Household Exposure to Incense and Respiratory Symptoms

Dalal Abdullatif Almaghrabi, Maryam Hamad Alghfeli

UAE, University of Sharjah
College of Health Sciences
Department of Environmental Health Sciences

Abstract: ***Burning incense is a relevant practice in the Arab world, applied to combat unpleasant odors by emitting a pleasant refreshing aroma in houses. The smoke of incense has diverse gas pollutants, and due to their hazardous effects on human health (such as being linked to cause indoor air pollution by World Health Organization (WHO), thus affecting the health). Therefore, this research project was conducted with objectives of determining the concentration levels of gases (Carbon monoxide, Carbon dioxide, Sulfur dioxide, Hydrogen sulfide, Nitrogen dioxide, Benzene, Formaldehyde, Total hydrocarbon, and Styrene) emitted from using three types of incense, Oud, Bakhour, and Frankincense "Luban" used in the houses on daily basis. Thirty exposed house members were surveyed to assess their respiratory health. The method used for the detection of gases and assessment of health effects were the Draeger Accuro Pump with the Draeger Tubes, along with a respiratory health questionnaire. Results showed that Oud has the highest emissions of gases compared to the other two types, then follows Frankincense "luban", and the least was Bakhour. Moreover, Carbon dioxide, Styrene, Benzene, Carbon monoxide, and Formaldehyde were the common gases with the highest concentrations in all three incense types used. Thus, can have significant adverse health effects, particularly on respiratory system. Additionally, Carbon dioxide was the only gas detected before the burn of incense, and was the highest during the burning. Recommendations included switching to electrical appliances for the burn of incense, along with ensuring proper ventilation, and lastly, is to reduce the practice of incense burning instead of daily, to weekly or monthly.***

Keywords: Indoor Air Quality, Indoor Air pollution, Gasses emissions, Respiratory Symptoms

1. Introduction

Burning incense is a very common, traditional practice in the Arab world, especially in the Middle East, it dates back for millennia. It has emerged as both a constituent of various religious practices and a widespread custom in many regions of Asia. Arab culture is particularly prevalent for the extensive use of incense in private houses and public places (Polusny, *n. d.)*. The practice is applied to combat unpleasant odors and provides fresh fragrance in houses.

Certain plants have become the most popular sources of incense because of the spectacular fragrant oils that they contain. The most prevalent are frankincense, *oud*, and *bakhoor*. Frankincense is an aromatic resin obtained from the olibanum tree, *Boswellia sacra*, which is alternately referred to as the frankincense tree. Agarwood is a resinous material that is produced by natural biochemical processes when trees of genus *Aquilaria* are infected by a specific fungus, *Phialophora parasitica*. Bakhoor actually refers to a wide variety of porous wood chips, most commonly derived from the sandalwood trees (genus *Santalum*), that can be impregnated with any of a huge variety of fragrant oils via soaking.

Once prepared for use, incense is burned in a vessel known as a *mubkhara* or *medkhan*. These can be built of metal, ceramics, or even heat-resistant hardwoods. The vessel, which is typically small enough to rest on a tabletop, incorporates a grill that rests over a heat source and a small orifice at the top from which smoke is emitted. The heat source is charcoal in the most traditional variations.

In general, incense smoke contains a wide variety of organic particulate matter. These pollutants, many of which are toxic, derive not only from the incense itself but from any fossil fuel, such as charcoal, that is itself burned in order to provide the heat that ultimately combusts the incense *per se*. The Environmental Protection Agency (EPA) has verified that incense smoke is linked to asthma, lung inflammation, and even a variety of upper respiratory cancers, including squamous cell lung cancer (Friborg *et al.*, 2008). Although a range of detailed studies have been conducted under a broad variety of circumstances, it has generally been demonstrated that incense smoke is as deleteriously mutagenic upon the cells of the human body as is tobacco smoke (Polusny, *n. d.)*.

Astonishing variety of noxious pollutants have been found to occur in various levels in incense smoke. Particulate matter is the most noticeable of these because its effects are directly visible. Particulate matter consists of actual physical granules of varying sizes that, by virtue of their size, are capable of penetrating more or less deeply within the respiratory system. Larger ones tend to accrete in thick deposits in the bronchi, whereas the smallest ones can reach all the way to the alveoli and even cause direct physical damage, including abrasions and cuts (Lin *et al.*, 2008).

