The National Ribat University

Faculty of Graduate Studies & Scientific Research

The Effect of Oil Refinery Exhaust on the Lung Functions of Residents in the Surrounding Villages of Khartoum North Refinery

A thesis Submitted for Partial Fulfillment of the Requirements for Master Degree in Human Physiology

By: Obaid Sideig Obaid

Supervisor: Prof. Omer A. Musa

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Dedication

This work is dedicated to whoever believed in me even long before I believe in myself, under or above the ground;
Thank you

Acknowledgment

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Contents *page number*

The Effect of Oil Refinery Exhaust on the Lung Functions in Surrounding Villages of Khartoum North Refinery

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Abstract

Background

Refineries exhaust product exposure may be linked to impairment in the lung function, and the aim of this study is to evaluate the available related literature.

Method

Extensive internet search was performed using different websites including: Google, PubMed and F1000 research, during the period of January 2016 to April 2016, covering the period from 2010 to 2016, keywords used were :asthma, air pollutants and asthma, refineries and asthma, asthma and petroleum.

Result

29 articles and full texts were retrieved, and 6 articles were directly related to the study.

Conclusion

There is a major link between lung functions impairment and exposure to refineries products.

Introduction

Asthma is a syndrome characterized by air flow obstruction that varies markedly, both spontaneously and with treatment. Asthmatics harbor a special type of inflammation in the airways that makes them more responsive than nonasthmatics to a wide range of triggers, leading to excessive narrowing with consequent reduced airflow and symptomatic wheezing and dyspnea[1].

Asthma attacks are triggered by multiple environmental pollutants, namely ozone (O_3), nitrogen dioxide (NO_2), particulate matter (PM), sulfur dioxide (SO_2), and carbon monoxide (CO)[2] .The relationship between air pollution and asthma has been well-established[3].

Sulphur dioxide (SO_2), a gaseous respiratory irritant, is among the air pollutants of public health concern in urban and industrialized environments. Most epidemiological investigations on the effects of SO_2 have assessed its acute and chronic effects as a component of the regional ambient air pollutant mix[4].

Refinery emissions may be an important source of sulfur dioxide on a local scale. The potential for short-term high-level SO_2 exposures to cause adverse health effects is well recognized[5].

Exposure to benzene in the open petroleum station has shown to increase asthma symptoms prevalence in workers[6].

And prevalence of asthma symptoms in workers of refineries was found to be 31.3% [7].

Methods

An extensive internet search has been conducted on researches concerned with the effects of Oil Refinery Exhaust on the Lung Function Tests using Google, PubMed and F1000 research. Key words used for the search included: asthma, air pollutants and asthma, refineries and asthma, asthma and petroleum.

Results

In total, 29 abstracts and full texts were retrieved. Eight articles [4,5,6,7,8,9,10,11] were selected after evaluation, being relevant to the phenomenon under study.

Leylâ Deger[4] and others in a study conducted in 2012 have found a relationship between exposure to refinery stack emissions of SO_2 and the prevalence of active and poor asthma control in children who lived and attended school in proximity to refineries.

The same conclusion was reached by Audrey Smargiassi[5] and others in their study in 2012, and Neil White[8] and his associate in their 2009 study, stating that short-term episodes of increased SO_2 exposures from refinery stack emissions were associated with a higher number of asthma episodes in nearby children[5], and increased prevalence of asthma symptoms among children in the area of exposure as a result of refinery emissions[8].

Workers in petroleum refineries have significantly impaired lung functions and the lung function impairment pattern provide evidence in the favor of an obstructive lung disease [9], prevalence of asthma symptoms in workers of refineries was found to be 31.3%[7], and even the workers in benzene stations have showed higher level of asthma symptoms[6], also not falling far Mohemid Al-Jebouri and others found that the incidence of allergy increase among refinery workers[10].

On the other hand Smargiassi A[11] and others have found that the effects of low daily average levels of exposure to industrial emissions on pulmonary and cardiovascular system is difficult to assess over short period in asthmatic children aged 7 to 12 years.

