

Health effects of refinery emissions on residents living near refineries. A case study of an undisclosed area in Oman

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Abstract—The vicinity of petroleum refineries and people residing in the adjoining areas are prone to several hazards such as noise, radiation, vibration and dust. The most prominent hazards faced by refinery residents are the emission of pollutants and toxic substances, which pose severe risks to human health safety and the environment. Despite the risks associated with refinery emissions, there are some discrepancies about the health effects of refinery emissions on residents living around refineries. To address this gap, this study investigated the acute and chronic health effects of refinery emissions on residents living near a refinery in Oman using a survey questionnaire. The questionnaires were distributed to fifty (50) respondents aged 15 – 65 years, whereas the resulting data were analysed using Microsoft Excel software. The demographic results showed youths account for 76% of the study population. Questionnaire analysis revealed that offensive smells from gases, fumes or dust are the most prevalent health effects affecting refinery residents. Therefore, the local authorities and refineries urgently need to establish comprehensive health and safety strategies, culture, and management practices to mitigate or curb the emissions. In addition, periodic environmental or air quality assessment as well as citing refinery or chemical plants away from residential areas is critical to preventing the acute and chronic effects of pollutants, emissions, and wastes. It is envisaged that such measures will help to prevent the long term effects of toxic emissions from refineries and other chemical plants.

Keywords— *Acute Health, Refinery Emissions, Petroleum Refining, Muscat, Oman*

I. INTRODUCTION

People living around industrial areas are exposed to numerous hazards such as noise, vibrations and excessive heat due to various operational processes [1, 2]. The outlined hazards have a considerable impact on the health, safety and wellbeing of people. Petroleum refineries are examples of industrial areas

that are prone to numerous hazards with potential effects on the health and safety of the workers and people residing within the proximity of the plants [3]. The risk arises from the toxic pollutants, emissions, and wastes generated from the plants [4, 5]. The emissions from refineries are typically various gases and heavy metals, which are precursors for adverse health effects such as cancer-related illnesses [6-8].

Over the years, researchers have investigated the socio-economic, environmental, health and safety impacts of petrochemical plants on human health, safety, and the environment [7, 9, 10]. The findings have shown that people living near petroleum refineries across various countries have complained about innumerable adverse health complications due to gaseous emissions from refineries released into the environment [11, 12]. These adverse health effects arise from either exposure to pollutants at toxic concentrations or through odious smells that leads to stress-related symptoms [13-15]. The most notable adverse effects include cancer (childhood and adult), cardiovascular and respiratory disease along with diabetes, leukaemia, and renal diseases [16-18]. Due to growing concerns about the adverse effects of refinery emissions on refinery residents across various contexts, it becomes necessary to research how these emissions impact the health of residents living near refineries in Oman.

According to the World Health Organization (WHO), developing countries experience 25% of mortality due to environmental hazards [19]. Likewise, people living around petroleum refineries, dumpsites and resource exploration sites are exposed to various environmental hazards such as toxic gases, chemicals and dust which poses risks to their health and safety [20, 21]. Hence, the effects of refinery emissions on refinery residents have been examined by various researchers in the literature [16, 22]. However, the findings have been inconsistent albeit controversial. Axelsson, et al. [23] observed that a region in Sweden with a high concentration of petrochemical industries showed no excess risk for lung, leukaemia, lymphoma, liver or central nervous system cancer. In another study, a region in the UK with large industrial activity including petrochemical complexes was compared with a region with no industry but similar socio-economical characteristics. The industrialized area showed an

increase in the risk of lung cancer particularly in women [24].

The inconsistency of such findings suggests that more studies are required to ascertain the health effects of various toxic chemicals and pollutant emissions on residents living around refineries and petrochemical plants. To address this gap, this study seeks to examine the health impacts of refinery emissions on refinery residents in Oman. Although numerous studies have been carried out across various contexts, there is limited knowledge on the health effects of refinery emissions on residents around refineries in Oman.

II. METHODOLOGY

A. Population of the study

The target population of the study consists of 70 people living near an undisclosed refinery in the Sultanate of Oman. The selected respondents numbering 50 people were randomly selected to represent the entire population that resides within the numerous residential areas and neighbourhoods surrounding the undisclosed refinery. The sample size was selected based on the findings of Krejcie and Morgan [25]. The residents of the target populations that reside near the refinery were selected due to their risk to community exposure.