The huge variety of gaseous emissions is actually far more troubling to medical researchers and clinicians. Carbon monoxide (CO) is foremost among these. It results from the incomplete combustion of the volatile oils in the incense. This gas unites much more readily with hemoglobin, the organometallic compound in red blood cells (RBC) that enables the cells to transport oxygen. Consequently, atmospheric CO tends to strip the body of vital oxygen, resulting in headaches, dizziness, lassitude, and nausea. It can even prove fatal in sufficient concentration, subtly leading to unconsciousness that prevents incense users from realizing that they are slowly asphyxiating (Lin *et al.*, 2008).

Sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) also occur liberally in incense smoke. These two pollutants can result in fatigue and depress pulmonary function. They irritate the tissues of the lungs, ultimately leading to pulmonary immunodeficiency or immunocompromise. They can also aggravate existing cardiovascular diseases (Lin *et al.*, 2008).

The incomplete combustion of the volatile oils present within the incense results in the production of volatile organic compounds (VOC). These substances evaporate easily at room temperature or slightly above, meaning that they enter the atmosphere almost from the moment that the incense burner is lighted. Commonly seen VOC include benzene and styrene. These compounds can result in intense irritation of nasal and ocular passages, nausea, vomiting, dizziness, and headache. Prolonged exposure to VOC has been statistically linked to instances of kidney damage, liver damage, a variety of cancers, and a host of disorders of the central nervous system (Lin *et al.*, 2008).

Further noxious toxins identified in incense smoke include aldehydes. Aldehydes, of which the formaldehyde is used as a bonding agent, can burn the nasal and oral mucosa and eventually cause coughing and even choking.

2. Objectives

The main objectives of this project were to:

1. Determine the concentration of the air pollutants emitted from the practice of incense burning in households.
2. Assess the respiratory symptoms due to the exposure to the air pollutants.

3. Methodology

Sample:

Convenient sampling technique was used to select both the 30 exposed house members for the questionnaire as well as three houses for the detection of gases, based on their practice of burning incense, the type used, and frequency as shown below:
House A: The mostly used type was Oud, daily, for 4 times a day.

House B: The mostly used type was Bakhour, daily, for 5 times per day.

House C: The mostly used type was Luban, daily, for 2 to 3 times a day.

4. Method

Two grams of the incense types used (Oud, Bakhour, and Frankincense *"Luban")* for burning, were determined to be used as it is the average amount used. Detection of the concentrations of Carbon monoxide, Carbon dioxide, Sulfur dioxide, Hydrogen sulfide, Nitrogen dioxide, Benzene, Formaldehyde, Total hydrocarbon, and Styrene in the ambient air before the burning of the incense in the living rooms of each of the three houses, as well as during the burning of the incense was through the use of the Draeger Accuro pump with the Draeger tubes. The Accuro draeger gas detection pump is a device that detects different gases using Draeger tubes, each tube is dedicated to a specific gas. These glass tubes contain an inert carrier impregnated with a reagent, each tube has a different measuring range. As well as different change in color of the indicating layer in the presence of the selected gas. The measuring range of each gas, color change and reaction principle for the chemicals is shown in table [1]. In addition to the first method, a questionnaire was distributed among thirty exposed house members, to assess the effects of emitted gases on the respiratory health of exposed house members.

Ethical Consideration:

Verbal Consent from the household owners was taken to conduct the research.

Calculations

After taking the readings and measurements of both the ambient air of the living rooms of the households before and during of the burning incense, actual concentration was calculated using the following equation:

$$Concentration\ of\ gas = \frac{N\ x\ Reading\ from\ the\ tube}{Number\ of\ strokes\ done}$$

Respiratory Symptoms:

In regard to the respiratory symptom assessment a questionnaire was used. The questionnaire included questions about cough, breathlessness, phlegm, wheezing, smoking, and past illnesses.

Statistical Analysis

Data were entered and analyzed in IBM SPSS Statistics program using relevant test.

Table 1: Measuring range, indicating color change, and reagent reaction of each gas tube.