First author (ref)	Type of study and date	Subjects	Results	Main conclusion
Leylâ Deger[4]	Cross sectional study 2012	842 children between six months and 12 years of age.	The adjusted prevalence ratios (PR) for the association between active asthma and SO_2 levels was 1.14 (95% CI 0.94 to 1.39) per interquartile range increase in modelled annual SO_2. The effect on poor asthma control was greater (PR=1.39 per interquartile range increase in modelled SO_2 [95% CI 1.00 to 1.94]).	A relationship between exposure to refinery stack emissions of SO_2 and the prevalence of active and poor asthma control in children who live and attend school in proximity to refineries.
Audrey Smargiassi[5]	Ttime-stratified case–crossover design 2012	Children 2–4 years of age living within 0.5–7.5 km of the refinery stacks.	The risks of asthma ED visits and hospitalizations were more pronounced for same-day (lag 0) SO_2 peak levels than for mean levels on the same day.	Short-term episodes of increased SO_2 exposures from refinery stack emissions were associated with a higher number of asthma episodes in nearby children.
Neil White[8]	Cross sectional study 2009	All consenting school children aged 11 to 14 years attending schools in the defined area of research (defined as north of Boundary Road in the Cape Town suburb of Milnerton and the	Meteorologically estimated exposure (MEE) was positively associated with having to take an inhaler to school, and with a number of video elicited asthma symptoms, including recent waking with	Increased prevalence of asthma symptoms among children in the area as a result of refinery emissions.

		N1 motorway leading out of the city)..	wheezing and frequent wheezing at rest. Symptom prevalences were higher than in other areas of the city, with frequent waking with wheezing being in great excess.	
Sultan Ayoub Meo[9]	Cross sectional study 2015	112 participants.	Significant decline in lung function parameters FEV1, FEV1/FVC Ratio, PEF, FEF 25 %, FEF-50 % was observed among oil refinery workers compared to their matched controls.	Subjects working in the petroleum refinery have significantly impaired lung functions. The lung function impairment pattern provides evidence in the favor of an obstructive lung disease.
[10]Mohemid Al-Jebouri	Cross sectional 2013	200 participants.	IgE level among refinery allergic patients ranged between 201-728 and 106-3266 IU/ml of refinery and nonrefinary hospitalized patients respectively.	The highest incidence of allergy was recorded among refinery patients.
Smargiassi A[11]	Panel study. 2014	Seventy-two children with asthma age 7-12 years	No consistent associations were observed between cardio-pulmonary indices and personal exposure to PM2.5, NO2 and benzene, although there was a suggestion for a small decrease in respiratory function with total concentrations of PAHs.	Low daily average levels of exposure to industrial emissions, effects on pulmonary and cardiovascular functions in children with asthma may be difficult to detect over 10 consecutive days.

Discussion

Five out of the six articles reviewed have concluded and stated clearly that there is association between exposure to refineries exhaust products, living nearby a refinery or working in a refinery and impairment of lung function [4,7,8,9] or even increase in allergy incidence [10], benzene station workers in Khartoum showed higher level of asthma symptoms than general population[6], while the sixth [11] hasn't disclaimed the association between exposure to refinery products and impairment of lung function but rather suggested that for the impairment to occur it should take the course of chronicity. The workers in Khartoum refinery have higher asthma symptoms prevalence and have been concerned about their families living nearby refinery[7].

Conclusion

There are undeniable evidences suggesting close link between exposure to refineries exhaust products and impairment of lung functions. There is a clear need for investigating the effects of refineries in surrounding residents, not only the workers.

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The Effect of Oil Refinery Exhaust on the Lung Functions of Residents in the Surrounding Villages of Khartoum North Refinery

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Abstract

Introduction The WHO has identified indoor and outdoor air pollution as the "world's largest single environmental health risk". Sulfur dioxide (SO_2), a gaseous respiratory irritant that is produced by refinery emissions causes adverse health effects. The asthma symptoms prevalence have been shown to increase both among refinery and Benzene stations workers. The aim of this study was to assess the effect of Khartoum North Refinery on the lung functions among residents in village near the refinery.

Methods A cross sectional study conducted in Wad Ramli Elga'alyeen village, 5 Km south west to the Khartoum North Refinery, Residents between 13-70 years of age of both sexes, who have lived in the village for 5 years, not working in the refinery or have a disabling or chronic illness were included. A modified International Study of Asthma and Allergy (ISAAC) questionnaire has been used to assess asthma symptoms prevalence and then Lung function tests ($FEV_{1,}$ FVC and PEFR) were performed to selected candidate of population upon presence of wheeze symptom in the past 12 month of the study date.

Results Asthma symptoms prevalence (wheeze and Shortness of breath) was found to be 13.1%, and that of wheeze alone in the past 12 month was

6.1%, allergic rhinitis among asthmatic was 50%. Reversibility test was positive in 20%.

Conclusion There is mild increase in asthma symptoms prevalence in the study area population when compared to that of the general population.

