Perception of air pollution in Saudi Arabia

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ABSTRACT

Air pollution is considered to be a major public health concern and the most important environmental health issue facing humanity today. Due to the importance of air pollution and its well-known negative effects on health, this study aimed to investigate people's perception towards air pollution in Saudi Arabia.A cross-sectional study design was used with an online questionnaire distributed via social media platforms. The 411 participants who completed the questionnaire had a mean age of 38 ±14 years and came from different cities in Saudi Arabia.In terms of participants general environmental concerns, 64% believed that air pollution is the major environmental issue in Saudi Arabia. Around 35% and 30% of participants perceived air pollution as dust and smoke respectively. Participants believed that natural dust was the major source for air pollution in their city (42 %) followed by transportation (33 %), local industries (20 %) and other sources (6 %). More participants reported feeling air pollution more during the day (46 %), followed by those who felt that it is present during both day and night (27 %), and more during the night (10 %). The majority of participants (67 %) believed weather does have an effect on air pollution and of that majority, most (57 %) believed that air pollution is worse during the summer, some (7 %) believed that it is worse during winter, others (4 %) believed that it is worse in both seasons and a minority (14 %) believed that weather doesn't have an effect air pollution. The findings provide insight into people's perception of air pollution in Saudi Arabia. Further research that examines the different factors that affect peoples' perception is needed.

Introduction

Air pollution is defined as the contamination of the outdoor and/or indoor environments by chemical, physical, and/or biological agents (WHO, 2022). Air pollutants can be emitted into the atmosphere from anthropogenic and/or natural sources (Hime *et al.,* 2015; Kim *et al.*, 2015). Anthropogenic sources, which are the result of various human activities, include things like fossil fuel combustion, industrial emissions, and agricultural activities' emissions amongst many others (Saxena and Sonwani, 2019; Vallero, 2007). Natural sources on the other hand, which are linked to the Earth's natural processes, include things like sand and dust storms, volcanos, and forest fires (Saxena and Sonwani, 2019; Zunckel *et al.*, 2007).

It is suggested that air pollution is considered to be one of the greatest concerns facing humanity today due to its wide-ranging and deleterious effects on human health (Landrigan, 2017; Saxena and Sonwani, 2019).The impact of air pollution on hu-

man health varies depending on several factors; (i) the dose; (ii) duration of exposure; (iii) composition of the air pollutants; and (iv) individual susceptibility (Badri, 2020; Cohen *et al.*, 2005; Kampa and Castanas, 2008). Short-term exposure to air pollutants has been found to be associated with chronic obstructive pulmonary diseases, cough, shortness of breath, wheezing, asthma, and respiratory diseases. Also, long-term exposure has been associated with chronic asthma, pulmonary insufficiency, cardiovascular diseases, and cardiovascular mortality (Manisalidis *et al.*, 2020). According to the WHO, outdoor air pollution in urban and rural areas is likely to have caused around 4.2 million premature deaths worldwide per year in 2016; evidence suggests that exposure to fine particulate matter of 2.5 microns or less specifically is more likely responsible for the aforementioned mortality rate (WHO, 2022). Without proper planned control, outdoor air pollution is projected by 2060 to cause between 6 million and 9 million deaths per year (Landrigan, 2017; Lanzi, 2016). Air pollution is considered to be an under-appreciated cause of non-communicable diseases as they account for around 70% of air pollution deaths (Forouzanfar *et al.*, 2016; Landrigan, 2017; Prüss-Üstün *et al.*, 2016). In 2015, air pollution was found to be responsible for 19% of all cardiovascular deaths, 24% of ischaemic heart disease deaths, 21% of stroke deaths, and 23% of lung cancer deaths (Landrigan, 2017; Wang *et al.*, 2016). In addition, outdoor air pollution seems to be an important risk factor for neurodevelopmental disorders in children and neurodegenerative diseases in adults (Grandjean and Landrigan, 2014; Kioumourtzoglou *et al.*, 2016; Landrigan, 2017).