Gas	Measuring Range	Color Change	Reagent Reaction
Carbon Monoxide	5-700 ppm	White > Brownish Green	**Reaction Principle** $5\,CO + I_2O_5 \xrightarrow{H_2S_2O_7} I_2 + 5\,CO_2$
Carbon Dioxide	100-3, 000 ppm	White > Violet Blue	$CO_2 + N_2H_4 \rightarrow NH_2\text{-}NH\text{-}COOH$
Nitrogen Dioxide	0.5 to 30 ppm	Gray-green > Blue-gray	a) $NO + Cr^{VI} \rightarrow NO_2$ b) NO_2 + Diphenylbenzidine —> blue grey reaction product
Sulfur Dioxide	20 – 200 ppm	Brown-yellow > White	$SO_2 + I_2 + 2\,H_2O \rightarrow H_2SO_4 + 2\,HI$
Hydrogen Sulfide	1 to 200 ppm	White > Pale brown	$H_2S + Cu_2 \rightarrow CuS + 2\,H^+$
Total Hydrocarbons	0.1 – 1.3 ppm	Orange > Brown-green	$C_8H_{18} + I_2O_5 \rightarrow I_2$
Styrene	10 to 250 ppm	White > Light-yellow	$C_6H_5\text{-}CH{=}CH_2 + H_2SO_4 \rightarrow$ yellow reaction product
Benzene	2 – 60 ppm	White > brownish-gray	$C_6H_6 + I_2O_5 + H_2SO_4 \rightarrow I_2$
Formaldehyde	2 – 40 ppm	White > Pink	$HCHO + C_6H_4(CH_3)_2 + H_2SO_4 \rightarrow$ quinoid reaction products

5. Results and Discussion

Carbon dioxide was the only gas detected before the burning of Oud in a concentration of 200 ppm. Whereas during the burning of Oud, the gasses with the highest concentrations were, Carbon dioxide, Styrene, Benzene, Carbon monoxide, and Formaldehyde, in the following concentrations, 800 ppm, 200 ppm, 166.6 ppm, 100 ppm, and 10 ppm, respectively as shown in Figure 1.

The gas that was detected before the burning of Bakhour, was Carbon dioxide in a concentration of 95 ppm. Whereas during the burning of Bakhour, the gasses with the highest concentrations were, Carbon dioxide [666.6 ppm], Benzene [20 ppm], Carbon monoxide [15 ppm], Styrene [10 ppm], Sulfur Dioxide [8.33ppm], Hydrogen Sulfide [6.6 ppm], and Formaldehyde [2.04 ppm] as shown in figure.2. Lastly, as shown in Figure.3, the gas that was detected before the burning of Frankincense *"Luban"*, was Carbon dioxide in a concentration of 133.3 ppm. Whereas during the burning of Frankincense *"Luban"*, the gasses with the highest concentrations were, Carbon dioxide, Benzene, Carbon monoxide, Styrene, Sulfur Dioxide, and Formaldehyde, in the following conctrations, 500 ppm, 125 ppm, 114.2 ppm, 100 ppm, 3.57 ppm, and 1.9 ppm, respectively.

(Figures 1-3) show that during the burning of inense, Carbon Monoxide emissions were hightest from Luban (125 ppm) and lowest from Bakhour (15 ppm), Carbon Dioxide emissions were the highest from Oud (800 ppm) and lowest from Luban (500 ppm), Styrene highest emissions were from the burning of Oud (200 ppm) and lowest from Bakhour (10 ppm), Formaldehyde emissions were highest from Oud (10 ppm) and lowest from Luban (1.9 ppm), Benezene highest emissions were from the burning of Oud (166.6 ppm) and lowest from Bakhour (20 ppm). Sulfur Dioxide was only emitted from Bakhour and Luban, at concentrations of 8.33 ppm, and 3.5 ppm, respectively. Lastly, Hydrogen Sulfide was only detected in burning of Bakhour at a concentration of 6.6 ppm.

