

UNIVERSITI PUTRA MALAYSIA

POLLUTANTS AND HEAVY METALS CONCENTRATION IN INDOOR AIR AND DUSTS FROM SCHOOL ENVIRONMENT IN KOTA KINABALU, SABAH : ASSOCIATION WITH LUNG INFLAMMATION AND OTHER RELATED HEALTH SYMPTOMS AMONG THE STUDENTS

NUR HASLYNA BINTI MOHD HAMIZUL

lp
FPSK4 2019 39

POLLUTANTS AND HEAVY METALS CONCENTRATION IN INDOOR AIR AND DUSTS FROM SCHOOL ENVIRONMENT IN KOTA KINABALU, SABAH : ASSOCIATION WITH LUNG INFLAMMATION AND OTHER RELATED HEALTH SYMPTOMS AMONG THE STUDENTS

BY

NUR HASLYNA BINTI MOHD HAMIZUL

UPM

© COPYRIGHT UPM

Thesis submitted in fulfilment of the requirement for the degree of Bachelor Science (Environmental and Occupational Health) from the Faculty of Medicine and Health Sciences, Universiti Putra Malaysia.

ACKNOWLEDGEMENTS

In the name of Allah, the Most Gracious and the Most Merciful. Alhamdulillah, all praises to Allah for the strengths and His blessing in completing the thesis. I would like to express my deepest gratitude and appreciation to every person who gave me strength and ideas to complete this report. Special appreciation goes to my supervisor, Prof. Dr. Zailina Hashim, for her guidance, encouragement and assistance throughout the whole project. Her invaluable help of constructive comments and suggestion throughout the experimental and thesis works have contributed to the success of this research.

Thank you to my co-supervisor, Assoc. Prof. Dr. Shamsul Shamsuddin who also had spent extra time and effort in data collection. Appreciation to Prof. Dr. Jamal Hisham Hashim for his big contribution in this study.

I would like to express my deeply and highest appreciation to the management of the schools in Kota Kinabalu, Sabah, medical doctors from Universiti Malaysia Sabah, and also respondents in this study for their participation, cooperation and support throughout this study. My gratitude also goes to my research team members for their endless support throughout this study.

Thank you to Anton Paar Malaysia Sdn Bhd for lending the instruments in the analysis and also thank you to Putra Grant, Universiti Putra Malaysia (UPM) for funding this research.

Next on the list, my deepest gratitude goes to my both my beloved parents, Mr. Mohd Hamizul bin Abdul Rashid and Mrs. Rosnalyza binti Muhammad for their constant love and immeasurable sacrifice. Without them besides me, I would never have enjoyed so many opportunities in my entire life.

Last but not least, thanks to my special friend in Universiti Putra Malaysia (UPM) for the endless support, prayers and encouragement. To those who indirectly contributed in this research, your kindness means a lot to me.

ABSTRACT

POLLUTANTS AND HEAVY METALS CONCENTRATION IN INDOOR AIR AND DUSTS FROM SCHOOL ENVIRONMENT IN KOTA KINABALU, SABAH : ASSOCIATION WITH LUNG INFLAMMATION AND OTHER RELATED HEALTH SYMPTOMS AMONG THE STUDENTS

NUR HASLYNA BINTI MOHD HAMIZUL

Introduction: Indoor air quality is an increasing public health concern due to amount of time people spend indoors and presence of chemical contaminants that might pose health effects. Heavy metals may come from many different sources including vehicle emissions, industrial discharges, mining and other activities. **Objective:** To study the relationship between air quality parameters [$PM_{2.5}$, PM_{10}, nitrogen dioxide, volatile organic compound (VOCs) and heavy metals concentrations (Cr, Mn, Ni, Pb, As, & Cd)] in indoor air and dusts from school environment with the respiratory health and lung inflammations of the school children. **Methodology:** A total of 332 randomly selected students from 24 Form 2 classrooms from 6 randomly selected secondary schools in Kota Kinabalu, Sabah, Malaysia. Information on reported respiratory symptoms and health was collected through questionnaire. FeNO was measured by NIOX VERO (50 ml/min). The classroom were inspected and dust was collected by vacuuming on special filters and were digested for heavy metals concentration by using aqua regia method and further analyzed by using ICP-MS. Multi-level logistic regression were used after adjusting for demographic data, environmental data and reported respiratory symptoms. **Results:** About 13% reported wheezing for past 12 months, 51.5% had dry throat, 60.8% had influenza symptoms, 50.6% had sore throat, 27.7% had irritating cough, 23.8% had breathing difficulty, 11.4% doctor diagnosed asthma and 55.1% had respiratory infection. Heavy metals concentration in indoor air in descending order was Cr>Pb>Mn>Ni>As>Cd. Meanwhile, the heavy metals concentration in settled dusts were Mn>Pb>As>Ni>Cr>Cd. There were 49.4% had lung inflammation with FeNO values above 20 ppb. **Conclusion:** Heavy metals concentration (Mn, Pb & As) and indoor air pollutants [PM_{10} (Gravimetric), CO_2 & VOCs] were related to lung inflammation and reported respiratory symptoms among the schools children.

Keywords: Pollutants, heavy metal concentration, indoor air, dusts, FeNO

ABSTRAK

BAHAN PENCEMAR DAN LOGAM BERAT DALAM KUALITI UDARA DAN DEBU DARIPADA PERSEKITARAN SEKOLAH DI KOTA KINABALU, SABAH : HUBUNGAN ANTARA KERADANGAN PARU-PARU DAN RISIKO KESIHATAN YANG LAIN DALAM KALANGAN PELAJAR.

NUR HASLYNA BINTI MOHD HAMIZUL

Pengenalan: Kualiti udara dalam rumah adalah isu kesihatan awam yang semakin meningkat disebabkan oleh banyak masa dihabiskan berada di dalam rumah dan kehadiran bahan pencemar kimia yang mungkin memberi kesan kesihatan. Logam berat mungkin berasal dari pelbagai sumber termasuk pelepasan kenderaan, pelepasan industri, perlombongan dan aktiviti lain. **Objektif:** Untuk mengkaji hubungan antara parameter kualiti udara [PM2.5, PM10, nitrogen dioksida, kompaun organik yang tidak menentu (VOCs) dan kepekatan logam berat (Cr, Mn, Ni, Pb, As, & Cd)] di udara dan habuk dalaman persekitaran dengan kesihatan pernafasan dan keradangan paru-paru kanak-kanak sekolah. **Metodologi:** Seramai 332 pelajar yang dipilih secara rawak dari 24 kelas Tingkatan 2 dari 6 sekolah menengah secara rawak di Kota Kinabalu, Sabah, Malaysia. Maklumat mengenai simptom pernafasan dan kesihatan yang dilaporkan telah dikumpulkan melalui soal selidik. FeNO diukur oleh NIOX VERO (50 ml / min). Kelas ini diperiksa dan debu dikumpulkan dengan menggunakan penyedut habuk dan penapis khas dan dicerna untuk kepekatan logam berat menggunakan kaedah aqua regia dan dianalisis dengan menggunakan ICP-MS. Regresi logistik pelbagai peringkat telah digunakan selepas menyesuaikan data demografi, data alam sekitar dan gejala pernafasan yang dilaporkan. **Keputusan:** Sekitar 13% dilaporkan mengeluarkan bunyi berdehit selama 12 bulan yang lalu, 51.5% mengalami tekak kering, 60.8% mengalami gejala influenza, 50.6% mengalami sakit tekak, 27.7% mengalami batuk yang menjengkelkan, 23.8% mengalami kesukaran bernafas, 11.4% yang menghidap asma dan 55.1% jangkitan. Kepekatan logam berat di udara tertutup dalam urutan menurun ialah Cr> Pb> Mn> Ni> As> Cd. Sementara itu, kepekatan logam berat dalam habuk yang diselesaikan adalah Mn> Pb> As> Ni> Cr> Cd. Terdapat 49.4% mempunyai keradangan paru-paru dengan nilai FeNO melebihi 20 ppb. **Kesimpulan:** Kepekatan logam berat (Mn, Pb & As) dan pencemar udara dalaman [PM10 (Gravimetric), CO2 & VOCs] berkaitan dengan keradangan paru-paru dan gejala pernafasan yang dilaporkan di kalangan kanak-kanak sekolah.

Kata Kunci: Bahan Pencemaran, Kepekatan Logam Berat, Udara Dalaman, Debu, FeNO

TABLE OF CONTENTS

		Page
DECLARATION		ii
SIGNATURE OF SUPEVISOR/ INTERNAL EXAMINER		iii
ACKNOLEDGEMENT		iv
ABSTRACT		v
ABSTRAK		vi
CONTENTS		vii
LIST OF TABLES		xi
LIST OF FIGURES		xiv
LIST OF ABBREVIATIONS		xv

CHAPTER 1: INTRODUCTION

1.1	Background	1
1.2	Research Justification	2
1.3	Problem Statement	3
1.4	Conceptual Framework	5
1.5	Research Objectives	8
	1.5.1 General Objectives	8
	1.5.2 Specific Objectives	8
1.6	Study Hypothesis	9
1.7	Terminology (Definition)	10
	1.7.1 Indoor Air Quality	10
	1.7.2 Heavy Metals	11
	1.7.3 Lung Inflammations	12
	1.7.4 Health Risks	13
	1.7.5 Particulate Matter ($PM_{2.5}$ & PM_{10})	14
	1.7.6 Volatile Organic Compound (VOCs)	15

CHATER 2: LITERATURE REVIEW

2.1	Indoor Air Quality	16
2.2	Particulate Matter ($PM_{2.5}$ & PM_{10})	18
2.3	Volatile Organic Compound (VOCs)	20

© COPYRIGHT UPM

2.4 Heavy Metals 21
2.5 Fractional Exhaled Nitric Oxide (FeNO) 23
2.6 Health Effects due to Heavy Metal Exposure 24

CHAPTER 3: METHDOLOGY

3.1 Study Design 26
3.2 Study Location 26
3.3 Study Population 27
3.4 Sampling Frame 27
3.5 Sampling Unit and Subject Criteria 28
3.5.1 Inclusion Criteria 28
3.5.1.1 Consent 28
3.5.1.2 Duration in school 28
3.5.1.3 Malaysian 29
3.5.1 Exclusion Criteria 29
3.5.2.1 Severe medical cases 29
3.6 Sample Size Calculation 30
3.7 Sampling Method and Subject Recruitment 31
3.8 Research Tools/Instruments 31
3.8.1 Questionnaire 32
3.8.1.1 Pre-questionnaire Screening Form 32
3.8.1.2 Questionnaire Form 33
3.8.1.3 Pre-Test 34
3.8.1.4 Content Validity 34
3.8.1.5 Face Validity 35
3.8.2 Exposure Measurement using Instruments 35
3.8.3 Health Assessment 39
3.8.3.1 FeNO Test 39
3.8.3.2 Safety Protocols on the use of FeNO 41
3.8.4 Laboratory Analysis 42
3.8.4.1 Digestion Process 42
3.8.4.1.1 Sample Collection and Preparation 42
3.8.4.1.2 Sample Digestion Procedure 42
3.8.4.1.3 Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) 43
3.9 Data Analysis 45
3.10 Quality Control 46
3.10.1 Environmental Measurement 46
3.10.2 Questionnaire 47
3.10.3 Nitric Oxide Measurement 47
3.11 Ethical Consideration 48

CHAPTER 4: RESULTS

4.1 Socio-demographic Data of Respondents among Secondary Schools 49

4.2 Prevalence of Respiratory Symptoms and FeNO Levels among Secondary Students 52

4.2.1 Respiratory Symptoms of the Respondents 52

4.2.2 Prevalence of FeNO Levels among Respondents 53

4.3 Concentration of Heavy Metals 54

4.3.1 Heavy Metals Concentration in Indoor Air 54

4.3.2 Concentration of Heavy Metals in Settled Dust 57

4.4 The Comparison of NO Exhaled Breath as Indicator of Airway Inflammation between the School Children from 6 Schools 60

4.5 Comparison of Indoor Air Parameters and Heavy Metals between 6 Different Schools 61

4.5.1 Indoor Air Parameters between 6 Different Schools 61

4.5.2 Heavy Metals in Indoor Air between 6 Different Schools 64

4.5.3 Heavy Metals in Settled Dust between 6 Different Schools 66

4.6 Relationship between Air Quality Parameters and Heavy Metals Concentration with Respiratory Symptoms and Lung Inflammation of the School Children 68

4.6.1 Relationship between Air Quality Parameters ($PM_{2.5}$, PM_{10}, NO_2, CO_2, VOCs and formaldehyde) with Respiratory Symptoms 68

4.6.2 Relationship between Heavy Metals in Indoor Air (Cr, Mn, Ni, Pb, As, Cd) with Respiratory Symptoms 75

4.6.3 Relationship between Heavy Metals in Settled Dusts (Cr, Mn, Ni, Pb, As, Cd) with Respiratory Symptoms 80

4.6.4 Relationship between Lung Inflammations (FeNO) with Air Quality Parameters, Heavy Metals in Indoor Air and Settled Dusts 86

4.6.5 Relationship between Lung Inflammations (FeNO) with Socio-demographic Characteristics, Air Quality Parameters and Heavy Metals in Indoor Air and Dusts. 90

4.6.6 Relationship between Respiratory Symptoms with Socio-demographic Characteristics, Air Quality Parameters and Heavy Metals in Indoor Air and Dusts. 92

CHAPTER 5: DISCUSSION

5.1 Individual Characteristics of the Respondents 97

5.2 Relationship between Air Quality Parameters with Respiratory

Symptoms 98
5.3 Relationship between Heavy Metals in Indoor Air and Settled Dusts with Respiratory Symptoms 101
5.4 Association between Lung Inflammations (FeNO) and reported respiratory symptoms with Heavy Metals in Indoor Air and Settled Dusts 104
5.5 Association between Respiratory Symptoms with Socio-demographic Characteristics 106

CHAPTER 6: CONCLUSION, STUDY LIMITATION AND RECOMMENDATIONS

6.1 Conclusion 108
6.2 Study Limitation 110
6.3 Recommendation 111
6.3.1 Recommendation for Further Study 111
6.3.2 Recommendation for the School Management, Parents and Respondents 112

REFERENCES 113

APPENDICES

Appendix A (Gantt Chart) 130
Appendix B (Ethics Approval (UPM)) 132
Appendix C (Approval from Ministry of Education) 136
Appendix D (Approval from District of Education Office, Kota Kinabalu, Sabah) 138
Appendix E (Consent Form) 140
Appendix F (Questionnaire) 151
Appendix G (Calibration Curve Report) 163
Appendix H (ICP-MS Report) 171

© COPYRIGHT UPM

LIST OF TABLES

		Page
Table 4.1	Socio-demographic Data of Respondents	50
Table 4.2	Reported Respiratory Symptoms of the Respondents	53
Table 4.3	Average Concentration of Heavy Metals in Indoor Air in Different Sample Location (mg/kg)	54
Table 4.4	Average Concentration of Heavy Metals in Settled Dust in Different Sample Location (mg/kg) Prevalence of FeNO Levels among Secondary Students	56
Table 4.5	Prevalence of FeNO Levels among Secondary Students	59
Table 4.6	Comparison of Indoor Air Parameters between 6 Different Schools	63
Table 4.7	Comparison of Heavy Metals Concentration in Indoor Air between 6 Different Schools	65
Table 4.8	Comparison of Heavy Metals Concentration in Settled Dust between 6 Different Schools	67
Table 4.9	Relationship between Air Quality Parameters ($PM_{2.5}$) with Respiratory Symptoms	69
Table 4.10	Relationship between Air Quality Parameters [PM_{10} (Real-Time Measurement)] with Respiratory Symptoms	70
Table 4.11	Relationship between Air Quality Parameters [PM_{10} (Gravimetric)] with Respiratory Symptoms	71

© COPYRIGHT UPM

Table 4.12	Relationship between Air Quality Parameters (VOCs) with Respiratory Symptoms	72
Table 4.13	Relationship between Air Quality Parameters (CO_2) with Respiratory Symptoms	73
Table 4.14	Relationship between Air Quality Parameters (Formaldehyde) with Respiratory Symptoms	74
Table 4.15	Relationship between Heavy Metals in Indoor Air (Cr) with Respiratory Symptoms	76
Table 4.16	Relationship between Heavy Metals in Indoor Air (Mn) with Respiratory Symptoms	77
Table 4.17	Relationship between Heavy Metals in Indoor Air (Ni) with Respiratory Symptoms	78
Table 4.18	Relationship between Heavy Metals in Indoor Air (As) with Respiratory Symptoms	79
Table 4.19	Relationship between Heavy Metals in Settled Dusts (Cr) with Respiratory Symptoms	81
Table 4.20	Relationship between Heavy Metals in Settled Dusts (Mn) with Respiratory Symptoms	82
Table 4.21	Relationship between Heavy Metals in Settled Dusts (Pb) with Respiratory Symptoms	83
Table 4.22	Relationship between Heavy Metals in Settled Dusts (As) with Respiratory Symptoms	84
Table 4.23	Relationship between Heavy Metals in Settled Dusts (Cd) with Respiratory Symptoms	85

© COPYRIGHT UPM

Table 4.24	Relationship between Lung Inflammations (FeNO) with Air Quality Parameters	87
Table 4.25	Relationship between Lung Inflammations (FeNO) with Heavy Metals in Indoor Air	88
Table 4.26	Relationship between Lung Inflammations (FeNO) with Heavy Metals in Settled Dusts	89
Table 4.27	Relationship between Lung Inflammations (FeNO) with Socio-demographic Characteristics	91
Table 4.28	Relationship between Lung Inflammations (FeNO) with Heavy Metals in Indoor Air	91
Table 4.29	Relationship between Respiratory Symptoms with Socio-demographic Characteristics	93
Table 4.30	Relationship between Respiratory Symptoms with Indoor Air Quality	94
Table 4.31	Relationship between Respiratory Symptoms with Heavy Metals in Indoor Air	95
Table 4.32	Relationship between Respiratory Symptoms with Heavy Metals in Settled Dusts	96

© COPYRIGHT UPM

LIST OF FIGURES

		Page
Figure 1.1	Conceptual Framework	7
Figure 2.1	Size comparison of PM2.5 and PM10 against the average diameter of a human hair (~70μm) and fine beach sand (~90μm)	19
Figure 2.2	The Difference between Normal and Inflamed lung proposed by Blausen Medical	23
Figure 3.1	Flowchart of Exposure Measurement	38
Figure 3.2	ICP-MS Structure	43
Figure 4.1	Heavy Metals Concentration in Indoor Air (mg/kg)	55
Figure 4.2	Heavy Metals Concentration in Settled Dusts (mg/kg)	58
Figure 4.3	Percentage of FeNO Levels among Respondents between 6 Different Schools	61

© COPYRIGHT UPM

LIST OF ABBREVATIONS

PM	Particulate Matter
CO_2	Carbon Dioxide
VOCs	Volatile Organic Compound
NO_2	Nitrogen Dioxide
DOSH	Department of Occupational & Safety Health
WHO	World Health Organization
Cr	Chromium
Mn	Manganese
Ni	Nickel
Pb	Lead
As	Arsenic
Cd	Cadmium
Zn	Zinc
Hg	Mercury
Al	Aluminium
Co	Cobalt

© COPYRIGHT UPM

Cu	Copper
Fe	Iron
CNS	Central Nervous System
ICP-MS	Inductively Coupled Plasma-Mass Spectrometry
ICP-AES	Inductively Coupled Plasma-Atomic Emission Spectroscopy
GFAAS	Graphite Furnace Atomic Absorption Spectroscopy
FeNO	Fractional exhaled Nitric Oxide
NO	Nitroc Oxide
ISAAC	International Study of Asthma & Allergy in Childhood
EPA	Environmental Protection Agency
ICOP	Industry Code of Practice
ATS	Agency for Toxic Substances
IARC	Internal Agency for Research on Cancer
ECRHS	European Community Respiratory Health Survey
ATSDR	Agency for Toxic Substances and Disease Registry
PVC	Polyvinyl Chloride
HCL	Hydrochloric Acid

© COPYRIGHT UPM

HNO_3	Nitric Acid
SPSS	Statistical Package for the Social Sciences
IQR	Interquartile Range
χ^2	Chi-square
PPB	Parts per billions
UPM	Universiti Putra Malaysia
MOE	Ministry of Education
DEO	District Education Office

© COPYRIGHT UPM

CHAPTER 1

INTRODUCTION

1.1 Background

Heavy metals may come from many different sources in urbanized areas, including vehicle emissions, industrial discharges and other activities (Atkinson et al., 2010). Over the past decades, there has been increasing concern about exposure of people, especially of vulnerable groups such as children, to indoor contaminants in order to assess the health impacts (Mitchell et al., 2007) and to reduce human health risks (Han et al., 2008). Health risk is especially high for children because of their low tolerance to toxins as well as the inadvertent ingestion of significant quantities of dust (or soils) through hand-to-mouth pathways (Acosta et al., 2011). Therefore, indoor air quality is an increasing public health concern due to amount of time people spend indoors (Nastov et al., 2016) and presence of chemical and biological contaminants that might pose health effects.