In Saudi Arabia, air pollution has been heavily investigated across the kingdom with some focusing on air quality in general by taking an in depth look at the emissions of various air pollutants (BH Alharbi, Pasha and Tapper, 2014; Anil & Alagha, 2021; Dasari *et al.,* 2020; Khalil *et al.*, 2016; Simpson *et al.*, 2014) and their interaction with meteorological parameters(Ben Maatoug, Triki, and Fazel, 2021; Gasmi *et al.*, 2017; Turki M Habeebullah *et al.*, 2015; Munir *et al.*, 2017; Rehan and Munir, 2022) while others focusing on various aspects of one of the most dangerous and major air pollutants due to its small size enabling it to penetrate deep into the respiratory tract, Particulate Matter (PM) (Molina *et al.,* 2017), including its spatial and temporal variations (Aina *et al.*, 2014; Lim *et al.*, 2018; Modaihsh *et al.*,

2015; Munir, Gabr *et al.*, 2016), concentrations (Algarni *et al.*, 2021; Badr Alharbi *et al.*, 2015; Hussein *et al.*, 2014; Othman *et al.*, 2010), composition (Badr Alharbi *et al.*, 2015; Turki MA Habeebullah, 2016; Rushdi *et al.*, 2017; Sufian, 2011), toxic effects (Badri, 2020; Brocato *et al.*, 2014; ElAssouli *et al.*, 2007; Sun *et al.*, 2012), health impacts via modelling (T. Habeebullah, 2013; Turki M Habeebullah, 2014; Harrison *et al.*, 2017) and association with hospital admissions (Azoz *et al.*, 2016; Nayebare *et al.*, 2019).

Even though attention has been paid to various important aspects related to air pollution in Saudi Arabia, unfortunately, no attention has been paid to the people's perception towards this environmental issue. People's perception of air pollution is extremely important as it can assist in decreasing air pollution levels and in turn its health effects through changes in their behaviours (Melki, 2017). The type of health behaviours relevant to air pollution include; (i) being involved in decreasing air pollution; (ii) taking precautions to protect against its health effects; and (iii) being aware, engaged, and updated regarding air pollution levels and its health effects (Oltra and Sala, 2014). Therefore, given the importance of air pollution in relation to human health and the lack of research on people's perception of air pollution in Saudi Arabia, the goal of this study was to add to current knowledge on air pollution in Saudi Arabia and elsewhere by investigating the perception of air pollution annoyance and health risk in a sample of Saudi Arabia's general population.

Methods

A quantitative research design has been selected as it fits the purpose of this study. The perception of air pollution will be investigated via a questionnaire previously used, however, modified for the purpose of this study (Melki, 2017). Microsoft Forms was used as an online platform to collect the data from the participants. Web links for the self-administered questionnaire was posted on various social media outlets. A post hoc power analysis indicated a need of at least 400 participants would be needed to obtain statistical power at the recommended .80 level (Cohen *et al.*, 1983). The questionnaire contained four sections: personal information, information on occupational factors affecting health, medical history, and information on general environmental concerns. Descriptive data was analysed using JASP

(version 0.15) and Microsoft Excel.

Results and Discussion

Demographics

Around 411 people participated in this study. Participants' ages ranged from 12 – 70 years ($M = 38 \pm 14$ years). More females (64%) participated compared to males (36%). The majority of those who participated were married (63%) followed by singles (31%), separated (5%) and widowed (2%). Of those who participated there were those who were; unemployed (43%), working in indoor professions (32%), students (21%), working in outdoor professions (3%), and working in industrial professions (1%).

