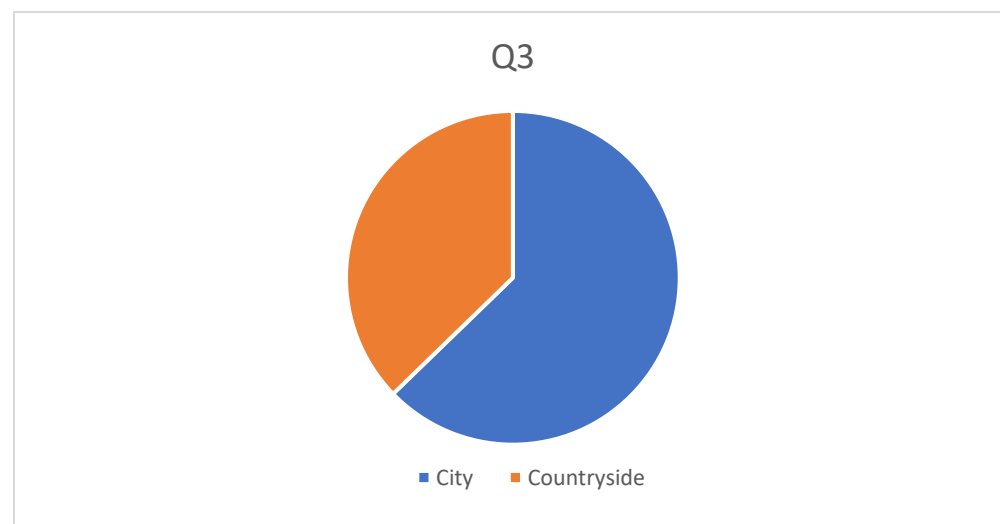


Figure 4: Education Level of Participants

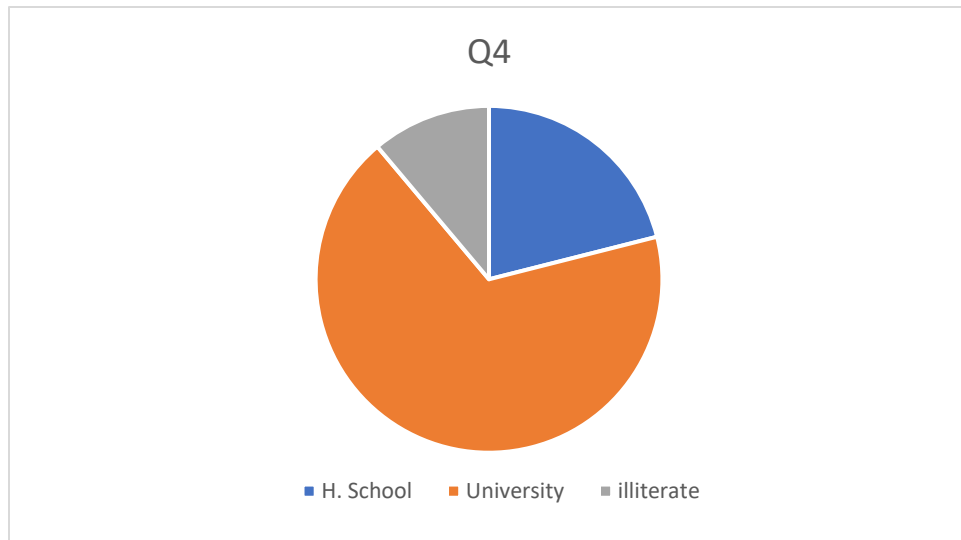


Figure 5: Transport Mode of Participants

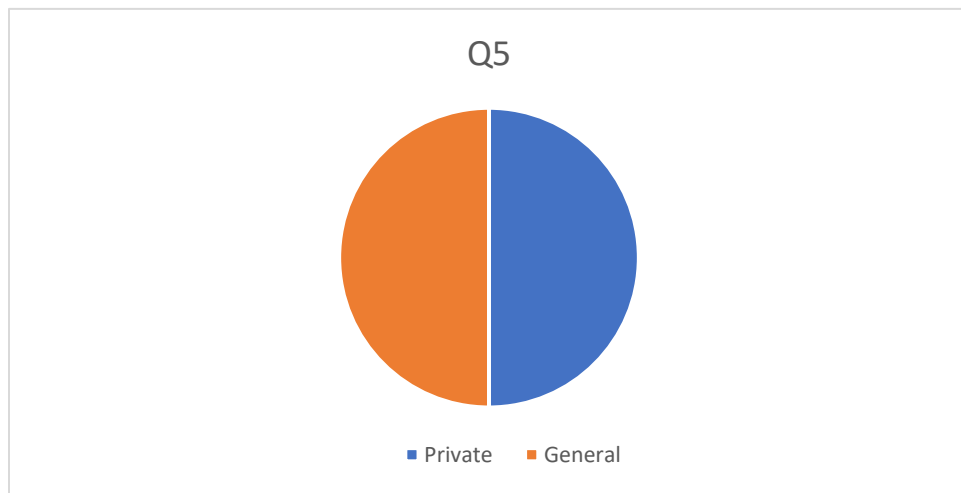


Figure 6: Do you think there is air pollution in your area?