1.2 Research Justification

Study on various adverse effect of air pollution on children's health and development are one of important aspect of continuous environmental health management. This study will enable better description of the prevalence and magnitude of indoor air pollutant circulating children among schools. The study outcome will provide essential information in an effort to establishing comprehensive database for monitoring indoor air quality among children. This study result will also provide better understanding and improved ability to identify current toxic contaminant and recommend effective strategies for reducing indoor air pollution.

Dust borne accumulate due to atmospheric deposition by sedimentation, impaction, and interception. Elevated emissions and their depositions over time can lead to anomalous enrichment, causing metal contamination of the surface environment. Metals being non-biodegradable accumulate in nature and become 'chemical time bombs' after long residence time. In order to keep the environment clean and protect lives from heavy metal contaminants, it is important to have thorough understanding of the nature and extent of heavy metal pollution.

Heavy metal poisoning is common among children. Some studies shows that lead is the main elements that lead to the heavy metal poisoning among children. In Malaysia as well as worldwide studies, much attention has not been paid to the

© COPYRIGHT UPM

problem of heavy metal contamination in classroom. There is a lack of information on classroom dust and consequently there are no regulations and guidelines. Thus, this study acts as a preliminary study to update on heavy metal contamination in classroom dust as well as health assessment to determine the health impact.

The knowledge gathered are intended to address various levels of economic development, cover all relevant population groups, and allow feasible approaches to reducing health risks from exposure to the selected pollutants in various regions of the country. Comprehensive data generated from this study will enable development of readily application of guidelines, standards of indoor air pollutants and provide means to feasible monitoring methods in identifying sources for controls of indoor air pollutants in nationwide scale. Cases of allergies and asthma can be further compared if we have baseline data and sources identifications from these studies. In the future, further intervention and mitigating measures could be formulated to reduce cases of allergies and asthma among school children.

1.3 Problem Statement

Evidence shows that indoor air quality plays an important part of children life as there much of time spent in the classroom (Yip et al., 2004). In Malaysia, there are guidelines (code of practice on indoor air quality) for indoor air quality and exposure standards to protect workers (DOSH, 2005), but no guidelines have yet been developed

that apply specifically to the school environment with susceptible children. Children are considered as the population group that deserves the highest level of protection as they are more vulnerable to the effects of air pollutant (WHO 2006). Children are more vulnerable to environmental pollution compared to adults since they breathe more relative to their body weight and also have a lower ability to deal with the toxic chemicals (Bragoszewska et al., 2018).

Indoor air quality in a hot and humid climate country is a relatively new issue. Limited data is available on the general understanding of the present indoor air quality in Malaysia especially for school buildings. It is therefore, important that indoor air quality be given more attention and further studies be conducted. Besides, the school building in Malaysia can be very different from those in western countries. The fact that policy development requires solid evidence on deleterious effect of air pollution provides means to further enhance effort to identify indoor air pollutants. Identification of hazard and factors influencing indoor air quality among children will attract interest of all parties and can be translated into a shared effort of exposure prevention at all levels of governmental agencies, private bodies and community.

© COPYRIGHT UPM

In recent years, there is growing concern for the potential contribution of inhaled dust to metal toxicity in humans. Some metals such as Cu, Zn at small amounts are harmless, but some include Pb, As, Hg and Cd are toxic even at extremely low concentration and potential cofactors, initiators or parameters in many diseases and

UNIVERSITI PUTRA MALAYSIA

cancer. Children are particularly vulnerable and susceptible to the heavy metal poisoning since this is the period of maximal brain growth and differentiation besides they have much higher absorption rate of heavy metal from inhalation system and higher hemoglobin sensitivity to metals compared to adults.

Many studies on dust have focused on heavy metals concentration, distribution and source identification in last decades. However, there is less attention on the problem of heavy metal contamination of classroom dust in Malaysia school especially in Sabah area. Therefore, this study is to identify the relationship between air quality parameters [PM_{10} and heavy metals concentrations (Cr, Mn, Ni, Pb, As, & Cd)] in indoor air and dusts from school environment with the respiratory health of the school children.

1.4 Conceptual Framework

The conceptual framework used to show the environmental and health impacts from the air quality parameters [$PM_{2.5}$, PM_{10}, heavy metals concentrations (Cr, Mn, Ni, Pb, As, & Cd), formaldehyde and nitrogen dioxide] in indoor air and dusts from school environment with the respiratory health of the school children. The indoor air and dusts from school environment can lead to short-term and long-term health problems. One of the health problems that arise with poor indoor air quality is lung inflammation and respiratory problems. The thermal environment (temperature, relative humidity and

© COPYRIGHT UPM

carbon dioxide) are important dimensions of indoor air quality. Much of the building fabrics, its furnishing and equipment, its occupants and their activities produces pollution. The outdoor air may also contains contaminants that may be brought inside. The pollutants in indoor air and dust comprised of higher heavy metal element. The contamination of heavy metal in dust to the environment will result in air pollution and reduce the health quality. This study wants to relate the environment impacts of indoor air and dust towards the exposure of human health.

The school children spend most of their time indoor in the classroom so the risk to health arise due to the poor indoor air quality and dust containing heavy metals. In recent years, heavy metal has been one of the global public health concern associated with the environmental contamination. As the heavy metal are elements, they cannot be broken down and will persist in the environment. Unlike many organic pollutants, which eventually degrade to carbon dioxide and water, heavy metal will tend to accumulate in the environment. As the result, the school children who spend most of their time indoor in the classroom will expose to the pollutant through inhalation. Other than that, the contamination of air quality and heavy metals in dust will came out the symptoms of inhalation problem especially to sensitive people such as children because they were easily exposed to the indoor air pollutants and dust when they are in school. The respiratory symptoms also arise due to the higher exposure to the indoor air pollutants and dust from the school environment. The impacts of the environment and health from the exposure of contaminated indoor air and dust affect the respiratory health of the school children.

Research Conceptual Framework

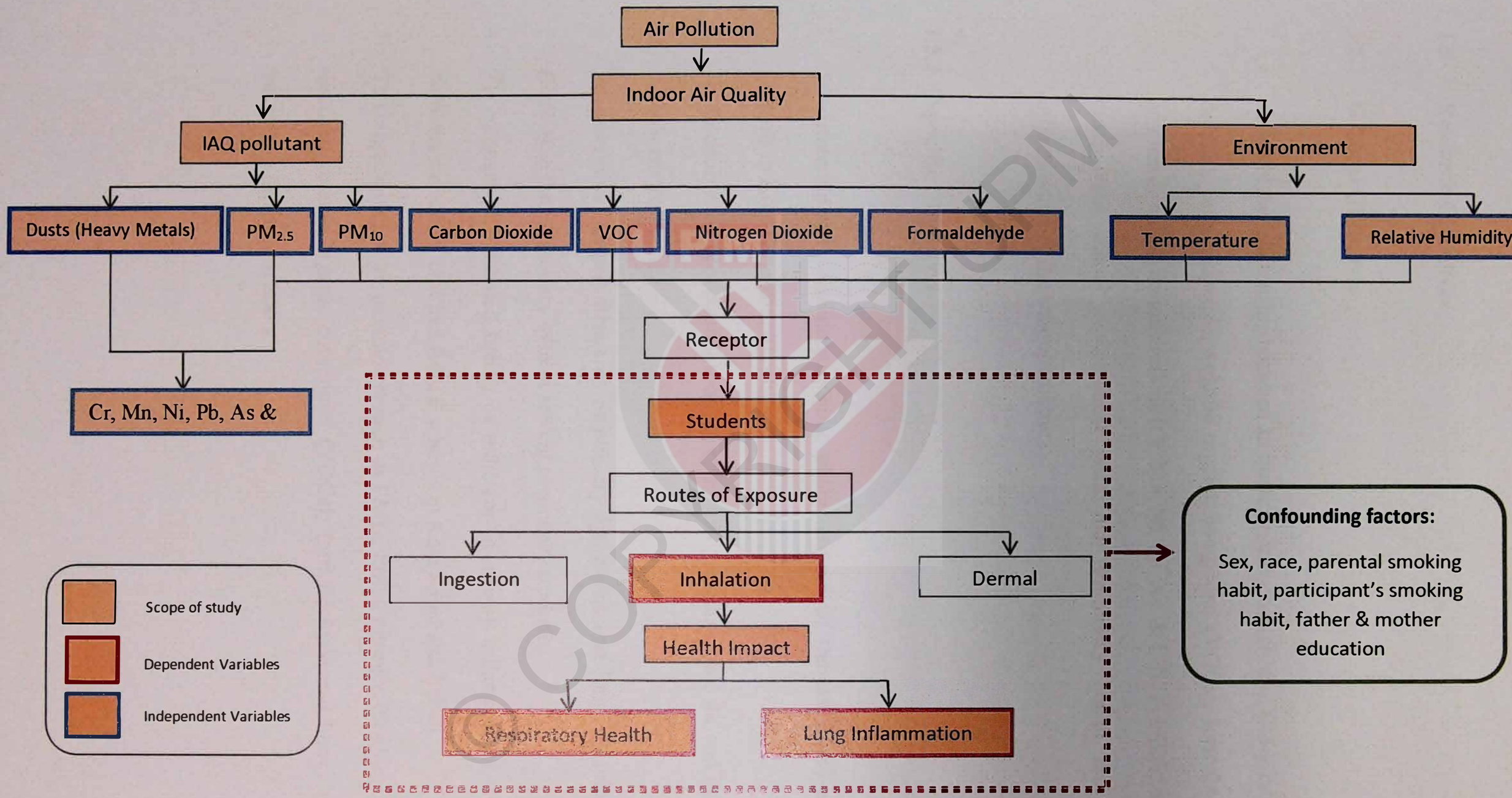


Figure 1.1: Conceptual Framework

© COPYRIGHT UPM

1.5 Research Objectives

1.5.1 General Objectives

- To study the relationship between air quality parameters [$PM_{2.5}$, PM_{10}, nitrogen dioxide, carbon dioxide, volatile organic compound (VOCs), formaldehyde and heavy metals concentrations (Cr, Mn, Ni, Pb, As, & Cd)] in indoor air and dusts from school environment with the respiratory health and lung inflammation of the school children.

1.5.2 Specific Objectives

1. To determine the socio-demographic characteristics of the secondary school students in Kota Kinabalu, Sabah.
2. To determine the concentration of heavy metals presents in the air and dusts of schools environment.
3. To determine the prevalence of respiratory symptoms and lung inflammation (FeNO) in the pulmonary system among secondary students.
4. To compare NO exhaled breath as indicator of airway inflammation (FeNO) between the school children from 6 schools in Kota Kinabalu, Sabah.
5. To compare indoor air parameters such as $PM_{2.5}$, PM_{10}, nitrogen dioxide, carbon dioxide, volatile organic compound (VOCs), formaldehyde and heavy metals between 6 different schools.

© COPYRIGHT UPM

6. To determine the relationship between air quality parameters [$PM_{2.5}$, PM_{10}, nitrogen dioxide, carbon dioxide, volatile organic compound (VOCs), formaldehyde and heavy metals concentrations (Cr, Mn, Ni, Pb, As, & Cd)] with respiratory symptoms and lung inflammation (FeNO) of the school children.
7. To determine the risk factors that influence reported respiratory symptoms, and lung inflammation (FeNO).

1.6 Study Hypothesis

1. There is significant difference between NO exhaled breath as indicator of airway inflammation (FeNO) and children from 6 schools in Kota Kinabalu, Sabah.
2. There is significant difference between indoor air parameters such as $PM_{2.5}$, PM_{10}, nitrogen dioxide, carbon dioxide, volatile organic compound (VOCs), formaldehyde and heavy metals between 6 different schools.
3. Heavy metals (Cr, Mn, Ni, Pb, As & Cd) in air and dusts is significantly related with reported respiratory problems and lung inflammations (FeNO) among school children.
4. The risk factor is significantly associated with the reported respiratory symptoms and lung inflammations.

1000740

1.7 Terminology (Definition)

1.7.1 Indoor Air Quality

Conceptual Definition

Indoor air quality shows the impact of indoor air towards human health, comfort, and ability to work. It can include but not limited to temperature, humidity, mould, bacteria, poor ventilation, or exposure to the other chemicals. (Department of Occupational Safety and Health, 2018).

Operational Definition

In this study, indoor air quality is assessed by measuring the indoor air quality pollutants in the study location. The indoor air quality pollutants that will be study are particulate matter ($PM_{2.5}$ & PM_{10}), heavy metals (Cr, Mn, Ni, Pb, As & Cd) and nitrogen dioxide (NO_2) as well as relative humidity, temperature and the concentration of carbon dioxide (CO_2) in the air. These pollutants are measured by using respective suitable indoor air quality pollutants instruments such as Q-trak indoor air quality monitor (Model 7565) to measure the air temperature (°C), relative air humidity (%) and carbon dioxide (ppm), TSI 8532 Dust Trak II to measure particulate matter of $PM_{2.5}$ and PM_{10} and also NO_2 passive sampler to measure the concentration of nitrogen dioxide and volatile organic compound in the air for 7 days.

1.7.2 Heavy Metals

Conceptual Definition

Heavy metal is defines as any number of higher atomic weight elements, which has the metallic substance at room temperature properties (Science Daily, 2018) that would mainly include the transition metals, some metalloids, lanthanides and actinides. (Coastal Wiki, 2018).

Operational Definition

Heavy metal in this study is defines as the carcinogenic heavy metals that contains in the dust and will give carcinogenic health impact towards human health. The heavy metal includes chromium (Cr), manganese (Mn), nickel (Ni), lead (Pb), arsenic (As) and cadmium (Cd). The settled dust will be collected by vacuum cleaning the floors, windows and a combination of dusts from floors and windows on special filters. The heavy metal will be extract from the dust and analyse by using aqua regia method for digestion part and lastly using ICP-MS to determine the concentration of the selected heavy metals present in the dusts.

© COPYRIGHT UPM

1.7.3 Lung Inflammations

Conceptual Definition

Lung inflammation is defined as the irritation and infection of the lung that will lead to the formation of lung abscess, a pus-filled cavity surrounded by inflammation, or an empyema, a collection of pus in the pleural space. The lung's air sacs fill with fluid and the respiratory failure ensures. Other than that, this complication has an acute respiratory distress syndrome and a high fatality rate. (Journal of Lung Disease & Treatment, 2018). The concentration of NO exhaled breath, or fractional exhaled nitric oxide (FeNO) can help identify allergic inflammation and thereby support a diagnosis of asthma when other objective evidence is lacking (FeNO by NIOX VERO, 2018).

Operational Definition

Lung inflammation in this study defines as the irritation of the respiratory airways measured from the school children that exposed towards the indoor air pollutants in the school environment. The lung inflammation of the school children is measured by using the fractional exhale nitric oxide (FeNO) instrument. FeNO is used to determine how much lung inflammation is present and how well inhaled steroids are suppressing this inflammation. The gas produced by cells involved in the inflammation associated with allergic or eosinophilic asthma. The exhaled air is exhaled through the machine at an exhalation rate of 50±5 ml/s.

© COPYRIGHT UPM

1.7.4 Health Risks

Conceptual Definition

Health risk is an adverse event or negative health consequence due to specific event, disease or condition and may be related to genetic conditions, chronic diseases, certain occupations or sports, lifestyle factors or any number of events or situations (MedicineNet, 2018). Other than that, health risk is also defines as something that could give harm to human's health. (Collins Dictionary, 2018).

Operational Definition

Health risks in this study is defines as the health symptoms experienced by the respondents. The type of questions asked about the symptoms is a close-ended questions which is a forced choice questions (Yes/No) and the frequency of getting the symptoms in day, weekly, monthly or none. The symptoms are self-reported by respondents by using the ISAAC questionnaire.

© COPYRIGHT UPM

1.7.5 Particulate Matter ($PM_{2.5}$ & PM_{10})

Conceptual Definition

Particulate matter (PM) is defines as particle pollution which is a complex mixture of extremely small particles and liquid droplets that contains in the environmental air. These particles can cause seriously adverse effect towards human health especially heart and lungs via inhalation. (Environmental Protection Agency, 2018).

Operational Definition

The major concern of particulate matter route of exposure is through inhalation that can cause serious adverse health effects. Hence, the exposure of respondents towards PM_{10} in indoor air will be measured by using the air sampling pump with filter paper based on gravimetric principle in mg/m^3 for 6 hours and the measurement of both $PM_{2.5}$ and PM_{10} also be measured by using a real-time measurement with Dust-Trak (Model: TSI 8534) for 45 minutes.

© COPYRIGHT UPM

1.7.6 Volatile Organic Compound (VOCs)

Conceptual Definition

Volatile organic compound (VOCs) is defines as an emitted gases from certain solids or liquids which include a variety of chemicals that may have short-term and long-term adverse health effects. The concentrations of volatile organic compound (VOCs) may be higher indoors compared to outdoors. (Environmental Protection Agency, 2018).

Operational Definition

Volatile Organic compound (VOCs) in the classroom might come from the furniture, paints, glue and adhesive. The level of volatile organic compound in indoor air of the classroom is measured by using real-time measurement with Air Velocity Meter (Model: TSI 9565-P).

© COPYRIGHT UPM

CHAPTER 2

LITERATURE REVIEW

2.1 Indoor Air Quality

Good indoor air quality is always needed for a healthy indoor environment and poor indoor air quality can lead to a various adverse health effects ranging from temporary to long-term health effects. Health effects arise from poor indoor air quality include allergic reactions, respiratory problems, eye irritation, sinusitis, bronchitis and pneumonia. (Industry Code of Practice on Indoor Air Quality, 2010)

Indoor air quality in school environment plays an important factor in affecting children's health especially respiratory health. Great concern is given due to the global increment of asthma and allergies particularly in children (Zhao et al., 2013). Children are vulnerable to the environmental risks compared to adults as they breathe higher volume of air, have little control over their environment and because of their lungs are still developing (Querol et al., 2008). Children are particularly vulnerable and susceptible compared to adults because they have higher absorption rate of heavy metal from inhalation system and higher hemoglobin sensitivity to metals (Bragoszewska et al., 2018).

