UNIVERSITI PUTRA MALAYSIA

ASSOCIATION OF RESPIRABLE CEMENT MINERAL DUST EXPOSURE WITH FRACTIONAL EXHALED NITRIC OXIDE AND INTERLEUKIN-8 ON AIRWAYS INFLAMMATION AMONG CEMENT WORKERS IN NEGERI SEMBILAN, MALAYSIA

NOOR HAZIQAH BTE KAMALUDIN

FPSK(p) 2020 9

ASSOCIATION OF RESPIRABLE CEMENT MINERAL DUST EXPOSURE WITH FRACTIONAL EXHALED NITRIC OXIDE AND INTERLEUKIN-8 ON AIRWAYS INFLAMMATION AMONG CEMENT WORKERS IN NEGERI SEMBILAN, MALAYSIA

By

NOOR HAZIQAH BTE KAMALUDIN

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirements for the Degree of Doctor of Philosophy

January 2020

COPYRIGHT

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirement for the degree of Doctor of Philosophy

ASSOCIATION OF RESPIRABLE CEMENT MINERAL DUST EXPOSURE WITH FRACTIONAL EXHALED NITRIC OXIDE AND INTERLEUKIN-8 ON AIRWAYS INFLAMMATION AMONG CEMENT WORKERS IN NEGERI SEMBILAN, MALAYSIA

By

NOOR HAZIQAH BTE KAMALUDIN

January 2020

Chairman : Associate Professor Juliana Jalaludin, PhD
Faculty : Medicine and Health Sciences

Prolonged exposure to cement dust may induce immunologic response due to high-level irritant-exposure. This study was to investigate the association of exposure to respirable cement mineral dust with the respiratory health performance by interpretation of Fractional Exhaled Nitric Oxide (FENO) and Interleukin-8 (IL-8) concentrations. A cross-sectional comparative study was carried out among 179 cement workers consist of manufacturing and administrative workers while 173 school staffs as a comparative group in Negeri Sembilan by simple random sampling method. Personal respirable dust exposure was collected by using air sampling pump. The cement mineral dust were analysed by using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) for Arsenic (As) and Chromium (Cr) while for the Silica (Si) by using X-ray powder Diffraction (XRD) method. IL-8 concentrations were analysed using human ELISA kit while FENO levels and Lung Function test were obtained by using NIOX MINO and Chestgraph H1-105 spirometer. Mean and standard deviation of cement respirable dust was higher in manufacturing workers with 4.94±3.32 mg/m^3 and administrative workers with 1.99±2.02 mg/m^3 compared with comparative group at 1.18±0.78 mg/m^3. Geometric mean (GM) of Si, As and Cr concentrations in manufacturing workers were 5.23 ± 2.29 mg/m^3, 0.10 ± 0.02 mg/m^3 and 1.51 ± 2.47 mg/m^3 respectively. Occurrence of phlegm (χ^2=26.868, p= <0.001) and cough (χ^2=14.576, p= <0.001) were significantly higher among cement workers compared to the comparative group. Lung function abnormalities of FVC% predicted and FEV_1% predicted showed significantly difference between cement workers and comparative group with (χ^2=31.228, p = <0.001) and (χ^2=34.855, p = <0.001) respectively. IL-8 and FENO were significantly higher among cement workers with GM, 239.33±1.67 pg/mL and 30.02 ± 26.55 ppb respectively. There was positive correlation between respirable Si and Cr dust with FENO level among administrative workers with (r= 0.646, p=0.004 and r=0.521, p=0.013). There was significant correlation between respirable As dust with IL-8 concentrations among manufacturing workers (r=0.464, p=<0.001). After controlling for confounders, the abnormalities of FVC% predicted and FEV_1% predicted were significantly associated with the respirable Si dust among cement workers (OR=6.913; CI=1.965-24.322 and OR=18.320; CI=3.078-109.027). Production of IL-8 concentrations in manufacturing workers were significantly influenced by the exposure to respirable As dust concentrations and factor of not wearing a mask or respirator (R^2=0.402, all p=<0.05). FENO concentrations in administrative workers were significantly influenced by the exposure to respirable Si dust (R^2=0.584, p=0.006). The higher concentration of FENO and IL-8 production are the indicator of airways inflammation. Probability of cancer risks for Si, As and Cr VI dust exposure among manufacturing workers were at 4.34 x 10^{-5}, 1.11 x 10^{-3} and 6.99 x 10^{-3}, respectively after considering the control measures. Exposure to respirable cement dust contributed to a high risk of lung impairment through various respiratory health symptoms, reducing lung function level, increased IL-8 and FENO concentrations. Both manufacturing and administrative workers showed a high prevalence of respiratory disease. Cement workers were at high risk of getting cancerous and non-cancerous diseases while working. It is recommended for the cement industry to improve their control measure on exposure to cement dust and strictly enforce on wearing respirator among workers especially administrative workers.

Abstrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

HUBUNGAN ANTARA PENDEDAHAN MINERAL HABUK SIMEN DENGAN PECAHAN HEMBUSAN NITRIK OKSIDA DAN *INTERLEUKIN-8* KE ATAS RADANG SALUR PERNAFASAN DALAM KALANGAN PEKERJA KILANG SIMEN DI NEGERI SEMBILAN, MALAYSIA

Oleh

NOOR HAZIQAH BTE KAMALUDIN

Januari 2020

Pengerusi : Profesor Madya Juliana Jalaludin, PhD
Fakulti : Perubatan dan Sains Kesihatan

Pendedahan yang berpanjangan terhadap habuk simen boleh menimbulkan tindak balas imunologi disebabkan oleh kerengsaan terutama oleh pendedahan pada tahap tinggi. Kajian ini adalah untuk menyiasat perkaitan bagi pendedahan habuk simen terhadap pencapaian kesihatan pernafasan dengan membuat tafsiran kepekatan Pecahan Hembusan Nitrik Oksida (FENO) dan *Interleukin-8* (IL-8). Kajian perbandingan keratan rentas telah dijalankan dalam kalangan 179 orang pekerja simen terdiri daripada pekerja pembuatan dan pentadbiran, manakala 173 orang dalam kalangan kakitangan sekolah sebagai kumpulan perbandingan di Negeri Sembilan melalui kaedah pensampelan rawak. Data pendedahan peribadi habuk simen telah dikumpulkan dengan menggunakan pam pensampelan udara. Mineral di dalam habuk simen dianalisa dengan menggunakan Inductively Coupled Plasma Mass Spectrometry (ICP-MS) bagi Arsenik (As) dan Kromium (Cr), manakala bagi Silika (Si) dengan menggunakan kaedah X-Ray powder Diffraction (XRD). Kepekatan IL-8 dianalisa dengan menggunakan kit ELISA bagi manusia manakala ujian FENO dan fungsi paru-paru diperoleh dengan menggunakan NIOX MINO dan spirometer Chestgraph H1-105. Min dan sisihan piawai bagi habuk simen adalah lebih tinggi dalam kalangan pekerja pembuatan dengan 4.94 ± 3.32 mg/m³ dan pekerja pentadbiran dengan 1.99±2.02 mg/m³ berbanding dengan kumpulan perbandingan 1.18±0.78 mg/m³. Min geometrik (GM) bagi kepekatan Si, As dan Cr dalam pekerja pembuatan, masing-masing adalah 5.23±2.29 mg/m³, 0.10±0.02 mg / m³ dan 1.51±2.47 mg/m³. Penghasilan kahak (χ^2= 26.868, p=<0.001) dan batuk (χ^2=14.576, p=<0.001) adalah lebih tinggi secara signifikan dalam kalangan pekerja simen berbanding dengan kumpulan perbandingan. Keabnormalan fungsi paru-paru bagi jangkaan FVC% dan jangkaan FEV_1% menunjukkan perbezaan secara signifikan antara pekerja simen dan kumpulan perbandingan dengan masing-masing (χ^2=31.228, p=<0.001) dan (χ^2=34.855, p=<0.001). IL-8 dan FENO adalah lebih tinggi dalam kalangan pekerja simen dengan GM masing-masing adalah 239.33±1.67 pg/mL dan 30.02±26.55 ppb. Terdapat hubungan yang positif di antara kepekatan Si dan Cr dengan aras FENO dalam kalangan pekerja pentadbiran (r=0.646, p=0.004 dan r=0.521, p=0.013). Terdapat hubungan yang signifikan di antara kepekatan As dengan aras IL-8 dalam kalangan pekerja pembuatan (r=0.464, p=<0.001). Selepas pengawalan faktor pembauran, keabnormalan bagi jangkaan FVC% dan jangkaan FEV_1% adalah berhubung secara signifikan dengan kepekatan Si dalam kalangan pekerja simen (OR=6.913; CI=1.965-24.322 dan OR=18.320; CI=3.078-109.027). Penghasilan kepekatan IL-8 dalam pekerja pembuatan adalah dipengaruhi secara signifikan oleh pendedahan kepekatan habuk As dan faktor tidak memakai topeng atau alat pernafasan (R^2=0.402, semua p=<0.05). Kepekatan FENO dalam kalangan pekerja pentadbiran dipengaruhi secara signifikan oleh pendedahan kepada Si (R^2=0.584, p=0.006). Kepekatan tinggi dalam penghasilan FENO and IL-8 adalah penunjuk kepada radang saluran pernafasan. Kebarangkalian risiko kanser terhadap pendedahan habuk Si, As dan Cr VI dalam kalangan pekerja pembuatan masing-masing adalah 4.34×10^{-5}, 1.11×10^{-3} dan 6.99×10^{-3}, selepas mengambil kira langkah kawalan. Pendedahan terhadap habuk simen menyumbang kepada risiko gangguan paru-paru melalui pelbagai gejala penyakit pernafasan, mengurangkan tahap fungsi paru-paru, peningkatan kepekatan IL-8 dan FENO. Kedua-dua pekerja pembuatan dan pentadbiran memperlihatkan kelaziman penyakit pernafasan yang tinggi. Pekerja simen berisiko tinggi untuk mengalami penyakit kanser dan bukan kanser semasa kerja. Adalah disyorkan agar industri simen untuk meningkatkan kawalan mereka terhadap pendedahan habuk simen dan tegas dalam menguatkuasakan pemakaian alat pernafasan dalam kalangan pekerja terutamanya pekerja pentadbiran.

ACKNOWLEDGEMENTS

Alhamdulillah, I praise and thank Allah SWT for His greatness and for giving me the strength and courage to complete this thesis. Foremost, I would like to express my sincere gratitude to my supervisor, Assoc. Prof. Dr. Juliana Jalaludin for the continuous support of study and research, for her patience, motivation, enthusiasm, and immense knowledge. Her guidance had helped me in all the time during my research and writing of this thesis.

My deepest gratitude to all members of supervisor committee, Prof. Dr. Shamsul Bahri Mohd Tamrin and Assoc Prof. Dr Abdah Md Akim for their encouragement and thoughtful comments. Huge thanks for them in contributing their knowledge and expertise for critical insights and invaluable advice in this study.

Special grateful to my parents and all my family members whom continuous supporting throughout my life, love me without condition, encourage me throughout my difficulty and always stand by me through thick and thin. I have been blessed and thankful for a friendly and cheerful group of friends. Sharing our funs and tears together and supporting each other throughout those difficulties.

A special thanks to the workers of cement industries, Ministry of Education, and all schools' management for the cooperation in allowing this study to be carried out. A million thanks to all workers and staffs for their willingness and cooperation in participating in this research study.

I would like to express my gratitude to all the Faculty of Medicine and Health Sciences members, Universiti Putra Malaysia, for their cooperation and valuable assistance in completing this research. A million thanks to Universiti Putra Malaysia for providing financial support for this research. This project was funded by Putra graduates' Initiative grant (Project Code: GP-IPS/2017/9527800)

Finally, I would like to thank everybody who was important to the successful realization of this thesis, as well as expressing my apology that I could not mention personally one by one.

This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfilment of the requirement for the degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

Juliana Jalaludin, PhD
Associate Professor
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Chairman)

Shamsul Bahri Mohd Tamrin, PhD
Professor
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Member)

Abdah Md Akim, PhD
Associate Professor
Faculty of Medicine and Health Sciences
Universiti Putra Malaysia
(Member)

ZALILAH MOHD SHARIFF, PhD
Professor and Dean
School of Graduate Studies
Universiti Putra Malaysia

Date:13 August 2020

Declaration by graduate student

I hereby confirm that:

- this thesis is my original work;
- quotations, illustrations and citations have been duly referenced;
- this thesis has not been submitted previously or concurrently for any other degree at any institutions;
- intellectual property from the thesis and copyright of thesis are fully-owned by Universiti Putra Malaysia, as according to the Universiti Putra Malaysia (Research) Rules 2012;
- written permission must be obtained from supervisor and the office of Deputy Vice-Chancellor (Research and innovation) before thesis is published (in the form of written, printed or in electronic form) including books, journals, modules, proceedings, popular writings, seminar papers, manuscripts, posters, reports, lecture notes, learning modules or any other materials as stated in the Universiti Putra Malaysia (Research) Rules 2012;
- there is no plagiarism or data falsification/fabrication in the thesis, and scholarly integrity is upheld as according to the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) and the Universiti Putra Malaysia (Research) Rules 2012. The thesis has undergone plagiarism detection software

Signature: ______________________________ Date: ________________

Name and Matric No: Noor Haziqah Bte Kamaludin, GS42195

Declaration by Members of Supervisory Committee

This is to confirm that:

- the research conducted and the writing of this thesis was under our supervision;
- supervision responsibilities as stated in the Universiti Putra Malaysia (Graduate Studies) Rules 2003 (Revision 2012-2013) were adhered to.