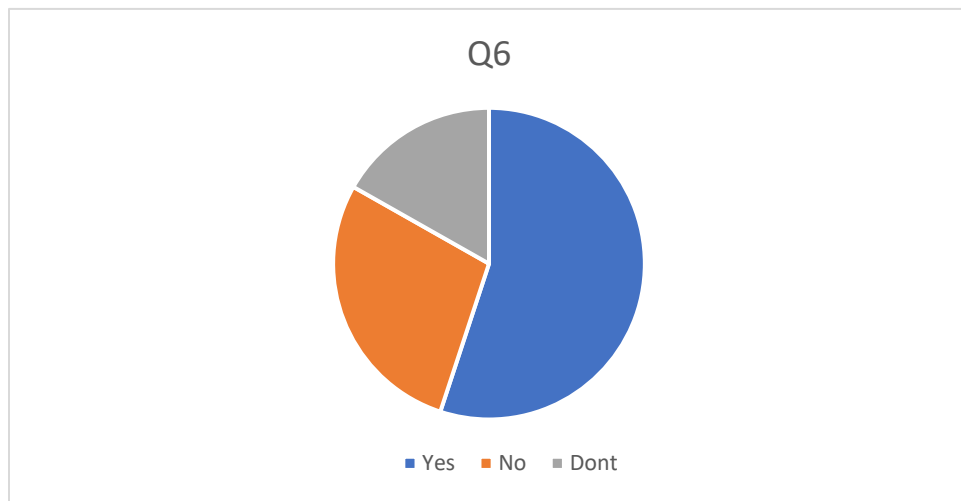


Figure 7: Degree of Air pollution in your area?

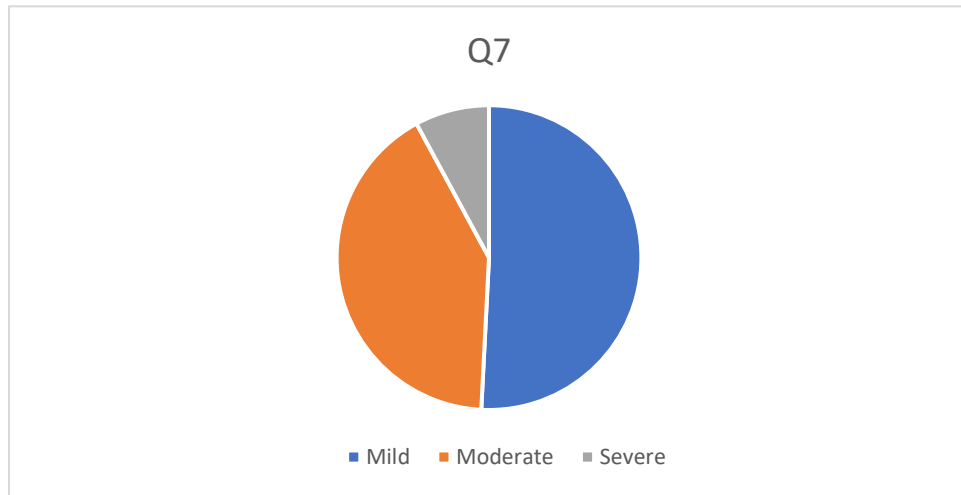


Figure 8: Wear Mask if you feel there is air pollution?

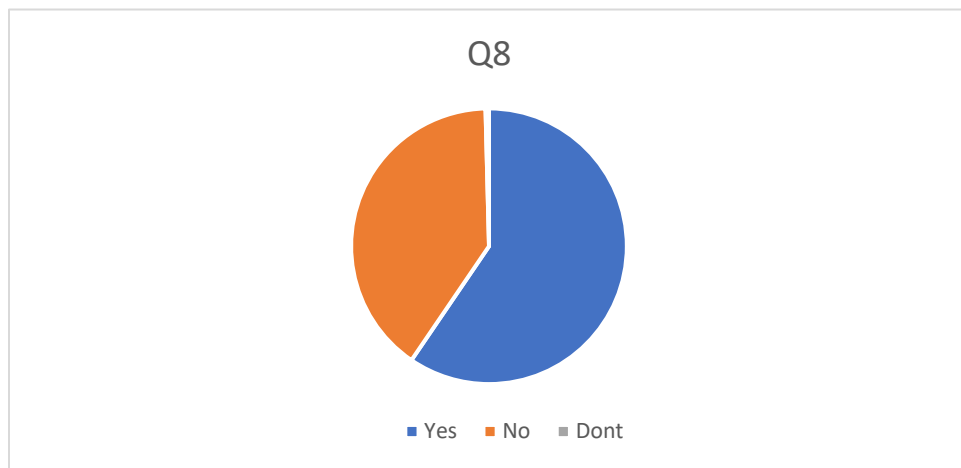


Figure 9: There is relationship between waste burning and air pollution?