The indoor air quality inside the classroom have been one of a major concern as the school students spend most of their time indoor and they belong to the susceptible group of population (Mendall and Heath, 2005). Approximately 65 to 90% of the children's time spend in indoor environments with a large portion at school which 65% of the indoor time is spent at home (Annesi-Maesano et al., 2013). Thus, the indoor air quality of the school environment requires particular attention. The most common indoor air pollutants sources, concentrations measured in the home, office and transportation microenvironments shows the impacts of air pollutants on human health (Samet and Krewski, 2007).

According to the Environment Protection Agency (EPA) data that shown many schools have problems that linked to the polluted indoor air quality, the pollutant levels is two to five times higher than the outdoor levels (Annesi-Maesano et al., 2012). The indoor air quality in schools are usually determined by the parameters such as volatile organic compound (VOCs), particulate matter, aldehydes, bacteria and molds (Madureira et al., 2012). Indoor air pollutants can cause or contribute to short-term and long-term health effects (Clause et al., 2009; Annesi-Maesano et al., 2013). Furthermore, the indoor air pollutants also can give effects to discomfort and reduce school attendance and productivity (Mendell & Heath, 2005).

A repeat multi-country cross-sectional Study on Asthma and Allergies in Childhood (ISAAC) showed an increase of asthma in middle-income countries especially in Asia (Asher et al., 2006). World Health Organization (2007) reported that indoor air pollution is responsible for roughly calculated 3.7% of the altogether disease burden in high-mortality developing countries which are the top killer after

malnutrition, unsafe sex, lack of safe water and sanitation. According to the latest WHO data published in 2017, Asthma deaths in Malaysia reached 1,258 or 0.91% of total deaths.

2.2 Particulate Matter ($PM_{2.5}$ & PM_{10})

The particulate matter in the environment air poses high prevalence of danger towards human health compared to the ground-level ozone or other common air pollutants such as carbon monoxide and the airborne particulate matter consists of heterogeneous mixture of solid and liquid particles that is suspended in the air, varies continuously in size and chemical composition in space and time (World Health Organization, 2013). It is found that the chemical constituents of PM are diverse enough to include nitrates; sulfates; elemental and organic carbon; organic compounds (e.g., polycyclic aromatic hydrocarbons); biological compounds (e.g., endotoxin, cell fragments); and metals (e.g., iron, copper, nickel, zinc, and vanadium) (World Health Organization, 2013).

The main criteria of aerodynamic diameter of particulate matter to describe its transport ability in the atmosphere and inhaling ability is through the respiratory organism (Esworthy, 2013). Environmental Protection Agency has been regulating particles in two size categories based on their prediction capacity of penetration into the lungs as either inhalable particles (PM_{10}) with diameters that are generally 10 micrometers and smaller and fine inhalable particles ($PM_{2.5}$) with diameters that are generally 2.5 micrometers and smaller (Esworthy, 2013). Fine particles that are less than 0.1 micrometers are categorized as an ultra-fine particles ($PM_{0.1}$) (Hasheminassab

et al., 2013). Figure 1 shows a comparison of the size between $PM_{2.5}$ and PM_{10} against the average diameter of a human hair (~70µm) and fine beach sand (~90µm).

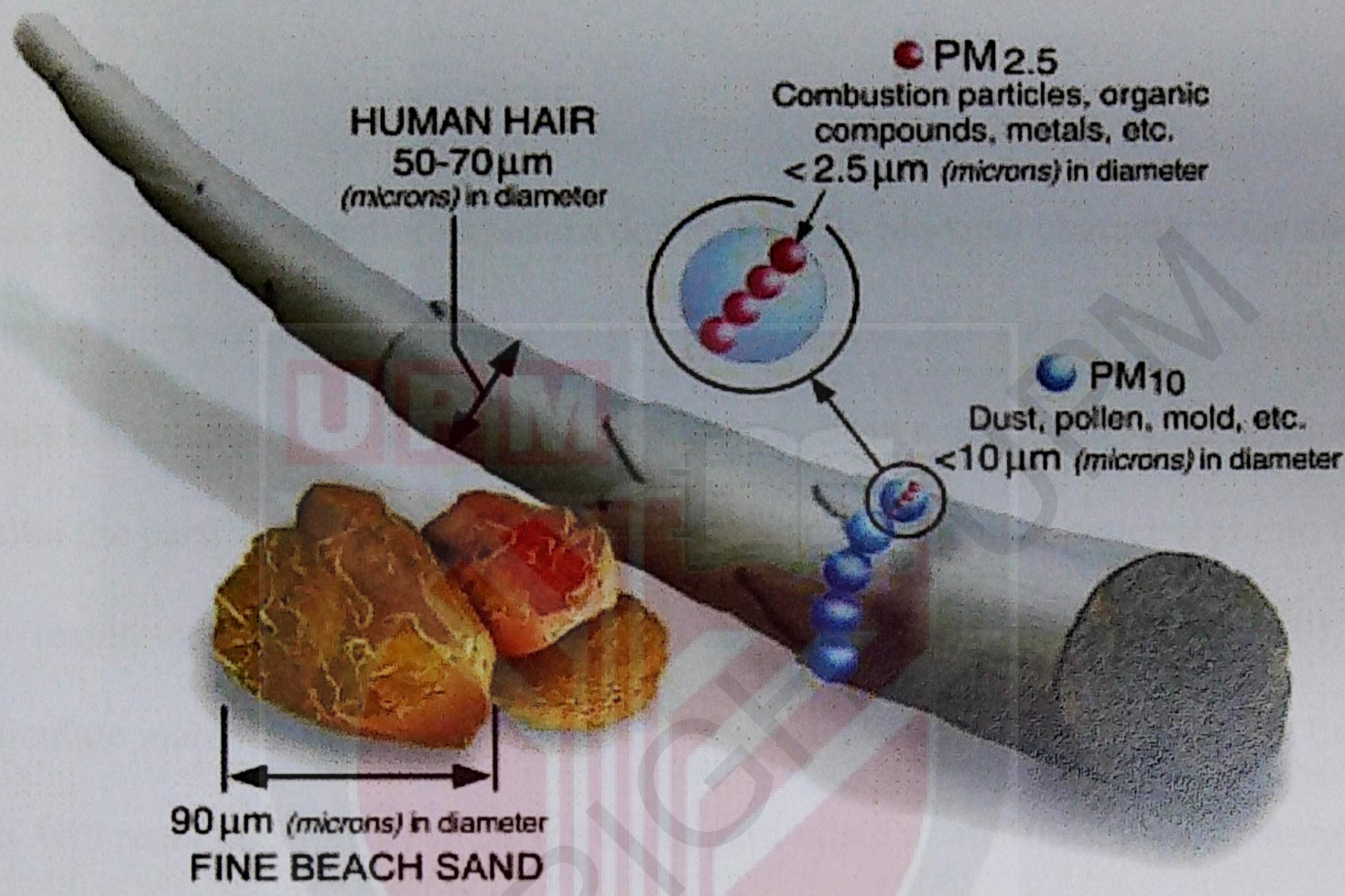


Figure 2.1: Size comparison of PM2.5 and PM10 against the average diameter of a human hair (~70µm) and fine beach sand (~90µm) (Source: Environmental Protection Agency, 2018).

The ambient particulate matter is a chemically non-specific pollutant that comes from a variety of sources in which, in line with composition, size and solubility to determine its toxicological characteristics (Kelly & Fussell, 2012). Most particles form in the ambient air as a result of a complex reactions such as sulfur dioxide and nitrogen oxides, which are pollutants that emitted from power plants, industries and automobiles (Environmental Protection Agency, 2018). Traffic is considered as one of the contribute in arising the health effects to air pollution (Health Effects Institute,

2010). Result of a source apportionment analysis has suggested that over half of the mean PM2.5 can be attributed to motor vehicles (42%) and road dust (12%), and children who has asthma is exposed everyday towards these sources which increased the risk of respiratory symptoms and requires greater inhaler use (Legret and Pagotto, 1999).

The effect of particulate matter exposure depends on its physical characteristics such as breathing more, rate and volume of a person, however, the size of the particulate matter has been directly causes the health problems (Brown et al., 2013). In addition, the smaller the particles of the particulate matter, the more deeply it penetrates into the lungs or respiratory tract and deposit at an increasing rate (Atkinson et al., 2010). If the particulate matter is inhaled, it will be collected in the nose and throat which then the body will react to eliminate these intruding particulate matter through such natural body processes such as sneezing or coughing (Cadelis et al., 2014)

2.3 Volatile Organic Compound (VOCs)

Volatile organic compound (VOCs) is classified as organic compounds that have the range of boiling point between 50 and 260°C (Godish, 2004). There are variety of volatile organic compound in the air which can increase the complexion of indoor air pollution. Previous studies shows that indoor air is contaminated to various degrees by a wide variety of hydrocarbons including paraffin, olefin, aromatics, carbonyls, polycyclic aromatics and chlorinated hydrocarbons (Kim et al., 2001; Lai et al., 2004; Sawant et al., 2004). Some of the indoor volatile organic compound are toxic such as toluene whereas some at high levels are carcinogenic include

formaldehyde and benzene (Agency for Toxic Substances and Disease Registry, 2007).

Indoor volatile organic compound exposure poses a greater concern in the population because indoor concentrations of many pollutants are significantly higher compared to the outdoor pollutants (Massolo, 2009). At the same time, indoor volatile organic compound might be a dominant contributor towards personal exposure because most people spend their 80% of time indoors either in the workplace or home (Guo et al., 2009; Wang & Zhao, 2008).

The sources of indoor volatile organic compound is quite numerous including combustion products, cooking, construction materials, furnishings, paints, varnishes and solvents, adhesives and caulks, office equipment and consumer products (Guo et al., 2003). Some volatile organic compound levels in the indoor environments may pose potential health effects to occupants of dwelling whereas some of it may be present at concentrations that is not considered acutely harmful at the short-term exposure, but, long-term exposure may result in mutagenic and carcinogenic effects (Son et al., 2003).

2.4 Heavy Metals

Heavy metals are ubiquitoes in the environment air because of the anthropogenic activities resulting from the rapid industrialization, urbanization and motorization (Tong and Lam 1998). Anthropogenic sources comes from motor vehicles, fossil fuel combustion, metal smelters and alloy refineries, cement

manufacturing plant and municipal incinerator, etc. (Thakur et al., 2004) has increase the levels of heavy metal concentration in the environment (Al-Khashman, 2004,2007; Banerjee, 2003). Indoor dust is a major media of interest for heavy metal exposure towards children (Lanphear et al., 2002; Rasmussen et al., 2001) which derived from indoor sources such as paints and dusts (Turner and Ip, 2007)

Excessive heavy metal emissions often emitted in the form of particulates (Duzgoren-Aydin et al., 2006), contaminated the environment surface which as they become airborne that contribute to atmospheric pollution, a major environmental issues in many countries (Lu et al., 2010). Numerous studies on heavy metal concentration, distribution and source identification in street dust have been conducted in recent decades that indicate the concentrations of most heavy metal in dust from the industrial and traffic area are generally higher than those of non-industrial areas such as residential area and commercial area (Han et al., 2008).

The Internal Agency for Research on Cancer (IARC) has classified aluminium (Al), cobalt (Co), copper (Cu), iron (Fe), nickel (Ni) and zinc (Zn) as non-carcinogenic elements whereas arsenic (As), cadmium (Cd), chromium (Cr) and lead (Pb) are classified as both carcinogenic and non-carcinogenic elements. Heavy metals such as As, Cd, Cr and Pb are widespread environmental pollutants which can cause harmful health effects, such as cancers (Sanborn et al., 2002; Tchounwou et al., 2003).

2.5 Fractional Exhaled Nitric Oxide (FeNO)

Fractional exhaled nitric oxide (FeNO) has now days been used in epidemiological studies in Asia (Xu et al., 2011; Zhao et al., 2013; Lim et al., 2015). Measurement of FeNO was recommended as one of the option to support asthma management (in conjunction with the British guideline on the management of asthma, 2012) among people that symptomatic despite using inhaled corticosteroids (Carroll, 2016). FeNO is produced by the inducible nitric oxide synthase (NOS) situated at activated bronchial epithelial cells. FeNO is non-invasive marker of airway inflammation (Janson et al., 2005) and a biomarker of TH2 driven lower airway inflammation connected to allergic asthma (Pike et al., 2013).

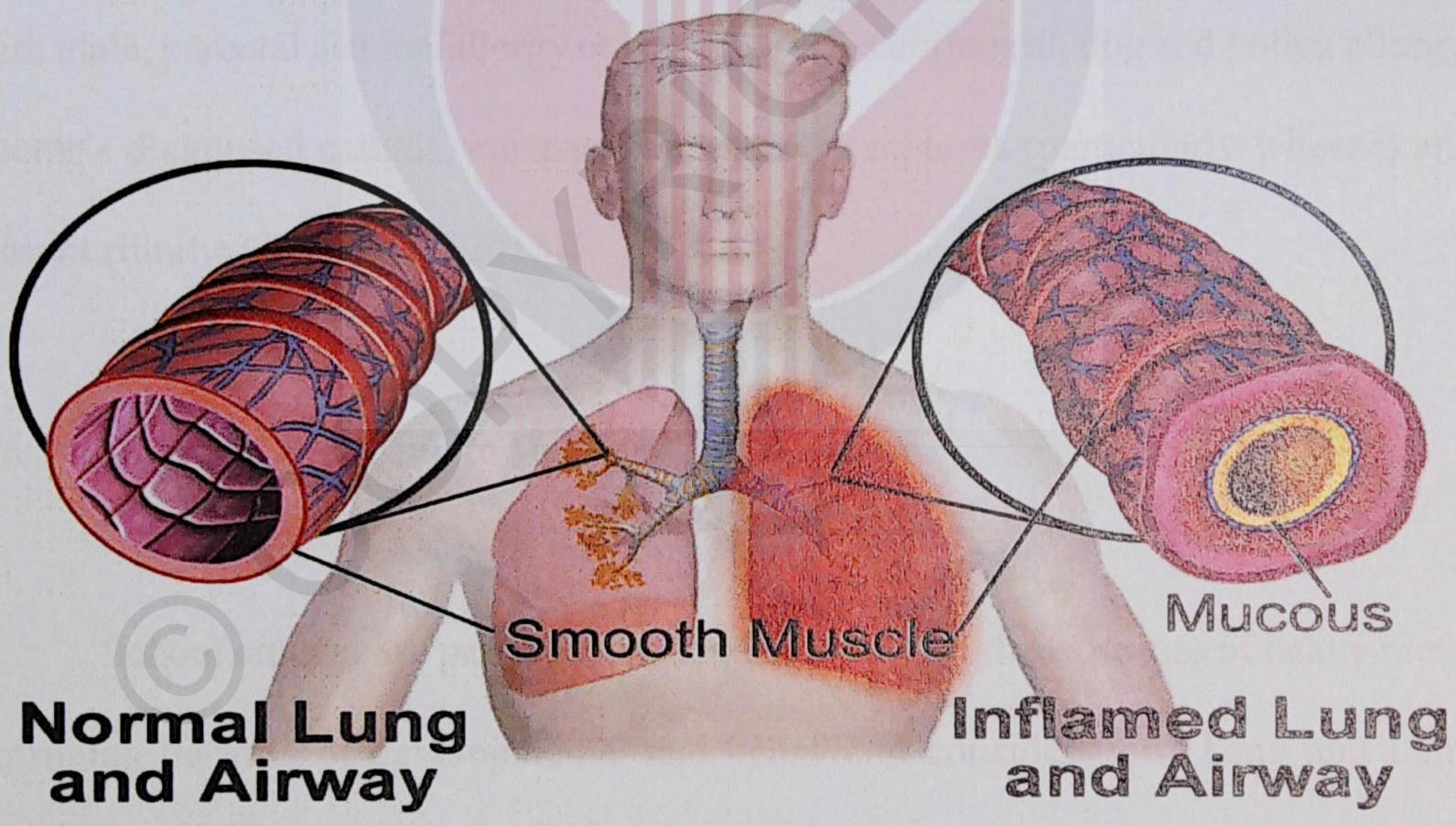


Figure 2.2: The Difference between Normal and Inflamed lung proposed by Blausen Medical, 2014.

From the ATS guidelines on the use of fractional exhaled nitric oxide (FeNO) in clinical practice (Dweik et al., 2011); the FeNO level were categorized as abnormal if it is 20 ppb or more and normal if it is below than 20 ppb (Norbäck, et al., 2017). Personal factor and environmental factor can influenced FeNO level (Zhao et al., 2013). The major personal factors are tobacco smoking, nitrate intake, height, gender and race (Malinovschi et al., 2012).

High FeNO levels among office workers in Malaysia were reported previously (Lim et al., 2015). A study conducted in Penang, Malaysia by Norback et al., (2016) reported that girls have higher prevalence of daytime attacks of breathlessness while boys showed elevated FeNO concentration. Other Asian study conducted among school children in China found that increased FeNO value was significantly associated with male, parental asthma/allergy or eczema, self-reported cat, dog and pollen allergy, doctor's diagnosed asthma, currents respiratory symptoms (particularly wheeze) and current rhinitis (Zhao et al., 2013).

2.6 Health Effects due to Heavy Metal Exposure

School student are particularly vulnerable toward the exposure of heavy metal poisoning because of developmental and behavioral consideration (Tong and Lam, 1998). Children inhale more compared to adults due to proportionately higher oxygen demand and smaller body weight (Tong and Lam, 1998). Moreover, they are extremely vulnerable to environment interference because their organs are developing rapidly at early stage of development which making them more susceptible to functional damage

or disorders (Yaaqub et al., 1991). Consequently, the pulmonary uptake for the inhaled aerosol toxins is also higher (Meza-Figueroa et al., 2007).

Heavy metal poisoning is asymptomatic and is associated with various metabolic and cognitive disorders such as the reduction in school performance, learning disabilities, neuropsychological deficits, decreased intelligence, behavioral and developmental impairment and disturbances in growth (Faiz et al., 2009). Heavy metal in dust can enter the human body via inhalation, ingestion and also dermal contact (Al-Rajhi et al., 1996).

The fine dust particles that contain heavy metal might be inhaled into the lungs of the children due to the air suspension caused by the wind (Latif et al., 2013). Moreover, many studies have shown that heavy metals can cause adverse health effects towards the vulnerable children (Sanborn et al., 2002). Some examples of carcinogenic effects are respiratory illnesses, cardiovascular deaths, damage to the nervous system and slow growth development (Faiz et al., 2009).

© COPYRIGHT UPM

CHAPTER 3

METHODOLOGY

3.1 Study Design

The type of study design that was used for this study was cross-sectional study. The study was conducted for six weeks at Kota Kinabalu, Sabah, Malaysia. The study objective were to study the relationship between air quality parameters [$PM_{2.5}$, PM_{10}, nitrogen dioxide, carbon dioxide, volatile organic compound (VOCs), formaldehyde and heavy metals concentrations (Cr, Mn, Ni, Pb, As, & Cd)] in indoor air and dusts from school environment with the respiratory symptoms and lung inflammation of the school children.

3.2 Study Location

This cross-sectional study was conducted at secondary schools in Kota Kinabalu, Sabah. Sabah was selected as more study have been conducted in peninsular Malaysia but less in East Malaysia. For study location, Kota Kinabalu was selected as these schools have many attending students. Kota Kinabalu was purposively selected due to the logistic reason and time limitation.

Six secondary schools in Kota Kinabalu was randomly selected from the district. After that, 4 classes of Form 2 was randomly selected from each of the selected schools. From each of selected class, students who returned the consent form was selected to join the study. This gave a total of 332 school children from 6 different schools in Kota Kinabalu. Besides that, the health assessment was also conducted in schools. The selected schools are labeled as School A, School B, School C, School D, School E, and School F.