Introduction

Asthma is a heterogeneous disease with interplay between genetic and environmental factors characterized by reversible air flow obstruction. Asthmatics harbor a special type of inflammation in the airways that makes them more responsive than non-asthmatics to a wide range of triggers, leading to excessive narrowing with consequent reduced airflow and symptomatic wheezing and dyspnea. [1]

Air pollution is associated with millions of premature deaths worldwide, 25% of which are estimated to be respiratory in nature, and is the world's largest environmental health risk .[2] Recently, the World Health Organization identified indoor and outdoor air pollution as the "world's largest single environmental health risk". [3]
According to the World Health Organization (WHO) report in 2008, 1.3 million deaths were estimated to be related to ambient air pollution globally. The figure became 3.7 million in 2012, which was nearly tripled. Two million deaths were attributable to the effects of household air pollution in 2008. This number also increased as nearly doubled (4.3 million) according to the latest report based on 2012 data by WHO. Air pollution is the cause and aggravating factor of many respiratory diseases like chronic obstructive pulmonary disease (COPD), asthma, and lung cancer. [4]

The major pollutants in outdoor air are particulate matter (PM), ozone (O_3), sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and Lead (Pb). Sulphur dioxide (SO_2), a gaseous respiratory irritant, is among the air pollutants of public health concern in urban and industrialized environments. Most epidemiological investigations on the effects of SO_2 have assessed its acute and chronic effects as a component of the regional ambient air pollutant mix. [5]

Refinery emissions may be an important source of sulfur dioxide on a local scale. The potential for short-term high-level SO_2 exposures to cause adverse health effects is well recognized. [6]

A large number of professionals work in the petrochemical industries. Oil refinery workers are prone to various pulmonary diseases secondary to inhalation of petrochemical compounds and lead to an immunological response mechanism causing hypersensitivity.[7] The prevalence of asthma symptoms in workers of Khartoum North refinery, Sudan, was found to be

31.3% [7],and there's an increase in asthma symptoms prevalence in Benzene stations workers in Khartoum[8] compared to prevalence of 10% in the general population.[9, 10]

A 2010 systemic analysis to estimate asthma prevalence in Africa yielded results of 13.9% in children less than 15 years old, 12.5% in adults less than 45 years old and 12.8% in the total population. [11]

Regarding association between asthma and allergic rhinitis, it is estimated that 60% to 78% of people who have asthma suffer from allergic rhinitis. [12]

Methods

A descriptive cross sectional study carried in Wad Ramli Elga'alyeen village, a small village 5 km south west to the Khartoum North oil refinery with total population of 2000, household visits were performed to the whole village, and residents aged 13-70 years from both sexes living in the area for at least five years were included with a total of 99.

Subjects suffering from other respiratory diseases other than asthma or who are working at the refinery or unable to perform lung function tests were excluded.

A modified (ISAAC) questionnaire was filled during the household visits. The questionnaire covered personal data, asthma symptoms, allergic symptoms and treatment. Individuals who answered yes to asthma symptoms (wheeze) were issued a second questionnaire specially designed for asthma patients and their symptoms were further validated by lung function tests. LFTs were performed using a pocket spirometer.

Three readings of FEV_1, FVC and PEFR were taken and the best were recorded. Reversibility test was done, readings were taken initially then the subject was given salbutamol inhaler and the readings were repeated 15 minutes later and reversibility percentages for FEV_1 and PEFR were

calculated with 12% and 20% being considered positive for $FEV1_1$ and PEFR respectively.

The collected data was analyzed using Microsoft Excel 2007 package.

Approval was guaranteed from the National Ribat University and the local authorities and consent was taken from the residents before the data collection process.

Results

The survey has covered the whole village of Wad Ramli El-Ga'aleen.

Out of the 2.000 resident, only 99 fitted the inclusion criteria at the time of the survey, when asked about whether or not they have had asthma symptoms in the past 12 month using the modified ISAAC questionnaire for adults, 16 out of the 99 replied positive (13.1%), and six out of these 16 have had wheeze in the past 12 month (6.1% of the total study population), and these six were asked upon their permission to perform lung function tests, only five accepted.

The study population were divided into age groups, the largest group was the population falling in the age of 13 to 23 accounting to 33.3% (33 individual), and the smallest age group were that between 64 and 70 years accounting to 6% (6 individuals). Females were slightly more than males in the study group being 51.5% (51 individual) whereas males were 48.5% (48 individual), 81.8% (81 individual) have consanguine parents, and 18.2% (18 individual) came from inconsanguine parents.

All the yes responders to wheeze (6) in the past 12 month have experienced night cough disturbing their sleep, two of them (33.3%) had early morning breathlessness and two (33.3%) had night shortness of breath as well (Table 1).