Figure.1: Gas Concentrations from Oud

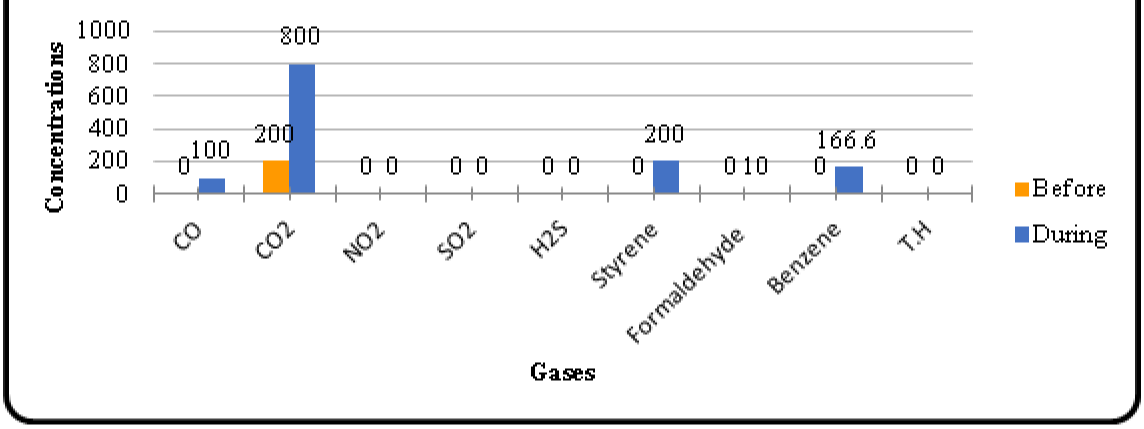


Figure.2: Gas Concentrations from Bakhour

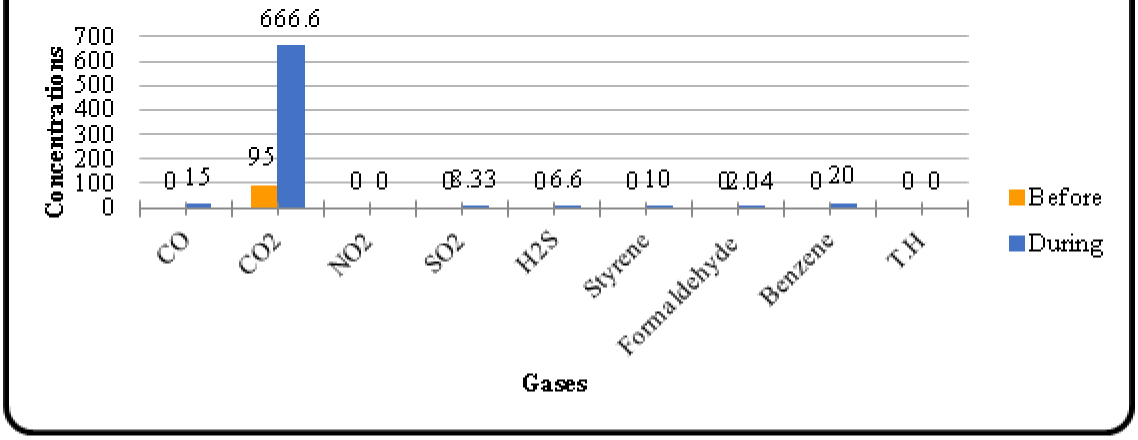
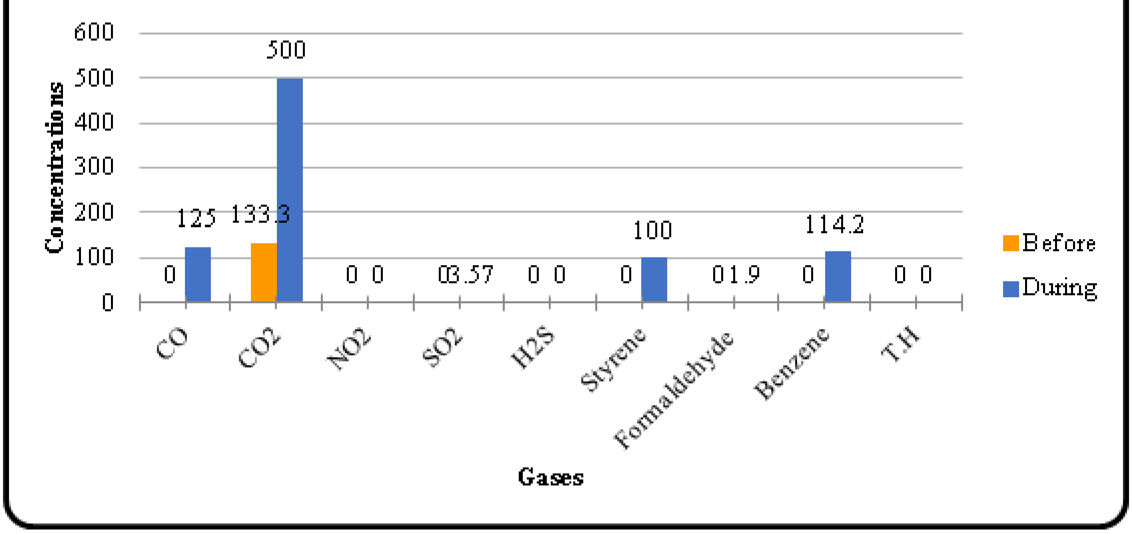