3.3 Study Population

Year 2 (Form 2) classes which made up of 14 years old children was selected as these were non-examination class (school principal restricted condition) and these children were old enough to fill up the questionnaire with some guidance from the researcher.

3.4 Sampling Frame

The list of students was obtained from the school administration. The sampling frame was from the random selection of 6 classes of Year 2 (Form 2) in the school. The total of school students had been selected to participate depends on the written consent that had been returned.

© COPYRIGHT UPM

3.5 Sampling Unit and Subject Criteria

Respondents was asked to participate voluntarily in this study with the informed consent given to the parents for the permission, prior to their participation. A respondent was chosen on the inclusive and exclusive criteria as below:-

3.5.1 Inclusion Criteria

3.5.1.1 Consent

Written consent of all selected Year 2 (Form 2) (non-examination class) students was obtained from their parents or guardians in order to participate in the study. All the procedures involved was clearly explained to the respondents.

3.5.1.2 Duration in school

School children age 14 years (Form 2) was involved in this study. Since these are non-examination class and they were matured enough to fill out questionnaires. Allergy sometime takes a while to develop in young children. Only school children who were in the same school previously in Year 1 (Form 2) was involved in this study, to indicate that they have been exposed to the same environment for a year.

3.5.1.3 Malaysian

Only Malaysian students was included in this study.

3.5.2 Exclusion Criteria

3.5.2.1 Severe medical cases

Individual having diseases such as heart disease, hypertension and congenital physical chest abnormality was not being included in the study. Screening was carried out before carrying out data collection by asking the parents using a pre-questionnaire form together with the written consent form before the start of the study.

© COPYRIGHT UPM

3.6 Sample Size Calculation

According to Leung & Ho., 1994, the prevalence of a history of wheeze and asthma in children were 8.2% in Kota Kinabalu, Sabah.

Formula:

$n = z^2_{1-\alpha/2} P (1-P) / d^2$

Where,

P= estimated proportion

D= desired precision

Calculation: $n = 1.96^2 \times 0.082 (1-0.082) / 0.05^2$

$n= 0.289/0.05^2$

n= 116

n= 116 + 20% drop out rate

So the minimum sample are 140 students from schools.

Lemeshow, Klar, & Lawanga (1990).

© COPYRIGHT UPM

3.7 Sampling Method and Subject Recruitment

The selection of districts from states was purposively sampled which is Kota Kinabalu, Sabah and the selection of schools was randomly choose in the district. Year 2 (Form 2) students was purposively selected since it is a non-national examination class in the secondary school. From the total classes of each selected schools that was randomly sampled from Kota Kinabalu, Sabah, it was randomly sampled to get 4 classes from each schools. Students were selected based on the inclusive and exclusive criteria of the study with the returned consent form from their parents.

3.8 Research Tools/Instruments

This study were assessed 3 method of data collection. Data on children's health and home exposure was being extracted from a validated questionnaire (ISAAC). Set of questionnaire was given and distributed to the children in schools and the health assessment was conducted concurrently. Data on pollutants such as nitrogen dioxide (NO_2), particulate matters ($PM_{2.5}$ & PM_{10}), formaldehyde, dusts containing heavy metals (Cr, Mn, Ni, Pb, As, & Cd) including climate variables was measured inside of the classrooms.

Dusts containing heavy metals were sampled inside the classrooms by using personal air sampler for indoor dust and vacuum cleaner for collecting settled dust. Air pollutant collected was analyzed at designated laboratory. Health related data and home exposure were extracted from a validated questionnaire. Questionnaire were distributed to the children in school and the health assessment conducted concurrently. While, health assessment was carried out on exhaled nitrous oxide (NO) using FeNO machine was carried out on the children. The field data collection were carried out from **9 January 2019 until 14 February 2019.** Written consent forms were distributed to each respondent prior to all procedures.

3.8.1 Questionnaire

3.8.1.1 Pre-Questionnaire Screening Form

This form was given along with the written consent form before the study start. Students who have a diseases such as hypertension, congenital physical chest abnormality and heart disease were not included in the study.

© COPYRIGHT UPM

3.8.1.2 Questionnaire Form

The study was using a self-administered questionnaire. Questionnaire on health and socio-demographic was distributed to the respondents. The questionnaire has several parts and concentrated on the demographic data, medical history, information on cigarette smoking, environmental exposure to animals/pets, indoor exposure to buildings, physical activities and lifestyle, dietary information, psychological well-being and symptoms experienced by the respondents in relation to health effects caused by the indoor air pollutants.

The questionnaire was a modified validated questionnaire translated into Malay language and the questions were compiled from large international studies such as European Community Respiratory Health Survey (ECRHS) (Burney et al., 1994), the ISAAC Study (Asher et al., 2006) and a previous Swedish school study (Smedje, 1997). The questions that were used is the same questions used in the studied conducted in Pulau Pinang and Johor Bharu. The questionnaire comprised standardized questions on airway infections, doctor's diagnosed asthma, current asthma, allergies and respiratory symptoms. This also can be supported by the similar questionnaires as were previous used in international studies on asthma and allergies among children, and school studies in Sweden, Norway, Denmark, France, Italy and China.

© COPYRIGHT UPM

The questionnaire was given directly to the students and must be completed by students with the assistance from enumerators/researchers. Then, the questionnaire were collected after all information completed. Meanwhile, if the questions were not completed by the students, the parents were called to get the missing information.

3.8.1.3 Pre-Test

Pre-test was conducted before commencement of the study to test the validity of the questionnaire and the aim of the pre-test was to collect data using the same questionnaires in the study and analyze these data to test the validity of the questionnaires and to estimate time needed to complete face-to-face interview the respondents to answer the questionnaires. Twenty school children from secondary schools in Shah Alam were involved in the pre-test.

3.8.1.4 Content Validity

Content validity of the questionnaires which are standardized and adapted from ISAAC study was used and the content of these questionnaires were checked via the opinions of the experts with knowledge and experience relevant to the study. The content validity aimed to identify and correct all sources of errors, ambiguous words, jargons and technical to them clear for the study.

3.8.1.5 Face Validity

Face validity was conducted during the pilot study. A questionnaire were tested with 20 respondents during the pilot study to ensure they understand the questions. The respondents were advised to ask if they did not understand any of questions or words or need further explanation. The students respond well to the Malay version of the questionnaire given.

3.8.2 Exposure Measurement using Instruments

Exposure measurement and building inspection was conducted during school visit together with the questionnaire distribution and medical assessment. Selected chemical pollutants such as Nitrogen Dioxide (NO_2), Particulate Matter ($PM_{2.5}$ & PM_{10}), formaldehyde, dusts containing heavy metals (Cr, Mn, Ni, Pb, As, & Cd) and indoor climate parameters such as room temperature, relative air humidity and carbon dioxide (CO_2) were measured. Indoor samples were collected near student's breathing zone (approximately 0.7-1.5 m above the floor. The indoor sampling locations that was selected were in the middle of the classrooms. In addition, the indoor sampling location that were selected was as far as possible from the blackboard.

© COPYRIGHT UPM

The measurement and air sampling will be performed during regular daily activities. Sampling was conducted in the 4 selected classrooms used by the selected students in each schools. Dust samples was collected from combination of floor, table and window using vacuum cleaning in a standardized fashion (vacuum area in square feet) and both PVC filters containing indoor dusts and dust samples from vacuum cleaning were analyzed for heavy metals (Cr, Mn, Ni, Pb, As & Cd) by using ICP-MS.

$PM_{2.5}$ & PM_{10} were sampled by using real-time measurement with Dust-Trak DRX (Model: TSI 8534) for 45 minutes in each classes. Meanwhile, gravimetric dust measurement were used to measure PM_{10} in indoor air in the class with PVC filter (Personal Air Sampler) for 6 hours and then were weighed by using weighing balance. The personal air sampler were calibrated before and after the sampling was done.

Next, a real-time measurement with Air Velocity Meter (Model: TSI 9565-P) were used for measuring CO_2 and VOCs while a real-time measurement with MultiRae Lite (Model: PGM-6208) were used to measure the concentration of formaldehyde in indoor air for 45 minutes. For the NO_2 concentration, it was analyzed by using a passive sampler and was left in the classroom for 7 days and were collected to further analyzed by IVL Swedish Environmental Research Institute Laboratory and

spectrometry method were used to analyze this sample in accordance with standard of SS-EN ISO 13395:1997 mod.

The indoor dusts were collected by using 2 methods which is firstly, a PVC filter were used with Personal Air Sampler to collect the indoor air dusts for 6 hours in the classroom and secondly, the settled dusts were collected by using 400W vacuum cleaner with a special filter. These dusts were then further analyzed for the heavy metals concentration. The type of heavy metals were Cr, Mn, Ni, Pb, As and Cd and it was selected due to its carcinogenic effects towards human health. The digestion was using the aqua regia method. All the digestion samples of indoor air dusts and settled dusts were then further analyzed for its heavy metals concentration by using inductively coupled plasma mass spectrometry (ICP-MS).

© COPYRIGHT UPM

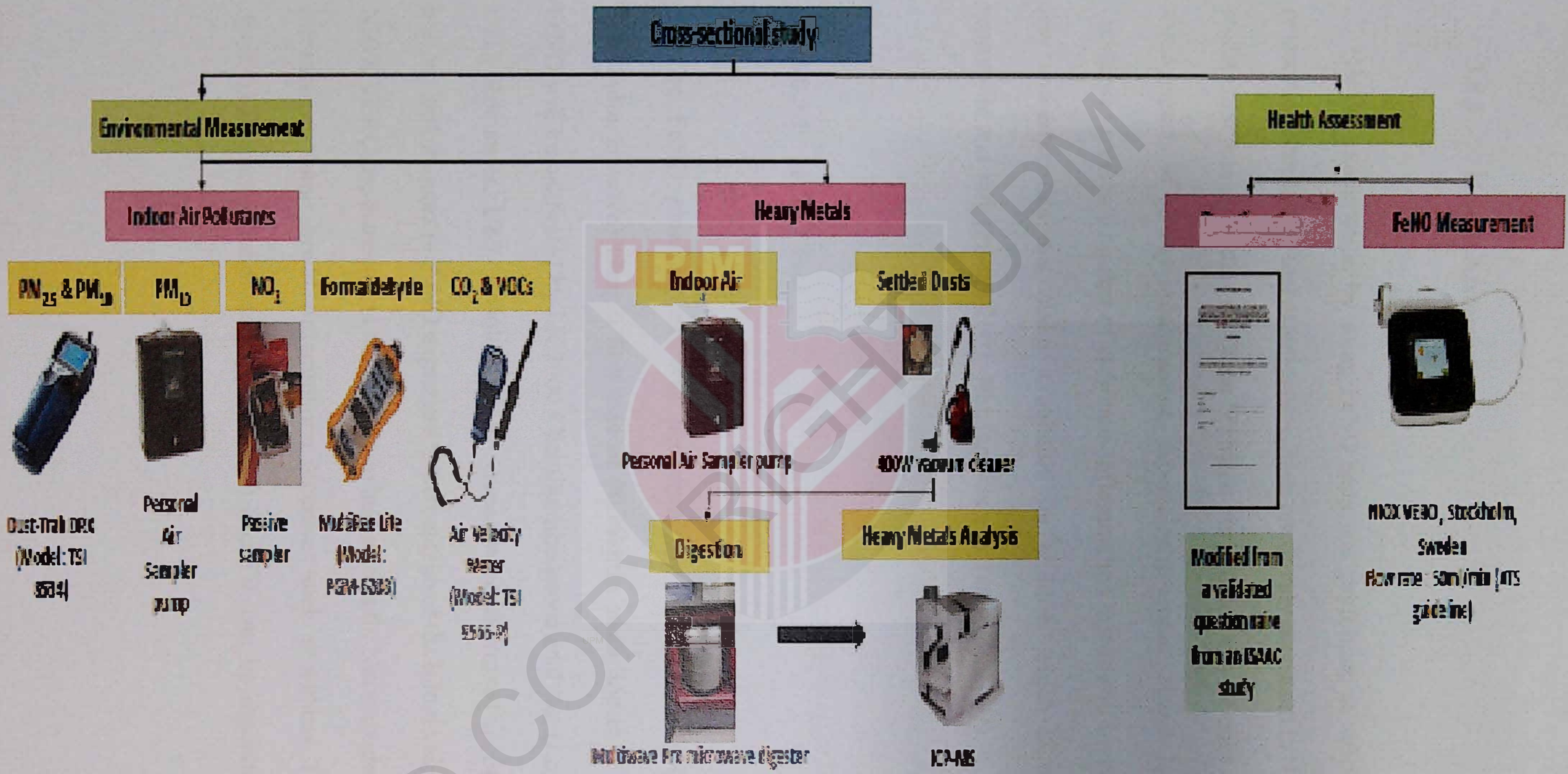


Figure 3.1: Flowchart of Exposure Measurement

© COPYRIGHT UPM

3.8.3 Health Assessment

Health examination by using FeNO tests was performed at school by trained researcher. Similar clinical examinations have previously been used in two EU-school studies and school studies in China. Exhaled nitric oxide can be used as readout of some aspects of airway inflammation, especially in atopic asthma. Exhaled Nitric Oxide was used as a marker of asthmatic inflammation that is non-invasive and have few characteristics that make it suitable for children which is instantaneous, repeatable and safe (Prieto, 2002; Hatziagorou and Tsanakas, 2007).

3.8.3.1 FeNO Test

The FeNO measurement was performed by the portable (NIOX MINO, Stockholm, Sweden) using a flow rate of 50 ml/min according to ATS guideline. FeNO will be calibrated by LR 2000 Chemiluminescence analyser (Logan Reseacrh LTD, Rochester, UK). Absolute FeNO values were expressed in ppb (parts per billion) and changes in FeNO expressed in percentage of the initial value (Δ %). The NIOX VERO measures nitric oxide (NO) in human breath. Nitric oxide is frequently increased in some airway inflammation processes such as asthma. The fractional nitric oxide concentration in expired breath (FeNO), can be measured by NIOX

VERO according to guidelines for NO measurement established by the American Thoracic Society.

The procedure of FeNO data collection in brief is, firstly, students will be required to sit and rinse the mouth by drinkable water. Next, they will inhaled the NO- free air through the disposable filter into the lung capacity and exhale the air through the machine at an exhalation rate set for the test. One single measurement will be collected for each students. The standard mode that will be use is 10s exhalation time for the test. Maximum of 5 repeated tests with 10 minutes rest between were allowed for children who could not completed the test successfully the first time and no nose clip will be used in this test. These are the details measurement of fractional exhaled nitric oxide test:

1. Empty the lungs by breathing out thoroughly.
2. Close the lips around the mouthpiece on the respondent's filter so that no air leakage occurs.
3. Inhale deeply through the patient filter to total lung capacity. During inhalation, the cloud on the display moves upwards.
4. Exhale slowly through the filter while keeping the cloud within the limits as indicated in the display (in the white lines).
5. The instruments display and audio signals guide the user to the correct exhalation pressure.

6. Exhale until the cloud has passed the flag.
7. The instrument will analyze the sample and generate a result in approximately 1 minute.

A continuous sound of the machine indicates correct pressure with a frequency proportional to the pressure. An intermittent high frequency sound indicates too strong pressure and an intermittent low frequency sound indicates too weak pressure. This test cannot be used with infants or by children under the age of 7, as measurement requires patient cooperation and also should not be used in critical care, emergency care or in anesthesiology (User manual NIOX VERO Airway Inflammation Monitor, 2018).

3.8.3.2 Safety Protocols on the use of FeNO

The FeNO instrument and the breathing handle must be cleaned with a cloth dampened with water or a mild soap solution. The respondents was required to use hand sanitizers before touching the breathing handle to perform the test. The researcher who conduct the test was require to use hand gloves. This is to prevent any occurrence of cross contaminated diseases. The mouthpiece of the respondents will be changed which means one mouthpiece is just for one respondent (User manual NIOX VERO Airway Inflammation Monitor, 2018).

© COPYRIGHT UPM

3.8.4 Laboratory Analysis

3.8.4.1 Digestion Process

3.8.4.1.1 Sample Collection and Preparation

The sample was collected by using vacuum cleaner from the combination of dusts from floors, tables and windows, on special filters and will be kept in an air-tight container. Each of the air tight container were placed in the labeled sealed plastic bags. Powder free gloves was worn during the sample collections. The dust samples will be screened to remove any visible hair, soil and grit. The samples are then over-dried at 100°C for 24 hours to drive out moisture.

3.8.4.1.2 Sample Digestion Procedure

The digestions of the heavy metals in settled dusts will be sample by using aqua regia method that is 3:1 ratio of hydrochloric acid (HCl) concentration and nitric acid (HNO_3) concentration respectively. The samples were dried in the oven at 100°C overnight. Portion of 0.5 grams of each samples were then weighed into a high sample throughput rotor 24HVT50 and 12 ml of 3:1 ratio of HCl and HNO_3 were added.

© COPYRIGHT UPM

The samples were then digested in the microwave digester system model in Multiwave Pro. After the digestion, the digested samples were then filtered through Whatman filter paper No 1 into 50 ml volumetric flask then make up to the volume with distilled water. For the dusts in indoor air, the PVC filter was soaked in 4mL of nitric acid, and were digested in Rotor 8NXQ8O with 700W Multiwave Pro microwave digester system.

Calibration standards was prepared from the stock solution of the elements to be determine by serial dilution and were matrix match with the acid concentration of the digested samples. The digested samples were then be analyzed for heavy metals by using Inductively Coupled Plasma-Mass Spectrometry (ICP-MS).

3.8.4.1.3 Inductively Coupled Plasma - Mass Spectrometry (ICP-MS)

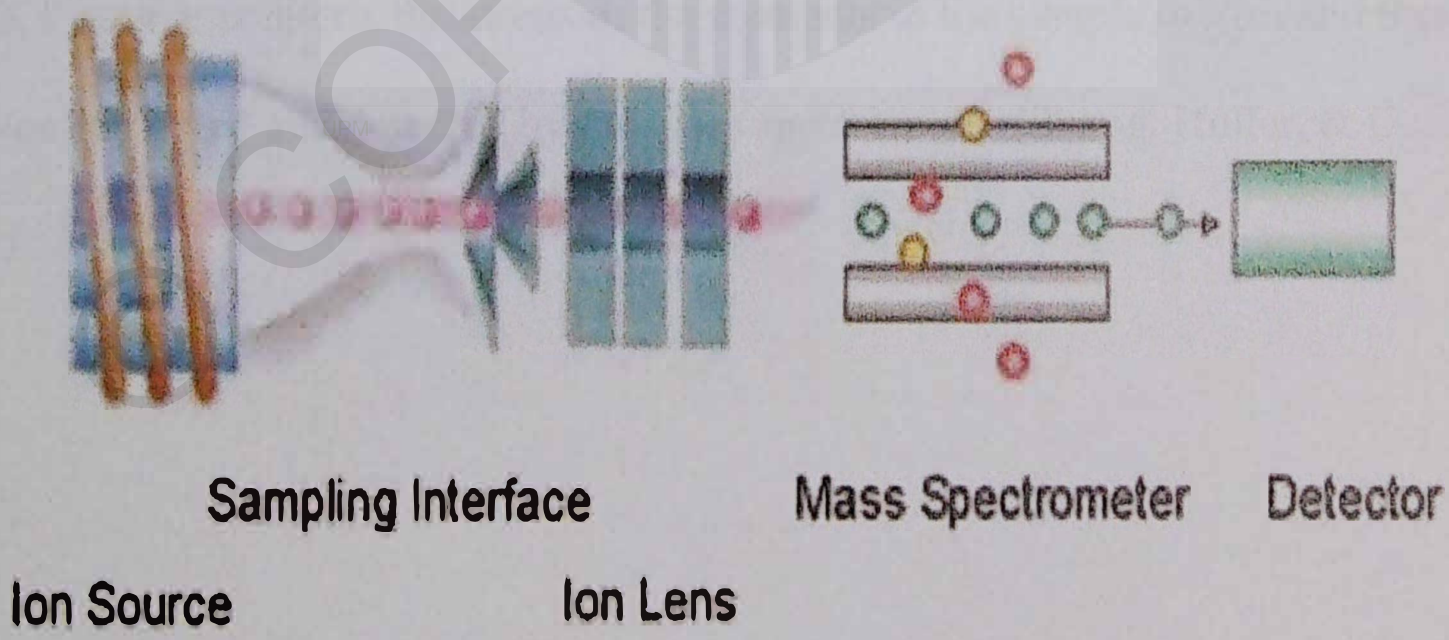


Figure 3.2: ICP-MS Structure

Inductively Coupled Plasma-Mass Spectrometry or ICP-MS is an analytical technique used for elemental determinations (Bazilio. A. & Weinrich. J., 2012) and is capable of detecting metals and several non-metals at concentrations as low as one part in 10^{15} (part per quadrillion, ppq). ICP-MS have advantages over other elemental analysis techniques such as atomic absorption and optical emission spectrometry including ICP Atomic Emission Spectroscopy (ICP-AES), including detection limits for most elements equal to or better than those obtained by Graphite Furnace Atomic Absorption Spectroscopy (GFAAS), have ability to handle both simple and complex matrices with a minimum of matrix interference due to the high-temperature of the ICP source, have superior detection capability to to ICP-AES with the same sample throughput and able to obtain isotopic information.