Signature: ______________________
Name of Chairman of Supervisory Committee: Associate Professor Dr. Juliana Jalaludin

Signature: ______________________
Name of Member of Supervisory Committee: Professor Dr. Shamsul Bahri Mohd Tamrin

Signature: ______________________
Name of Member of Supervisory Committee: Associate Professor Dr. Abdah Md Akim

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

LIST OF ABBREVIATIONS

>	More than
≥	More than and equal to
<	Less than
≤	Less than and equal to
ANOVA	Analysis of Variance
As	Arsenic
ATS	American Thoracic Society
COPD	Chronic Obstructive Pulmonary Diseases
DOSH	Department of Occupational Safety & Health
EPA	Environmental Protection Agency
FVC	Force Vital Capacity
FEV_1	Forced Expiratory Volume in 1 second
PM_{10}	Particulate Matter less or equal to 10 µm in aerodynamic diameter
$PM_{2.5}$	Particulate Matter less or equal to 2.5 µm in aerodynamic diameter
ppm	Part per million
ppb	Part per billion
Pg/mL	Pictogram per millilitre
SD	Standard Deviation
GM	Geometric Mean
FENO	Fractional Exhaled nitric Oxide
IL-8	Interleukin-8
SPSS	Statistical Package for Social Science
TWA-8	Time-Weighted Average for 8 hours
PEL	Permissible Exposure Limit

mg/m^3	Milligram per meter cubic
USEPA	United State Environmental Protection Agency
OSHA	Occupational Safety and Health Association (America)
WWF	World Wild Foundation
WHO	World Health Organization
NIOSH	National Institute of Occupational Health
DOE	Department of Environment (Malaysia)
TNF-α	Tumor Necrosis Factor-Alpha
ICP-MS	Inductively Coupled Plasma Mass Spectrometry
Cr	Chromium
Si	Silica
XRD	X-ray powder Diffraction
ELISA	Enzyme-Linked Immunosorbent Assay
OR	Odd Ratio
ILCR	Incremental Lifetime Cancer Risk
HQ	Hazard Quotient
IARC	International Agency for Research on Cancer
ILCRpc	Incremental Lifetime Cancer Risk with prevention and control
HQpc	Hazard Quotient with prevention and control
Ni	Nickel
Al	Aluminium
Mn	Manganese
Cu	Copper
Cd	Cadmium
Pb	Lead
Zn	Zinc

ATSDR	Agency for Toxic Substances and Disease Registry
MAQG	Malaysia Air Quality Guideline
MDA	Malondialdehyde
GSH	Glutathione
NO	Nitric Oxide
NO_2	Nitric Dioxide
NOS_2	Nitric Oxide Synthase
nl/L	Nano litre per litre
VNO	Volume of Nitric Oxide
L/minute	Litre per minute
ppq	Part per quadrillion
L/s	Litre per second

CHAPTER 1

INTRODUCTION

1.1 Research Background

Cement is a mixture of fine greyish powder that is used to bind fine sand and coarse aggregates together and hardens when water is added or known as a hydraulic binder then becomes a durable material known as concrete. This industry is an important link in the supply of essential raw materials to the construction industry in order to develop the most buildings or structures in Malaysia. However, the cement industry is one of the major industries contributing to air pollution. Cement plants are usually located close to the areas where the raw materials such as limestone, clay, rock, chalk, and shale are sufficiently supplied to reduce transport costs. This raw material contains four basic oxides of Calcium Oxide, Silicon Oxide, alumina oxide, and iron oxide.

Cement production is divided into two-step processes, the clinker process and the cement process (Portland Cement Association, 2015). In the clinker process, raw materials are homogeneously mixed by the addition of waste or by-products from other industries, such as paper ash, and are crushed through a milling process for the production of fine powder known as raw meal (Lafarge Holcim, 2015). The most important step in this process is to heat the raw mills inside the kiln at 1500 ^{o}C before it is cooled and stored. The next process in the production of cement, which adds a small amount of gypsum and the difference in mineral materials to the cement grinding mill (Cembereau, 2016). It is then stored in silos before being transported to the customers either in bulk or in baggage.

The entire process of cement manufacturing release of enormous pollutants consists of particulate matter, Sulphur Dioxide and Nitrogen Oxides. Much attention has been paid to this industry to the pollution of particulate matter, especially inorganic pollutants due to their serious respiratory health effects. People who are exposed to cement dust have been studied and shows adverse respiratory health effects and increase the frequency of the respiratory problems (Al-Neaimi, Gomes, and Lloyd, 2001).

According to Cullinan and Tarlo, 2010, occupational asthma can be defined as a presumed immunological response to a work agent due to a high level of irritant exposure caused by specific exposure at work. However, the Malaysian Occupational Safety and Health Act 1994 (Act 514) defined that Occupational Asthma related to the cement industry is any occupation involving exposure to inhalation of mineral dust such as cement. The diagnosis of occupational asthma should be suspected in all adults with symptoms of airflow limitation and positively for patients at high risk occupational or exposure (British Thoracic Society, 2014).

Its size can be divided into three primary categories: respirable dust, inhalable dust, and total dust. Respirable dust is a small amount of dust particles with a size of less than 4μm that can penetrate the nose and upper respiratory system and lower respiratory system to the depths of the lungs. This particle is generally beyond the body's natural clearance mechanisms of cilia and mucus and has a higher tendency to retain and penetrate the blood vessel. Inhalable dust is a small particle that is less than 10μm inhaled but trapped in the nose, throat and upper respiratory tract. Total dust, however, includes all airborne particles, regardless of their size or composition. There are four factors that influence the degree of health hazard, namely the composition of the dust, the concentration of dust, the size of the particle, and the shape and time of exposure. According to Canadian Centre for Occupational Health and Safety (2012) in the article, "What are the effects of dust on the lungs?", some studies have shown that human lungs have a defence mechanism that protects themselves by removing dust particles from the respiratory system, however excessive inhalation of dust may still lead to disease.

The mechanism of inflammation of the airways occurs when the unwanted particle is inhaled and deposited to different stimuli, causing the airways of the bronchial tubes to become over-sensitive and inflamed or swollen (Tarlo, Cullinan, Nemery, 2010). This overreacting mechanism stimulates various symptoms of inflammation of the airways. Cement workers have respiratory symptoms such as coughing, wheezing, dyspnea, sinusitis, shortness of breath bronchitis, and bronchial asthma and are associated with lower ventilator function levels (Al-Neaimi et al., 2001). Inflammation of the upper airway causes rhinitis, while inflammation of the lower airways can cause asthma. According to the World Allergy Organisation (2015), 70-90% of asthma patients were found to have rhinitis concomitants.

1.2 Problem Statement

According to the Occupational Respiratory Disease Statistics in Malaysia by the Department of Occupational Safety and Health, the number of cases reported increased from 2008 to 2013 and decreased slowly until 2018, as shown in Figure 1.1. Occupational lung disease is estimated to be between 6% and 7% of all reported cases (Department of Occupational Safety and Health, 2018). However, the number of patients diagnosed with occupational respiratory disease is less reported due to some doctors who do not link the patient's condition to his or her working environment or the patient themselves did not want to inform their working exposure due to fear that they will lose their job (DOSH, 2018). This is because, the symptoms of respiratory disease such as cough, phlegm and wheezing is a common disease that may be developed in any individual caused by various factors and can be treated. The occupational disease is not as obvious as occupational accidents or injuries and the symptoms show after some period of exposure (Subramaniam, Arip, and Subramaniam, 2017). Therefore, the medical officer is infrequently treated occupational diseases as a common disease and not relate the diseases with their occupational exposure if the patient did not inform about their exposure. Besides, the workers are reporting the disease to the public or private hospitals and clinics where the physician is not occupational health doctors. The usual medical personnel might have limited knowledge of identifying the working exposure as a primary cause, which leads the diagnosis not related to occupational exposure dose-diseases (Rosenman et al., 2006; Yusof et al., 2019).

The most serious concern is when treatment has only been received if there have been any symptoms or severity without first controlling exposure. Employees' awareness of the occupational disease has not yet been recognized and occupational disease caused by work and environmental factors in the workplace is still largely under-reported in the country (DOSH, 2018; Yusof et al., 2019). The most common occupational respiratory disorder is occupational asthma and chronic obstructive pulmonary disease (COPD). However, the other lung conditions associated with the occupation are pneumoconiosis, a condition often suffered by miners who inhale dust from coal over long periods (DOSH, 2013). The occupational lung disease that was verified in September 2018 in 55 cases and the occupational poisoning that was verified in September 2018 in 47 cases. The manufacturing sector contributes 7.27% of occupational lung disease and 85.11% of occupational poisoning in 2018.

The Malaysian statistic of occupational disease and poison have been reported 47.5% by occupational health doctors, 2.8% by the medical officer and 3.4% by the Social Security Organisation (SOCSO) (DOSH, 2019). Therefore, the statistic for occupational lung disease was mostly from the report of occupational health doctors. However, the less number reported might be due to the workers seek medical treatment from a general clinic or hospital that does not link their disease with occupational exposure. Thus, less percentage was reported by the medical officer. In 2013 until 2016, the annual domestic cement demand was positive growth of 4%-5% per annum. Nevertheless, 2016 onwards this industry had contracted on production demand until 6%-8% due to the market price competition and new government's election pledge to delay and even cancel some of the mega infrastructure projects. This leads to the concern of the employee to report their sickness and worried that they would lose their job (DOSH, 2018).

The latest report by SOCSO was on 2017 cases. The total number of occupational respiratory diseases were reported to SOCSO in 2017 was 493, with 190 cases regarding upper respiratory tract diseases, 124 cases on other respiratory system diseases and 174 cases for other pulmonary circulation diseases (SOCSO, 2017). Meanwhile, in 2016, there were 124 cases regarding upper respiratory tract diseases and 126 cases on other respiratory system diseases were reported by SOCSO. Nevertheless, it was reported that 7 cases had pneumoconioses caused by sclerogenic mineral dust, 3 cases had occupational asthma, 4 cases had chronic obstructive pulmonary diseases (COPD), 6 cases had upper airways disorder and 96 cases had other respiratory diseases (SOCSO, 2016). Besides, SOCSO was found that 211 cases regarding the exposure dust, gases, liquids and chemicals have been reported (SOCSO, 2017). The cement industry was reported to have 172 cases from various incidents and accidents (SOCSO, 2016).

The different number of cases reported by DOSH and SOCSO are regarding on their different requirements or purposes, case definition, and the categories of diseases (DOSH, 2016). Thus, the number that reported to the DOSH is less than SOCSO. Besides, many industries are not reported to DOSH for the occurrence of diseases but claiming the medical fees with SOCSO.

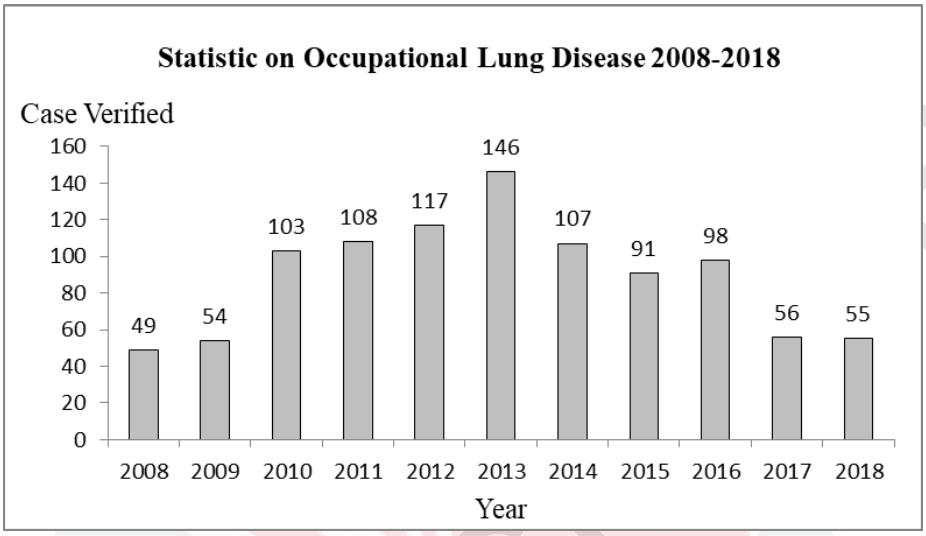

Figure 1.1 : Statistic on Occupational Lung Disease in Malaysia 2008-2018 (DOSH, 2018)

Most workers spend at least eight hours a day in the workplace, especially in manufacturing workers. They are exposed to a variety of dust and chemicals in the working area, especially in the cement industry. In cement production, the dust from the manufacturing or quarrying process will often disperse into the atmosphere. It is a challenge for these industries to ensure that the dust from their processes does not leak or disperse into the working atmosphere, even though they have a good ventilation system. The World Wild Foundation's forecast for cement production is estimated to be 4.41 Gtonne per year in 2020 and to be increased to 5.00 Gtonne per year in 2030 (World Wild Foundation, 2008). The total estimated annual production of cement in Malaysia by eight major cement industries are 40.2 million metric tonnes per year (Malaysia Competition Commission (MyCC), 2017). Meanwhile, 7.2 million metric tonnes per year is an annual cement production capacity by Cement Industries of Malaysia Berhad (CIMA) which constitute as the second-largest cement producers in Malaysia (MyCC, 2017)

Figure 1.2 below shows the increase in the statistic in emissions of dust in the Malaysian cement industry in Perlis and Bahau from 2009 to 2011 (EMU, 2011). This situation may concern companies, environmentalists and workers themselves with the effects of these emissions of dust on the working area and the environment. The main environmental concern with cement production is the emission of dust (Department of Environment, 2014).

People who are exposed to cement dust have been studied and have adverse respiratory health effects and increase the frequency of the respiratory problems (Al-Neaimi et al., 2001; Al-Neaimi et al.,2001). Delicate particulate matter that disperses into the working atmosphere has a strong correlation with the asthmatic disease, which is also possible when inflammatory lungs are triggered (Tarlo & Malo, 2009; Tarlo et al.,2010). In the Malaysian study, smoking workers exposed to cement dust showed a significantly lower value of FEV_1 % predicted compared to non-smoking workers (Noor, Yap, Zulkepli, and Faridah, 2000). While the duration of exposure played a role in health severity when cement mill workers with exposure durations higher than ten years showed a significant reduction in FVC and FEV_1 in the lung function test (Meo, 2013).

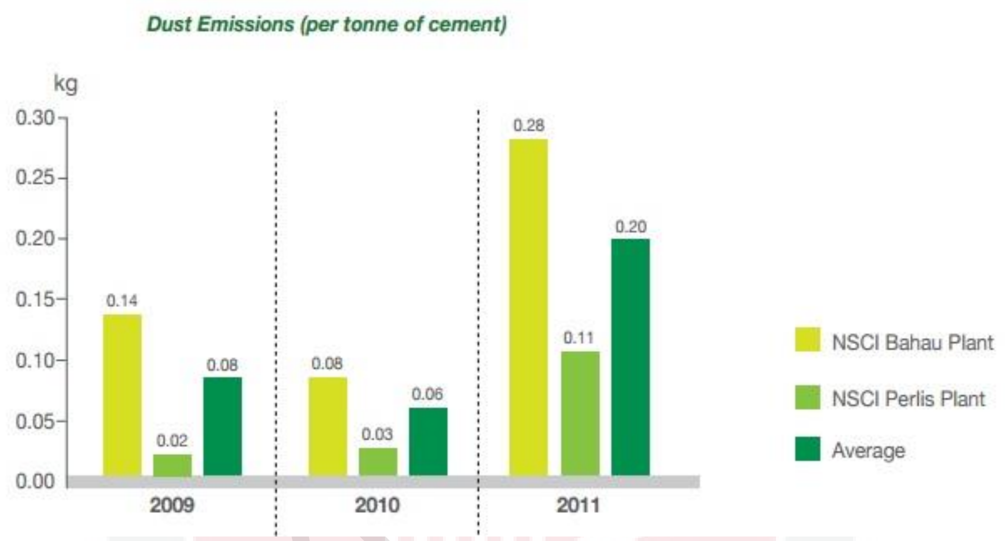

Figure 1.2 : Statistic on Dust Emission in Malaysia Cement industry (UEM, 2011)

The process of cement produces various types of chemical dust from quarrying to transport. The common types of dust chemicals released are inorganic pollutants that exist in cement raw materials. The non-volatile metal dust emissions in the cement industry include Chromium (Cr), Arsenic (As), Nickel (Ni), Aluminum (Al), and Manganese (Mn) (DOE, 2014). Silica is mostly comprised of Malaysia's natural sand deposits and used in the production of cement (Department of Mineral and Geoscience, Malaysia). Thus, Si, As and Cr is the most toxicity to respiratory disease and classified as class 1 carcinogenic by the various agency has been chosen in this study (International Agency for Research on Cancer (IARC), 2012; Agency for Toxic Substances and Disease Registry (ATSDR), 2012). It is estimated that almost 24 000 tonnes of As emitted to the global atmosphere per year by various industries (IARC, 2012). The difference in the type of mineral dust dispersed from the cement industry is based on minerals in raw materials such as limestone, clay, rock, chalk and shale used to make cement. There was an increase of Mn, Cr, and Ni from raw food to clinker, mostly retained by the solid cement kiln process (Cipurkovic, Trumic, Hodžic, Selimbašic, & Djozic, 2014).