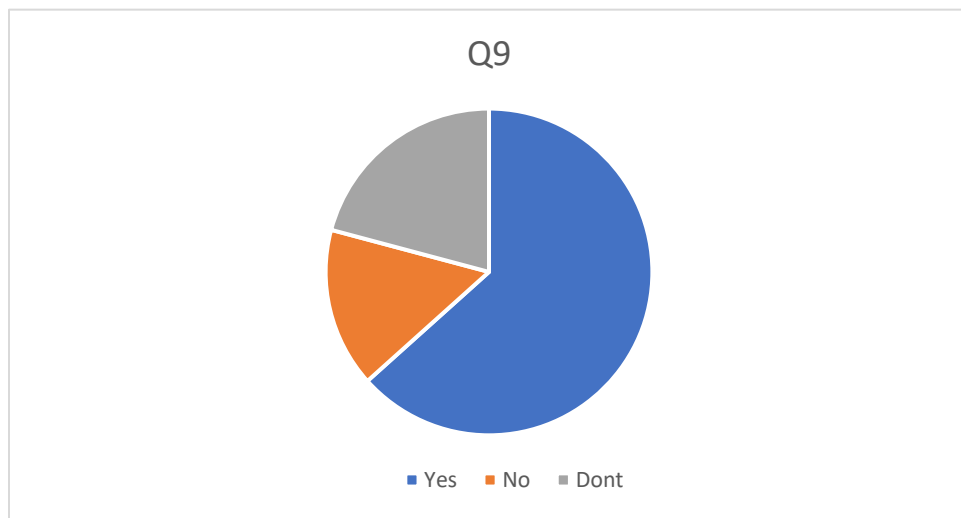


Figure 10: There is relation between air pollution and numbers of cars and motors?

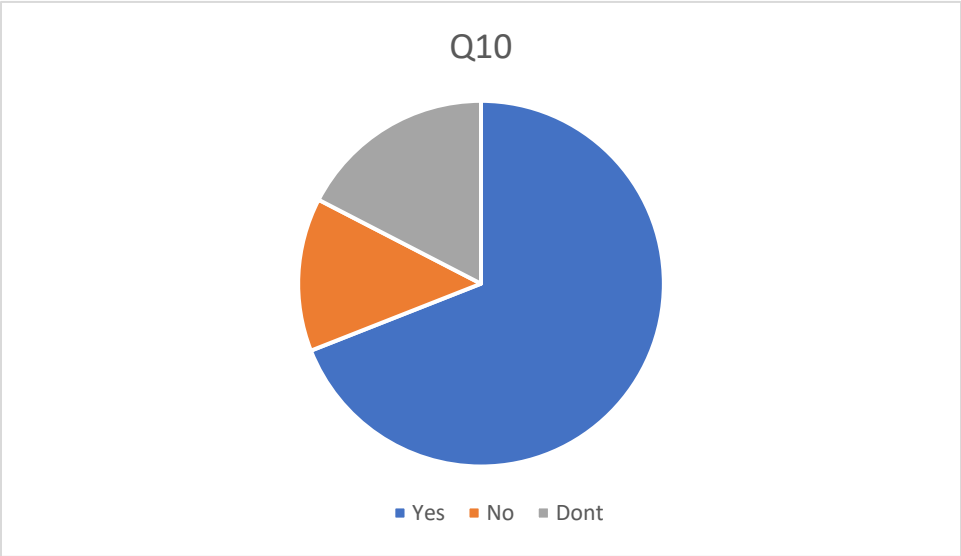


Figure 11: There is relationship between air pollution and diesel generators?

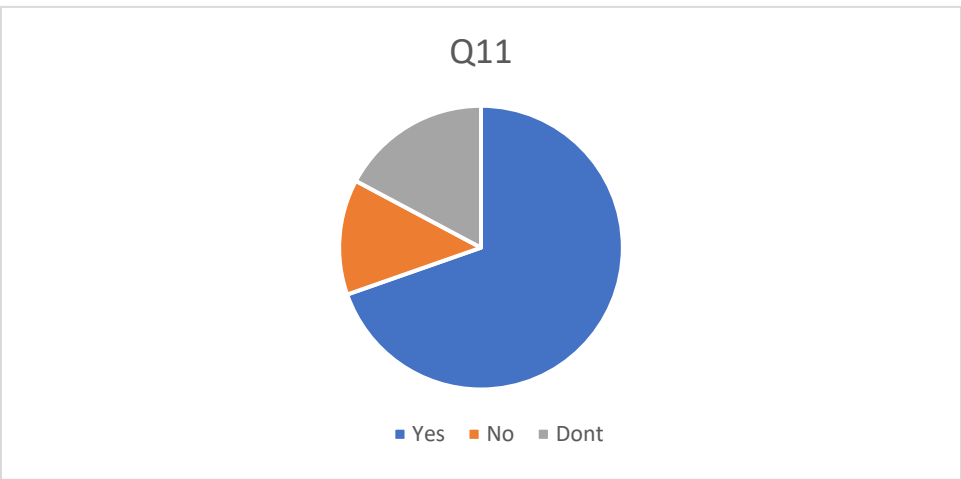


Figure 12: Government do great efforts to solve air pollution issue?