The ICP-MS combines a high temperature ICP source with a mass spectrometer. The ICP source converts the atoms of the elements in the sample to ions and these ions are then separated and detected by the mass spectrometer (Skoog, Holler, & Crouch, 2007).

© COPYRIGHT UPM

3.9 Data Analysis

These statistics were performed with Statistical Package for the Social Sciences (SPSS) 22.0 or the STATA statistical package version 14 (for multi-level logistic regression), using two-tailed tests and a 5% significance level.

Non-parametric statistics were performed according to data distribution as determined by Shapiro-Wilk normality test. Data were presented as median (Interquartile range, IQR). Continuous variables were compared by using Kruskal-Wallis H test to compare indoor air parameters, heavy metals in indoor air and dusts between 6 different schools and Dunn-Bonferroni's pairwise tests were carried out for fifteen pairs of groups for each indoor air pollutants after the Kruskal-Wallis H tests shows a significant results.

A Chi-square cross tabulation were used for significant difference in categorical parameters to study the relationship between air quality parameters and heavy metals concentration in indoor air and dusts with reported respiratory symptoms and lung inflammation among the school children. A cut off level for statistical significant was considered at $p<0.05$.

A multi-level logistic regression was applied to evaluate the relationship between lung inflammations (FeNO) and reported respiratory symptoms with socio-demographic characteristics, air quality parameters and heavy metals in indoor air and dusts.

3.10 Quality Control

3.10.1 Environmental Measurement

The environmental measurement equipment including TSI 8534 Dust Trak DRX and Air Velocity Meter (Model: TSI 9565-P) will be calibrated every time before sampling the data. For the NO_2 passive sampler, the equipment was put in a unreachable or high place with tagging of "Do Not Disturb". The NO_2 were kept in a sealed plastic bags after the measurement, and after that, kept in a box contained bubble wrap in it to avoid breaking the samples if it is snapped or dropped.

To measure PM_{10} in indoor dusts, gravimetric method was used by using Personal Air Sampler pump and the pump was calibrated before and after the sampling was done. The reading of before and after the calibration were make sure to be in close range. Real-time measurement with MultiRae Lite (Model: PGM-6208) was calibrated every time before taking the formaldehyde data sample. The sensitivity limit of the instruments were known before doing the measurement to make sure there was no error while collecting the data. Lastly, the cassette used for measuring dusts with Personal Air Sampler was soaked in acid wash overnight.

© COPYRIGHT UPM

3.10.2 Questionnaire

Pre-testing of the questionnaire was conducted among similar characteristics of exposed group to ensure the validity and reliability of the question items. The time taken for the respondents to answer the questionnaire were also measured.

3.10.3 Nitric Oxide Measurement

NIOX-VERO measure reading of nitric oxide ranging between 5 to 300ppb. The device does not require calibration as its sensor was recalibrated by the manufacturer. However, daily and full quality control procedures were performed based on user manual of the manufacturer (Silkoff, 1999). In addition, powder-free gloves and hand sanitizers were used while measuring the FeNO of the respondents to prevent cross contamination and viruses. The mouthpiece of the NIOX-VERO instruments were also changed for each person and not reusable.

© COPYRIGHT UPM

3.11 Ethical Consideration

i. The approval from human subject's Ethic Committee, Universiti Putra Malaysia (UPM) was obtained

ii. Permission and approval letter from Ministry of Education (MOE) was obtained.

iii. Permission and approval from District Education Office (DEO), Kota Kinabalu, Sabah was obtained.

iv. The management and respondents were informed about the purpose of the study through presentation.

v. Two medical doctors were standby while doing the health assessment.

vi. Written consents from the parents and respondents were obtained prior to study.

vii. Short briefing to the study subjects was carried out to ensure they understand the procedure and instruction before the data collection process.

viii. All the collected data from the study were confidential.

© COPYRIGHT UPM

CHAPTER 4

RESULT

4.1 Socio-demographic Data of Respondents among Secondary Schools

This study was carried out at 6 different schools in Kota Kinabalu, Sabah, Malaysia. A total of 332 respondents which had 139 (41.9%) boys and 193 (58.1%) girls participated in this study. The demographic data of the respondents were obtained through a validated questionnaire from International Study of Asthma and Allergy in Childhood (ISAAC) in which individual information from 6 different schools were collected. Socio-demographic background data on gender, race, father and mother education, and total household income of respondents are shown in Table 4.1.

Majority of the respondents in this study were Bajau 118 (35.5%) from 332 of total respondents. Most of the education level of the parents were secondary school and the total household income were mostly less than RM1500 (48.2%). Father shows the highest prevalence of smoking status which is 51.5% as compared to mother (2.7%) and other family members (40.1%), whereas only 8.1% of the respondents are smokers. Other than that, siblings shows the higher value of family history asthma which is 19.6% as compared to father (4.5%) and mother (8.4%).

Table 4.1: Socio-demographic Data of Respondents

Variables	School (n, %)						
	A	B	C	D	E	F	Total
Gender							
Boy	13 (34.2)	14 (25.0)	18 (41.9)	27 (35.5)	42 (73.7 0	25 (40.3)	139 (41.9)
Girl	25 (65.8)	42 (75.0)	25 (58.1)	49 (64.5)	15 (26.3)	37 (59.7)	193 (58.1)
Race							
Kadazan-dusun	13 (34.2)	13 (23.2)	3 (7.0)	7 (9.2)	3 (5.3)	9 (14.5)	48 (14.5)
Bajau	5 (13.2)	24 (42.9)	19 (44.2)	21 (27.6)	23 (40.4)	26 (41.9)	118 (35.5)
Bugis	2 (5.3)	1 (1.8)	0 (0.0)	7 (9.2)	9 (15.8)	5 (8.1)	24 (7.2)
Malay	5 (13.2)	4 (7.1)	11 (25.6)	33 (43.4)	11 (19.3)	7 (11.3)	71 (21.4)
Others	14 (36.8)	14 (25.0)	10 (23.3)	8 (10.5)	11 (19.3)	15 (24.2)	71 (21.4)
Father Education							
No formal school	0 (0.0)	3 (5.4)	2 (4.7)	1 (1.3)	5 (8.8)	2 (3.2)	13 (3.9)
Primary School	1 (2.6)	8 (14.3)	7 (16.3)	2 (2.6)	5 (8.8)	5 (8.1)	28 (8.4)
Secondary School	21 (55.3)	38 (67.9)	30 (69.8)	17 (22.4)	39 (68.4)	42 (67.7)	187 (56.3)
Certificate/A level/Diploma	10 (26.3)	4 (7.1)	1 (2.3)	20 (26.3)	2 (3.5)	9 (14.5)	46 (13.9)
University	6 (15.8)	3 (5.4)	3 (7.0)	36 (47.4)	6 (10.5)	4 (6.5)	58 (17.5)
Mother Education							
No formal school	1 (2.6)	5 (8.9)	1 (2.3)	1 (1.3)	8 (14.0)	3 (4.8)	19 (5.7)
Primary School	3 (7.9)	7 (12.5)	8 (18.6)	1 (1.3)	8 (14.0)	7 (11.3)	34 (10.2)
Secondary School	11 (28.9)	37 (66.1)	28 (65.1)	24 (31.6)	33 (57.9)	39 (62.9)	172 (51.8)
Certificate/A level/Diploma	10 (26.3)	3 (5.4)	3 (7.0)	20 (26.3)	5 (8.8)	7 (11.3)	48 (14.5)
University	13 (34.2)	4 (7.1)	3 (7.0)	30 (39.5)	3 (5.3)	6 (9.7)	59 (17.8)

Total Household Income							
<RM1500	14 (36.8)	43 (76.8)	22 (51.2)	8 (10.5)	37 (64.9)	36 (58.1)	160 (48.2)
RM1501-RM3000	6 (15.8)	9 (16.1)	11 (25.6)	6 (7.9)	13 (22.8)	14 (22.6)	59 (17.8)
>RM3001	18 (47.4)	4 (7.1)	10 (23.3)	62 (81.6)	7 (12.3)	12 (19.4)	113 (34.0)
Smoking Status							
Yes	0 (0.0)	4 (7.1)	5 (11.6)	0 (0.0)	14 (24.6)	4 (6.5)	27 (8.1)
No	38 (100.0)	52 (92.9)	38 (88.4)	76 (100.0)	43 (75.4)	58 (93.5)	305 (91.9)
Family Member Smoking Status							
Father	15 (39.5)	32 (57.1)	26 (60.5)	29 (38.2)	33 (57.9)	36 (58.1)	171 (51.5)
Mother	0 (0.0)	0 (0.0)	4 (9.3)	1 (1.3)	2 (3.5)	2 (3.2)	9 (2.7)
Other family member	12 (31.6)	19 (33.9)	20 (46.5)	23 (30.3)	33(57.9)	26 (41.9)	133 (40.1)
Family History Asthma							
Father	3 (7.9)	2 (3.6)	1 (2.3)	3 (3.9)	4 (7.0)	2 (3.2)	15 (4.5)
Mother	2 (5.3)	5 (8.9)	4 (9.3)	3 (3.9)	5 (8.8)	9 (14.5)	28 (8.4)
Siblings	7 (18.4)	8 (14.3)	9 (20.9)	13 (17.1)	9 (15.8)	19 (30.6)	65 (19.6)

N=332

© COPYRIGHT UPM

4.2 Prevalence of Respiratory Symptoms and FeNO Levels among Secondary Students.

4.2.1 Respiratory Symptoms of the Respondents

Table 4.2 shows the prevalence of the reported respiratory symptoms of respondents obtained from the questionnaire. There were 13.0% of the respondents experienced wheezing for the past 12 months. Only 11.4% of total respondents who had diagnosed asthma while the other 88.6% of the respondents were not an asthmatic children.

Majority of respondents reported the occurrence of influenza symptoms (60.8%), dry throat (51.5%) and sore throat (50.6%). Whereas, only 27.7% reported on the occurrence of irritating cough and 23.8% of respondents experienced difficulty in breathing. More than half of the respondents had respiratory infections (have flu, cough and/or fever) in the past week during the health assessment which is 183 (55.1%) from total of 332 respondents.

© COPYRIGHT UPM

Table 4.2: Reported Respiratory Symptoms of the Respondents

Variables	Frequency, n (Percentage, %)
Respiratory Symptoms	
Wheezing for past 12 Months	43 (13.0)
Dry Throat	171 (51.5)
Influenza Symptoms	202 (60.8)
Sore Throat	168 (50.6)
Irritating Cough	92 (27.7)
Breathing Difficulty	79 (23.8)
Diagnosed Asthma	38 (11.4)
Respiratory Infection	183 (55.1)

N=332

4.2.2 Prevalence of FeNO Levels among Respondents

The FeNO levels indicates the lung inflammation in the pulmonary systems among the secondary students. The FeNO levels of the respondents were measured at 6 different schools in Kota Kinabalu, Sabah, Malaysia. The levels of FeNO were categorized as abnormal if it is 20 ppb or more and normal if it is below than 20 ppb (Norbäck et al., 2017).

Results shows that there were 50.6% had a normal value of FeNO which is less than 20 ppb while the other 49.4% of the respondents had a normal or lung inflammation which the FeNO values exceeded 20 ppb.

© COPYRIGHT UPM

Table 4.3: Prevalence of FeNO Levels among Secondary Students

Variable	Frequency,n (Percentage,%)
FeNO Levels	
Abnormal (≥20ppb)	164 (49.4)
Normal (<20ppb)	168 (50.6)

N=332

4.3 Concentration of Heavy Metals

4.3.1 Heavy Metals Concentration in Indoor Air

Table 4.4 shows the average mean of heavy metals concentration which includes Cr, Mn, Ni, Pb, As, and Cd from indoor air of 6 different schools. The heavy metals were obtained from 4 classes in each of the schools and were analysed to get the concentration values of the heavy metals. The mean of each heavy metal concentration were adjusted in descending order in different schools.

In School A, the average mean of heavy metals concentration were in descending order with Cr>Ni>Pb>Mn>As>Cd while for School B, the average mean of heavy metals concentration were Pb>Cr>Mn>Ni>Cd>As. Meanwhile, School C recorded Cr>Mn>Ni>Pb>As>Cd while School D had the mean of Cr>Mn>Ni>Pb>As>Cd. Mean of heavy metals concentration of School E were Cr>Pb>Mn>Ni>As>Cd and for the last school which is School F, had decreasing order of mean that were Cr>Mn>Pb>Ni>As>Cd.

In overall, the order of the mean heavy metals concentration for the total of 6 different schools were Cr>Pb>Mn>Ni>As>Cd. In conclusion, the Cr concentration has the highest in almost all of the schools sampled. This may because of the atomic weight of the Cr was the lightest as compared to the other elements and very likely to suspend in the indoor air.

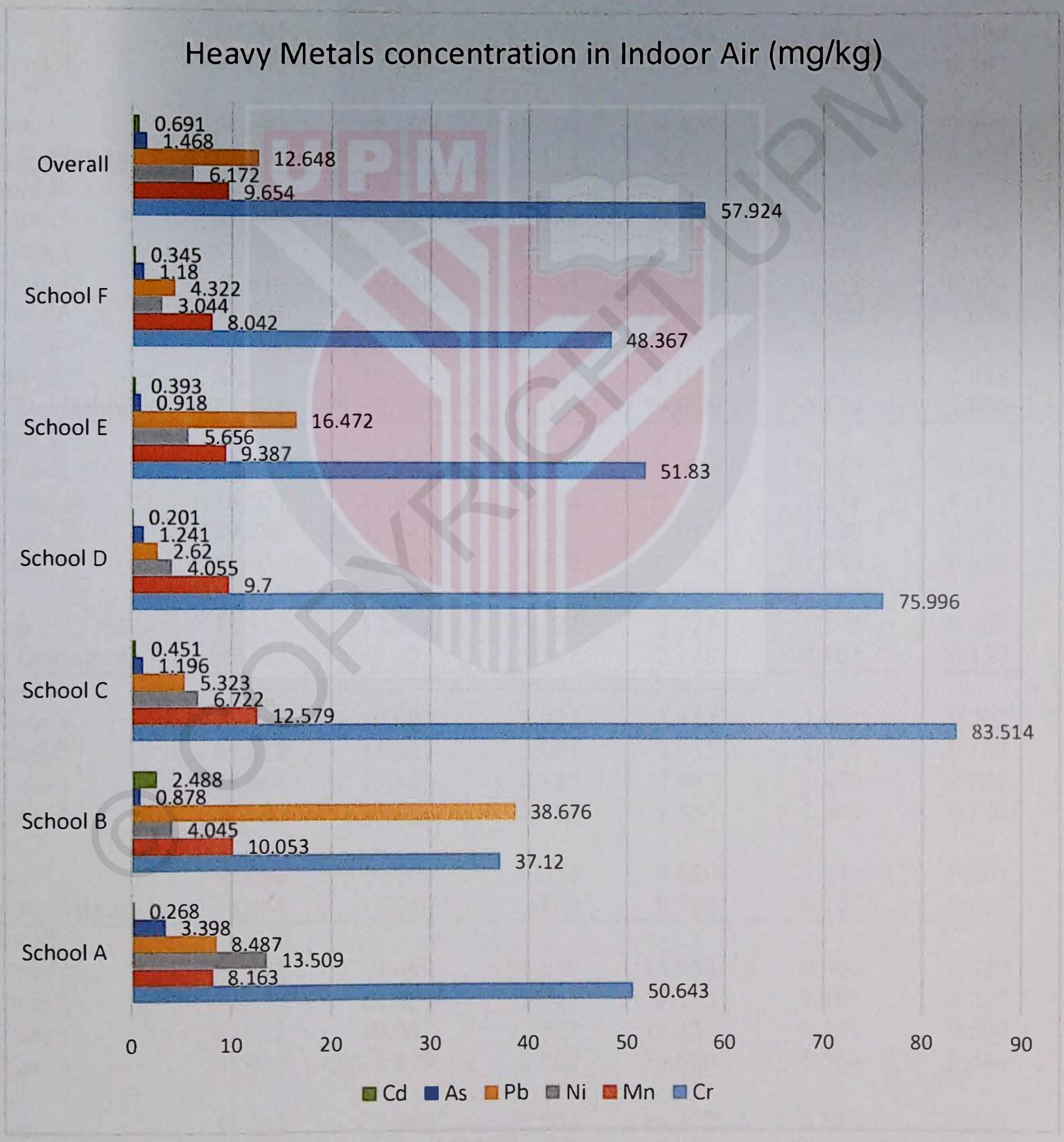


Figure 4.1: Heavy Metals Concentration in Indoor Air (mg/kg)

Table 4.4: Average Concentration of Heavy Metals in Indoor Air in Different Sample Location (µg/kg)

Samples	Average mean concentration of heavy metals in indoor air in different samples location (mg/kg)					
	Cr	**Mn**	**Ni**	**Pb**	**As**	**Cd**
School A						
Class 1	46.021	6.643	2.538	10.672	0.979	0.335
Class 2	52.748	9.255	13.041	14.436	1.015	0.269
Class 3	60.001	13.164	33.601	6.248	0.964	0.300
Class 4	43.803	7.695	4.855	2.544	0.942	0.167
Mean	50.643	8.163	13.509	8.475	3.398	0.268
Std. Deviation	7.306	4.399	14.132	5.180	4.849	0.072
School B						
Class 1	51.283	9.991	3.764	95.147	0.912	6.320
Class 2	52.067	10.466	2.716	31.406	0.958	1.443
Class 3	6.814	9.024	4.451	6.358	0.933	0.534
Class 4	38.621	10.729	5.249	21.793	0.709	1.656
Mean	37.120	10.053	4.045	38.676	0.878	2.488
Std. Deviation	21.171	0.751	1.074	39.036	0.114	2.600
School C						
Class 1	68.486	10.794	4.024	5.224	1.317	0.368
Class 2	116.637	15.823	14.584	5.375	1.239	0.453
Class 3	89.280	12.012	4.248	7.951	1.139	0.696
Class 4	59.654	11.685	4.032	0.274	1.086	0.288
Mean	83.514	12.579	6.722	5.323	1.196	0.451
Std. Deviation	25.335	2.223	5.242	2.128	0.103	0.177
School D						
Class 1	76.987	10.393	3.923	3.353	1.091	0.202
Class 2	79.412	11.427	5.051	3.055	1.112	0.182
Class 3	96.088	13.129	4.816	2.487	1.459	0.231
Class 4	51.497	3.849	2.428	1.584	1.300	0.190
Mean	75.996	9.700	4.055	2.620	1.241	0.201
Std. Deviation	18.401	4.060	1188	0.778	0.173	0.021
School E						
Class 1	27.673	7.499	4.079	14.958	0.550	0.320
Class 2	72.379	10.534	5.061	8.575	1.108	0.295
Class 3	62.211	10.637	7.822	12.333	1.151	0.507
Class 4	45.057	8.879	5.662	30.020	0.564	0.449
Mean	51.830	9.387	5.656	16.472	0.918	0.393
Std. Deviation	19.659	1.495	1.585	9.404	0.276	0.102

© COPYRIGHT UPM

School F						
Class 1	64.133	7.754	3.967	4.812	1.540	0.370
Class 2	51.583	9.034	3.552	4.872	1.279	0.468
Class 3	49.663	0.649	2.307	5.239	0.854	0.341
Class 4	28.088	0.889	2.351	2.363	1.045	0.202
Mean	48.367	8.042	3.044	4.322	1.180	0.345
Std. Deviation	14.965	1.182	0.843	1.320	0.297	0.110
Overall						
Min	6.814	2.538	2.307	1.584	0.550	0.167
Max	116.637	15.823	33.601	95.147	10.672	6.320
Mean	57.924	9.654	6.172	12.648	1.468	0.691
Std. Deviation	23.451	2.869	6.566	19.415	1.973	1.253

N=24

4.3.2 Concentration of Heavy Metals in Settled Dust

From the Table 4.5, the mean used to determine the level of heavy metal concentration in settled dust by the combination of window and floor of the total 4 classrooms from each schools. The mean of the heavy metals concentration is determined by analyzing the heavy metals by using ICP-MS instruments which gave a results in mg/kg. From the result, the mean of the heavy metals concentration were reported in descending order.