Figure.3: Gas Concentrations from Luban



Regarding to the results of the questionnaire it revealed that 16.7% of exposed house members had cough, 13.3% of them phlegm, 20% suffered with breathlessness, and 6.7% had wheezing as shown in Figure.4.

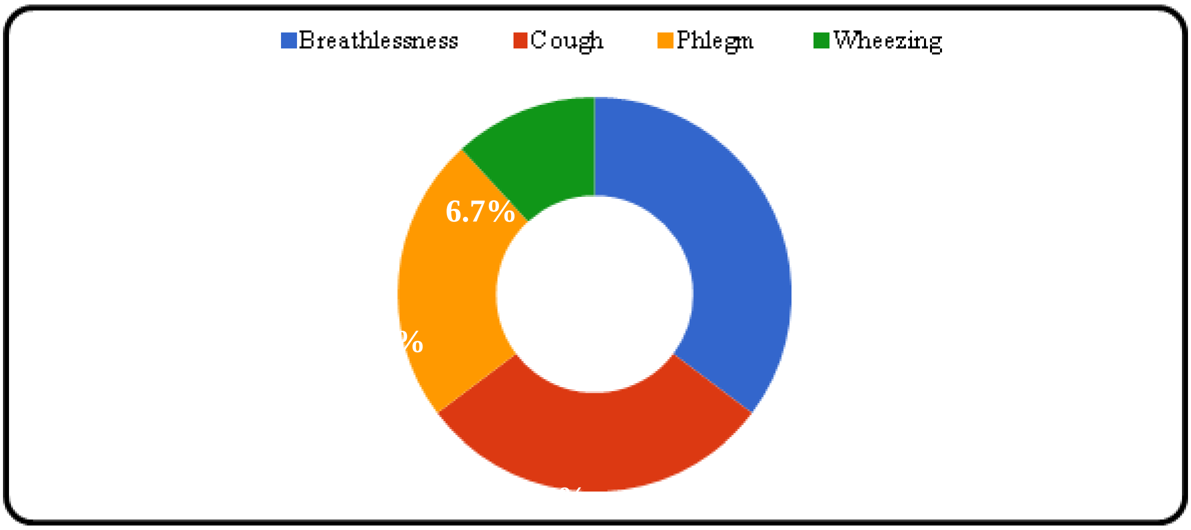


Figure 4: Prevalence of respiratory symptoms among exposed houses members.

6. Conclusion and Recommendation

The common gases with the highest concentrations in all three incense types used were Carbon dioxide, Styrene, Benzene, Carbon monoxide, and Formaldehyde, thus, could be harmful to human health. Oud, has the highest concentrations of gas emissions compared to the other two types. Followed by Luban. Lastly, Bakhour had the lowest concentrations among the three houses. Carbon dioxide was the only gas detected before the burning, and was the highest during the burning, and this is owed to the fact the incense was burned using charcoal. Few of the exposed house members suffered from cough, phlegm, breathlessness, and wheezing.

Based on the conclusions, the following are recommended, switch to modern electrical appliances to burn the incense to reduce the emissions of CO2. Ventilate the location during and/or after the use of incenses in order to reduce the exposure concentration of combustion residues in the air. Lastly, reduce the daily practice of incense burning, to weekly or monthly.

7. Limitations

There are number of limitations in this study, including:

1. No houses free of incense exposure were found to compare the results with, which may influence the interpretation of results and limit generalizability.
2. The sample size is small to generalize the results.
3. Time limitation was also an issue faced.