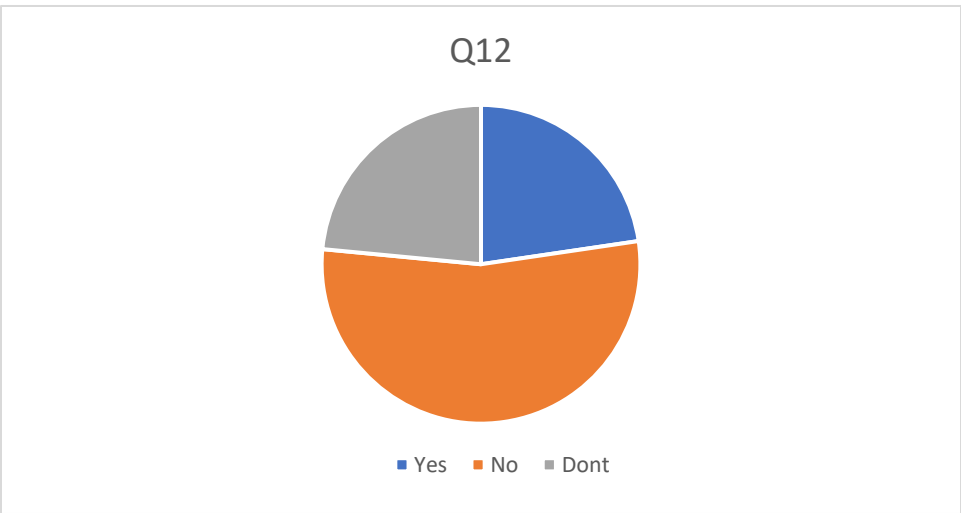


Figure 13: There is relationship between air pollution and lung cancer?

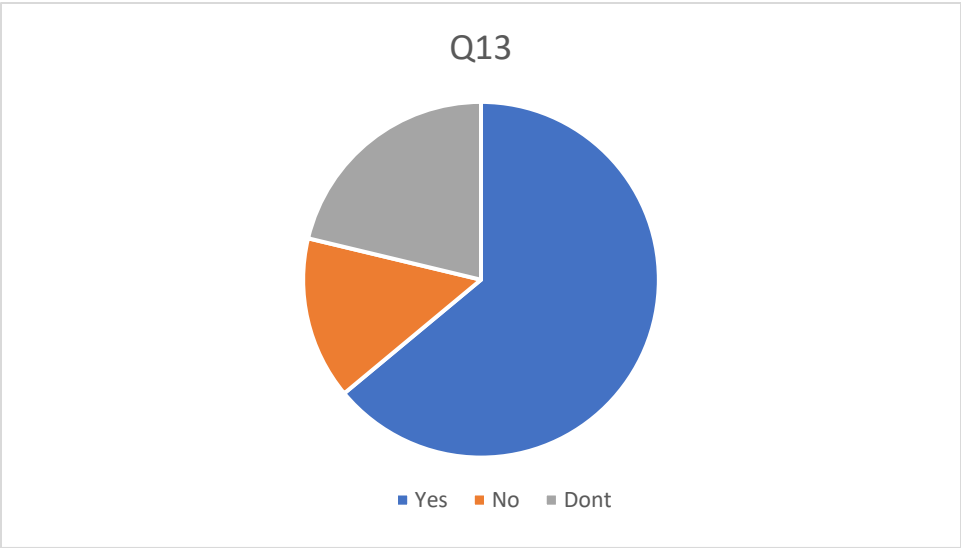


Figure 14: Are you ready to replace your diesel car with electric car?

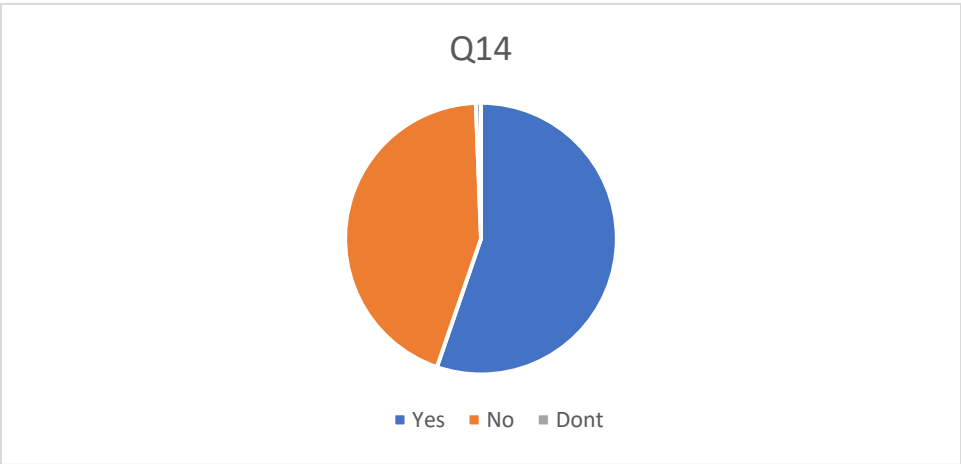


Figure 15: Are you ready to replace private transport with general transport?

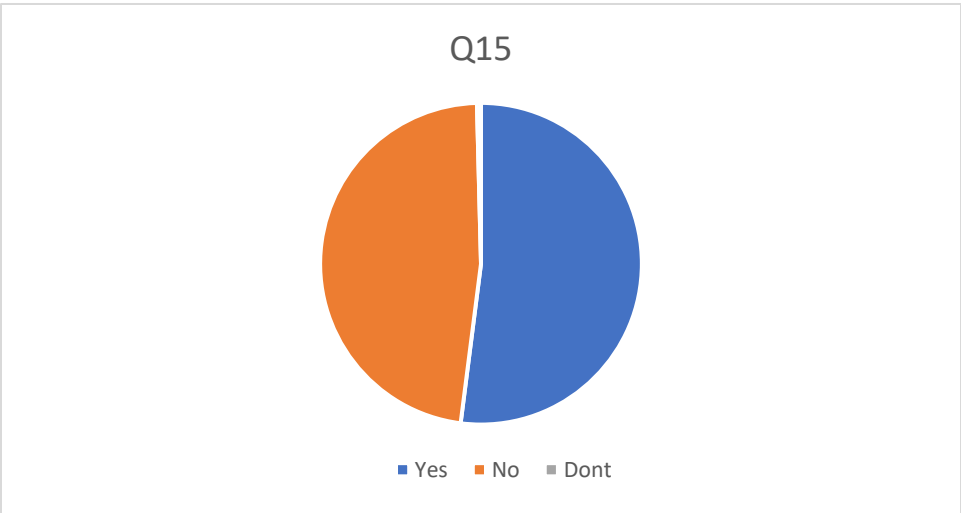


Figure 16: Recycling will solve air pollution issue?