In School A, the mean were Ni>Mn>As>Cr>Pb>Cd and for School B, the mean were Mn>As>Cr>Ni>Pb>Cd. Next, School C recorded Mn>Pb>As>Cr>Cd>Ni, meanwhile, mean for School D were Mn>Pb>As>Cr>Ni>Cd while School F were Mn>Ni>Pb>As>Cr>Cd. For School E, the mean cfor heavy metals concentration were Mn>Pb>As>Cr>Ni>Cd. As a total, the mean of 6 different schools were Mn>Pb>As>Ni>Cr>Cd in descending order from the highest to the lowest of heavy metal concentration.

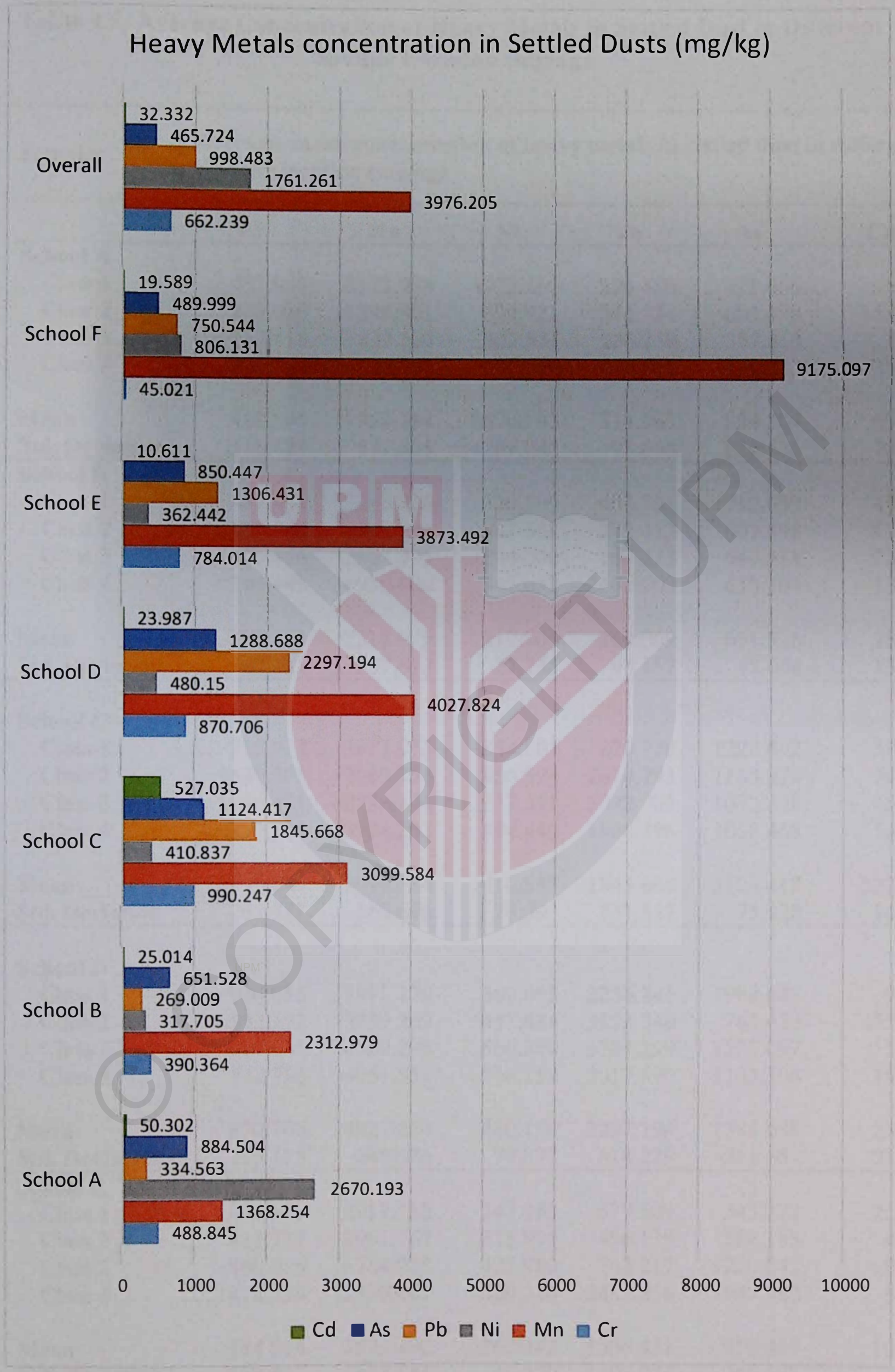


Figure 4.2: Heavy Metals Concentration in Settled Dusts (mg/kg)

© COPYRIGHT UPM

Table 4.5: Average Concentration of Heavy Metals in Settled Dust in Different Sample Location (mg/kg)

Samples	Average mean concentration of heavy metals in settled dust in different samples location (mg/kg)					
	Cr	**Mn**	**Ni**	**Pb**	**As**	**Cd**
School A						
Class 1	453.945	2173.988	8973.269	390.480	471.666	5.307
Class 2	320.030	1295.801	899.921	244.724	602.470	153.315
Class 3	237.616	832.504	307.531	266.239	357.618	3.377
Class 4	943.788	1170.721	500.050	436.808	2106.262	39.207
Mean	488.845	1368.254	2670.193	334.563	884.504	50.302
Std. Deviation	316.125	571.695	4209.288	93.666	820.626	70.319
School B						
Class 1	475.491	2265.826	320.599	403.801	712.639	43.894
Class 2	365.064	2467.696	308.568	242.413	602.598	13.657
Class 3	326.456	2587.995	294.000	169.223	640.571	23.793
Class 4	394.443	1930.400	347.652	260.6000	650.304	18.711
Mean	390.364	2312.979	317.705	269.009	651.528	25.014
Std. Deviation	62.213	287.612	22.735	98.157	45.644	13.250
School C						
Class 1	715.017	3613.975	354.803	870.779	1222.692	37.049
Class 2	1339.505	3069.753	456.594	2614.793	1143.879	71.715
Class 3	1036.671	2788.404	337.511	2092.702	1072.628	45.853
Class 4	869.793	3908.203	494.440	1804.398	1058.468	56.197
Mean	990.247	3099.584	410.837	1845.668	1124.417	527.035
Std. Deviation	267.331	568.696	76.593	731.367	75.428	14.896
School D						
Class 1	920.056	3991.179	380.665	2234.246	1989.647	9.207
Class 2	982.132	3239.269	457.434	3172.340	761.422	55.612
Class 3	867.845	4829.296	566.340	1764.299	1220.087	15.757
Class 4	712.793	4051.551	516.159	2017.890	1183.596	15.373
Mean	870.706	4027.824	480.150	2297.194	1288.688	23.987
Std. Deviation	115.175	649.636	79.872	614.229	511.567	21.296
School E						
Class 1	445.919	2917.712	347.483	577.509	345.272	22.530
Class 2	411.787	2961.767	315.996	496.139	888.185	4.830
Class 3	460.026	6784.088	425.980	748.217	1220.841	9.599
Class 4	1818.324	2830.401	360.310	3403.858	947.490	5.485
Mean	784.014	3873.492	362.442	1306.431	850.447	10.611
Std. Deviation	689.837	1941.165	46.270	1402.225	366.622	8.222

© COPYRIGHT UPM

School F						
Class 1	437.660	3633.062	1852.906	1351.020	478.381	13.108
Class 2	465.377	2695.565	588.249	570.448	606.521	37.364
Class 3	354.850	2924.966	396.294	361.258	505.778	16.766
Class 4	542.968	27446.796	387.075	719.450	369.315	11.118
Mean	45.021	9175.097	806.131	750.544	489.999	19.589
Std. Deviation	77.643	12187.666	703.985	426.426	97.512	12.079
Overall						
Min	237.616	832.504	294.000	169.223	345.272	3.377
Max	1818.324	27446.796	8973.269	3403.858	2103.262	153.315
Mean	662.298	3976.205	841.243	1133.901	881.597	30.368
Std. Deviation	377.114	5149.498	1761.261	998.483	465.724	32.332

N=24

4.4 The Comparison of NO Exhaled Breath as Indicator of Airway Inflammation between the School Children from 6 Schools

Figure 4.1 shows the results of FeNO values between 6 different schools that indicates the airway inflammation. In general, all schools have a same trend of data except for School B with the percentage of normality. School F had the same value of normal and abnormal among the students. Overall, School D had the highest percentage of airway inflammation abnormality as compared to other schools.

The number of respondents is different between the schools which gives a total number of 332 respondents. So, the percentage given is based on the total number of respondents from each school.

© COPYRIGHT UPM

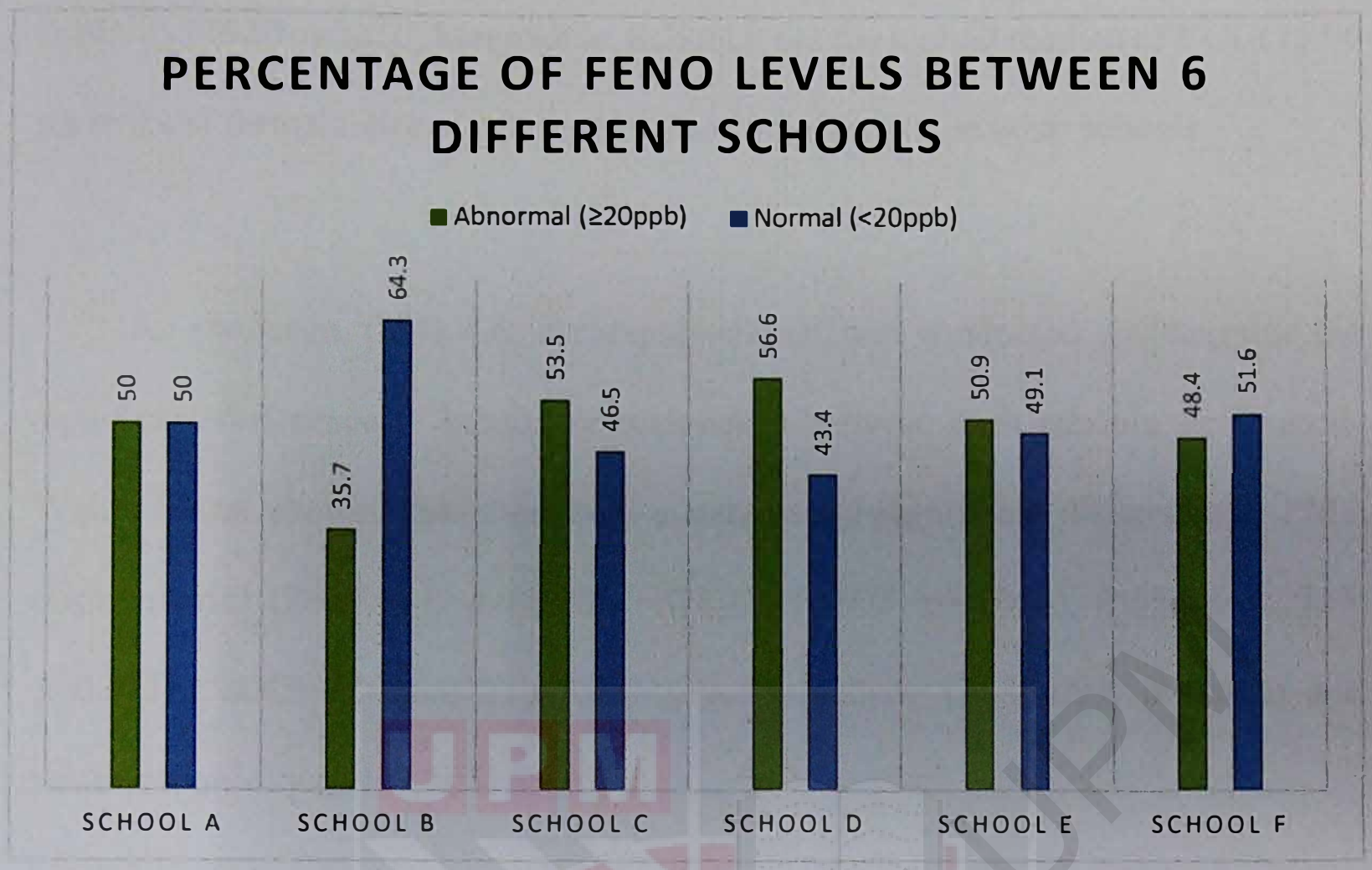


Figure 4.3: Percentage of FeNO Levels among Respondents between 6 Different Schools

4.5 Comparison of Indoor Air Parameters and Heavy Metals between 6 Different Schools

4.5.1 Indoor Air Parameters between 6 Different Schools

The indoor air parameters which consists of $PM_{2.5}$, PM_{10}, PM_{10} (gravimetric), NO_2, CO_2, VOCs, formaldehyde, temperature and relative humidity at 6 different schools were measured. Table 4.5 shows the distribution of indoor air parameters in different schools. Results shows that School B has the highest median of $PM_{2.5}$, PM_{10} and PM_{10} (gravimetric measurement) which is (29.00 $\mu g/m^3$), (41.00 $\mu g/m^3$) and (8050.00 $\mu g/m^3$) respectively. School C recorded the highest median for NO_2 (25.00 $\mu g/m^3$) while School A has the highest median of CO_2 (540.00 $\mu g/m^3$) and relative

humidity (76.55μg/m^3). Meanwhile, School F has the highest median of VOCs (5.06 μg/m^3) and formaldehyde (0.034 μg/m^3) as compared to the other schools.

As shown in Table 4.6, a comparison test was conducted to determine the significant difference of indoor air parameters between each schools. A Kruskal-Wallis H test showed that there was a statistically significant difference in PM_{10} (Gravimetric) (Z=17.631, p=0.003), NO2 (Z=16.975, p=0.005), CO2 (Z=12.717, p=0.011), VOCs (Z=16.072, p=0.007), formaldehyde (Z=14.093, p=0.012) and relative humidity (Z=12.305, p=0.031).

Dunn-Bonferroni's pairwise tests were carried out for fifteen pairs of groups for each indoor air pollutants after the Kruskal-Wallis H tests shows a significant results. There was a significant difference (adjusted using the Dunn-Bonferroni correction) of School A with School B (p=0.010) and also School F with School B (p=0.047) for PM_{10} (Gravimetric). Meanwhile, for NO_2, there was a significant difference between School A and School C (p=0.014) while School C and School F showed a significant difference result of CO_2 which is p=0.027.

The Dunn's pairwise tests also showed a significant result of School C with School F (p=0.012) and School B with School F (p=0.028) for VOCs. Next, formaldehyde also showed a significant difference of result between School E and School F (p=0.043) and lastly, for the relative humidity, there is significant difference between School F and School A.

Table 4.6: Comparison of Indoor Air Parameters between 6 Different Schools

Indoor Air Parameter	Schools , Median (IQR)						N	Median (IQR)	Z	p
	A	B	C	D	E	F				
PM2.5 (μg/m³) (Real-time Measurement) [a]	20.50 (8.25)	29.00 (8.50)	19.00 (2.00)	22.50 (12.25)	25.00 (16.25)	20.50 (16.75)	23	23.00 (8.00)	6.403	0.269
PM10 (μg/m³) (Real-time Measurement) [a]	25.00 (11.25)	41.00 (6.50)	23.00 (2.00)	31.00 (15.25)	32.50 (20.50)	28.50 (20.00)	23	31.00 (16.00)	9.911	0.078
PM10 (mg/m³) (Gravimetric) [b]	2.50 (11.50)	80.50 (10.00)	54.00 (7.00)	10.00 (3.50)	12.00 (5.25)	8.50 (4.50)	24	11.50 (48.00)	17.631	**0.003****
NO2 (μg/m³) (Passive Sampler) [c]	4.05 (1.50)	15.00 (2.00)	25.00 (102.25)	20.00 (0.00)	17.50 (118.00)	20.00 (3.00)	19	18.00 (6.00)	16.975	**0.005****
CO2 (ppm) (Real-time Measurement) [d]	540.00 (101.00)	412.00 (408.75)	399.00 (5.00)	400.50 (133.75)	424.50 (37.00)	412.00 (99.75)	23	415.00 (50.00)	12.717	**0.011***
VOCs (ppm) (Real-time Measurement) (ppm) [d]	0.55 (0.16)	0.48 (0.12)	0.44 (0.09)	0.59 (0.16)	0.69 (0.72)	5.06 (5.69)	23	0.58 (0.22)	16.072	**0.007****
Formaldehyde (ppm) (Real-time Measurement) [e]	0.027 (0.015)	0.008 (0.005)	0.006 (0.006)	0.004 (0.002)	0.001 (0.001)	0.034 (0.030)	23	0.005 (0.020)	14.093	**0.012***
Temperature (°C) (Real-time Measurement) [d]	26.65 (2.95)	26.05 (0.88)	25.20 (0.80)	25.25 (4.65)	29.65 (4.97)	31.40 (2.08)	23	26.30 (4.30)	10.685	0.058
Relative Humidity (%) (Real-time Measurement) [d]	76.55 (1.90)	65.10 (6.50)	65.70 (3.40)	68.50 (3.45)	65.80 (1.65)	61.00 (10.05)	23	66.40 (4.90)	12.305	**0.031***

N=204, Kruskal-Wallis Test, *significant at p<0.05, **significant at p<0.01

a Real-time Measurement with Dust-Trak DRX (Model: TSI 8534)

b Gravimetric dust measurement with PVC filter (Personal Air Sampler)

c passive sampler of NO2

d Real-time Measurement with Air Velocity Meter (Model: TSI 9565-P)

e Real-time Measurement with MultiRae Lite (Model: PGM-6208)

© COPYRIGHT UPM

4.5.2 Heavy Metals in Indoor Air between 6 Different Schools

Kruskal-Wallis H test were used to compare the concentration of heavy metals in indoor air between 6 different schools. Table 4.7 shows the distribution of heavy metals in indoor air between different schools. School C has the highest median for Cr and Mn which is (78.883 μg/kg) and (11.849 μg/kg) respectively. School B recorded the highest median for both Pb (26.600 μg/kg) and Cd (1.550 μg/kg) while median for Ni was highest among School A which is 8.948 μg/kg. Meanwhile, the highest median for As was School D which 1.206 μg/kg.