Occupational factors affecting health

Participants were asked about certain factors that might affect their overall health; such factors included whether participants were exposed to dusty environments and/or gases and chemicals in their occupation and whether they were smokers. With regards to occupational exposures, the majority of participants reported not being exposed to dust (80%) nor gases and chemicals (88%) – Figure 1. As for smoking, the majority (78%) reported not being smokers. For those who smoked, smoking durations ranged from 1 – 50 years ($M = 12 \pm 13$ years).
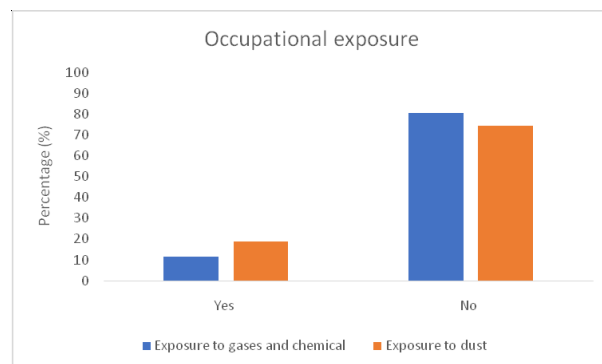

Fig. 1. Occupational exposure to dusty environments and/or gases and chemicals.

Medical history

The participants were asked if they have or had experienced certain health issues that could be related to lung and/or heart diseases such as coughing, chest sounds (whistling and/or whining), abnormal fatigue when speeding or walking up a hill, and abnormal movement/speed compared to others in the

Table 1. Self-reported health issues.

Condition	Yes (%)	No (%)
Coughing	28	72
Chest sounds	22	79
Abnormal fatigue when speeding or walking up a hill	46	54
Abnormal movement speed compared to others in the same age category	19	81

same age category. Moreover, participants were asked if they've ever been diagnosed with certain diseases such as bronchitis, pneumonia, hay fever, asthma, heart problems, and high blood pressure.

Almost half of the participants (46%) reported abnormal fatigue when speeding or walking up a hill. In addition, only 28% reported coughing, 22% reported chest sounds, and 19% reported abnormal movement/speed compared to others in the same age category.

Regarding medical conditions, participants reported being diagnosed with bronchitis (26%), hypertension (23%), asthma (12%), pneumonia (12%), heart problems (6%), and hay fever (5%) – Table 2.

Table 2. Self-reported medical conditions.

Condition	Yes (%)	No (%)
Bronchitis	26	74
Pneumonia	12	88
Hay fever	5	95
Asthma	12	88
Heart problems	6	94
Hypertension	23	77

General environmental concerns

Participants were asked about their general environmental concerns. When asked about the major environmental issue occurring in their cities, the majority (64%) believed that air pollution is much more common than food safety (21%), water pollution (8%), and soil pollution (7%) – Figure 2.

The majority of participants felt that the previous environmental issues were either present most of the time (48%) or rarely (32%). The rest felt that it is always present (%), never present (4%), and some participants (9%) didn't have an answer – Figure 3.

Almost half (47%) of the participants described air quality in their city as good. The rest described it as being very good (27%), weak (10%), excellent (7%), and very bad (2%). Some participants (7%) didn't have an answer – Figure 4.
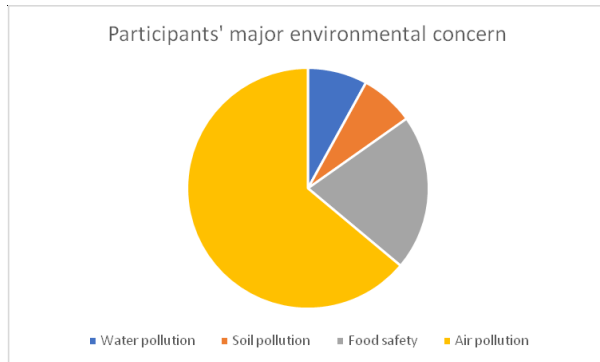
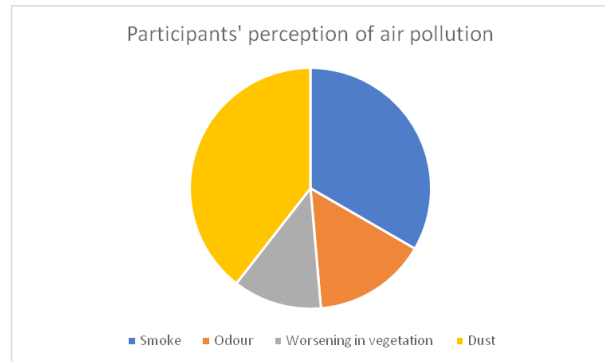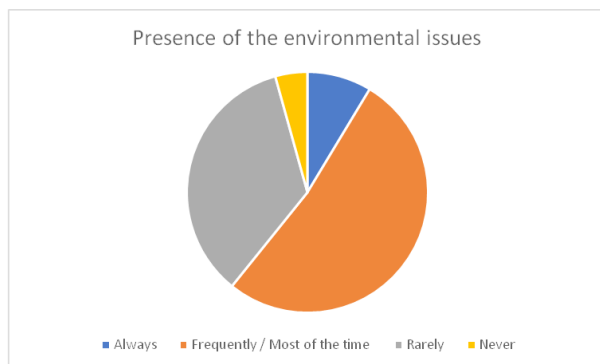**Fig. 2.** Participants' perception on the major environmental issue.