B. Study instruments

In this study, the selected instrument for data collection was a self-administered survey questionnaire. The questions were adopted from Gadalla, et al. [22] who conducted a similar study on health effects and complaints among locals residing near petroleum plants in El Brega, Libya. The use of a survey questionnaire in this study was to enable the researcher to justify the aims and advantages of the study as well as encourage participants to provide reliable responses [26]. Likewise, the respondents were reassured that the questionnaire information will be kept confidential, whereas their responses were strictly for academic purposes. Based on Gadalla, et al. [22], the questionnaire included information on the demographic characteristics and risk factors (such as respiratory diseases and illnesses). Furthermore, the study included cardinal symptoms including respiratory symptoms such as cough pain during breathing and irritations of upper respiratory airways. Likewise, dermal problems such as itching, burning, and dermatitis or irritation as well as irritation of eyes and complaints from offensive odours were also included in the questionnaire. The questions were close-ended questions with either yes or no responses required from the respondents. However, the study question did not include the medical history of the respondents from the questionnaires since it emphasizes only acute health effects.

C. Data Analysis

After the data collection procedure was completed, the data was input in Microsoft© Excel Spreadsheet for computation and subsequent analysis. The data analysis included computation of the findings which included the health problems and complaints from respondents, was based on percentages and pie chart plots.

III. RESULTS AND DISCUSSION

A. Demographic results

The total number of questionnaires distributed in the study was fifty (50). The data collection process revealed that all respondents successfully returned the questionnaires, which indicates a response rate of 100%. Based on the returned questionnaires, the respondents were subsequently classified into three age groups according to age. The groups include 15-29 years, 30-44 years, and 45-65 years of age. Table 1 presents the demographic distribution of the respondents in the study.

Table 1: Demographic distribution of respondents based on Age

Age Group	Population Size	Percentage (%)
15 - 29	21	42
30 - 45	17	34
46 - 65	12	24

Based on the demographic characteristics, the population of the respondents ranged from 12 to 21. The age group with the highest population is 15-29, whereas the lowest population was observed for the 46-65 age group. The findings indicate the youths account for 76% of the entire population of the study, which suggests high vulnerability to toxic substances and emissions from refinery or manufacturing operations. However, older members of society are usually more vulnerable to diseases and illnesses which could arise due to the long-term effects of various experiences in their lives. Examples of such experiences could be exposed to toxic chemicals, gases and emissions from the industry. According to various studies, these substances pose significant threats to human health, safety and the environment. These effects are typically evident in the prevalence of diseases, illnesses and even death to people living in the vicinity of such places. The most notable are the diseases or disorders of the human respiratory system, which are typically categorized into various groups such as obstructive, restrictive, acute or chronic [27].

B. Questionnaire results

Figure 1 shows the results of the respondents who have experienced chronic respiratory diseases (CRDs). The CRDs are illnesses that affect the airways and other parts of the respiratory system such as the nose, larynx, pharynx, trachea, bronchi and lungs. Examples of some of the most common CRDs

include bronchitis, asthma, allergic rhinitis, chronic obstructive pulmonary disease (COPD), pulmonary hypertension, and occupational lung diseases among others [28]. Studies have shown that over 3 million people around the globe suffer from CRDs owing to the toxic emissions, pollution, industrial chemicals, wastes and dust from chemicals, landfills, dumpsites, power plants and secondary tobacco smoke [29]. However, another factor is recurrent lower respiratory infections from infancy [28]. In addition, Figure 1 shows that 50% of the population reported symptoms related to CRDs such as bronchitis, asthma, and allergic rhinitis. However, the remainder (50%) did not manifest any of such symptoms. The findings indicate that refinery emissions may be responsible for the high number of cases of CRDs among the respondents of the study. Since CRDs are incurable, treatments are administered to aid dilate the primary airways to address the issues of shortness of breath, regulate symptoms and enhance the quality of life of patients [28]. Another group of illnesses caused by emissions are acute respiratory diseases (ARD). Typically, the ARDs include illnesses such as coughing, wheezing and pain while breathing from the target population.