There is a limited study in Malaysia concerning the association between exposure to cement mineral dust, in particular Silica (Si), As and Cr to biomarkers for airway inflammation, particularly in the cement industry. Mostly, the cement industrial respiratory health study is determined by the lung function test, which shows only obstructive and restrictive lung. Occupational asthma remains under-recognized, poorly managed, and inadequately compensated, especially in developing countries (Jeebhay & Quirce, 2006). Based on the response of human biomarkers such as Fractional Exhaled Nitric Oxide (FENO) and nasopharyngeal epithelial cells, there is a need to determine the exposure of cement mineral dust (Si, As and Cr) to indicate inflammation of the airways on cement industrial workers.

1.3 Study Justification

The key route of entry of chemical toxins is through inhalation, and the significant sequential effect of the iron and steel industry is on the respiratory system, where all substances in this industry can cause toxicity (Tarlo, 2010). Statistics on Occupational Respiratory Disease in Malaysia from 2008 to 2018 show an increasing number of cases of DOSH. Occupational exposure to dust may lead to a variety of airways diseases such as rhinitis, asthma, chronic obstructive disease (COPD), pneumoconiosis, and even the worst cases of cancer and fatality. Airways inflammation, such as rhinitis and asthma is the most common of respiratory disease among workers (ATSDR, 2008),(Jeebhay & Quirce, 2007). According to Cullinan and Tarlo, 2010, occupational asthma can be defined as a presumed immunological response to a work agent due to a high-level irritant-exposure due to specific exposure at work. Workers may show symptoms of airway inflammation directly after exposure or after prolonged exposure, such as coughing, wheezing, dyspnea, sinusitis, shortness of breath bronchitis and bronchial asthma, and may coincide with lower ventilation function levels (Al-Neaimi et al., 2001). This respiratory disease will disrupt the efficiency and effectiveness of workers and cause a high level of medical leave. 60.7% of the respondents agreed that the cement processing plant is a major contributor to air pollution in the nearest residential area (Mohamad, Ibrahim, and Dogo, 2018). If the residential area had received this impact, what would happen to the workers in that cement industry?

The cement industry is one of the major industries contributing to air pollution. Cement production will disperse toxic pollutants such as heavy metals, Si and asbestos. It is a concern that workers in the cement industry have been exposed to this dust for 8 hours per day. Improper use of personal protective equipment may lead to a high risk of respiratory disease even if there is mechanical prevention. The study found that lowering the lung function level of the ventilator and increasing the prevalence of respiratory health symptoms in cement factory workers is associated with a high concentration of cement dust exposure (Noor et al., 2000). dust It was also found that the concentration of dust in the Rawang cement plant exceeds 3000 µg/m3 for fine dust and 5000 µg/m3 for total dust which is higher than the recommended limit set by the country (MAQG= 150 µg/m3) and then causes workers personal exposure to 570 µg/m3 for respirable dust and 2900 µg/m3 for total dust (Noor et al., 2000). The higher percentage of neutrophil found in the period when workers were exposed to cement dust compared to the period when they were not exposed to cement dust (Fell, Sikkeland, Svendsen, and Kongerud, 2010).

Si, As and Cr are among the highest emissions of dust in the cement industry. Inhalation of these inorganic particulate matters will have an effect on respiratory diseases, particularly inflammation of the airways. Prolonged exposure may cause lung function impairment and the development of obstructive and restrictive airways causes illnesses such as occupational asthma and pneumoconiosis. Some may be lodged in the lungs and remain there for a lifetime, and may accumulate and cause scarring and inflammation (ATSDR, 2008). Some studies have shown that cement workers have a higher prevalence of respiratory diseases and a lower level of ventilator function, suggesting that cement dust inhalation may irritate the respiratory epithelium (Al-Neaimi et al.,2001). Increased plasma MDA levels and reduced erythrocyte GSH levels are associated with silicosis by providing an oxidative link in cement factory workers (Orman, Kahraman, Cakar, Ellidokuz, and Serteser, 2004).

This study serves to provide more detail on airway inflammation, which leads to occupational asthma, especially in the highly exposed industry. This study is also intended to prepare for further medical surveillance, which has only been carried out by industrial employees. In addition, this study would be essential and valuable information for further investigation of toxic inorganic pollutants (Si, As, and Cr) among cement industrial workers who are highly exposed or intermediately exposed to cement dust. The success of this study may lead to further preventive measures to reduce occupational health risks among workers in the cement industry.

1.3.1 General objectives

To determine the association of exposure to respirable cement dust containing Si, As, and Cr with the respiratory health assessment of cement industrial workers by interpretation of FENO and Interleukin-8 (IL-8) concentration levels in respiratory airways.

1.3.2 Specific objectives

1) to identify the socio-demographic factors of cement industrial workers and the comparative group
2) to compare the concentration of personal respirable dust exposure between cement industrial workers and the comparative group.
3) to compare the symptoms of respiratory health between cement industrial workers and a comparative group.
4) to compare the lung function status, the FENO concentration and the IL-8 concentration between cement industrial workers and the comparative group.
5) to determine the relationship between personal respirable dust exposure with FENO concentration, IL-8 concentration, and lung function status among cement industrial workers in Negeri Sembilan

6) to evaluate the concentration of respirable cement dust containing Si, As, and Cr among cement industrial workers in Negeri Sembilan.
7) to determine the relationship between FENO concentration, IL-8 concentration and lung function status with respirable cement dust exposure contained Si, As, and Cr among cement industrial workers in Negeri Sembilan.
8) to predict the production of FENO and IL-8 concentration derived from the exposure to Si, As and Cr respirable cement dust among all cement workers
9) to estimate the health risk probability of exposure to Si, As, and Cr among cement industrial workers in Negeri Sembilan.

1.4 Hypothesis

1) There is a significant difference in concentration for personal respirable dust exposure between cement industrial workers and comparative groups.
2) There is a significant difference in respiratory health symptoms between cement industrial workers and a comparative group.
3) There is a significant difference in lung function status, FENO concentration and IL-8 concentration between cement industrial workers and the comparative group.
4) There is a significant relationship between personal respirable dust exposure with FENO concentration, IL-8 concentration, and lung function status among cement industrial workers in Negeri Sembilan.
5) There is a significantly higher concentration for personal respirable cement dust exposure contained Si, As, and Cr among cement industrial workers in Negeri Sembilan.
6) There is a significant relationship between FENO concentration, IL-8 concentration, and lung function status with the personal respirable cement dust exposure contained Si, As, and Cr among cement industrial workers in Negeri Sembilan.
7) There is a higher prediction of FENO and IL-8 concentration derived from the exposure to Si, As and Cr respirable cement dust among all cement worker
8) There is a higher probability of health risk regarding exposure to Si, As, and Cr among cement industrial workers in Negeri Sembilan

1.5 Conceptual Framework

According to the Department of the Environment, the manufacturing of cement is the most important industry for the emission of dust. The size of the particle concerned is less than 4μm where the dust may penetrate the lower respiratory tract, such as Si, As and Cr, which are produced by the cement process. These pollutants may increase the risk of respiratory diseases, such as occupational asthma, by inhaling cement dust. In this study, the independent variable was the personal exposure of respirable cement dust, while the dependent variable was the symptoms of airway inflammation and respiratory health level. The respiratory health level of workers may be divided into three tests, the lung function test, the nasopharyngeal flocked swab test and the FENO test. The lung function test to indicate lung impairment by using spirometer Chest Graph HI-105 model, flocked nasopharyngeal swab to determine the IL-8 in the epithelial cell by using ELISA test kits and exhaled nitric oxide test to determine the nitric oxide concentration that is exhaled by the workers by using NIOX MINO device. Personal exposure of respirable cement dust is a test to determine the exposure of working dust while working using air sampling pump technique, and the sample was analysed using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS) for As and Cr while for Si using X-ray Powder Diffraction (XRD) analysis. The Si, As, and Cr data was calculated for health risk assessment for incremental lifetime cancer risk (ILCR) and hazard quotient (HQ) adopted by USEPA. Symptoms of respiratory disease were investigated using a questionnaire (ATS-DLD) and a direct interview. The confounding feature of this study is gender, age, nationality, and existing medical treatment and illness within six weeks prior to study conducted, which may interfere with the findings of this study as shown in Figure 1.3.

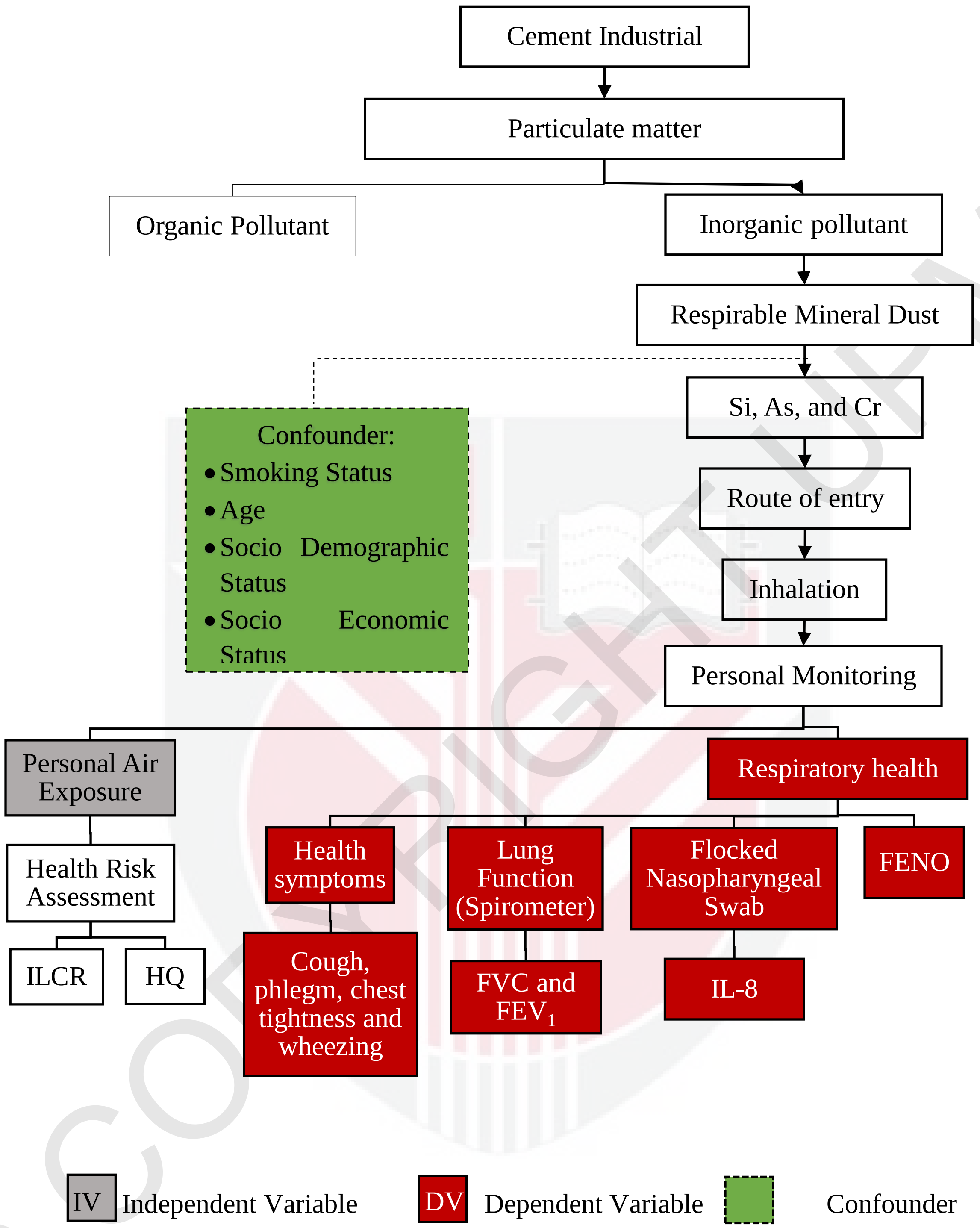

Figure 1.3 : Conceptual Framework of Cement Industrial Respirable Dust Assessment

1.6 Definition of variables

1.6.1 Conceptual Definition

1.6.1.1 Occupational airways inflammation

Occupational airways Inflammation or occupational asthma occurs when the bronchial tubes of the airways become inflamed or swollen and oversensitive due to unwanted particles, which cause the airways to overreact and become narrower, which restricts airflow into and out of the lungs, or problems breathing when workers are exposed in the working area (Busse & Busse, 2003). Workers of industry and occupation are exposed to at least one of the many agents that have intermittent difficulty breathing associated with occupational asthma (Occupational Safety and Health Administration, 2013).

1.6.1.2 FENO

FENO is the method used to measure the amount of forced-exhaled nitric oxide (NO) in the breath produced by the lungs (National Institute for Health and Care Excellence, 2014). According to the American Thoracic Society, FENO is a simple, accessible biomarker that can detect inflammation types and serve as a reliable clinical tool for the diagnosis and management of asthma. FENO is recommended for the diagnosis of eosinophilic airway inflammation and monitoring of airway inflammation in asthma patients (Dweik et al., 2011).

1.6.1.3 lung function Test

Spirometry is a test to measure how much air enters the lungs, and the airflow level is inhaled and exhaled from the lungs (Workers Health Protection Program, 2013). The spirometer is a device used to measure how an individual inhales and exhales volumes of air as a function of time (Miller2 et al., 2005). This test is also recognised as a lung function test or a pulmonary function test used to detect abnormalities in the lung function even though there are no signs and symptoms of disease evidence (Ranu et al., 2011)

1.6.1.4 Nasopharyngeal Epithelial Cell Swab

Flocked Nasopharyngeal Swab is a sampling procedure using a flocked swab or soft brush swab in the anterior nasal naris to the nasopharynx to obtained nasal epithelial cell containing IL-8. Flocked Nasopharyngeal Swab consists of a solid moulded plastic applicator shaft with a tip without an internal absorbent core to disperse and trap the specimen cell in the nasopharynx (World Health Organization (WHO), 2005).

1.6.1.5 Respirable Dust

The interpretation of respirable dust in the Occupational Safety and Health Act 1994 (Act 514) prescribed by the Usage and Exposure Standards of Chemicals Hazardous to Health Regulations, 2000 is "a fraction of airborne particulate matter that is captured by a particle size-selective device ..." with 50% of the respirable particulate matter having to pass the collection efficiency by 4µm of the aerodynamic particle diameter (Malaysia, 2011).