Fig. 3. Presence of the environmental issues
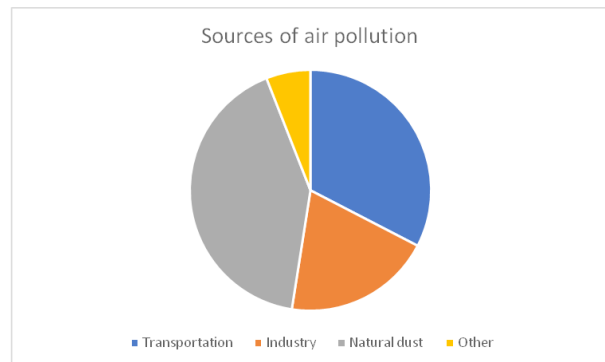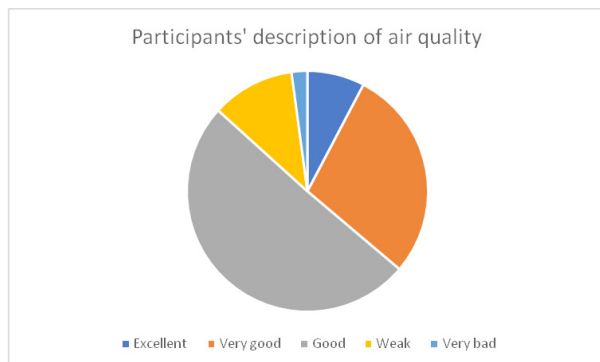

Fig. 4. Participants' description of air quality.

Participants perceived air pollution differently; dust (35%) and smoke (30%) were how the majority perceived the environmental issue. The rest perceived air pollution as being odour (14%) and worsening in vegetation (11%). Some participants (11%) didn't have an answer – Figure 5.

When asked about the sources of air pollution in the city, participants believed that natural dust was the major source (42%) followed by transportation (33%), local industries (20%) and other sources (6%) – Figure 6.

Fig. 5. Participants' perception of air pollution

Fig. 6. Sources of air pollution.

A high percentage of participants reported feeling air pollution more during the day (46%), followed by those who felt that it is present during both day and night (27%), and more during the night (10%). Some (9%) who didn't have an answer – Figure 7.

The majority of participants (67%) believed weather does have an effect on air pollution. Of that majority, most (57%) believed that air pollution is worse during the summer, some (7%) believed that it is worse during winter, and others (4%) believed that it is worse in both seasons. A minority of participants (14%) believed that weather doesn't influence air pollution. Also, some participants (20%) didn't have an answer – Figure 8.