When asked about whether or not they had ever have asthma, 93 out of the 99 of the study population answered 'No' (93.9%), and 6 out of the 99 answered 'Yes' (6.1%). Regarding family history of asthma among the study population, 81 subject (81.8%) has negative family history of asthma whereas 18 subjects (18.2%) have positive family history of asthma, and out of the 18 subject who admitted to have family history of asthma, 17 of them have a relative of a first degree who has asthma, and 1 has a relative of a second degree who has asthma.

Residents who had experienced nasal symptoms of allergy (Rhinitis) were 28 (28.3%) and those who don't were 71 (71.7%), and out of the 28 who have had experienced nasal symptoms of allergy (Rhinitis), 14 of them

(50%) have had Rhino-conjunctivitis and 14 (50%) haven't. Asthmatic patients (who experienced wheeze in the past 12 month), 3 of them have had allergic rhinitis (50%), whereas 3 (50%) haven't.

Regarding which season do aggravate allergies in residents who have had experienced nasal symptoms of allergy (rhinitis), the season that held strong percentage to aggravate allergies was summer being 39.3% (11 subjects), followed by winter 28.8% (8 subjects), then autumn 3.8% (1 subject).

When analyzing factors aggravating allergy symptom in residents who have had experienced rhinitis in the past 12 month, dust accounts for the majority of allergy symptoms being the causative agent in 20 individual (71.4%), followed by others (e.g pollens) in 11 individual (39.3%), then trees 4 individuals (14.9%).

Out of the 99 residents who have fitted the inclusion criteria, 77 of them (77.8%) do not have family history of allergy, whereas 22 (22.2%) have family history of allergy, and when coming to the diagnosis of allergy (rhinitis), 86 out of the 99 study population (86.8%) have not ever diagnosed with rhinitis or sinusitis, and 13 (13.2%) have been diagnosed previously with rhinitis or sinusitis.

Prevalence of skin allergies in the past 12 month among the study population was as follow: 80 subject (80.8%) have not experienced skin allergies, 19 subjects (81.2%) have experienced skin allergies. And among those who have had skin allergies in the past 12 month, 18 (94.7%) have the skin rash over the extensor surfaces, around the eyes, ears or neck, whereas 1 (5.3%) has not. 98 of the study population (98.9%) have never diagnosed with eczema and 1 (1.1%) has been diagnosed with eczema previously.

All of the study group population uses electricity, gas and coal for cooking, and have Lorries and big vans frequently going through the high way adjacent to the village and through the intra-village road.

The residents keep their own habitual animals (goats, chickens and dogs) within their yards, insecticides exposure was not frequent.

Dust and mosquitoes were more intense in autumn than during the rest of the year as stated by the study population.

Of the 6 individuals who responded 'Yes' regarding asthma in the past 12 month, 57% prefer to use oral bronchodilators (tabs or syrup), while 43% prefer inhaled medications, and all of the 6 (100%) have their medication prescribed by a doctor. Concerning the attainment of medications, 83% have their medication by the insurance service while 17% get their medications in cash, and 67% have never had problems in attaining their medication, while 33% rarely had problems in getting their medications.

67% of the individuals who responded yes to wheeze within the 12 month prefer to be called allergic, while 33% prefer to be called asthmatic. And also 67% of them have family history asthma, while the remainders (33%) haven't.

Frequency of asthma symptoms ranged from intermittent (50%) to mild persistent (33.3%) to moderate persistent (16.7%).

Results of the lung function tests

Only one subject (17%) of the 6 who responded yes to wheeze within 12 month has performed lung functions test before, and 5 (83%) haven't performed lung functions test.

Of the five (5.05%) individuals who performed the lung function tests only one (20%) had positive reversibility test. All individuals had less than expected lung volumes for their age, gender and height.

Table (1) Comparison between symptom combinations in wheeze correspondents N=99:

Symptoms	subjects	Percentage from subjects with wheeze
Wheeze +night cough disturbing sleep within the past 12 month	6	100%
Wheeze + night cough disturbing sleep and breathlessness at night within the past 12 months	2	33.3%
Wheeze + night cough disturbing sleep and early morning breathlessness	2	33.3%

Discussion

The study area fall in a remote area south west to the Khartoum North refinery, a small village and that account for the small population, the age group with the highest percentage was that of youth in consistence with the high percentage of the younger population in Sudan.

The prevalence of asthma symptoms is not higher than Khartoum general population, although in another village it was very high, it seems that the location of this village is not in the wind direction which brings the fumes and movement of the level of pollution in the two villages, is needed.

Conclusion

The affection of lung functions and the asthma symptoms prevalence due to Khartoum North Refinery in the study area is little if there is any.

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