1.6.1.5.1 Si

Silicon dioxide (SiO2) or Si is a colourless crystalline and water-insoluble compound. Si, naturally, there is in the crust and sand of the earth. The most type of crystalline Si in cement dust is quartz (Key-Schwartz, Baron, Bartley, Rice, and Schlecht, 2002). The thermodynamic size of Si dust particles can be very fined and small as one to six microns in diameters (Workplace Health and Safety Queensland, 2013). Respirable of Si dust can cause silicosis, lung cancer, pulmonary tuberculosis, Chronic Obstructive Pulmonary Disease (COPD), and airways diseases (Key-Schwartz et al., 2002). In addition, crystalline Si exposure can also cause chronic bronchitis and emphysema (WHSQ, 2013).

1.6.1.5.2 As

As is a grey solid steel, which naturally exists in many types of rock, combined with other elements, such as oxygen, chlorine, and inorganic sulfur, as white or colourless powders which do not evaporate (ATSDR, 2007). Exposure levels above 100µg/m3 may cause irritation to the lungs, especially to cement workers who have been exposed to cement raw materials for a longer period of time.

1.6.1.5.3 Cr

Cr is a solid material grey steel that naturally exists in rocks and soils. This element is odourless and usually does not remain in the atmosphere unless it is released from industry. In general, rural or suburban areas have a lower concentration of Cr compared to urban air. Portland cement production is potentially producing Cr atmospheric with a Cr content of 41.2 mg/kg (range 27.5-60 mg/kg) (ATSDR, 2012).

1.6.1.6 Chronic Cough

Cough is a respiratory defence mechanism mostly involuntary automatic reflex action stemming from irritation of the bronchial mucosa or forced expulsive manoeuvre which against a closed glottis cause a sound (Morice, Mcgarvey, and Pavord, 2006). A chronic cough symptom is a continuous cough that lasts longer than eight weeks or two months, which has been arbitrarily agreed in both the American and European guidelines.

1.6.1.7 Wheezing

Wheezing is symptoms of asthma disease that can be identified by high pitched whistling when workers exhaled during normal breathing (US Department of Health and Human Services, 2007). Wheezes generated by localised or diffuse airways, by narrowing or obstructing airways, causing oscillations or vibrations of almost closed airway walls (Gong, Walker, Hall, and Hurst, 1990). Wheezing may occur when exposed during work and early in the morning or night when in a cold state and may or may not occur with chronic cough.

1.6.1.8 Phlegm

The inflamed bronchial airways make the lining swell and the glands in the walls of the tube secreted by excess mucus or phlegm make it difficult to breathe (American Thoracic Society, 2015). Phlegm production in workers is a normal response to lung irritation followed by chronic cough symptoms that last longer than eight weeks or two months after exposure to cement dust particles.

1.6.1.9 Chest tightness

Breathing difficulty is usually followed by chest pain or tightness due to lung inflammation, where the muscles around the lungs press against them when the pressure within the lungs decreases due to the tubes swallowed (US Department of Health and Human Services, 2007). Usually, the workers will have this symptom immediately after exposure or in the cold weather.

1.6.1.10 Cement Industrial Workers

The full employment of male workers who have spent eight hours at the Cement Factory in Negeri Sembilan can be divided into two main departments, administration and manufacturing. Administration usually spends most of its working time in an office with excellent support for air conditioning such as the Finance Unit, Human Resources (HR), Information and Communication Technology (ICT), Information Management System (IMS), Planning, Procurement, Quality Control, Higher Management Support and Technical Support. The manufacturing department is based on workers who are involved in the production of cement and are highly exposed to cement dust while working as a quarrying unit, bricks, electrical, inventory, logistics, mechanics and safety, health and the environment (SHE).

1.6.2 Operational Variables

1.6.2.1 Occupational airways inflammation

Occupational airway inflammation or occupational asthma has been identified by NIOX MINO and Nasopharyngeal Epithelial Cell Swab. NIOX MINO is designed to measure FENO, which acts as a biomarker to indicate inflammation of the airways. FENO is measured by the detection of chemiluminescence in the unit of concentration parts per billion (ppb). Nasopharyngeal Epithelial Cell Swab is a method used to determine the concentration of biomarker IL-8 in the epithelial nasopharyngeal cell to respond to airway inflammation. The cell was analysed using the ELISA kits to determine the concentration of IL-8 in the pg/mL unit concentration.

1.6.2.2 FENO

Asthma patients will have high levels of nitric oxide (NO) in their exhaled breath and high levels of inducible nitric oxide synthase (NOS2) enzyme activity in the epithelial cells of their airways, so that it is suspected that nitric oxide (NO) plays a role in asthma pathogenesis (Dweik et al., 2011). FENO is measured by the detection of chemiluminescence in the unit of concentration parts per billion (ppb). Measurement of exhaled Nitric Oxide (NO) is not decreased when the exhaled air is channelled through a condenser for breathing (Nguyen et al., 2005). Nitric Oxide (NO) output represents the rate of Nitric Oxide (NO) exhaled, is denoted by Volume of Nitric Oxide (VNO), and calculated from the product of Nitric Oxide (NO) concentration in nano-litre per litre and expiratory flow rate in litre per minute: VNO (nL/minute) = NO (nl/L) x airflow rate (L/minute) (ATS, 2005). The concentration level of FENO was compared with the clinical interpretation guideline of FENO by the American Thoracic Society.

1.6.2.3 lung function Test

Spirometry is used to measure the function of the lung and is a measure of the volume of air flow against time (Ranu *et al*., 2011). This test is performed by deep inhalation and forceful exhalation of the spirometer (a device that records various measurements of lung function) and the result is interpreted by two measurements called forced vital capacity (FVC) and forced expiratory volume-one second (FEV_1) (Workers Health Protection Program, 2013). Forced Vital Capacity (FVC) represents the total amount of air flowing when the patient is exhaled. Forced expiratory volume-one second (FEV_1) is the total amount of air exhaled during the first second of the test or forced volume within 1 second of the test (Jones Medical, 2010). The lung function level was compared with the Spirometry interpretation guideline of the Workers Health Protection Programme (2013).

1.6.2.4 Nasopharyngeal Epithelial Cell Swab

Nasopharyngeal Epithelial Cell Swab is a method used to determine the concentration of biomarker IL-8 in the nasopharyngeal epithelial cell for the response of airways inflammation. The cell was analysed by using ELISA kits. ELISA is a biomarker technique used to measure immunology to detect the presence of antibody or antigen in order to determine the concentration of IL-8 in the unit concentration of pictogram per milliliter (pg/mL). The IL-8 concentration unit was converted into parts per billion (ppb) or parts per million (ppm) for synchronisation with the FENO unit concentration.

1.6.2.5 Respirable Dust

The respirable dust was measured by using Gilian GilAir-3 R Basic Air Sampling Pump 800485-171 for personal exposure. The filter paper was weighed before and after sampling to calculate the timed weight average for eight hours (TWA-8) exposure concentration of respirable dust in mg/m^3. It is then compared with the permissible exposure limit for mineral respirable dust set out in Factories and Machinery Act 1967 (Act 139) under Factories and Machinery (Mineral Dust) Regulations 1989 with a concentration limitation of 5.0 mg/m^3. Levels of exposure are measured by taking breathing zone air samples that reflect an employee’s regular, daily TWA exposure over eight hours.

1.6.2.5.1 Si

Si dust is collected by using the Gilian GilAir-3 R Basic Air Sampling Pump 800485-171 for personal exposure and analyse using X-ray powder Diffraction (XRD) technique. Usually, the concentration of Si dust determined by calculating the frequency of wavelength in the mg/m^3 unit. Exposure levels are measured by taking breathing zone air samples that reflect the employee's regular, daily TWA exposure over eight hours.

1.6.2.5.2 As

As dust is collected by using the Gilian GilAir-3 R Basic Air Sampling Pump 800485-171 from the working area and the personal exposure and analyse using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) at concentration sensitivity as low as one part of the quadrillion (ppq). The concentration used will, however, be converted into a unit of mg/m3. Exposure levels are measured by taking breathing zone air samples that reflect the employee’s regular, daily TWA exposure over eight hours.

1.6.2.5.3 Cr

Cr dust is collected by using the Gilian GilAir-3 R Basic Air Sampling Pump 800485-171 from the working area and the personal exposure and analyse using Inductively Coupled Plasma Mass Spectrometry (ICP-MS) at concentration sensitivity as low as one part of the quadrillion (ppq). Usually, the concentration of Cr in industrial dust ranges from parts per billion (ppb) to parts per million (ppm). The concentration used will, however, be converted into a unit of mg/m^3. Exposure levels are measured by taking breathing zone air samples that reflect the employee's regular, daily TWA exposure over 8 hours.

1.6.2.6 Chronic Cough

The chronic cough symptom has been obtained for more than two months or 8 weeks using a questionnaire. The workers were asked to answer the question if they had ever been given a long, consecutive cough for more than two months while working. The American Thoracic Society recommended the use of chronic cough as a respiratory disease questionnaire (ATS-DLD) for adult use in epidemiological research (Ferris, 1978).

1.6.2.7 Wheezing

The wheezing symptom has been obtained for more than two months or eight weeks using a questionnaire. The workers were asked to answer the question if they had ever been given a long period of consecutive wheezing for more than two months while working. The American Thoracic Society proposed the topic of wheezing as a respiratory disease questionnaire (ATS-DLD) for use with adults in epidemiological studies (Ferris, 1978).

1.6.2.8 Phlegm

Phlegm produced symptoms for more than two months or eight weeks using a questionnaire. The workers were asked to answer the question as to whether they would ever have a prolonged consecutive build-up of phlegm for more than two months while at work. The American Thoracic Society had approved the use of phlegm as a respiratory disease questionnaires (ATS-DLD) for adult use in epidemiological studies (Ferris, 1978).

1.6.2.9 Chest Tightness

The symptoms of chest tightness for more than two months or eight weeks were obtained using a questionnaire. The workers were asked to answer the question as to whether they would ever have long, consecutive chest tightness for more than two months while at work. American Thoracic Society had recommended the question of chest tightness as a respiratory disease questionnaires (ATS-DLD) for use with adults in epidemiological research (Ferris, 1978).

1.6.2.10 Cement Industrial Workers

Cement industrial workers in Negeri Sembilan who are exposed to cement dust associated with occupational airway inflammation were measured using four methods of interpretation of FENO levels, lung function Level, IL-8 concentrations in epithelial nasopharyngeal cells and the personal exposure concentration of respirable cement dust contained in Si, As and Cr.

REFERENCES

Addo, M. A., Darko, E. O., Gordon, C., Davor, P., Ameyaw, F., Affum, H., Gbadago, J. K., and Dzide, S. (2016). Human health risk assessment of airborne trace elements for human receptors in the vicinity of the diamond cement factory, Volta Region, Ghana. *International Journal of Sustainable Development and Planning*, 11(4):522-536.

Adelroth, E., Hedlund, U., Blomberg, A., Helleday, R., Ledin, M. C., Levin, J. O., Pourazar, J., Sandstrom, T., and Jarvholm, B. (2006). Airway inflammation in iron ore miners exposed to dust and diesel exhaust. *European Respiratory Journal*, 27:714-719.

Agency for Toxic Substances and Disease Registry (ATSDR). 2005. Toxicological profile for Nickel. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2007. Toxicological profile for Arsenic. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2008. Toxicological profile for Aluminum. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2012. Toxicological profile for Chromium. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2012. Toxicological profile for Manganese. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry (ATSDR). 2014. Toxic Substances Portal – Arsenic Trioxide. Retrieved 3 March, 2020 from https://www.atsdr.cdc.gov/MMG/MMG.asp?id=1200&tid=279

Agency for Toxic Substances and Disease Registry (ATSDR). 2019. Toxicological profile for Silica. Atlanta, GA: U.S. Department of Health and Human Services, Public Health Service.

Agency for Toxic Substances and Disease Registry. (2007). Public health statement: Arsenic (As). Retrieved 20 April, 2016, from http://www.atsdr.cdc.gov/ToxProfiles /tp2-c1-b.pdf.

Agency for Toxic Substances and Disease Registry. (2012). *Toxicological Profile for Chromium (Cr). Public Health Statement: Chromium (Cr).* US Department of Health and Human Services. Federal Register Publisher. Atlanta, Georgia. 1-592

Ahmed Shafik, S. and Abd El-Mohsen, A. S. (2012). Occupational health: Health promotion program to improve health workers in Tourah Cement Factory. *Journal of American Science*, 8(3):486-496.

Ahmed, S., & Nimir, M. (n.d.). Environmental Impact of Some Trace E L E M E N T S Emission From T H E Work Environment of Atbara Cement Factory and Atbara Rialway Foundry.

Aljeesh, Y., Al-Madhoun, W., and El-Jabaly, S. (2015). Effect of exposure to cement dust on pulmonary function among cement plants workers in the Middle Governorate, Gaza, Palestine. *Public Health Research*, 5(5):129-134.

Al-Neaimi, Y. I., Gomes, J. and Lloyd, O. L. (2001). Respiratory illnesses and ventilatory function among workers at a cement factory in a rapidly developing country. *Occupational Medicine*, 51(6):367-373.

American Association for Public Opinion Research (AAPOR). (2016).Standard definitions: Final dispositions of case codes and outcome rates for surveys 9th Edition. Retrieved 3 March, 2019, from https://www.aapor.org/AAPOR_Main/media/publications/Standard-Definitions20169theditionfinal.pdf.

American Conference of Government Industrial Hygienist (ACGIH). (2005). Threshold limit values for chemical substances and physical agents and biological exposure indices. Cincinnati (OH), USA.

American Thoracic Society. (2005). ATS/ERS Recommendations for standardized procedures for the online and offline measurement of exhaled lower respiratory nitric oxide and nasal nitric oxide. *American Journal of Respiratory and Critical Care Medicine.* 171:912-930.

American Thoracic Society. (2015). What are the signs and symptoms of COPD? Retrieved 20 April, 2016, from https://www.thoracic.org/copd-guidelines/for-patients/what-are-the-signs-and-symptoms-of-copd.php

Amin, K., Ludvıksdottir, D., and Janson, C. (2000). Inflammation and structural changes in the airways of patients with atopic and nonatopic asthma. *American Journal of Respiratory and Critical Care Medicine*, 162(6):2295–2301.

Aminian, O., Aslani, M., and Haghighi, K. S. (2014). Cross-shift study of acute respiratory effects in cement production workers. *Acta Medica Iranica*, 52 (2):146-152.

Amos, B. B., Musa, I., Abashiya, M. and Abaje, I. B. (2015). Impacts of cement dust emissions on soils within 10km radius in Ashaka Area, Gombe State, Nigeria. *Environmental and Pollution*, 4(1):29-36.

Amran, S., Latif, M. T., Khan, M.F., Goh, E., Leman, A. M., and Jaafar, S. A. (2017). Underestimation of Respirable Crystalline Silica (RCS) compliance status among the granite crusher operators in Malaysian quarries. *Air Quality Atmosphere Health*, 10:371-379.

Attfield, M. D. and Costello, J. (2004). Quantitative exposure-response for Silica dust and lung cancer in Vermont granite workers. *American Journal of Industrial Medicine*, 45:129-138.