Acknowledgements

We would like to express our deepest gratitude for our respected professors and supervisors at the University of Sharjah, we appreciate all their continued efforts and encouragement throughout the years. Our completion of this research project could not have been accomplished without the support and guidance of our supportive supervisor Dr. Hafiz Omer, we are so thankful for his efforts, help and guidance provided throughout the project and research. A special thanks to Ms. Badriya Ibrahim, the Laboratory Assistant for facilitating the conduction of this research through her limitless help and assistance.

References

[1] Al-Rawas, O. A., Al-Maniri, A. A., & Al-Riyami, B. M. (2009). Home exposure to Arabian incense (bakhour) and asthma symptoms in children: a community survey in two regions in Oman. *BMC pulmonary medicine*, *9* (1), 1-9.

[2] Bootdee, S., Chantara, S., & Prapamontol, T. (2016). Determination of PM2.5 and polycyclic aromatic hydrocarbons from incense burning emission at shrine for health risk assessment. *Atmospheric Pollution Research*, *7* (4), 680–689. https://doi. org/10.1016/j. apr.2016.03.002

[3] Chuang, H. C., Jones, T., Chen, Y., Bell, J., Wenger, J., & BéruBé, K. (2011). Characterisation of airborne particles and associated organic components produced from incense burning. *Analytical and bioanalytical chemistry*, *401* (10), 3095-3102.

[4] Elsayed, Y., Dalibalta, S., Gomes, I., Fernandes, N., & Alqtaishat, F. (2016). Chemical composition and potential health risks of raw Arabian incense (Bakhour). *Journal of Saudi Chemical Society*, *20* (4), 465–473. https://doi.org/10.1016/j. jscs.2014.10.005

[5] Friborg, J. T., *et al*. (2008, October 1). Incense use and respiratory tract carcinomas: A prospective cohort study. *Cancer 113* (7): 1676-1684. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2559972/.

[6] Ji, X., Le Bihan, O., Ramalho, O., Mandin, C., D'Anna, B., Martinon, L., & Pairon, J. C. (2010). Characterization of particles emitted by incense burning in an experimental house. *Indoor Air*, *20* (2), 147-158.

[7] Lin, T.-C-., Krishnaswamy, G., & Chi, D. S. (2008). Incense smoke: Clinical, structural, and molecular effects on airway disease. *Clinical and Molecular Allergy 6* (3). Retrieved from https://www.ncbi. nlm. nih. gov/pmc/articles/PMC2377255/.

[8] Lung, S. C. C., Kao, M. C., & Hu, S. C. (2003). Contribution of incense burning to indoor PM10 and particle-bound polycyclic aromatic hydrocarbons under two ventilation conditions. *Indoor Air*, *13* (2), 194-199.

[9] MacKinnon, I. (2008, July 30). Burning joss sticks 'as deadly as traffic fumes or cigarette smoke'. *The Guardian*. Retrieved from https://www.theguardian.com/world/2008/jul/30/health.

[10] Mahgoub, H. A., Salih, N. A., & Mohammedzain, T. E. (2015). Identification of polycyclic aromatic hydrocarbons emissions from Oud Incense–Al–Baha City Southwest Saudi Arabia. *International journal of chemical science and research*, *5* (6), 12-22.

[11] *Oud & bakhoor: Fill your homes with luxurious scent of Arabia*. (undated). Arabian Luxuries. Retrieved from https://www.arabianluxuries.com/oud-bakhoor-homes-luxurious-scent-of-arabia/.

[12] Poslusny, C. (undated). *Is incense smoke bad for you?* Molekule. Retrieved from https://molekule.com/blog/is-incense-smoke-bad-for-you/.

[13] See, S. W., & Balasubramanian, R. (2011). Characterization of fine particle emissions from incense burning. *Building and Environment*, *46* (5), 1074–1080. https://doi. org/10.1016/j. buildenv.2010.11.006

[14] Wang, B., Lee, S. C., & Ho, K. F. (2006). Chemical composition of fine particles from incense burning in a large environmental chamber. *Atmospheric environment*, *40* (40), 7858-7868.

[15] Yeatts, K. B., El-Sadig, M., Leith, D., Kalsbeek, W., Al-Maskari, F., Couper, D.,. . . & Davidson, C. A. (2012). Indoor air pollutants and health in the United Arab Emirates. *Environmental health perspectives*, *120* (5), 687-694