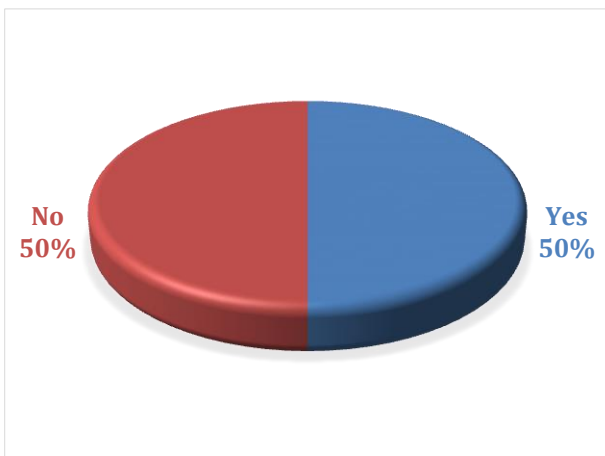


Fig. 1: Respondents who have experienced symptoms of chronic respiratory diseases (CRDs)

Figure 2 presents the results of the respondents who have experienced symptoms of acute respiratory diseases (ARD) such as coughing, wheezing and pain while breathing. The findings indicate that 54% of the population reported symptoms related to ARDs, whereas 46% did not report any of such symptoms. These results of the present study are in good agreement with Gadalla, et al. [22] carried out on the residents of a petrochemical plant in Libya. Likewise, the findings are in good agreement with Spitzer, et al. [11] carried out on residents living near petrochemical plants in Canada. The above-mentioned studies support our findings that residents who reside near petrochemical plants experience ARD symptoms. Due to the higher prevalence of ARDs (such as nose irritation) when compared to CRDs, further analysis of the results and symptoms was examined.

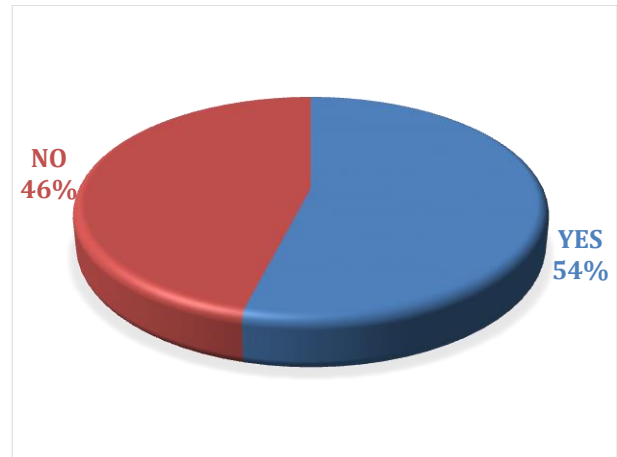


Fig.2: Respondents who have experienced symptoms of acute respiratory diseases (ARD)

Figure 3 shows the percentage of respondents who have experienced symptoms of nose irritation or red nose. As observed, 22% of the respondents reported symptoms of nose irritation and red nose, whereas 78% did not show any prevalent symptoms. The findings are in good agreement with Gadalla, et al. [22]. The respondents of the study were also found to have experienced offensive smells from the refinery.

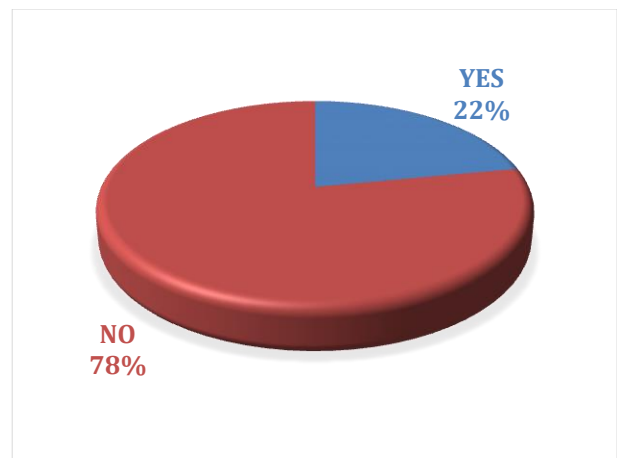


Fig. 3: Respondents who experienced symptoms of nose irritation or red nose

Figure 4 presents the results of the respondents who experienced emissions of gases, fumes and dust from the refinery during the study. The findings show that 82% had experienced offensive smells from refinery emissions such as gases, fumes, and dust. Likewise, the study by Tanyanont and Vichit-Vadakan [30] reported similar findings for respondents who complained about odours arising from a nearby refinery. The study also revealed the residents experienced far more emissions when compared to others who reside farther from the petroleum sites. Another notable complaint among residents who reside near petroleum refineries is the problem of eye irritation or red eye.