Table 4.7 shows a significant difference of Pb and Cd between all the 6 schools. Dunn's test was conducted to find the significant groups between 15 pairwise groups for each elements of heavy metals.

There was 2 elements that shows a significant result and for Pb, there was a significant difference between School D with School E (p=0.048) and School D with School B (p=0.017). For the second element, Cd, there was a significant difference between School D with School B (p=0.004) and School A with School B (p=0.048).

© COPYRIGHT UPM

Table 4.7: Comparison of Heavy Metals Concentration in Indoor Air between 6 Different Schools

Elements (μg/kg)	Schools , Median (IQR)						N	Median (IQR)	Z	p
	A	B	C	D	E	F				
Chromium (Cr)	49.385 (13.830)	44.952 (37.105)	78.883 (47.936)	78.200 (34.049)	53.634 (39.368)	50.623 (27.514)	24	57.924 (23.451)	11.03	0.051
Manganese (Mn)	8.475 (8.360)	10.229 (1.397)	11.849 (3.853)	10.910 (7.219)	9.707 (2.767)	8.322 (2.192)	24	9.654 (2.869)	9.11	0.105
Nickel (Ni)	8.948 (25.344)	4.108 (2.072)	4.140 (7.974)	4.370 (2.190)	5.362 (2.957)	2.952 (1.545)	24	6.172 (6.566)	9.22	0.101
Lead (Pb)	8.460 (10.025)	26.600 (68.995)	5.260 (3.946)	2.771 (1.469)	13.646 (16.740)	4.842 (2.172)	24	12.648 (19.415)	16.31	**0.006****
Arsenic (As)	0.990 (7.310)	0.923 (0.192)	1.189 (0.199)	1.206 (0.323)	0.989 (0.511)	1.162 (0.573)	24	1.468 (1.973)	8.81	0.117
Cadmium (Cd)	0.285 (0.133)	1.550 (4.393)	0.411 (0.327)	0.196 (0.040)	0.385 (0.192)	0.355 (0.207)	24	0.691 (1.253)	16.19	**0.006****

N=144
Kruskal-Wallis Test
**significant at p<0.01

© COPYRIGHT UPM

4.5.3 Heavy Metals in Settled Dust between 6 Different Schools

Table 4.8 shows the distribution of heavy metals concentration in settled dust that were collected by using vacuum cleaner (400W) between 6 different schools. The highest median was determined by all of the elements which includes Cr, Mn, Ni, Pb, As and also Cd. School D recorded the highest median among all 6 schools which was Mn, Pb and As that has a median of (4021.365 µg/kg), (2126.068 µg/kg) and (1201.842 µg/kg) respectively. Meanwhile, School C recorded the highest median for both Cr (953.232 µg/kg) and Cd (51.025 µg/kg). Next, Ni has the highest median of School A which (699.986 µg/kg).

Kruskal-Wallis H tests was conducted to find the significant difference between the heavy metals in settled dusts and the schools. There result shows that there was significant difference between Cr, Mn and Pb with the schools which has the value of (p=0.043), (p=0.004) and (p=0.003) while the Z value was 12, 14 and 16 respectively.

Dunn's test was conducted to find the significant values between fifteen groups of each elements of heavy metals in settled dusts. There was significant difference of Mn between School A and School D with p=0.008 and there was also a significant difference between Pb with two groups which includes School B with School C (p=0.040) and School B with School D (p=0.017).

Table 4.8: Comparison of Heavy Metals Concentration in Settled Dust between 6 Different Schools

Elements (µg/kg)	Schools , Median (IQR)						N	Median (IQR)	Z	p
	A	B	C	D	E	F				
Chromium (Cr)	386.988 (563.107)	379.754 (119.121)	953.232 (510.086)	893.951 (215.057)	452.973 (1058.430)	415.519 (148.018)	24	470.434 (508.711)	12	**0.0430***
Manganese (Mn)	1233.261 (1037.383)	2366.761 (543.663)	2929.079 (1027.509)	4021.365 (1207.613)	2939.740 (2976.279)	3279.014 (18767.450)	24	2874.057 (1523.124)	14	**0.004****
Nickel (Ni)	699.986 (6599.271)	314.584 (43.247)	405.699 (143.145)	486.797 (153.938)	353.897 (85.695)	492.272 (1147.362)	24	391.685 (172.128)	8	0.052
Lead (Pb)	328.360 (175.123)	251.507 (180.491)	1948.550 (1380.087)	2126.068 (1110.120)	662.863 (2223.466)	644.949 (777.573)	24	648.480 (1595.953)	16	**0.003****
Arsenic (As)	537.068 (1344.184)	645.438 (84.964)	1108.254 (140.981)	1201.842 (930.291)	917.838 (671.503)	492.080 (184.753)	24	737.031 (643.716	18	0.058
Cadmium (Cd)	22.257 (120.928)	21.252 (23.948)	51.025 (28.586)	15.565 (34.899)	7.542 (14.303)	14.937 (20.599)	24	17.739 (32.743)	8	0.147

N=144
Kruskal-Wallis Test
*significant at $p<0.05$
**significant at $p<0.01$

© COPYRIGHT UPM

4.6 Relationship between Air Quality Parameters and Heavy Metals Concentration with Respiratory Symptoms and Lung Inflammation of the School Children

4.6.1 Relationship between Air Quality Parameters ($PM_{2.5}$, PM_{10}, NO_2, CO_2, VOCs and formaldehyde) with Respiratory Symptoms

The relationship between $PM_{2.5}$ and PM_{10} with respiratory symptoms reported among the students are shown in the Table 4.9 and Table 4.10 respectively. Results shows that there were a significant correlation between wheezing for past 12 months with $PM_{2.5}$ and PM_{10} with the significant value of ($p=0.043$) and ($p=0.033$) respectively. These results were obtained for the real-time measurement by using Dust-Trak DRX. Meanwhile, Table 4.11 shows the results for PM_{10} that was measured by using gravimetric dust measurement with PVC filter (Personal Air Sampler) which recorded significant correlation of diagnosed asthma with the significant value of ($p=0.033$).

However, there was no significant correlation between NO_2 with the reported respiratory symptoms among the students. The findings in Table 4.13 shows that there were significant correlation between CO_2 with the irritating cough ($p<0.001$) and influenza symptoms ($p=0.024$).

Table 4.12 and Table 4.14 shows the relationship between VOCs and formaldehyde respectively with reported respiratory symptoms among the students. The results showed that both of the VOCs and formaldehyde has the significant correlation between respiratory infection with respective values of (p=0.008) and (p=0.026).

Table 4.9: Relationship between Air Quality Parameters ($PM_{2.5}$) with Respiratory Symptoms

Variables	PM2.5		χ^2	p	OR	95% CI
	Low	High				
Wheezing for past 12 Months						
Yes	27 (64.3)	15 (35.7)	4.107	**0.043***	0.503	0.257 - 0.986
No	135 (47.5)	149 (52.5)				
Dry Throat						
Yes	85 (50.6)	83 (49.4)	0.113	0.737	0.928	0.601 - 1.433
No	77 (48.7)	81 (51.3)				
Influenza Symptoms						
Yes	100 (50.5)	98 (49.5)	0.133	0.715	0.921	0.590 - 1.436
No	62 (48.4)	66 (51.6)				
Sore Throat						
Yes	82 (49.7)	83 (50.3)	0.000	0.999	1.000	0.648 - 1.543
No	80 (49.7)	81 (50.3)				
Irritating Cough						
Yes	46 (51.7)	43 (48.3)	0.194	0.659	0.896	0.550 - 1.459
No	116 (48.9)	121 (51.1)				
Breathing Difficulty						
Yes	39 (50.0)	39 (50.0)	0.004	0.950	0.984	0.592 - 1.637
No	123 (49.6)	125 (50.4)				
Diagnosed Asthma						
Yes	19 (51.4)	18 (48.6)	0.046	0.830	0.928	0.468 - 1.840
No	143 (49.5)	146 (50.5)				
Respiratory Infection						
Yes	84 (46.7)	96 (53.3)	1.473	0.225	1.311	0.846 - 2.031
No	78 (53.4)	68 (46.6)				

N (respondents)=332
N (Environmental data)=24
Chi-square test
*significant at p<0.05

Table 4.10: Relationship between Air Quality Parameters [PM_{10} (Real-Time Measurement)] with Respiratory Symptoms

Variables	PM10 (Real-Time)		X2	p	OR	95% CI
	Low	High				
Wheezing for past 12 Months						
Yes	26 (61.9)	16 (38.1)	4.523	**0.033***	0.491	0.252 - 0.955
No	126 (44.4)	158 (55.6)				
Dry Throat						
Yes	77 (45.8)	91 (54.2)	0.087	0.767	1.068	0.691 - 1.651
No	75 (47.5)	83 (52.5)				
Influenza Symptoms						
Yes	94 (47.5)	104 (52.5)	0.146	0.702	0.917	0.587 - 1.432
No	58 (45.3)	70 (54.7)				
Sore Throat						
Yes	78 (47.3)	87 (52.7)	0.056	0.813	0.949	0.614 - 1.466
No	74 (46.0)	87 (54.0)				
Irritating Cough						
Yes	47 (52.8)	42 (47.2)	1.881	0.170	0.711	0.436 - 1.159
No	105 (44.3)	132 (55.7)				
Breathing Difficulty						
Yes	38 (48.7)	40 (51.3)	0.180	0.671	0.896	0.538 - 1.490
No	114 (46.0)	134 (54.0)				
Diagnosed Asthma						
Yes	15 (40.5)	22 (59.5)	0.621	0.431	1.322	0.659 - 2.651
No	137 (47.4)	152 (52.6)				
Respiratory Infection						
Yes	81 (45.0)	99 (55.0)	0.427	0.514	1.157	0.747 - 1.792
No	71 (48.6)	75 (51.4)				

N (respondents)=332
N (Environmental data)=24
Chi-square test
*significant at $p<0.05$

COPYRIGHT UPM

Table 4.11: Relationship between Air Quality Parameters [PM_{10} (Gravimetric)] with Respiratory Symptoms

Variables	PM_{10} (Gravimetric)		χ^2	p	OR (95% CI)
	Low	High			
Wheezing for past 12 Months					
Yes	127 (84.7)	23 (15.3)	1.377	0.241	1.467 (0.771 - 2.790)
No	162 (89.0)	20 (11.0)			
Dry Throat					
Yes	73 (48.7)	77 (51.3)	0.003	0.954	0.987 (0.641 - 1.522)
No	88 (48.4)	94 (51.6)			
Influenza Symptoms					
Yes	66 (44.0)	84 (56.0)	2.694	0.101	0.690 (0.443 - 1.075)
No	64 (35.2)	118 (64.8)			
Sore Throat					
Yes	79 (52.7)	71 (47.3)	1.170	0.279	0.788 (0.511 - 1.214)
No	85 (46.7)	97 (53.3)			
Irritating Cough					
Yes	112 (74.7)	38 (25.3)	0.772	0.380	0.804 (0.494 - 1.308)
No	128 (70.3)	54 (29.7)			
Breathing Difficulty					
Yes	117 (78.0)	33 (22.0)	0.486	0.486	0.834 (0.500 - 1.390)
No	136 (74.7)	46 (25.3)			
Diagnosed Asthma					
Yes	139 (92.7)	11 (7.3)	4.566	**0.033***	0.454 (0.217 - 0.950)
No	155 (85.2)	27 (14.8)			
Respiratory Infection					
Yes	63 (42.0)	87 (58.0)	0.917	0.338	1.237 (0.80 - 1.913)
No	86 (47.3)	96 (52.7)			

N (respondents)=332
N (Environmental data)=24
Chi-square test
*significant at $p<0.05$

© COPYRIGHT UPM

Table 4.12: Relationship between Air Quality Parameters (VOCs) with Respiratory Symptoms

Variables	VOCs		χ^2	p	OR (95% CI)
	Low	High			
Wheezing for past 12 Months					
Yes	159 (88.8)	20 (11.2)	1.035	0.309	0.715 (0.373 - 1.368)
No	125 (85.0)	22 (15.0)			
Dry Throat					
Yes	90 (50.3)	89 (49.7)	0.522	0.470	0.851 (0.550 - 1.318)
No	68 (46.3)	79 (53.7)			
Influenza Symptoms					
Yes	67 (37.4)	112 (62.6)	0.560	0.454	1.186 (0.759 - 1.83)
No	61 (41.5)	86 (58.5)			
Sore Throat					
Yes	86 (48.0)	93 (52.0)	0.286	0.593	1.126 (0.728 - 1.743)
No	75 (51.0)	72 (49.0)			
Irritating Cough					
Yes	135 (75.4)	44 (24.6)	1.479	0.224	0.739 (0.453 - 1.204)
No	102 (69.4)	45 (60.3)			
Breathing Difficulty					
Yes	133 (74.3)	46 (25.7)	0.685	0.408	1.243 (0.742 - 2.081)
No	115 (78.2)	32 (21.8)			
Diagnosed Asthma					
Yes	154 (86.0)	25 (14.0)	2.702	0.100	1.826 (0.884 - 3.775)
No	135 (91.8)	12 (8.2)			
Respiratory Infection					
Yes	92 (51.4)	87 (48.6)	7.017	**0.008****	0.549 (0.352 - 0.857)
No	54 (36.7)	93 (63.3)			

N (respondents)=332
N (Environmental data)=24
Chi-square test
**significant at p<0.01

© COPYRIGHT UPM

Table 4.13: Relationship between Air Quality Parameters (CO_2) with Respiratory Symptoms

Variables	CO_2		χ^2	p	OR (95% CI)
	Low	High			
Wheezing for past 12 Months					
Yes	228 (88.7)	29 (11.3)	2.807	0.094	0.554 (0.276 - 1.113)
No	61 (81.3)	14 (18.7)			
Dry Throat					
Yes	128 (49.8)	129 (50.2)	0.783	0.376	0.792 (0.472 - 1.328)
No	33 (44.0)	42 (56.0)			
Influenza Symptoms					
Yes	109 (42.4)	148 (57.6)	5.062	**0.024***	0.528 (0.301 - 0.926)
No	21 (28.0)	54 (72.0)			
Sore Throat					
Yes	130 (5.6)	127 (49.4)	0.640	0.424	0.810 (0.483 - 1.358)
No	34 (45.3)	41 (54.7)			
Irritating Cough					
Yes	198 (77.0)	59 (23.0)	12.833	**<0.001*****	0.379 (0.221 - 0.651)
No	42 (56.0)	33 (44.0)			
Breathing Difficulty					
Yes	193 (75.1)	64 (24.9)	0.770	0.380	1.326 (0.705 - 2.497)
No	60 (80.0)	15 (20.0)			
Diagnosed Asthma					
Yes	224 (87.2)	33 (12.8)	2.183	0.140	2.063 (0.776 - 5.485)
No	70 (93.3)	5 (6.7)			
Respiratory Infection					
Yes	122 (47.5)	135 (52.5)	3.088	0.079	0.622 (0.366 - 1.059)
No	27 (36.0)	48 (64.0)			

N (respondents)=332
N (Environmental data)=24
Chi-square test
*significant at $p<0.05$
***significant at $p<0.001$

© COPYRIGHT UPM

Table 4.14: Relationship between Air Quality Parameters (Formaldehyde) with Respiratory Symptoms

Variables	Formaldehyde		χ^2	p	OR (95% CI)
	Low	High			
Wheezing for past 12 Months					
Yes	168 (85.3)	29 (14.7)	1.497	0.221	1.540 (0.768 - 3.088)
No	116 (89.9)	13 (10.1)			
Dry Throat					
Yes	100 (50.8)	97 (49.2)	1.050	0.306	0.792 (0.508 - 1.237)
No	58 (45.0)	71 (55.0)			
Influenza Symptoms					
Yes	77 (39.1)	120 (60.9)	0.007	0.935	1.019 (0.647 - 1.605)
No	51 (39.5)	78 (60.5)			
Sore Throat					
Yes	94 (47.7)	103 (52.3)	0.556	0.456	1.184 (0.759 - 1.847)
No	67 (51.9)	62 (48.1)			
Irritating Cough					
Yes	144 (73.1)	53 (26.9)	0.040	0.842	0.951 (0.578 - 1.563)
No	93 (72.1)	36 (27.9)			
Breathing Difficulty					
Yes	148 (75.1)	49 (24.9)	0.245	0.621	1.142 (0.676 - 1.929)
No	100 (77.5)	29 (22.5)			
Diagnosed Asthma					
Yes	174 (88.3)	23 (11.7)	0.052	0.819	1.086 (0.537 - 2.197)
No	115 (89.1)	14 (10.9)			
Respiratory Infection					
Yes	98 (49.7)	99 (50.3)	4.955	**0.026***	0.599 (0.380 - 0.942)
No	48 (37.2)	81 (62.8)			

N (respondents)=332
N (Environmental data)=24
Chi-square test
*significant at $p<0.05$

© COPYRIGHT UPM

4.6.2 Relationship between Heavy Metals in Indoor Air (Cr, Mn, Ni, Pb, As, Cd) with Respiratory Symptoms

The relationship between heavy metals in indoor air with respiratory symptoms reported among the school children are shown on the Table 4.15, Table 4.16, Table 4.17 and Table 4.18 for different types of elements on heavy metals that consists of Cr, Mn, Ni, and As. Results shows that Cr has significant correlation with both diagnosed asthma (p=0.030) and respiratory infection (p=0.030) while for Mn were (p=0.001) and (p=0.005) respectively.

Table 4.17 shows the relationship between Ni with reported respiratory symptoms and there was significant correlation with the wheezing for past 12 months (p=0.046). However, there was no significant correlation between Pb and Cd with the respiratory symptoms reported among the school children. Lastly, As has significantly correlate with dry throat and respiratory infection.