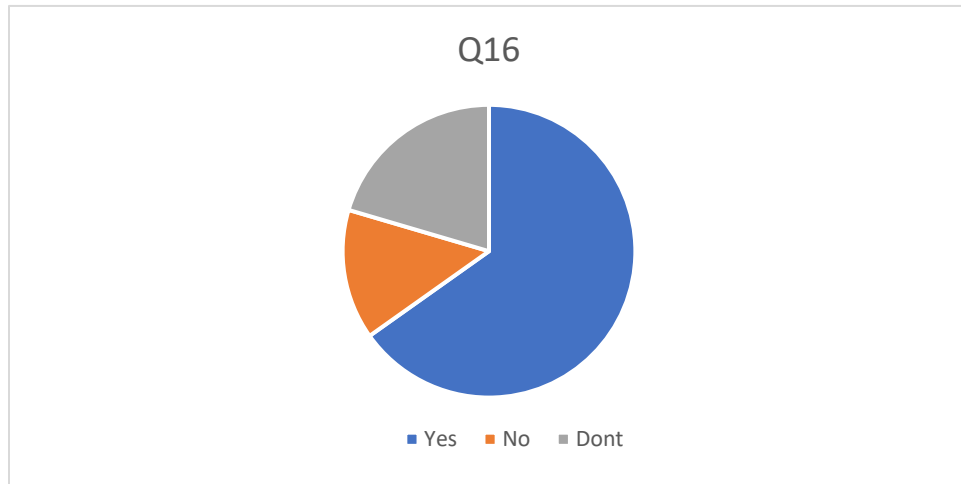


Figure 17: You with prevent children from going to schools if air pollution present?

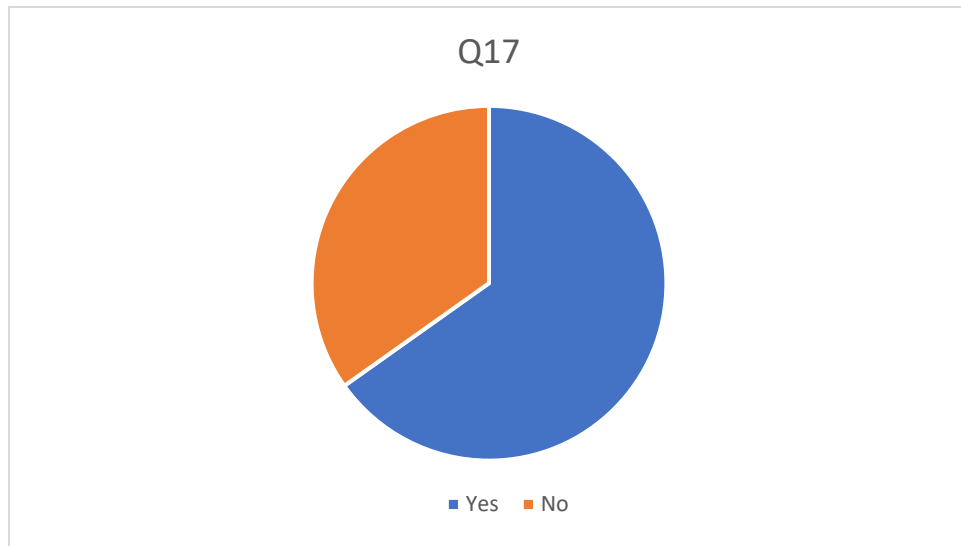


Figure 18: You know exactly what AQI (Air Quality Index) ranges are mean?

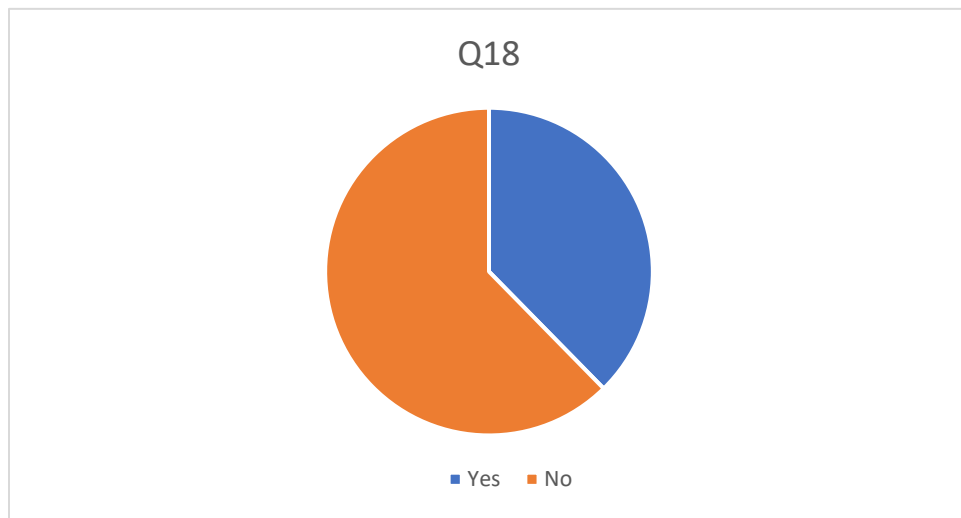


Figure 19: There is intentional neglecting of Iraqi Ministry of Health to this issue?