The majority (97%) of participants believed that air pollution has a negative impact on human health. Of that majority, half (50%) believed that it had a very important impact followed by those who believed that its impact is important (31%), very low impact (2%), and a low impact (14%). A very small percentage of participants (1%) believed that air pollution is not associated with negative health outcomes in humans. Also, another small percentage of participants (2%) didn't have an answer – Figure 9.
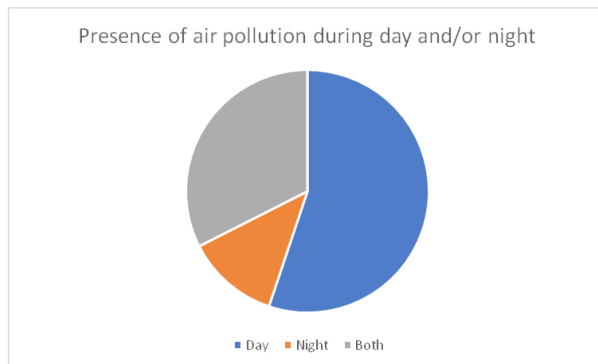
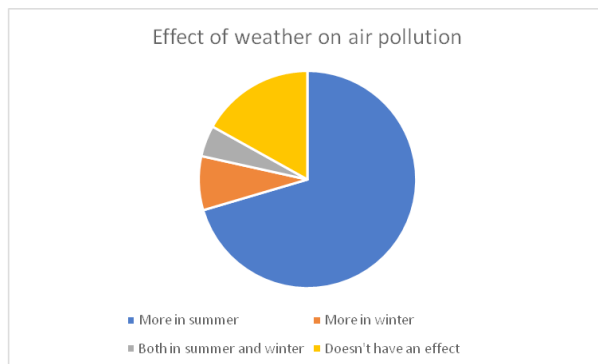**Fig. 7.** Presence of air pollution during day and/or night.

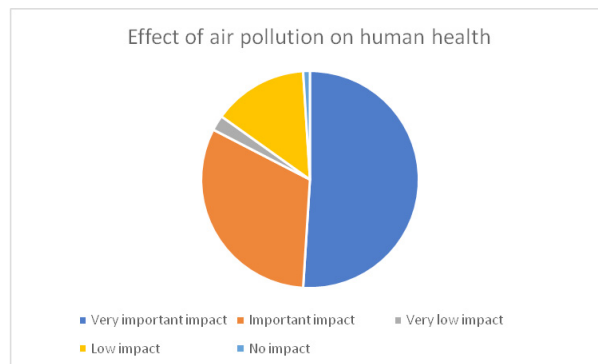**Fig. 8.** Effect of weather on air pollution.

Fig. 9. Effect of air pollution on human health

This study aimed to investigate the perception of air pollution among the general population of Saudi Arabia. Other than demographics, the questionnaire used was divided into three sections that enabled the obtainment of participants overall perception while taking into consideration certain factors that could have influenced that perception.

The majority of those who participated were found to be from the western region of Saudi Arabia. Nonetheless, there were also participants from major Saudi cities such as Riyadh, Damam,

and Abha. The results showed that most participants were adults as the mean age range was 38 ± 14 years old. Two main factors could have led to such results; (i) the data collection team was comprised of young adults as it included university students in their final year and their respective university supervisors in which both attempted to contact as many participants as possible known to them personally or via social media; and (ii) the method of data collection, via a web link,is more attractive to those who use smartphones more which are mainly young adults as found in previous studies (Mulder and de Bruijne, 2019; Taylor and Siliver, 2019). More females participated in the online questionnaire compared to males. It has been indicated previously that women are more likely to participate in surveys compared to men(Smith, 2008). With regards to employment status, results illustrated that more than half of the participants were either unemployed and/or students which as previously mentioned is due to the composition of the research team and who they tried to reach out to. As for the rest, the results showed that the majority of respondents work in indoor professions compared to outdoor field oriented or industrial professions.

With regards to air pollution related factors that could have a possible effect on the perception of air pollution and its effects on health, the results showed that most participants were not exposed to dust nor gases and chemicals in their places of work. This could be attributed to the nature of their jobs. As previously mentioned, only a minority of participants worked in outdoors and/or in industrial professions.

In terms of medical history, most participants were found to be healthy and not suffering from any major health issues. This again could be related to the age of participants; most were still young.