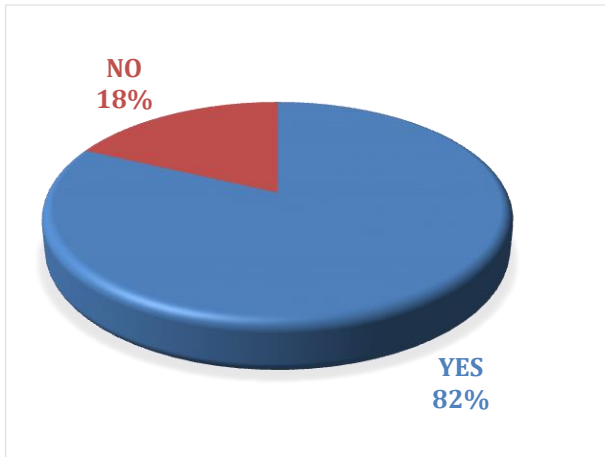


Fig. 4: Percentage of the respondents who experienced offensive smell from gases emissions

Figure 5 presents the percentage of respondents who experienced eye irritation or red eye. As observed, 34% of the respondents experienced symptoms of eye irritation and red eye, whereas 66% did not experience any such symptoms. Likewise, the findings are in tandem with Tanyanont and Vichit-Vadakan [30] and Gadalla, et al. [22]. The findings show that eye irritation or red eye arising from exposure to refinery emissions from the refinery is also a critical concern due to the respondents who have felt such symptoms. Likewise, the respondents reported symptoms of dermal reactions.

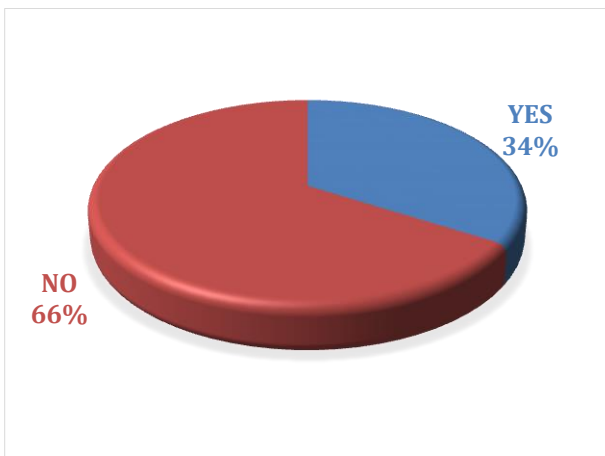


Fig. 5: Percentage of respondents who have experienced feeling eye irritation or red eye

Figure 6 presents the results of respondents who have shown symptoms of dermal or skin reactions such as irritations, rash or redness. As observed, 24% of the respondents reported experiencing such symptoms, whereas 76% did not feel any such symptoms. It is important to note that this study investigated the proportions of respondents around the refinery who showed health effects arising from refinery emissions. It does not investigate the

causative relationship between refinery emissions and the health effects of residents who live close to refineries

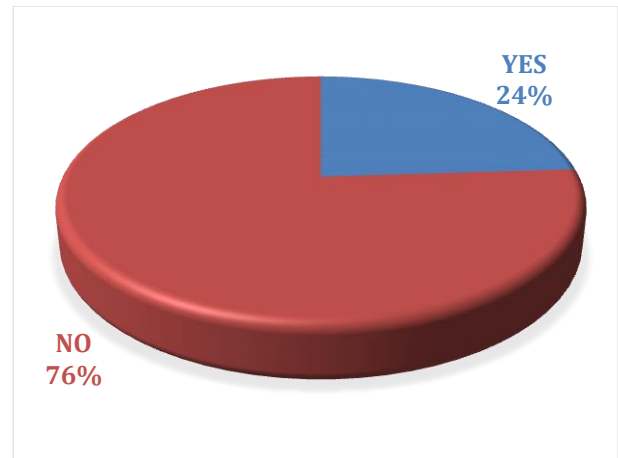


Fig. 6: Percentage of respondents with symptoms of dermal reactions

IV. CONCLUSIONS

The study examined the acute health effects of refinery emissions on residents living near a refinery in the Sultanate of Oman. The findings revealed that the most prevalent health effect of refinery residents around the refinery arise from offensive smells from gases, fumes or dust. Therefore, the local authorities must prohibit emissions or substances to safeguard the health and safety of the populace. The establishment of proper safety culture and management could help to prevent the long-term effects of toxic emissions from refineries and other chemical plants. Furthermore, it is imperative to enforce strategies such as periodic environmental or air quality assessment to reduce odour and the emission of fumes to protect human health, safety, and the environment. Lastly, the locating and relocation of refinery and chemical plants away from residential areas is critical to preventing the acute and chronic effects of pollutants, emissions, and wastes.

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