Australian Institute of Occupational Hygienist (AIOH). (2016). Adjustment of workplace exposure standards for extended work shifts. Retrieved 23 February, 2019 from. https://www.aioh.org.au/static/uploads/files/adjustment-of-workplace-exposure-standards-for-extended-work-shifts-wfvuzaencbed.pdf

Azari, M. R., Rokni, M., Salehpou, S., Mehrabi, Y., Jafari, M. J., Moaddeli, A. N., Movahedi, M., Ramezankhani, A., Hatami, H., Mosavion, M. A., and Ramazani, B. (2009). Risk assessment of workers exposed to Crystalline Silica aerosols in the East Zone of Tehran. *Tanaffos*, 8(3):43-50.

Bae, S., Hikaru, F., Kanematsu, M., Yoshizawa, C., Noguchi, T., Yu, Y., and Ha, J. (2017). Removal of hexavalent Chromium in Portland cement using ground granulated blast-furnace slag powder. *Materials*, 11(11):1-17.

Baggiolini M, Moser B, Clark-Lewis I. (1994). Interleukin-8 (IL-8) and related chemotactic cytokines. The Biles Filley lecture. *Chest*, 105:95–98.

Balakrishnan, B., Mehta, S., Ouelette, D. R., Talavera, F., Mosenifar, Z., Varkey, B. Tino, G., and Varkey, A. B. (2019). Silicosis. Retrieved 7 March, 2020 from https://emedicine.medscape.com/article/302027-overview#a4

Barnes, H., Goh, N. S. L., Leong, T. L., and Hoy, R. (2019). Silica-associated lung disease: An old-world exposure in modern industries. *Respirology*, 24, 1165-1175.

Barnes. P. J. (2003). Therapeutic target in airway inflammation. in N C. Lenfant, lung biology in health and disease: Monitoring of exhaled breath to assess airway inflammation in asthma. *National Heart and Lung Institute Imperial College*, 177:81-92.

Bartley, D. L. and Feldman, R. (1998). Particulates not otherwise regulated, respirable (NIOSH Method 0600). Center for Disease Control, The National Institute for Occupational Safety and Health (NIOSH) Web site. Retrieved 19 February, 2016 from https://www.cdc.gov/niosh/docs/2003-154/pdfs/0600.pdf

Bazilio, B. A., & Weinrich, J. (2012). *The Easy Guide to : Inductively Coupled Plasma- Mass Spectrometry (ICP-MS)*. PerkinElmer SCIEX

Bazilio, B. A., & Weinrich, J. (2012). The Easy Guide to : Inductively Coupled Plasma- Mass Spectrometry (ICP-MS), (December).

Benson, M., Strannegard, I. L., Wennergren, G., and Strannegard, O. (1999). Interleukin-5 and Interleukin-8 (IL-8) in relation to eosinophils and neutrophils in nasal fluids from school children with seasonal allergic rhinitis. *Paediatric Allergy Immunology*, 10:178–185

British Thoracic Society. (2014). *A National Clinical Guideline SIGN 141: British Guideline on The Management of Asthma.* Edenburgh. Scottish Intercollegiate Guidelines Network.

Busse, P. J., & Busse, W. W. (2003). *Therapeutic Target in Airway Inflammation. In N C. Lenfant Lung Biology in Health and Disease: Pathophysiology of Airway Inflammation in Asthma Mount Sinai Hospital*. Marcel Dekker Inc, 177:1-53.

Canadian Centre for Occupational Health and Safety. (2012). What are the effects of dust on the lungs? retrieved 3rd January 2016, from http://www.ccohs.ca/oshanswers/ chemicals/lungs_dust.html

Cankaya, S., and Cankaya, S. (2015). Occupational health and safety in cement industry. *Ecology and safety*, 9:243-250.

Cassidy, A., Mannetje, A., Van Tongeran, M., Field, J. K., Zaridze, D., Dabrowska, N. S., Rudnai, P., Lissowska, J., Fabianova, E., Mates, D., Bencko, V., Foretova, L., Janout, V., Fevotte, J., Fletcher, T., Brennan, P., and Boffeta, P. (2007). Occupational exposure to Crystalline Silica and risk of lung cancer: A multicenter case–control study in Europe. *Epidemiology*, 18:36-43.

Cecala, A. B. and Thimons, E. D. (1993). Tips for reducing dust from secondary sources during bagging. Powder *Bulk Engineering*, 7(5):77–84.

Cecala, A. B., Timko, R. J., and Prokop, A. D. (2000). Methods to lower the dust exposure of bag machine operators and bag stackers. *Applied Occupational and Environmental Hygiene*, 15(10):751–765.

Cembureau – The European Cement Association. (2016). Cement manufacturing process. Retrieved 3rd January, 2016, from http://www.cembureau.eu/about-cement/cement-manufacturing-process.

Centers for Disease Control and Prevention (CDC). (2016). Tuberculosis (TB): How TB Spreads. Retrieved 23 February, 2020 from https://www.cdc.gov/tb/topic/basics/howtbspreads.htm#:~:text=TB%20bacteria%20are%20spread%20through,these%20bacteria%20and%20become%20infected.

Centers for Disease Control and Prevention. (2012). NIOSH respiratory disease: occupational risks of airways disease. Retrieved 16th January, 2016, from http://www.cdc. gov/niosh/programs/resp/risks.htmL

Chan, Y. M., MacLean, L., and Paggiaro, P. L. (1987). Follow-up study of 232 patients with occupational asthma caused by western red cedar (Thuja plicata). *Journal Allergy Clinical Immunology,* 79(5):792-6.

Chest M. I. (2012). Spirometer System: Chestgraph HI-105 for testing asthma, COPD, and other respiratory failure patients and Evaluation of middle aged smokers and people with chronic cough and sputum. Retrieved 23rd November, 2015, from http://www.chest-mi.co.jp/enproduct/chestgraph-hi-105/

Cipurkovic, A., Trumic, I., Hodžic, Z., Selimbašic, V., & Djozic, A. (2014). Distribution of heavy metals in Portland cement production process. *Advances in Applied Science Research,* 5(6): 252–259.

Cipurkovic, A., Trumic, I., Hodžic, Z., Selimbašic, V., & Djozic, A. (2014). Distribution of heavy metals in Portland cement production process. *Advances in Applied Science Research*, *5*(6), 252–259. Retrieved from www.pelagiaresearchlibrary.com

Codorean, E., Raducanu, A., Albulescu, L., Tanase, C., Meghea, A., and Albulescu, R. (2011). Multiplex Cytokine Profiling in whole blood from individuals occupationally exposed to particulate coal species. *Romanian Biotechnologies Latters*. 16: 6.

Collins, J. F., Salmon, A. G., Brown, J. P., Marty, M. A. and Alexeeff, G. V. (2005). Development of a chronic inhalation reference level for respirable crystalline Silica (Si). *Regulatory Toxicology and Pharmacology*, 43:292–300.

Cullinan, P. and Tarlo, S. M. (2010). *Occupational and Environmental Lung Diseases: Disease from Work, Home, Outdoor and Other Exposures.* United Kingdom: Wiley-Blackwell.

Daley, P., Castriciano, S., Chernesky, M., and Smieja, M. (2006). Comparison of flocked and rayon swabs for collection of respiratory epithelial cells from uninfected volunteers and symptomatic patients. *Journal Clinical Microbiology*, 44:2265–2267.

Department of Environment. (2014). Best Available Techniques Guidance Document On Non-metallic (Mineral) Industry). Retrieved 16th January, 2016, from http://www.doe.gov.my/portalv1/wp-content/uploads/2014/07/bestavailabletechniquesguidance document-on-non-metallic-mineral-industry.pdf -

Department of Occupational Safety and Health - DOSH. (2013). Article News: Your work and your lungs. New Straits Times. Retrieved 3 January, 2016, from http://www.dosh.gov.my/index.php?option=com_content&view=article&id=821:your-work-and-your-lungs&catid=150:in-the-news&Itemid=1051&lang=en

Department of Occupational Safety and Health (DOSH). (2016). Malaysian Occupational Safety and Health Profile. Retrieved 23 February, 2019 from https://www.dosh.gov.my/index.php/publication-sp-249/laporan-kajian-osh-profile/2641-ringkasan-laporan-chapter-6/file

Department of Occupational Safety and Health (DOSH). (2018). A manual of recommended practice on: assessment of the health risks arising from the use of chemicals hazardous to health at the workplace 3rd edition. Retrieved 23 February, 2019 from http://www.dosh.gov.my/index.php/en/legislation/guidelines/chemical/2874-01-a-manual-of-recommended-practice-on-assessment-of-the-health-risks-arising-from-the-use-of-chemicals-hazardous-to-health-at-the-workplace-3rd-edition/file.

Department of Occupational Safety and Health (DOSH). (2019). Statistical on Occupational Diseases and Poison 2019 (until February). Retrieved 23 April, 2020 from https://www.dosh.gov.my/index.php/competent-person-form/occupational-health/statistics/occupational-diseases-and-poisoning-statistic/occupational-diseases-and-poisoning-statistic-2019/3463-occupational-diseases-and-poisoning-2019/file

Dietz, A., Ramroth, H., Urban, T., Ahrens, W. and Becher, H. (2003). Exposure to cement dust, related occupational groups and laryngeal cancer risk: results of a population based case-control study. *International journal Cancer*, 108:907-911

Dunn, J. and Grider, M. H. (2020). Physiology, Adenosine Triphosphate (ATP). StatPearls Publishing. Retrieved 3 March, 2020 from https://www.ncbi.nlm.nih.gov/books/NBK553175/

Dweik, R. A., Boggs, P. B., Erzurum, S. C., Irvin, C. G., Leigh, M. W., Lundberg, J. O., Olin, A. C., Plummer, A. L., & Taylor, D. R. (2011). An Official ATS Clinical Practice Guideline: Interpretation of Exhaled Nitric Oxide Levels (Fractional Exhaled Nitric Oxide (FENO)) for Clinical Applications. *American Journal of Respiratory and Critical Care Medicine*, 184:601-615.

Elango, N., Kasi, V., Vembhu, B., and Poornima, J. G. (2013). Chronic exposure to emissions from photocopiers in copy shops causes oxidative stress and systematic inflammation among photocopier operators in India. *Environmental Health*. 12: 78.

Eom, S. Y., Cho, E. B., Oh, M. K., Kweon, S. S., Nam, H. S., Kim, Y. D., and Kim, H. (2016). Increased incidence of respiratory tract cancers in people living near Portland cement plants in Korea. *International Archived of Occupational and Environmental Health*, 90(8):859-864.

Fan, J., Ho, L., Hobson, P., and Brookes, J. (2013). Evaluating the effectiveness of copper sulphate, chlorine, potassium permanganate, hydrogen peroxide and ozone on cyanobacterial cell integrity. *Water Research*, 47:5153 -5164.

Fang, W., Yang, Y., and Xu, Z. (2013). PM_{10} and $PM_{2.5}$ and health risk assessment for heavy metals in a typical factory for cathode ray tube television recycling. *Environmental Science and Technology*, 47:12469-12476.

Fell, a. K. M., and Nordby, K. C. (2017). Association between exposure in the cement production industry and non-malignant respiratory effects: a systematic review. *BMJ Open*, doi:10.1136/bmjopen-2016-012381

Fell, A. K. M., Noto, H., Skogstad, M., Nordby, K. C., Eduard, W., Svendsen, M. V., Ovstebo, R., Troseid, A. M. S., and Kongerud, J. (2011). A cross-shift study of lung function, exhaled nitric oxide and inflammatory markers in blood in Norwegian cement production workers. *Occupational and Environmental Medicine*, 11:799-805.

Fell, A. K. M., Sikkeland, L. I. B., Svendsen, M. V., and Kongerud, J. (2010). Airway inflammation in cement production workers. *Occupational and Environmental Medicine,* 67:395-400.

Fell, A. K. M., Thomassen, T. R., Kristensen, P., Egeland, T., and Kongerud, J. (2003). Respiratory symptoms and ventilator function in workers exposed to Portland cement dust. *Occupational and Environmental Medicine*, 45(9):1008-1014.

Ferris, B. G. (1978). Epidemiology Standardization Project (American Thoracic Society): II. Recommended respiratory disease questionnaires for use with adults and children in epidemiological research. *American Review of Respiratory Disease*, 118:7-57

Formanek, W., Inci, D., Lauener, R. P., Wildhaber, J. H., Frey, U., and Hall, G. L. (2002). Elevated nitrite in breath condensates of children with respiratory disease *European Respiratory Journal*, 19:487–491.

Frank T. L., Adisesh, A., Pickering, A. C., Morrison, J. F., Wright, T., Francis, H., Fletcher, A., Frank, P. I., and Hannaford, P. (1998). Relationship between exhaled nitric oxide and childhood asthma. *American Journal of Respiratory and Critical Care Medicine*, 158:1032–1036.

Frías, M., de Rojas, M.I.S., García, N., and Luxán, M.P. (1994). Contribution of toxic elements: Hexavalent chromium in materials used in the manufacture of cement. *Cement and Concrete Research*, 24(3):533–541.

Galea, S., and Tracy, M. (2007). Participation Rates in Epidemiologic Studies. *Annals of Epidemiology Journal*, 17(9):643-653.

Ganas, K., Loukides, S., Papatheodorou, G., Panagou, P., and Kalogeropoulos, N. (2001). Total nitrite/nitrate in expired breath condensate of patients with asthma. *Respiratory Medicine*, 95, 649–654.

Garey, K., Neuhauser, M. M., Robbins, R. A., Danziger, L. H., and Rubinstein, I. (2004). Markers of inflammation in exhaled breath condensate of young healthy smokers. *Chest*, 125:22–26.

Ghasemkhani, M., Kumashiro, M., Rezaei, M., Anvari, A. R., Mazloumi, A. and Sadeghipour, H. R. (2005). Prevalence of respiratory symptoms among workers in industries of South Tehran, Iran. *Industrial Health*, 44:218-224.

Gibson, P. G., Simpson, J. L., and Saltos, N. (2001). Heterogeneity of airway inflammation in persistent asthma: evidence of neutrophilic inflammation and increase sputum Interleukin-8 (IL-8). *Chest*, 119:1329-1336

Gizaw, Z., Yifred, B. and Tadesse T. (2016). Chronic respiratory symptoms and associated factors among cement factory workers in Dejen town, Amhara regional state, Ethiopia, 2015. *Multidisciplinary Respiratory Medicine*, 11 (13):1-9.

Goldsmith, D. F., Ruble, R. P. and Klein, C. O. (1995). Comparative cancer potency for Silica (Si) from extrapolations of human and animal findings. *Scandinavian Journal of Work, Environment & Health*, 21(2):104-107.

Gong, H., Walker, H. K., Hall, W. D., and Hurst, J. W. (1990). *Clinical Methods: The History, Physical, and Laboratory Examinations: Chapter 37: Wheezing and Asthma*. (3rd edition). Butterworth Publishers. 203–206.