When asked about their general environmental concerns, more than half of the participants reported air pollution to be their main concern in Saudi Arabia. Current scientific literature suggests that air pollution is one of the leading public health problems and the major environmental health problem facing humanity today (Brunekreef and Holgate, 2002; Dominski *et al.*, 2021; Landrigan, 2017). Even though great efforts have been made to tackle the issue of air pollution in Saudi Arabia, it continues to be a major concern due to; (i) the ongoing rapid socio-economic growth that is characterized by heavy industrialization and urbanization; and (ii)

the uncontrollable nature of the country's terrain (dominated by deserts) and climate (harsh and dry with extreme temperatures and frequent dust and sand storms) (Azorin Molina *et al.*, 2018; Badri, 2020; ElNesr *et al.*, 2010; Khodeir *et al.*, 2012).

More than half the participants believed thatair pollution is their main concern.Their perception towards the issue in terms of its presence and the quality of air in the Kingdom illustrated their level of understanding of the issue. The majority felt that air pollution is present frequently/most of the time and the majority also felt that the quality of air in their cities is good. Air pollution in Saudi Arabia does not occur all year round, however, it is affected by certain seasons and activities (Badri, 2020).

Many participants perceived air pollution as dust and smoke, which are the two most visible indicators of air pollution in the country. Their perception and understanding are confirmed in their answer to the main sources of air pollution; similarly, many participants believed that natural dust and transportation are the major sources of air pollution in the country. Current scientific evidence does suggest that the main sources of air pollution in Saudi cities are natural dust from surrounding deserts and transportation related activities (Badri, 2020; Farahat, 2016; Nayebare *et al.*, 2018).

More participants reported feeling air pollution more during the day compared to those who reported feeling it during night-time. Also, more participants believed that air pollution is worse during the summer compared to those who believed that it is worse during winter. There are several factors that could influence the quality of air by the time of day and weather conditions. Current scientific evidence suggests that at conditions of high temperature, low humidity, and high wind speeds (i.e. day-time – summer time), air quality is more likely to deteriorate due to the heavy presence of dust and sand particles originating from local and/or regional deserts (Badri, 2020; Bolles *et al.*, 2019; Bourotte *et al.*, 2011). On the other hand, at opposite conditions of low temperature, high humidity, and low windspeeds, (i.e. night-time – winter time) air quality is more likely to be better. However, even though the concentrations of air pollutants could be lower at this time, it is possible that secondary particles, formed through the conversion of Anthropogenically emitted gases into particles, and bioaerosols, particles from microbial, plant, and animal origin comprise the majority of the composition of air pollutants. With regards to the impact of dust and sand particles compared to secondary particles, the latter has been found to be more likely to cause negative effects in humans (Badri, 2020; Cholakian *et al.*, 2019; Hernandez *et al.*, 2017; Qiu *et al.*, 2019).

With regards to the impact of air pollution on human health, the majority believed that it has serious negative effects on human health. This is a known fact nowadays, other than organisations such as the WHO, which states that air pollution is associated with strokes, heart diseases, lung cancer, and acute and chronic respiratory diseases, (WHO, 2022)a plethora of reports suggest that exposure to air pollution is associated with an increase in mortality and hospital admissions (Achilleos *et al.*, 2019; Albahar *et al.*, 2022; Brunekreef and Holgate, 2002; Castillejos *et al.*, 2000; Phosri *et al.*, 2019).

Even though our study highlights peoples' perception towards air pollution in Saudi Arabia, a few limitations do exist. First, the study design was cross sectional reporting only descriptive data. Second, it did not investigate the different factors that affect peoples' perception. Third, the convenience sampling method and nature of the recruitment process did not allow for generalizing the results and could be affected by selection bias mainly because most participants were from the western region of Saudi Arabia. Finally, the study relied on self-reported data, which might be susceptible to information bias.

Conclusion

The current study investigated people's perception of air pollution in Saudi Arabia. The results indicated that in general, people have a good understanding of the major environmental issue in the kingdom and its possible impact on human health. This study is the first of its kind in the Saudi Arabia, and it just highlights how the major environmental health issue is perceived. Further detailed research that investigates the different factors that affect peoples' perception is needed.

Acknowledgements

Conflict of interest

The authors declare no conflict of interest.

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