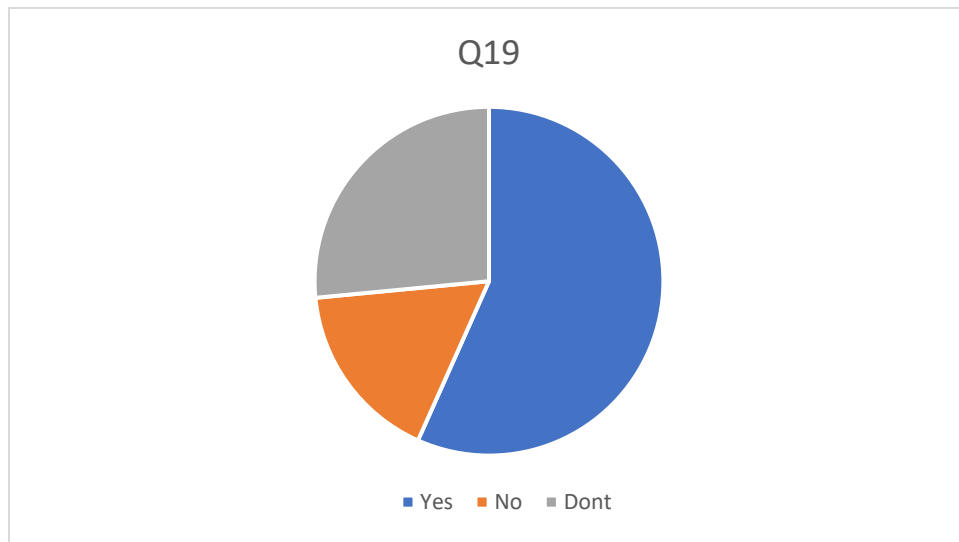


Figure 20: There are Sulfur and other chemicals in the air of your area?

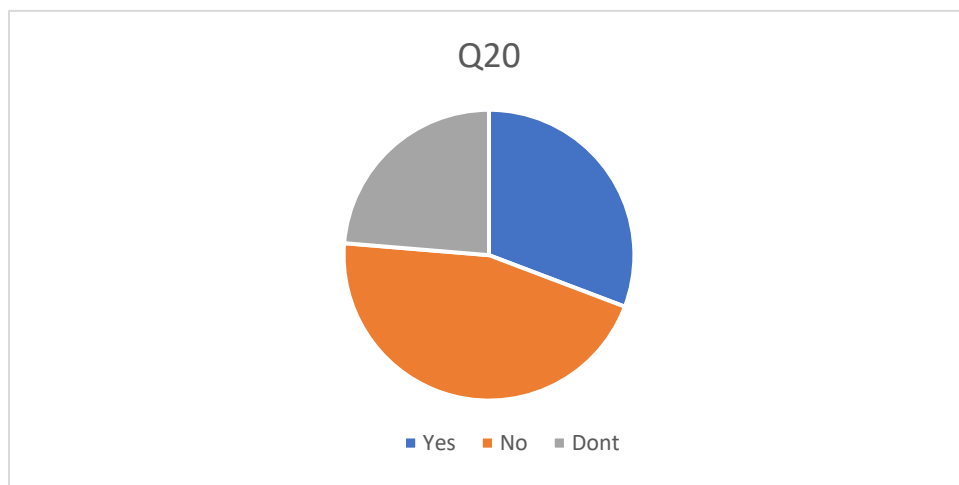


Figure 21: You with applying strict fines on cars and motors that pollute the air?

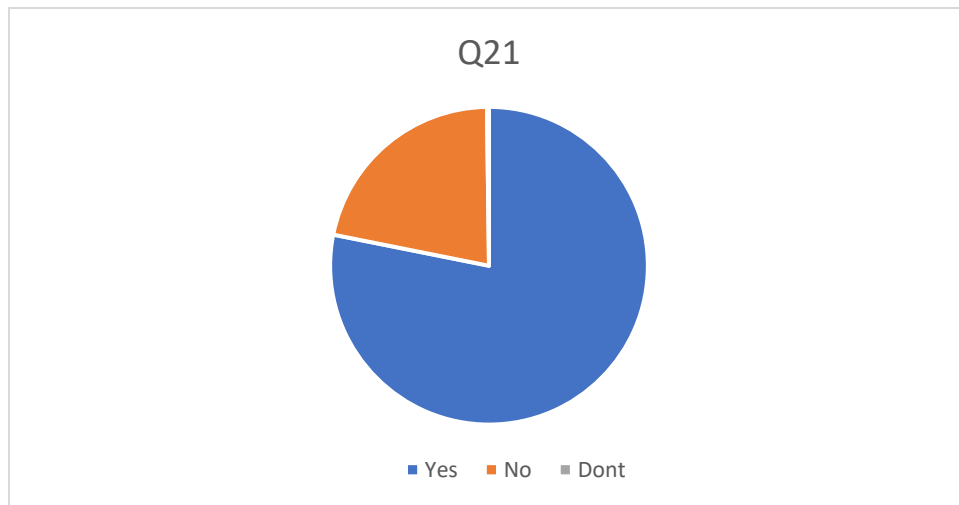


Figure 22: There is relationship between air pollution and human life years?