Greenberg, M. I., Waksman, j., and Curtis, J. (2007). Silicosis: A review. Retrieved 3 March, 2020 from http://www.armoni.dk/sites/default/files/Armoni_Fildeling/files/Public/Uddannelse/Kursusmaterialer/david_sherson_silicose.pdf

Grutta, S. L., Ferrante, G., Malizia, V., Cibella, F., & Viegi, G. (2011). Review Article: Environmental Effects on Fractional Exhaled Nitric Oxide (FENO) in Allergic Children. Journal of Allergy. *Hindawi Publishing Corporation, Vol 2012 Id: 916926*, pp. 1-7. Doi :10.1155/2012/916926

Gupta, B. (2016). Correlation and Regression. In: Interview Questions in Business Analytics. *Apress*, Berkeley, CA. Bangalore, India. DOI: 10.1007/978-1-4842-0599-0_5.

Haslam, P. L. (1994). *Occupational Lung Disorder Basic Immunology and Immunopathology* (3rd Ed.). Butterworth: Heinemann. 50-99

Hazra, A. and Gogtay, N. (2016). Biostatistics series module 6: Correlation and linear regression. *Indian Journal of Dermatology*, 61(6):593-601.

Health and safety Executive. (2018). EH40/2005 *Workplace Exposure Limits (3rd Edition)*. The Stationery Office (TSO). Norwich. United Kingdom. Retrieved 23 February, 2019 from http://www.hse.gov.uk/pUbns/priced/eh40.pdf

Health Protection Agency. (2012). Compendium of chemical hazard: Inorganic Arsenic (As). Version 4. Retrieved 16th January, 2016, https://www.gov.uk/government/uploads/ system/uploads/attachment_data/file/203631/CHaP_Report_21.pdf

Hedges, J. C., Singer, C. A., and Gerthoffer, W. T. (2000). Mitogen-activated protein kinases regulate cytokine gene expression in human airway myocytes. *American. Journal Respiratory Cell Molecular Biology*, 23(1):86–94.

Hilt, B., Qvenild, T., Holme, J., Svendsen, K., and Ulvestad, B. (2002). Increase in interleukin-6 and fibrinogen after exposure to dust in tunnel construction workers. *Occupational Environmental Medicine*, 59:9-12

Ho, L. P., Faccenda, J., Innes, J. A., and Greening, A. P. (1999). Expired hydrogen peroxide in breath condensate of cystic fibrosis patients. *European Respiratory Journal*, 13:103–106.

Horvath, I., Hunt, J., and Barnes, P. J. (2005). Exhaled breath condensate: methodological recommendations and unresolved questions. *European Respiratory Journal*, 26:523-548.

Hunt, J., Byrns, R. E., Ignarro, L. J., and Gaston, B. (1995). Condensed expirate nitrite as a home marker for acute asthma. *Lancet,* 346:1235–1236.

Hutyrova, B., Smolkova, P., Nakladalova, M., Tichy, T., and Kolek, V. (2015). Case of accelerated silicosis in a sandblaster. *Industrial Health*, 53, 178-183.

Hwang, J. H., Yoon, J. H., Shin, J. H., Choi, B. S., Lee Y. L., Lee J. S., and Lee, K. M. (2013). Chronic Obstructive Pulmonary Disease and Inflammatory Biomarkers in Retired Workers exposed to inorganic dusts. *Toxicology Environmental Health Science*. 5(2), 86-9.

Ilavska. S., Johnova, E., Tulinska, J., Horvathova, M., Dusinska, M., Wsolova, L., Kyrtopoulos, S. A., and Fourtes, L. 2005. Immunological monitoring in workers occupationally exposed to asbestos. *Toxicology*, 206:299-308

International Agency for Research on Cancer (IARC). (1997). Silica (Si), some Silica (Si)tes, coal dust and paramid fibrils. IARC *Monograph Evaluation Carcinogenic Risks to Human*, 68:1-475.

International Agency for Research on Cancer (IARC). (2012). IARC Monographs on the evaluation of carcinogenic risks to human: Arsenic, metals, fibres, and dusts: A review of human carcinogens vol 100c. WHO Press. Lyon, France.

International Agency for Research on Cancer (IARC). (2019). IARC Monographs on the identification of carcinogenic hazards to humans: Preamble. Retrieved 3 March, 2019 from https://monographs.iarc.fr/wp-content/uploads/2019/01/Preamble-2019.pdf

International Programme on Chemical Safety (IPCS). (1981). *Arsenic (As). Poisons Information Monograph.* Geneva. World Health Organization Publication.

Jacobs, P. and Viechtbauer, W. (2015). Estimation of the biserial correlation and its sampling variance for use in meta-analysis. *Research Synthesis Methods*, 8(2):161-180.

Jarjour, N. N., Peters, S. P., Djukanovic, R., and Calhoun, W. J. (1998). Investigative use of bronchoscopy in asthma. *American Journal Respiratory Critical Care Medicine*, 157:692-697.

Jasim, R. H. (2012). Evaluation of Some Trace Element Levels in Sera Samples of Kufa Cement Factory Workers. *Journal of Photocatalysis Science*, 3(1):9-15

Jeebhay, M. F., and Quirce, S. (2007). Occupational asthma in the developing and industrialised world: a review. *International Journal of Tuberculosis and Lung Disease,* 11:122–133

Jia, G., Erickson, R. W., and Choy, D. F. (2012). Periostin is a systemic biomarker of eosinophilic airway inflammation in asthmatic patients. *Journal Allergy Clinical Immunology*, 130:647–654.

Johns. P., and Pierce, R. (2008). *Spirometry: The Measurement and Interpretation of Ventilatory Function in Clinical Practice*. Australia: McGraw-Hill.

Jones Medical Instrument Company. (2010). Easy Spirometry Interpretation Guide. Retrieved 30th June, 2015, from http://www.jonesmedical.com/spirometry101/what.asp

Karatekin, C., and Ahluwalia, R. (2016). Effects of adverse childhood experiences, stress, and social support on the health of college students. *Journal of Interpersonal Violence*, 1-23.

Kauffer, E., Moulut, J. C., masson, A., Protois, J. C., and Grzebyk, M. (2002). Comparison by X-ray Diffraction and Infrared Spectroscopy of two samples of α Quartz with the NIST SRM 1878a α Quartz. *The Annals of Occupational Hygiene*, 46(4):409-421.

Kavitha, M., Juliana, J., and Abdah, M. A. (2011). Relationship Between Exposure to Particulate Matter And Biomarkers Among Bus Drivers In Klang Valley, Malaysia. *Health and the environment journal*, 2, 2.

Key-Schwartz, R. J., Baron, P. A., Bartley, D. L., Rice, F. L., and Schlecht, P. C. (2002). *Determination of airborne crystalline Silica (Si).* Niosh Manual of Analytical Methods, 260-280

Key-Schwartz, R., Ramsey, D., and Schlecht, P. (2003). Silica, Crystalline, by XRD (filter redeposition) (NIOSH Method 7500). Center for Disease Control, The National Institute for Occupational Safety and Health (NIOSH) Web site. Retrieved 19 February, 2016 from http://www.cdc.gov/niosh/docs/2003-154/pdfs/7500.pdf

Kharitonov, S. A., Donnelly, L. E., Montuschi, P., Collins, J. V., and Barnes, P. J. (2002). Dose-dependent onset and cessation of action of inhaled budesonide on exhaled nitric oxide and symptoms in mild asthma. *Thorax,* 57:889–896.

Kim, B. W., Lee, J. S., and Choi, B. S. (2009). Comparison of analytical methods for α-Quartz by FTIR and XRD. *Korean Journal of Environmental Health Sciences*, 35:1-9.

Kim, M. A., Shin, Y. S., Pham, L. D., and Park, H. S. (2014). Adult asthma biomarker. *Current Opinion Allergy Clinical Immunology Journal*, 14:49–54

Kim, S. H., Lee, C. G., Song, H. S., Lee, H, S., Jung, M, S., Kim, J. Y., Park, C. H., Ahn, S. C., and Yu, S. D. (2015). Ventilation impairment of residents around a cement plant. *Annals of Occupational and Environmental Medicine*, 27(3):1-10.

Klemm, W.A. (1994). Hexavalent Chromium in Portland-Cement. *Cement and Concrete Aggregates*, 16(1):43–47.

Koutsokera, A., Kostikas, K., Nicod, L. P., and William, J. (2013). Pulmonary biomarkers in COPD exacerbations: a systematic review. *Respiratory Research*, 14:111

Kuivenhoven, M. and Mason, K. (2019). Arsenic (Arsine) toxicity. StatPearls Publishing. Retrieved 3 March, 2020 from https://www.ncbi.nlm.nih.gov/books/NBK541125/

Kukhtinova, N. V., Kondyurina, E. G., and Lentze, M. J. (2012). Atopic and Nonatopic Asthma in Children: Two Difference Diseases?. *International Journal of Biomedicine,* 2(3):214-221

Laberge, S., and El Bassam, S. (2004). Cytokines, structural cells of the lungs and airway inflammation. *Pediatric Respiratory Review,* 5:41–45.

Labiris, N. R. and Dolovich, M. B. (2003). Pulmonary drug delivery. Part I: Physiological factors affecting therapeutic effectiveness of aerosolized medications. *Journal of Clinical Pharmacology*, 56, 588–599

Lafarge Holcim. (2015). Cement manufacturing process. Retrieved 3th Jan, 2016, from http://www.lafarge-na.com/wps/portal/na/en/2_2_1-Manufacturing_process

Lahiri, S., Levenstein, C., Nelson, D. I. and Rosenberg, B. (2005). The cost effectiveness of occupational health interventions: prevention of silicosis. *American Journal Of Industrial Medicine*, 48:503-514.

Larsson, B. M., Palmberg, L., Malmberg, P. O., and Larsson, K. (1997). Effect of exposure to swine dust on levels of IL-8 in airway lavage fluid. *Thorax*, 52:638-642.

Latif, M. T., Baharudin, N. H., Velayutham, P., Awang, N., Hamdan, H., Mohamad, R., and Mokhtar, M. (2011). Composition of heavy metals and airborne fibers in the indoor environment of a building during renovation. *Environmental Monitoring Assessment,* 181:479–489

Lauwerys, R. (1986). Dimethylformamide. In: Alessio, L., Berlin, A., Boni, M., and Roi, R. *Biological indicators for the assessment of human exposure to industrial chemicals*. Luxembourg: Commission of the European Communities, Industrial Health and Safety Series, European 10704:18-27.

Lee, H. S., Lee, C. G., Kim, D. H.,Song, H. S., Jung, M. S., Kim, J, Y., Park, C. H., Ahn, S. C., and Yu, S. D. (2016). Emphysema prevalence related air pollution caused by a cement plant. *Annals of Occupational and Environmental Medicine*,28(17):1-8

Lee, J. S., Shin, J. H., Lee, J. O., Lee, K. M., Kim, J. H., and Choi, B. S. (2010). Serum levels of Interleukin-8 (IL-8) and Tumor Necrosis Factor-alpha in coal workers' pneumoconiosis: one-year follow-up study. *Safety and Health at work*, 1(1):69-79.

Lee, K. M., Shin, J. H., Hwang, J. H., Lee, J. S., Choi, B. S, and Kim, I. S. (2014). The Serum Concentrations of YKL-40, IL-6, and TNF-α in Retired Workers Exposed to Inorganic Dusts. *Biomedical Science Letter*, 20(1),8-13.

Lemeshow, S., Hosmer Jr, D. W., Klar, J., and Lwanga S. K. (1990). *Adequacy of Sample Size in Health Studies*. Chichester, England: John Wiley & Sons.

Li, L., Chen, Q. Y., Li, Y. Y., Wang, Y. F., Yang, Z. F., and Zhong, N. S. (2013). Comparison among nasopharyngeal swab, nasal wash, and oropharyngeal swab for respiratory virus detection in adults with acute pharyngitis. *BMC Infectious Diseases*, 13:281-293

Maina, H. M., Egila, J. N., and Peter, R. A. (2015). Impact of cement dust deposition on plants in the vicinity of Ashaka Cement Factory, Gombe State, Nigeria. *Journal of Science and Technology,* 5(8):406-414.

Malaysia (2011). Occupational Safety and Health Act 1994 (ACT 514), *Regulation and Order*. Kuala Lumpur: International Law Book Services.

Malaysia (2012). Employment Act, 1955 (ACT 265), *Regulation and Order*. Kuala Lumpur: International Law Book Services.

Malaysia Competition Commission (MyCC). (2017). Annual report 2017: Promoting competition, protecting you. Retrieved 7 March, 2020 from https://www.mycc.gov.my/sites/default/files/pdf/newsroom/MyCC%20AR2017%20BI.pdf

Malaysia Competition Commission (MyCC). (2017). Market review of building materials in the construction industry under Competition Act 2010. Retrieved 23 February 2020 from http://www.cnca.org.my/pdf/Market-Review-of-Building-Materials-in-the-Construction-Industry_0.pdf

Malinovschi, A., Janson, C., Holmkvist, T., Norback, D., Merilainen, P., and Hogman, M. (2006). Effect of smoking on exhaled nitric oxide and flow-independent nitric oxide exchange parameters. *European Respiratory Journal*, 28(2):339-345.

Malo, J. L., Cartier, A., Ghezzo, H., Lafrance, M., McCants, M., and Lehrer, S. B. (1988) Patterns of improvement in spirometry, bronchial hyper-responsiveness, and specific IgE antibody levels after cessation of exposure in occupational asthma caused by snow-crab processing. *American Review Respiratory Disease*, 138(4):807-12.

Manahan, S. E. (1992). *Toxicology Chemistry*. (2nd Ed.). New York: CRC Press/Lewis Publisher.

Manise, M., Schleich, F., and Gusbin, N. (2010). Cytokine production from sputum cells and blood leukocytes in asthmatics according to disease severity. *Allergy*, 65:889-896.

Manjula, R., Praveena, R., Clevin, R. R., Ghattargi, C. H., Dorle, A. S. and Lalitha, D. H. (2013). Effects of occupational dust exposure on the health status of portland cement factory workers. International Journal of Medicine and Public Health, 3(3):192-196.

Martin, R., Dowling, k., Pearce, D., Sillitoe, J., and Florentine, S. (2014). Health effects associated with inhalation of airborne arsenic arising from mining operations. *Geosciences*, 4, 128-175.

Martins da Silva, C. H., Estevão da Silva, T., O. Morales, N. M., Fernandes, K. P., C. Pinto, R. M. (2009). Quality of life in children and adolescents with allergic rhinitis. *Brazilian Journal of Otorhinolaryngology*, 75(5):642-649.

Mazumder D., N., Das-Gupta J, and, Santra A. (1998). Chronic Arsenic (As) toxicity in West Bengal—the worse calamity in the world. *Journal Indian Medical Association*, 96(18):4–7

Mbelambela, E. P., Eitoku, M., Muchanga, S. M. J., Villanueva, A. F., Hirota, R., Pulphus, T. Y., Sokolo, G. J., Yasumitsu-Lovell, K., Komori, K., and Suganuma, N. (2018). Prevalence of Chronic Obstructive Pulmonary Disease (COPD) among Congolese cement workers exposed to cement dust, in Kongo Central Province. *Environmental Science and Pollution Research*, 25(35):35074-35083

Mehraj, S. S., Bhat, G. A., Balkhi, H. M., and Gul, T. (2013). Health risks for population living in the neighbourhood of a cement factory. *African Journal of Environmental Science and Technology*,7(12):1044-1052.

Mekasha, M., Haddis, A., Shaweno, T., and Mereta, S. T. (2018). Emission level of $PM_{2.5}$ and its association with chronic respiratory symptoms among workers in cement industry: A case of Mugher cement industry, Central Ethiopia. *Avicenna Journal of Environmental Health Engineering*, 5(1):1-7.

Meo, S. A., & Alshehri, M. K. (2014). Effect of exposure to cement dust on Fractional Exhaled Nitric Oxide (FENO) in non-smoking cement mill workers. *European Review for Medical and Pharmacological Sciences*, 1458–1464.

Merenu, I. A., Mojiminiyi, F. Bo. O., Njoku, C. H. and Ibrahim, M. T. O. (2007). The effect of chronic cement dust exposure on lung function of cement factory workers in Sokoto, Nigeria. *African Journal of Biomedical Research*, 10:139-143

Miedinger, D., Lavoie, K. L., L'Archeveque, J., Ghezzo, H. and Malo, J. L. (2011). Identification of clinically significant psychological distress and psychiatric morbidity by examining quality of life in subjects with occupational asthma. *Health and Quality of Life Outcomes*, 9 (76):1-10.

Miller[1], M. R., Crapo, R., Hankinson, J., Brusasco, V., Burgos, F., Casaburi, R., Coates, A., Enright, P., Van Der Grinten, C. P. M., Gustafsson, P., Jesnsen, R., Johnson, D. C., Macintyre, N., Mckay, R., Navajas, D., Pedersen, O. F., Pellegrino, R., Viegi, G., and Wanger, J. (2005). ATS/ERS Task force: standardisation of lung function testing- general considerations for lung function testing. *European Respiratory Journal*, 26:153–161

Miller[2], M. R., Hankinson, J., Brusasco, V., Burgos, F., Casaburi, R., Coates, A., Crapo, R., Enright, P., Van Der Grinten, C. P. M., Gustafsson, P., Jensen, R., Johnson, D. C., Macintyre, N., McKay, R., Navajas, D., Pedersen, O. F., Pellegrino, R., Viegi, G., and Wanger, J. (2005). ATS/ERS Task force: standardisation of lung function testing. *European Respiratory Journal*, 26:319–338.

Milson, M., Hull, R. D., Perkins, J. B., Wheeler, D. L., Nicholson, K., and Andrews, R. (2003). Elements by ICP (Nitric/Perchloric Acid Ashing) (NIOSH Method 7300). Center for Disease Control, The National Institute for Occupational Safety and Health (NIOSH) Web site. Retrieved 19 February, 2016 from https://www.cdc.gov/niosh/docs/2003-154/pdfs/7300.pdf

Ministry of Health. (2012). *Global Adult Tobacco Survey (GATS) Malaysia 2011*. Institute for Public Health, National Institute of Health, Ministry of Health, Malaysia. 1-203.

Mohamad, M. I., Ibrahim, M. H., and Dogo, A. N. (2018). Study on impact and adjustment of community around the cement industry in Rawang, Selangor. *Institute of Physics Publishing*, 145, doi:10.1088/1755-1315/145/1/012144

Mohamed Nimir, S. A. (2006). *Environmental Impact Of Some Trace Element Emission From The Work Environment Of Atbara Cement Factory And Atbara Railway Foundry*. University of Khartoum: Department of Chemistry, Faculty of Education.

Morice, A. H., Mcgarvey, L., Pavord, I. (2006). Recommendations for the management of cough in adults. *British Thoracic Society*, 1–24.

Morton, L. M., Cahill, J., and Hartge, P. (2005). Reporting participation in epidemiologic studies: a survey of practice. *American Journal of Epidemiology*, 163 (3):197-203.

Mwaiselage, J., Bråtveit, M., Moen, B., & Mashalla, Y. (2004). Cement dust exposure and ventilatory function impairment: an exposure–response study. *Journal of Occupational and Environmental Medicine,* 46(7):658–667.

Mwaiselage, J., Moen, B., & Bråtveit, M. (2005). Acute respiratory health effects among cement factory workers in Tanzania: an evaluation of a simple health surveillance tool. *International Archives of Occupational and Environmental Health*, 79(1):49–56.

Nakladalova, M., Stepanek, L., Kolek, V., Zurkova, M., and Tichy, T. (2018). A case of Accelerated silicosis. *Occupational Medicine*, 68, 482-484.

National Health and Nutrition Examination Survey (NHANES). (2008). Respiratory health ENO procedure manual. Centres for Disease Control and Prevention. Retrieved 16 January, 2016, from http://www.cdc.gov/nchs/data/nhanes/nhanes_07_08/ENO.pdf

National Institute for Health and Care Excellence. (2014). measuring Fractional Exhaled Nitric Oxide (FENO) concentration in asthma: NIOX MINO, NIOX VERO and NO breath. Retrieved 30th June, 2015, from https://www.nice.org.uk/guidance/dg12

National Institute for Occupational Safety and Health (Centers for Disease Control and Prevention). (2007). NIOSH Pocket Guide To Chemical Hazards. NIOSH Publications. Ohio. United State of America. Retrieved 23 February, 2019 from https://www.cdc.gov/niosh/docs/2005-149/pdfs/2005-149.pdf.

National Institute for Occupational Safety and Health (NIOSH). (1998). NIOSH Environmental Surveillance Report Baker Concrete Construction.

National Institute for Occupational Safety and Health, NIOSH US. (1984). Current Intelligence Bulletin 42: Cadmium. Retrieved 16 January, 2016, from http://www.cdc.gov/niosh/ docs/84-116/

National Institute for Occupational Safety and Health, NIOSH. (1976). Occupational health guideline for Manganese. Retrieved 16 January, 2016, from http://www.cdc.gov/ niosh/docs/81-123/pdfs/0379.pdf

National Institute for Occupational Safety and Health. (2013). Criteria for a recommended standard: Occupational exposure to Hexavalent Chromium (Cr) Retrieved 6 June, 2019 from https://www.cdc.gov/niosh/docs/2013-128/pdfs/2013_128.pdf

Nguyen, T. A., Park, J. W., Hess, M., Goins, M., Urban, P., Vaughan, J., Smith, A., & Hunt, J. (2005). Assaying all of the nitrogen oxides in breath modifies the interpretation of exhaled Nitric Oxide. *Vascular Pharmacology*, 43:379-384.

NIOSH Manual of Analytical Methods. 2003. Element by ICP: Method 7300 (4th edition).Retrieved 15 December, 2016, from https://www.cdc.gov/niosh/docs/2003-154/method-m.htmL

NIOSH Manual of Analytical Methods. 2003. Element by ICP: Method 7601 (4th edition).Retrieved 15 December, 2016, from https://www.cdc.gov/niosh/docs/2003-154/pdfs/7601.pdf

Noor, H., Yap, C. L., Zulkepli, O., and Faridah, M. (2000). Effect of exposure to dust on lung function of cement factory workers. *Medical Journal Malaysia*, 55:1-7.

Nordby, K. C., Fell, A. K. M., Noto, H., Eduard, W., Skogstad, M., Thomassen, Y., Bergamaschi, A., Kongerud, J. and Kjuus, H. (2011). Exposure to thoracic dust, airway symptoms and lung function in cement production workers. *European Respiratory Journal*, 38:1278-1286.

Nordby, K. C., Noto, H., Eduard, W., Skogstad, M., Fell, A. K., Thomassen, Y., Skare, O., Bergamaschi, A., Pietroiusti, A., Abderhalden, R., Kongerud, J., and Kjuus, H. (2016). Thoracic dust exposure is associated with lung function decline in cement production workers. *European Respiratory Journal*, 48(2):1-9

Occupational Safety and Health Administration (OSHA). (2010). Occupational Exposure to Respirable Crystalline Silica -- Review of Health Effects Literature and Preliminary Quantitative Risk Assessment. OSHA Publication.

Washington DC. Retrieved 23 February, 2020 from https://www.osha.gov/silica/Combined_Background.pdf

Occupational Safety and Health Administration (OSHA). (2017). Air contaminant: Permissible Exposure Limit-Annotated Z-1 Table. OSHA Publication. Washington DC. Retrieved 23 February, 2019 from https://www.osha.gov/dsg/annotated-pels/tablez-1.html#notes

Ogunbileje, J. O., Sadagoparamanujam, V. M., Anetor, J. I., Farombi, E. O., Akinosun, O. M., and Okorodudu, A. O. (2013). Lead, mercury, cadmium, Chromium (Cr), nickel, copper, zinc, calcium, iron, manganese and Chromium (Cr) (VI) levels in Nigeria and United States of America cement dust. *Chemosphere*, 90:2743-2749.

Orditura, M., De Vita, F., and Catalano, G. (2002). Elevated serum levels of Interleukin-8 in advanced non-small cell lung cancer patients: relationship with prognosis. *Journal Interferon Cytokine Research*, 22(11):1129–1135

Orman, A., Kahraman, A., Cakar, H., Ellidokuz, H., and Serteser, M. (2004). Plasma malondialdehyde and erythrocyte glutathione levels in workers with cement dust exposure silicosis. *Toxicology*, 207:15-20.

Ostrowski, S. and Barud, W. (2006). factors influencing lung function: are the predicted value for spirometry reliable enough?. *Journal of Physiology and Pharmacology*, 4:263-271.

Othman, M., Latif, M. T., and Mohamed, A. F. (2016). The PM_{10} compositions, sources and health risks assessment in mechanically ventilated office buildings in an urban environment. *Air Quality Atmospheric Health*, 9:597-612

Oyinloye, M. A. (2015). Environmental Pollution and health risks of residents living near Ewekoro cement factory, Ewekoro, Nigeria. *International Journal of Environmental, Chemical, Ecological, Geological and Geophysical Engineering*, 9(2):108-114.

Pakhale, S., Bshouty, Z., Marras, T. K. (2009). Comparison of percent predicted and percentile values for pulmonary function test interpretation. *Canada Respiratory Journal*. 16:190-194.

Pelclova, D., Fenclova, Z., Syslova, K., Vlckova, S., Lebedova, J., Pecha, O., Belacek, J., Navratil, T., Kuzma, M., and Kacer, P. (2011). Oxidative stress markers in exhaled breath condensate in lung fibroses are not significantly affected by systemic diseases. *Industrial Health*, 49:746-754.

Pellegrino, R., Viegi, G., Brusasco, V., Crapo, R. O.. Burgos, F., Casaburi, R., Coates, A., Van der Grinten, C. P. M., Gustafsson, P., Hankinson, J., Jensen, R., Johnson, D. C., MacIntyre, N., McKay, R., Miller, M. R., Navajas, D., Pedersen, O. F. and Wanger, J. (2005). Interpretative startegies for lung function tests. *European Respiratory journal*, 26:948-968.

Portland Cement Association – America’s Cement Manufacturing. (2015). How cement is made. Retrieved 3 January, 2016, from http://www.cement.org/cement-concrete-basics/how-cement-is-made

Rachiotis, G., Kostikas, K., Pinotsi, D., Hadjichristodoulou, C., and Drivas, S., (2018). Prevalence of lung function impairment among Greek cement production workers: a cross-sectional study. *Industrial Health,* 56:49-52.

Rafeemanesh, E., Alizadeh, A., Saleh, L. A., and Zakeri, H. (2015). A study on respiratory problems and pulmonary function indexes among cement industry workers in Mashhad, Iran. *Medycyna Pracy,* 66(4):471-477.

Rahmani, A. H., Almatroudi, A., Babiker, A. Y., Khan, A, A., and Alsahly, M. A. (2018). Effect of exposure to cement dust among the workers: An evaluation of health related complications. *Macedonian Journal of Medical Sciences*, 6(6):1159-1162.

Ranu. H., Wilde. M., & Madden. B. (2011). Pulmonary function test. *Ulster Medical Journal*, 80(2):84-90.

Rathore, B., neelkanth, N., and Toppo, M. (2017). A study to assess the pulmonary functions in a cement ware house workers near railway station, Nishatpura, Bhopal. *International Journal of Community Medicine and Public Health, 4(9):3239-4342.*

Ravimohan, S., Kornfeld, H., Weissman, D., and Bisson, G. P. (2018). Tuberculosis and lung damage: from epidemiology to pathophysiology. European Respiratory Review, 27, 1-20.

Rice, F. L., Park, R., Stayner, L., Smith, R., Gilbert, S., and Checkoway, H. (2001). Crystalline silica exposure and lung cancer mortality in diatomaceous earth industry workers: a quantitative risk assessment. *Occupational Environmental Medicine*, 58 (1):38- 45.

Richard, E. E., Chinyere, N. A. A., Jeremaiah, O. S., Opara, U. C. A., Henrieta, E. M., and Ifunanya, E. D. (2016). Cement dust exposure and perturbations in some elements and lung and liver functions of cement factory workers. *Journal of Toxicology*, 4:1-7.

Rodriguez-Cotto, R. I., Ortiz-Martinez, M. G., Rivera-Ramirez, E., Mateus, V. L., Amaral, B. S., Jimenez-Velez, B. D., and Gioda, A. (2014). Particle pollution in Rio de Janeiro, Brazil: Increase and decrease of pro-inflammatory cytokines IL-6 and IL-8 in human lung cells. *Environmental Pollution*, 194:112-120.

Rohling. M. L. and Demakis, G. J. (2006). A meta-analysis of the neuropsychological effects of occupational exposure to Mercury. *The Clinical Neuropsychologist*, 20:108–132.

Rosenman, K. D., Kalush, A., Reilly, M. J., Gardiner, J. C., Reeves, M., and Luo, Z. (2006). How much work-related injury and illness is missed by the current national surveillance system? Journal of Occupational and Environmental Medicine, 48(4):357-365.

Sabirin, J., Krishnasamy, M., Ahmad Mahayiddin, A., Muttalif, A. R., Md Zainuddin, N., Bakri, R., Simon, G. K., and Abd Wahab, N. (2008). Health technology assessment report: Exhaled Nitric Oxide measurement using NIOX or NIOX MINO. Retrieved 3 January, 2016, from http://www.moh.gov.my/attachments/3723.pdf

Shahid, S. K., Kharitonov, S. A., Wilson, N. M., Bush, A., and Barnes, P. J. (2002). Increased Interleukin-4 and decreased interferon-c in exhaled breath condensate of children with asthma. *American Journal of Respiratory and Critical Care Medicine*, 165:1290–1293.

Shannon, J., Ernst, P., and Yamauchi, Y. (2008). Differences in airway cytokine profile in severe asthma compared to moderate asthma. *Chest*, 133:420-426.

Simpson, J. L., Phipps, S., and Gibson, P. G. (2009) Inflammatory mechanisms and treatment of obstructive airway diseases with neutrophilic bronchitis. *Pharmacology and Therapeutics*, 124:86–95.

Singh, R., Singh, H. J., and Sirisinghe, R. G. (1993). Spirometric studies in Malaysians between 13 and 69 years of age. *Medical Journal Malaysia,* 48:175-84.