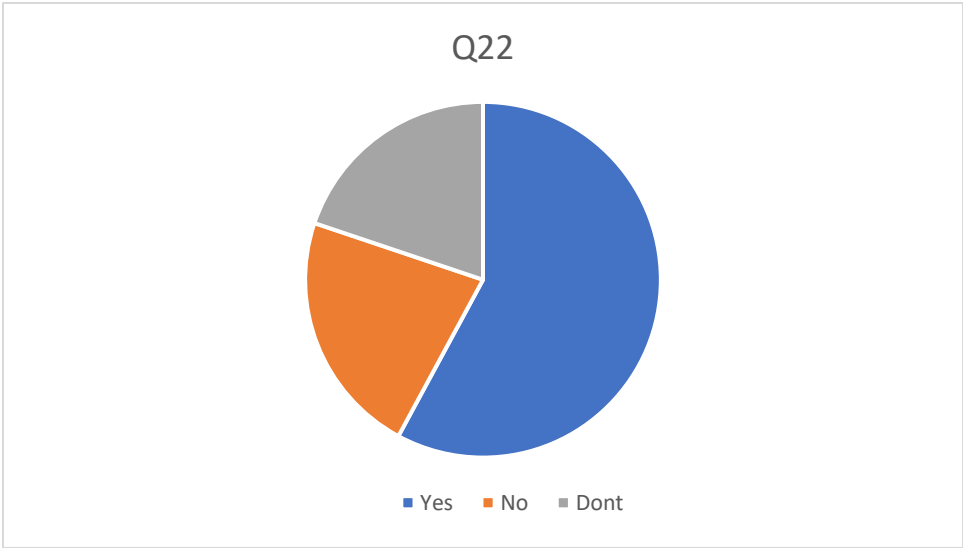


Figure 23: Iraq within the worst countries regarding air quality degrees?

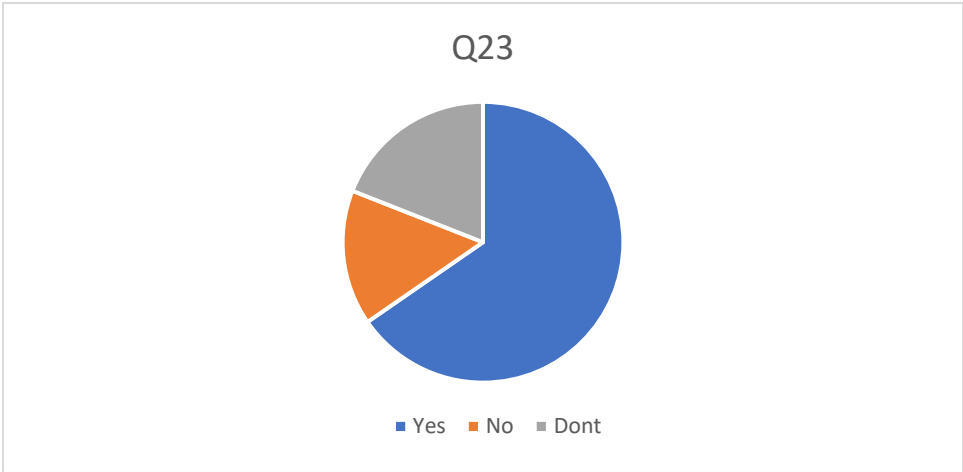
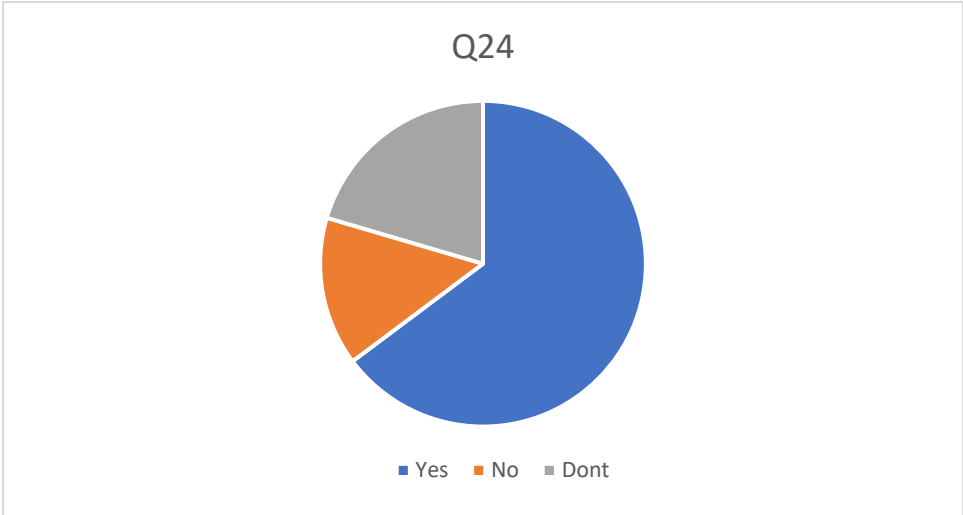


Figure 24: Baghdad within the worst cities regarding air quality degrees?