Social Security Organisation (SOCSO). 2017. Annual Report.Retrieved 23th May, 2020, from https://www.perkeso.gov.my/images/laporan_tahunan/Laporan_Tahunan2018.pdf

Stacey, P., Tylee, B., Bard, D., and Atkinson, R. (2003). The performance of laboratories analysing α-Quartz in the Workplace Analysis Scheme for Proficiency (WASP). *The Annals of Occupational Hygiene.* 47(4):269-277.

Stifelman, M. (2007). Using doubly-labeled water measurements of human energy expenditure to estimate inhalation rates. *Science Total Environment,* 373:585-590.

Subramaniam, G. C., Arip, M, and Subramaniam, T. S. S. (2017). Knowledge and risk perceptions of occupational infections among health-care workers in Malaysia. Safety and Health at work, 8:246-249.

Sulong, N. A., Latif, M. T., Khan, M. F., Amil, N., Ashfold, M. J., Abdul Wahab, M. I., Chan, K. M., and Sahani, M. (2017). Source apportionment and health risk assessment among specific age groups during haze and non-haze episodes in Kuala Lumpur, Malaysia. *Science of the Total Environment,* 601-602:556-570.

Sumana. L. P. V., Jemima, A. M., Rani, J. D., and Madhuri, T. (2016). Cement dust exposure and pulmonary function tests in construction site workers. Asian *Pacific Journal of Health Sciences,* 3(2):43-46.

Tarlo, S. M., & Malo, J. L. (2009). An official ATS proceedings: Asthma in the workplace: The Third Jack Pepys Workshop on asthma in the workplace: Answered and unanswered questions. *Proceedings of the American Thoracic Society*, *6*(4), 339–349. https://doi.org/10.1513/pats.200810-119ST

Tarlo, S. M., Cullinan, P., & Nemery, B. (2010). *Occupational And Environmental Lung Diseases: Diseases from work, home, outdoor and other exposure*. United Kingdom: Wiley Blackwell.

The Japan Society for Occupational Health. (2018). Recommendation of Occupational Exposure Limits (OEL). *Journal of Occupational Health*, 60:419-452

Thermo Scientific. Instructions: Human IL-8 ELISA kit (EH2IL8 -1349.4). Pierce Biotechnology 3747 N. Meridian Road. Retrieved 23th November, 2015, from www.thermoscientific.com/pierce

Tinkelman, D., Boggs, P., Jain, N., Lanz, M., Szefler, S., Lim, K., Liu, A., Nelson, H., and Rosch, J. (2009). Consensus Statement on: The use of Fractional Exhaled Nitric Oxide (FENO) in the clinical management of asthma. *National Jewish Health*, 1:1-16.

Tolinggi, S., Nakoe, M. R., Gobel, I. A., Sengke, J., Keman, S., Sudiana, I. K., Yudhastuti, R., Mukono, and Azizah, R. (2014). Effect inhaling of limestone dust exposure on increased level of IL-8 serum and pulmonary function decline to workers of limestone mining industry. *International Refereed Journal of Engineering and Science*, 3(8):66-72.

Torrelles, J. B. and Schlesinger, L. S. (2017). Integrating Lung Physiology, Immunology and Tuberculosis. *Trends Microbiology*, 25(8), 688-697.

Tungu, A. M., Bratveit, M., Mamuya, S. D., and Moen, B. E. (2013). Fractional Exhaled Nitric Oxide (FENO) among cement factory workers: a cross sectional study. *Occupational Environmental Medicine*, 70:289–295.

Tungu, A. M., Bratveit, M., Mamuya, S. H. and Moen, B. E. (2014). Reduction in respiratory symptoms among cement workers: a follow-up study. *Occupational Medicine*, 65:57-60.

Tungu, A. M., Bratveit, M., Mamuya, S. H. and Moen, B. E. (2016). Cross-shift reduction in Fractional Exhaled Nitric Oxide among cement workers. *Occupational Medicine & Health Affairs*, 4(5):1-6.

UEM (2011). Sustainability Report. Retrieved 16 January, 2016, from http://www.uem.com.my/images/SReport/SRCIMA.pdf p_table=preambles&p _id=819

US Department of Health and Human Services. *Guideline for the Diagnosis and Management of Asthma: National Asthma Education and Prevention Program Expert Panel Report 3.* National Heart, Lung and Blood Institute. National Institute of Health Publication. United States. October 2007.

US Environmental Protection Agency (USEPA). (1989). *Risk-assessment guidance for superfund. Volume 1. Human health evaluation manual*. Part A. Interim report (Final). Office of Emergency and Remedial Response U.S. Environmental Protection Agency, Washington, D.C.

US Environmental Protection Agency (USEPA). (1995). Integrated Risk Information System (IRIS) : chemical assessment summary (Arsenic), inorganic; CASRN 7440-38-2) Retrieved 3 March, 2019 from https://cfpub.epa.gov/ncea/iris/iris _documents/documents/subst/0278_summary.pdf#nameddest=cancerinhal

US Environmental Protection Agency (USEPA). (1997). *Exposure Factors Handbook*. National Center for Environmental Assessment, Office of Research and Development, Washington, DC, USA

US Environmental Protection Agency (USEPA). (1998). Integrated Risk Information System (IRIS): chemical assessment summary (Chromium VI) ; CASRN 18540-29-9) Retrieved 3 March, 2019 from https://cfpub.epa.gov/ncea/iris/iris _documents/documents/subst/0144_summary.pdf#nameddest=cancerinhal.

US Environmental Protection Agency (USEPA). (2003). Region/ORD workshop on inhalation risk assessment: a superfund focus. Retrieved 3 March, 2019 from https://www.epa.gov/sites/production/files/201511/documents/finalinhala tionriskworkshop.pdf

US Environmental Protection Agency (USEPA). (2011). *Exposure Factors Handbook: 2011 Edition*. National Center for Environmental Assessment, Office of Research and Development, Washington, DC, USA

US Environmental Protection Agency (USEPA). (2012). Arsenic (As) compound. Retrieved 16 January, 2016, from https://www3.epa.gov/airtoxics/hlthef/Arsenic (As).htmL

US Environmental Protection Agency (USEPA). (2015). Particulate matter. Retrieved 4 November, 2015, from http://www3.epa.gov/pm/

US Occupational Safety and Health Administration (OSHA). (2002). "Crystalline silica exposure" health hazard information for general industry employees. Retrieved 7 March, 2020, from https://www.osha.gov/Publications/osha3176.html

US Occupational Safety and Health Administration (OSHA). (2013). Safety and health topic: occupational asthma. Retrieved 16 January, 2016, from https://www.osha.gov/SLTC/ occupationalasthma/

Waelde, L. C., M. Hechanova, M. R., P. Ramos, P. A., Macia, K. S., and Moschetto J. M. (2017). Mindfulness and mantra training for disaster mental health workers in the Philippines. *Mindfulness,* 9(4):1181-1190.

Wali. F., Khan, K., Ali, W., and Khan, F. R. (2012). Trace elements concentration in various brands of Portland cement, environmental and occupational health and safety concerns: a comparative study. *2nd International Conference on Energy, Environment & Sustainable Development,* 18:1-8.

Wang, Y., Su, H., Gu, Y., Song, Xi., and Zhou, J. (2017). Carcinogenicity of chromium and chemoprevention: a brief update. *Onco Targets and Therapy,* 10, 4065-4079.

Wardlaw, A., Hay, H., Cromwell, O., Collins, J. V., Kay, A. B. (1989). Leukotrienes LTC4 and LTB4 in bronchoalveolar lavage in bronchial asthma and other respiratory diseases. *Journal Allergy Clinical Immunology*, 84:19–26.

Whittaker, C., Rice, F., McKernan, L., Dankovic, D., Lentz, T. J., MacMahon, K., Kuempel, E., Zumwalde, R., and Schulte, P. (2017). NIOSH current Intelligence Bulletin 68: NIOSH chemical carcinogen policy. Retrieved 14 July 2019 from https://www.cdc.gov/niosh/docs/2017-100/pdf/2017-100.pdf.

Widziewicz, K., Kozlowska, W. R., and Loska, K. (2016). Cancer risk from arsenic and chromium species bound to $PM_{2.5}$ and PM_1 - Polish case study. *Atmospheric Pollution Research*, 1-11

Workers Health Protection Program. (2013). Understanding your breathing test results. Retrieved 30 June, 2015, from http://www.workers-health.org/breathingtestresults.htmL

Workplace Health and Safety Queensland (WHSQ). (2013). *Silica (Si) and the Lung*. Department of Justice and Attorney General. Queensland.

World Health Organization (WHO). (2018). Arsenic. Retrieved 3 March, 2020 from https://www.who.int/news-room/fact-sheets/detail/arsenic

World Health Organization. (1999). Hazard *Prevention and Control in the Work Environment: Airborne Dust*. Occupational and Environmental Health Department of Protection of the Human Environment. Geneva.

World Health Organization. (2005). WHO recommendations on the use of rapid testing for influenza diagnosis retrieved 11 January, 2016, from http://www.who.int/influenza/resources/documents/RapidTestInfluenza_WebVersion.pdf

World Health Organization. Occupational and Environmental Health Team. (1999). Hazard prevention and control in the work environment: airborne dust. World Health Organization. http://www.who.int/iris/handle/10665/66147 https://monographs.iarc.fr/wp-content/uploads/2018/07/Table4.pdf https://monographs.iarc.fr/list-of-classifications-volumes/

World Wild Foundation (WWF). (2008). A blueprint for a climate friendly cement industry. Retrieved 23 June, 2017 from http://wwf.panda.org/wwf_news/?151621%2FA-blueprint-for-a-climate-friendly-cement-industry.

Worlds Allergy Organization. (2015). Combined allergic rhinitis and asthma syndrome Retrieved 11 January, 2016, from http://www.worldallergy.org/professional/allergic_diseases_center/caras/airwayssynopsis.php

Yanagawa, H., Sone, S., and Takahashi, Y. (1995). Serum levels of Interleukin-6 in patients with lung cancer. *British Journal of Cancer*, 71(5):1095–1098.

Yang, S. Y., Lin, J. M., Lin, W. Y., and Chang, C. W. (2018). Cancer risk assessment for occupational exposure to chromium and nickel in welding fumes from pipeline construction, pressure container manufacturing, and shipyard building in Taiwan. *Journal of Occupational Health*, 60:515-524.

Yeheyis, M., Aguilar, G., Hewage, K. and Sadiq, R. (2012). Exposure to Crystalline Silica (Si) inhalation among construction workers: a probabilistic risk analysis. *Human and Ecological Risk Assessment*, 18:1036-1050.

Yusof, M. Z., Nik Mahmod, N. A. K., A. Rahman, N. A., Razali, A., Samsuddin, N., Nik Mohamed, N. M. N., yed Jamaludin, M. S., Mohd Roze, A., and Abdullah Hair, A. F. (2019). Prevalence of occupational diseases among small and medium industry workers in Malaysia: A systematic review. Journal of Clinical and Health Sciences, 4(2):4-30.

Zeb, K., Ali, Y., and Khan, M. W. (2018). Factors influencing environment and human health by cement industry: Pakistan a case in point. *Management of environmental quality: An International Journal*, doi:https://doi.org/10.1108/MEQ-06-2018-0112.

Zeleke, Z. K., Moen, B. E., and Bratveit, M. (2010). Cement dust exposure and acute lung function: A cross shift study. *Biomedicine Central Pulmonary Medicine*, 10(19):1-8.

BIODATA OF STUDENT

Noor Haziqah Bte Kamaludin received her primary and secondary education in Muar, a city in the state of Johor, Malaysia. In 2008, she gained admission, as an undergraduate student, into the Faculty of Environmental Studies of Universiti Putra Malaysia. She graduated in 2011 with Bachelors Degree in Science (Environment). Then, she continues her studies in the Faculty of Chemical Engineering, Universiti Teknologi Malaysia. She received her Master Degree of Science (Safety Health and Environment) in 2012. She joined Melaka International College of Science and Technology (MiCoST) as a lecturer cums Coordinator Program. She was the pioneer in this college who first developed, set up and run the Diploma in Occupational Safety and Health program in MiCoST. To gain more knowledge and develop a strong career in academician, she continues her further studies in Philosophy Doctorate of Occupational Safety and Health program at Universiti Putra Malaysia in the year 2015. To date, she has published three scientific journals focusing on cement workers exposure and respiratory health effect. She has participated as an oral presenter and poster presenter in several national and international conference.

LIST OF PUBLICATIONS

Noor Haziqah Kamaludin, Nurul Shahira Ahmad Razlan and Juliana Jalaludin (2018). Association between Respirable Cement Dust Exposure and Respiratory Health among Cement Workers. *Malaysia Journal of Medical and Health Sciences*. 14(SP2):78-86.

Noor Haziqah Kamaludin, Juliana Jalaludin, Shamsul Bahri Mohd Tamrin, Abdah Md Akim Biomarker of Occupational Airways Inflammation for Exposure to Inorganic Dust. (2018). *Asian Journal of Agriculture and Biology*. Special Issue:23-28

Noor Haziqah Kamaludin, Juliana Jalaludin, Shamsul Bahri Mohd Tamrin, and Abdah Md Akim. Exposure Silica, Arsenic and Chromium (VI) in Cement Industrial Workers': A Probability Health Risk Assessment. *Aerosol and Air Quality Research*. In reviewed

UNIVERSITI PUTRA MALAYSIA

STATUS CONFIRMATION FOR THESIS / PROJECT REPORT AND COPYRIGHT

ACADEMIC SESSION : Second Semester 2019/2020

TITLE OF THESIS / PROJECT REPORT :

ASSOCIATION OF RESPIRABLE CEMENT MINERAL DUST EXPOSURE WITH FRACTIONAL EXHALED NITRIC OXIDE AND INTERLEUKIN-8 ON AIRWAYS INFLAMMATION AMONG CEMENT WORKERS IN NEGERI SEMBILAN, MALAYSIA

NAME OF STUDENT: NOOR HAZIQAH BTE KAMALUDIN

I acknowledge that the copyright and other intellectual property in the thesis/project report belonged to Universiti Putra Malaysia and I agree to allow this thesis/project report to be placed at the library under the following terms:

1. This thesis/project report is the property of Universiti Putra Malaysia.
2. The library of Universiti Putra Malaysia has the right to make copies for educational purposes only.
3. The library of Universiti Putra Malaysia is allowed to make copies of this thesis for academic exchange.

I declare that this thesis is classified as :

*Please tick (√)

☐	**CONFIDENTIAL**	(Contain confidential information under Official Secret Act 1972).
☐	**RESTRICTED**	(Contains restricted information as specified by the organization/institution where research was done).
☐	**OPEN ACCESS**	I agree that my thesis/project report to be published as hard copy or online open access.

This thesis is submitted for :

☐	**PATENT**	Embargo from _____________ (date) until _____________ (date)

Approved by:

_____________________	_____________________
(Signature of Student)	(Signature of Chairman of Supervisory Committee)
New IC No/ Passport No.:	Name:
Date :	Date :

[Note : If the thesis is CONFIDENTIAL or RESTRICTED, please attach with the letter from the organization/institution with period and reasons for confidentially or restricted.]