4. Discussion

The analysis reveals significant associations between several categorical variables related to air pollution awareness, sources, and impacts among the residents of Karbala. The strong significance levels ($P\text{-value} < 0.0001$) across multiple variables highlight the robustness of these associations.

Awareness of Air Pollution (Q1) vs. Health Impacts (Q15, Q16, Q21, Q22): The results indicate that there is a strong association between the awareness of air pollution (Q1) and the perception of its health impacts (Q15, Q16, Q21, Q22). Participants who were aware of air pollution were more likely to recognize its impact on respiratory and cardiovascular health, as well as its potential to cause lung cancer and neurological effects. This underscores the importance of educational initiatives to raise awareness about the health risks associated with air pollution.

Sources of Air Pollution (Q2) vs. Environmental and Health Perceptions (Q8, Q9, Q17, Q18): The analysis shows a significant association between the perceived sources of air pollution (Q2) and participants' perceptions of its environmental and health impacts (Q8, Q9, Q17, Q18).

The findings suggest that residents who identified transportation and industrial activities as major sources of pollution were more likely to report adverse effects on visibility, vegetation, and wildlife, as well as respiratory and cardiovascular issues. This highlights the need for targeted interventions to reduce emissions from these sources.

Demographics (Q3) vs. Awareness and Perception (Q6, Q7, Q12, Q20): The demographic characteristics of the participants (Q3) were significantly associated with their awareness and perception of air pollution (Q6, Q7, Q12, Q20). Specifically, age, gender, and educational level influenced participants' knowledge of specific pollutants and their severity perceptions. This finding suggests that tailored communication strategies should be developed to address the unique needs of different demographic groups.

Living Place and Mode of Transportation (Q4) vs. Awareness and Perception (Q10, Q11, Q13, Q14): The participants' living place and mode of transportation (Q4) were strongly associated with their awareness and the perception of air pollution (Q10, Q11, Q13, Q14). Those living in urban areas and using private vehicles were more likely to report higher awareness and concern about air pollution. This points to the importance of addressing urban transportation policies and promoting public transportation to mitigate air pollution.

Comparison of Results

- Regarding Awareness Levels and Health Impacts:

Our Study: There is a strong association between awareness of air pollution and the perception of its health impacts, with high significance levels.

Other Studies: Similarly, other studies highlight high levels of awareness and recognition of health risks associated with air pollution. ^{(6) (7)}

- Regarding Sources of Pollution:

Our Study: Transportation and industrial activities are identified as the primary sources of air pollution in Karbala, significantly associated with environmental and health issues.

Other Studies: Consistently, other studies also identify transportation and industrial activities as major sources, with pollutants like ground-level ozone (O₃) and sulfur dioxide (SO₂) being prominent. ^{(6) (7)}

- Regarding Demographic Influences:

Our Study: Demographic factors such as age, gender, and educational level significantly influence awareness and perception of air pollution. Urban residents and private vehicle users report higher awareness and concern.

Other Studies: While other studies may not explicitly focus on demographic influences, they suggest the need for targeted interventions based on identified pollution sources, indirectly supporting our findings. ^{(6) (7)}

5. Conclusions

This study sheds light on the awareness, sources, and impacts of air pollution among the residents of Karbala, Iraq. The findings indicate a significant association between awareness levels and the perception of air pollution's health and environmental impacts.

Key conclusions from the study are as follows:

- **High Awareness Levels:** The majority of participants demonstrated a high level of awareness about air pollution and its health impacts. This awareness is significantly associated with their perception of respiratory, cardiovascular, and other health issues caused by air pollution.
- **Identified Sources:** Transportation and industrial activities were identified as the primary sources of air pollution in Karbala. Participants who recognized these sources were more likely to report adverse health and environmental impacts.
- **Demographic Influences:** Demographic factors such as age, gender, and educational level played a crucial role in influencing participants' awareness and perception of air pollution.
- **Urban and Transportation Factors:** Residents living in urban areas and those using private vehicles were more aware and concerned about air pollution. This finding highlights the importance of addressing urban transportation policies to mitigate air pollution.

6. Recommendations

Based on the findings of this study, several recommendations can be made to improve air quality and public health in Karbala:

- **Public Awareness Campaigns:** Implement comprehensive educational programs to raise awareness about the sources and health impacts of air pollution. Target different demographic groups with tailored messages to ensure broad reach and effectiveness.
- **Emission Reduction Initiatives:** Develop and enforce regulations to reduce emissions from major sources of air pollution, including transportation and industrial activities. Promote the use of cleaner technologies and alternative energy sources.
- **Urban Planning and Transportation Policies:** Encourage strategies that use public transportation and non-motorized modes of transport, such as walking and cycling. These strategies can reduce traffic congestion and improve air quality.
- **Health Monitoring and Support:** Establish health monitoring programs to track the prevalence of air pollution-related health conditions. Provide support and resources to healthcare facilities to manage and treat these conditions effectively.

By implementing these recommendations, Karbala can work towards reducing air pollution, improving public health, and creating sustainable environment for its residents.

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