© COPYRIGHT UPM

Table 4.15: Relationship between Heavy Metals in Indoor Air (Cr) with Respiratory Symptoms

Variables	Chromium (Cr)		χ^2	p	OR (95% CI)
	Low	High			
Wheezing for past 12 Months					
Yes	130 (86.1)	21 (13.9)	0.224	0.636	1.167 (0.615 - 2.217)
No	159 (87.7)	22 (12.2)			
Dry Throat					
Yes	72 (47.7)	79 (52.3)	0.073	0.787	1.061 (0.689 - 1.635)
No	89 (49.2)	92 (50.8)			
Influenza Symptoms					
Yes	52 (34.4)	99 (65.6)	2.590	0.108	1.442 (0.923 - 2.253)
No	78 (43.1)	103 (56.9)			
Sore Throat					
Yes	70 (46.4)	81 (53.6)	1.024	0.312	1.250 (0.811 - 1.927)
No	94 (51.9)	87 (48.1)			
Irritating Cough					
Yes	102 (67.5)	49 (32.5)	3.106	0.078	1.542 (0.951 - 2.499)
No	138 (76.2)	43 (23.8)			
Breathing Difficulty					
Yes	117 (77.5)	34 (22.5)	0.250	0.617	0.878 (0.528 - 1.462)
No	136 (75.1)	45 (24.9)			
Diagnosed Asthma					
Yes	140 (92.7)	11 (7.3)	4.731	**0.030***	0.448 (0.214 - 0.937)
No	154 (85.1)	27 (14.9)			
Respiratory Infection					
Yes	58 (38.4)	93 (61.6)	4.685	**0.030***	1.621 (1.046 - 2.514)
No	91 (50.3)	90 (49.7)			

N (respondents)=332
N (Environmental data)=24
Chi-square test
*significant at $p<0.05$

Table 4.16: Relationship between Heavy Metals in Indoor Air (Mn) with Respiratory Symptoms

Variables	Manganese (Mn)		χ^2	p	OR (95% CI)
	Low	High			
Wheezing for past 12 Months					
Yes	158 (87.8)	22 (12.2)	0.186	0.667	0.869 (0.457 - 1.649)
No	131 (86.2)	21 (13.8)			
Dry Throat					
Yes	82 (45.6)	98 (54.4)	1.359	0.244	1.293 (0.839 - 1.994)
No	79 (52.0)	73 (48.0)			
Influenza Symptoms					
Yes	66 (36.7)	114 (63.3)	1.023	0.312	1.256 (0.807 - 1.955)
No	64 (42.1)	88 (57.9)			
Sore Throat					
Yes	83 (46.1)	97 (53.9)	1.699	0.192	1.333 (0.865 - 2.056)
No	81 (53.3)	71 (46.7)			
Irritating Cough					
Yes	125 (69.4)	55 (30.6)	1.588	0.208	1.368 (0.840 - 2.227)
No	115 (75.7)	37 (24.3)			
Breathing Difficulty					
Yes	141 (78.3)	39 (21.7)	0.982	0.322	0.774 (0.467 - 1.285)
No	112 (73.7)	40 (26.3)			
Diagnosed Asthma					
Yes	169 (93.9)	11 (6.1)	11.039	**0.001****	0.301 (0.144 - 0.630)
No	125 (82.2)	27 (17.8)			
Respiratory Infection					
Yes	68 (37.8)	112 (62.2)	8.016	**0.005****	1.879 (1.212 - 2.913)
No	81 (53.3)	71 (46.7)			

N (respondents)=332
N (Environmental data)=24
Chi-square test
**significant at $p<0.01$

Table 4.17: Relationship between Heavy Metals in Indoor Air (Ni) with Respiratory Symptoms

Variables	Nickel (Ni)		χ^2	p	OR (95% CI)
	Low	High			
Wheezing for past 12 Months					
Yes	40 (78.4)	11 (21.6)	3.968	**0.046***	2.140 (0.999 - 4.585)
No	249 (88.6)	32 (11.4)			
Dry Throat					
Yes	28 (54.9)	23 (45.1)	0.991	0.320	0.738 (0.405 - 1.344)
No	133 (47.3)	148 (52.7)			
Influenza Symptoms					
Yes	19 (37.3)	32 (62.7)	0.091	0.762	1.100 (0.594 - 2.036)
No	111 (39.5)	170 (60.5)			
Sore Throat					
Yes	26 (51.0)	25 (49.0)	0.060	0.806	0.928 (0.511 - 1.685)
No	138 (49.1)	143 (50.9)			
Irritating Cough					
Yes	37 (72.5)	14 (27.5)	0.002	0.964	0.985 (0.505 - 1.921)
No	203 (72.2)	78 (27.8)			
Breathing Difficulty					
Yes	37 (72.5)	14 (27.5)	0.444	0.505	1.257 (0.640 - 2.469)
No	216 (76.9)	65 (23.1)			
Diagnosed Asthma					
Yes	46 (90.2)	5 (9.8)	0.160	0.689	0.817 (0.303 - 2.202)
No	248 (88.3)	33 (11.7)			
Respiratory Infection					
Yes	17 (33.3)	34 (66.7)	3.247	0.072	1.772 (0.946 - 3.319)
No	132 (47.0)	149 (53.0)			

N (respondents)=332
N (Environmental data)=24
Chi-square test
*significant at $p<0.05$

Table 4.18: Relationship between Heavy Metals in Indoor Air (As) with Respiratory Symptoms

Variables	Arsenic (As)		χ^2	p	OR (95% CI)
	Low	High			
Wheezing for past 12 Months					
Yes	22 (84.6)	4 (15.4)	0.148	0.700	1.245 (0.407 - 3.804)
No	267 (87.3)	39 (12.7)			
Dry Throat					
Yes	18 (69.2)	8 (30.8)	4.857	**0.028***	0.390 (0.165 - 0.924)
No	143 (46.7)	163 (53.3)			
Influenza Symptoms					
Yes	12 (46.2)	14 (53.8)	0.580	0.446	0.732 (0.327 - 1.637)
No	118 (38.6)	188 (61.4)			
Sore Throat					
Yes	15 (57.7)	11 (42.3)	0.776	0.378	0.696 (0.310 - 1.564)
No	149 (48.7)	157 (51.3)			
Irritating Cough					
Yes	22 (84.6)	4 (15.4)	2.140	0.144	0.540 (0.151 - 1.345)
No	218 (71.2)	88 (28.8)			
Breathing Difficulty					
Yes	19 (73.1)	7 (26.9)	0.152	0.696	1.197 (0.484 - 2.963)
No	234 (76.5)	72 (23.5)			
Diagnosed Asthma					
Yes	22 (84.6)	4 (15.4)	0.432	0.511	1.455 (0.473 - 4.473)
No	272 (88.9)	34 (11.1)			
Respiratory Infection					
Yes	19 (73.1)	7 (26.9)	9.067	**0.003****	0.272 (0.111 - 0.666)
No	130 (42.5)	176 (57.5)			

N (respondents)=332
N (Environmental data)=24
Chi-square test
*significant at $p<0.05$
**significant at $p<0.01$

4.6.3 Relationship between Heavy Metals in Settled Dusts (Cr, Mn, Ni, Pb, As, Cd) with Respiratory Symptoms

The relationship between heavy metals in settled dusts which consists of Cr, Mn, Ni, Pb, As and Cd with the respiratory symptoms reported among the school children were analyzed by using Chi-square tests.

There were significant correlation between Cr and Cd with diagnosed asthma. Meanwhile, Mn, Pb and As has significant results with the influenza symptoms. As shows significant correlation with irritating cough. Lastly, Ni does not have any significant correlation with the respiratory symptoms.

© COPYRIGHT UPM

Table 4.19: Relationship between Heavy Metals in Settled Dusts (Cr) with Respiratory Symptoms

Variables	Chromium (Cr)		χ^2	p	OR (95% CI)
	Low	High			
Wheezing for past 12 Months					
Yes	23 (53.5)	20 (46.5)	0.762	0.383	0.752 (0.395 - 1.429)
No	134 (46.4)	155 (53.6)			
Dry Throat					
Yes	78 (45.6)	93 (54.4)	0.397	0.529	1.149 (0.746 - 1.768)
No	79 (49.1)	82 (50.9)			
Influenza Symptoms					
Yes	88 (43.6)	114 (56.4)	2.871	0.090	1.465 (0.941 - 2.281)
No	69 (53.1)	61 (46.9)			
Sore Throat					
Yes	75 (44.6)	93 (55.4)	0.955	0.328	1.24 (0.805 - 1.909)
No	82 (50.0)	82 (50.0)			
Irritating Cough					
Yes	36 (39.1)	56 (60.9)	3.399	0.065	1.582 (0.970 - 2.580)
No	121 (50.4)	119 (49.6)			
Breathing Difficulty					
Yes	40 (50.6)	39 (49.4)	0.465	0.495	0.839 (0.506 - 1.391)
No	117 (46.2)	136 (53.8)			
Diagnosed Asthma					
Yes	24 (63.2)	14 (36.8)	4.335	**0.037***	0.482 (0.240 - 0.968)
No	133 (45.2)	161 (54.8)			
Respiratory Infection					
Yes	78 (42.6)	105 (57.4)	3.562	0.059	1.519 (0.983 - 2.347)
No	79 (53.0)	70 (47.0)			

N (respondents)=332
N (Environmental data)=24
Chi-square test
*significant at $p<0.05$

Table 4.20: Relationship between Heavy Metals in Settled Dusts (Mn) with Respiratory Symptoms

Variables	Manganese (Mn)		χ^2	P	OR (95% CI)
	Low	High			
Wheezing for past 12 Months					
Yes	15 (34.9)	28 (65.1)	0.49	0.484	1.270 (0.650 - 2.481)
No	117 (40.5)	172 (59.5)			
Dry Throat					
Yes	62 (36.3)	109 (63.7)	1.805	0.179	1.352 (0.870 - 2.101)
No	70 (43.5)	91 (56.5)			
Influenza Symptoms					
Yes	66 (32.7)	136 (67.3)	10.814	**0.001****	2.125 (1.352 - 3.341)
No	66 (50.8)	64 (49.2)			
Sore Throat					
Yes	62 (36.9)	106 (63.1)	1.157	0.282	1.273 (0.820 - 1.978)
No	70 (42.7)	94 (57.3)			
Irritating Cough					
Yes	33 (35.9)	59 (64.1)	0.804	0.370	1.255 (0.763 - 2.065)
No	99 (41.3)	141 (58.8)			
Breathing Difficulty					
Yes	31 (39.2)	48 (60.8)	0.012	0.914	1.029 (0.614 - 1.725)
No	101 (39.9)	152 (60.1)			
Diagnosed Asthma					
Yes	13 (34.2)	25 (65.8)	0.552	0.458	1.308 (0.643 - 2.659)
No	119 (40.5)	175 (59.5)			
Respiratory Infection					
Yes	71 (38.8)	112 (61.2)	0.157	0.692	1.093 (0.703 - 1.701)
No	61 (40.9)	88 (59.1)			

N (respondents)=332
N (Environmental data)=24
Chi-square test
**significant at p<0.01

© COPYRIGHT UPM

Table 4.21: Relationship between Heavy Metals in Settled Dusts (Pb) with Respiratory Symptoms

Variables	Lead (Pb)		χ^2	p	OR (95% CI)
	Low	High			
Wheezing for past 12 Months					
Yes	21 (48.8)	22 (51.2)	0.313	0.576	0.833 (0.439 - 1.582)
No	128 (44.3)	161 (55.7)			
Dry Throat					
Yes	70 (40.9)	101 (59.1)	2.217	0.136	1.390 (0.901 - 2.146)
No	79 (49.1)	82 (50.9)			
Influenza Symptoms					
Yes	81 (40.1)	121 (59.9)	4.766	**0.029***	1.638 (1.050 - 2.556)
No	68 (52.3)	62 (47.7)			
Sore Throat					
Yes	73 (43.5)	95 (56.5)	0.280	0.597	1.124 (0.729 - 1.732)
No	76 (46.3)	88 (53.7)			
Irritating Cough					
Yes	39 (42.4)	53 (57.6)	0.319	0.573	1.150 (0.708 - 1.868)
No	110 (45.8)	130 (54.2)			
Breathing Difficulty					
Yes	37 (46.8)	42 (53.2)	0.160	0.689	0.902 (0.543 – 1497)
No	112 (44.3)	141 (55.7)			
Diagnosed Asthma					
Yes	19 (50.0)	19 (50.0)	0.455	0.500	0.793 (0.403 - 1.559)
No	130 (44.2)	164 (55.8)			
Respiratory Infection					
Yes	72 (39.3)	111 (60.7)	5.050	**0.025***	1.649 (1.065 - 2.553)
No	77 (51.7)	72 (48.3)			

N (respondents)=332
N (Environmental data)=24
Chi-square test
*significant at $p<0.05$

© COPYRIGHT UPM

Table 4.22: Relationship between Heavy Metals in Settled Dusts (As) with Respiratory Symptoms

Variables	Arsenic (As)		χ^2	p	OR (95% CI)
	Low	High			
Wheezing for past 12 Months					
Yes	22 (51.2)	21 (48.8)	0.253	0.615	0.848 (0.447 - 1.611)
No	136 (47.1)	153 (52.9)			
Dry Throat					
Yes	76 (44.4)	95 (55.6)	1.399	0.237	1.297 (0.842 - 1.998)
No	82 (50.9)	79 (49.1)			
Influenza Symptoms					
Yes	83 (41.1)	119 (58.9)	8.742	**0.003****	1.955 (1.251 - 3.056)
No	75 (57.7)	55 (42.3)			
Sore Throat					
Yes	75 (44.6)	93 (55.4)	1.185	0.276	1.271 (0.825 - 1.956)
No	83 (50.6)	81 (49.4)			
Irritating Cough					
Yes	33 (35.9)	59 (64.1)	7.010	**0.008****	1.943 (1.184 - 3.19)
No	125 (52.1)	115 (47.9)			
Breathing Difficulty					
Yes	39 (49.4)	40 (50.6)	0.131	0.717	0.911 (0.549 - 1.510)
No	119 (47.0)	134 (53.0)			
Diagnosed Asthma					
Yes	23 (60.5)	15 (39.5)	2.879	0.090	0.554 (0.278 - 1.104)
No	135 (45.9)	159 (54.1)			
Respiratory Infection					
Yes	70 (38.3)	113 (61.7)	14.258	**<0.001*****	2.329 (1.497 - 3.624)
No	88 (59.1)	61 (40.9)			

N (respondents)=332
N (Environmental data)=24
Chi-square test
**significant at p<0.01
***significant at p<0.001

Table 4.23: Relationship between Heavy Metals in Settled Dusts (Cd) with Respiratory Symptoms

Variables	Cadmium (Cd)		χ^2	p	OR (95% CI)
	Low	High			
Wheezing for past 12 Months					
Yes	21 (48.8)	22 (51.2)	0.643	0.423	1.299 (0.684 - 2.468)
No	160 (55.4)	129 (44.6)			
Dry Throat					
Yes	95 (55.6)	76 (44.4)	0.153	0.696	0.917 (0.595 - 1.413)
No	86 (53.4)	75 (46.6)			
Influenza Symptoms					
Yes	117 (57.9)	85 (42.1)	2.409	0.121	0.704 (0.452 - 1.097)
No	64 (49.2)	66 (50.8)			
Sore Throat					
Yes	91 (54.2)	77 (45.8)	0.017	0.896	1.029 (0.668 - 1.585)
No	9 (54.9)	74 (45.8)			
Irritating Cough					
Yes	51 (55.4)	41 (44.6)	0.043	0.835	0.950 (0.586 - 1.540)
No	130 (54.2)	110 (45.8)			
Breathing Difficulty					
Yes	44 (55.7)	35 (44.3)	0.058	0.810	0.939 (0.565 - 1.562)
No	137 (54.2)	116 (45.8)			
Diagnosed Asthma					
Yes	27 (71.1)	11 (28.9)	4.731	**0.030***	0.448 (0.214 - 0.937)
No	154 (52.4)	140 (47.6)			
Respiratory Infection					
Yes	102 (55.7)	81 (44.3)	0.245	0.621	0.896 (0.581 - 1.384)
No	79 (53.0)	70 (47.0)			

N (respondents)=332
N (Environmental data)=24
Chi-square test
*significant at $p<0.05$

4.6.4 Relationship between Lung Inflammations (FeNO) with Air Quality Parameters, Heavy Metals in Indoor Air and Settled Dusts

Table 4.24 shows the relationship between lung inflammations with air quality parameters. However, there were no significant difference relationship between lung inflammations with air quality parameters.

The relationship between lung inflammations with heavy metals present in indoor air are shown in Table 4.25. Results shows that there were significant correlation between lead (Pb) with lung inflammations (p=0.029). However, the other elements of heavy metals in indoor air does not relates to the lung inflammations.

Table 4.26 shows the relationship between lung inflammation with heavy metals present in settled dust and it shows a significant correlation with nickel (Ni), lead (Pb) and arsenic (As) with significant value of (p=0.047), (p=0.034) and (p=0.047) respectively.

UPM COPYRIGHT UPM

Table 4.24: Relationship between Lung Inflammations (FeNO) with Air Quality Parameters

Indoor Air Pollutants	Concentration of FeNO		χ^2	p	OR (95% CI)
	Abnormal (≥20ppb)	Normal (<20ppb)			
$PM_{2.5}$ (Real-time Measurement)[a]					
High	86 (52.4)	78 (47.6)	0.194	0.66	1.103 (0.714 - 1.703)
Low	81 (50.0)	81 (50.0)			
PM_{10} (Real-time Measurement)[a]					
High	90 (51.7)	84 (48.3)	0.037	0.848	1.044 (0.675 - 1.613)
Low	77 (50.7)	75 (49.3)			
PM_{10} (Gravimetric)[b]					
High	78 (52.0)	72 (48.0)	0.214	0.644	1.107 (0.719 - 1.707)
Low	90 (49.5)	92 (50.5)			
NO_2 (Passive Sampler)[c]					
High	79 (48.2)	85 (51.8)	2.864	0.091	0.658 (0.404 - 1.070)
Low	65 (58.6)	46 (41.4)			
CO_2 (ppm)[d]					
High	133 (51.8)	124 (48.2)	0.600	0.438	1.226 (0.732 - 2.052)
Low	35 (46.7)	40 (53.3)			
VOCs (Real-time Measurement) (ppm)[d]					
High	91 (50.8)	88 (49.2)	0.024	0.877	0.966 (0.624 - 1.495)
Low	76 (51.7)	71 (48.3)			
Formaldehyde (ppm)[e]					
High	100 (51.2)	97 (49.2)	0.043	0.835	0.954 (0.612 - 1.488)
Low	67 (51.9)	62 (48.1)			

N=332
Chi-square Test
*significant
a Real-time Measurement with Dust-Trak DRX (Model: TSI 8534)
b Gravimetric dust measurement with PVC filter (Personal Air Sampler)
c passive sampler of NO2
d Real-time Measurement with Air Velocity Meter (Model: TSI 9565-P)
e Real-time Measurement with MultiRae Lite (Model: PGM-6208)

© COPYRIGHT UPM

Table 4.25: Relationship between Lung Inflammations (FeNO) with Heavy Metals in Indoor Air

Elements	Concentration of FeNO		χ^2	p	OR (95% CI)
	Abnormal (≥20ppb)	Normal (<20ppb)			
Chromium (Cr)					
High	70 (46.4)	81 (53.6)	1.997	0.158	0.732 (0.475 - 1.129)
Low	98 (54.1)	83 (45.9)			
Manganese (Mn)					
High	88 (48.9)	92 (51.1)	0.462	0.497	0.861 (0.559 - 1.326)
Low	80 (52.6)	72 (47.4)			
Nickel (ni)					
High	25 (49.0)	26 (51.0)	0.060	0.806	0.928 (0.511 - 1.685)
Low	143 (50.9)	138 (49.1)			
Lead (Pb)					
High	51 (61.4)	32 (38.6)	5.206	**0.023***	1.798 (1.083 - 2.986)
Low	117 (47.0)	132 (53.0)			
Arsenic (As)					
High	15 (57.7)	11 (42.3)	0.567	0.451	1.364 (0.607 - 3.064)
Low	153 (50.0)	153 (50.0)			
Cadmium (Cd)					
High	39 (58.2)	28 (41.8)	1.943	0.163	1.468 (0.854 - 2.525)
Low	129 (48.7)	136 (51.3)			

N (respondents) = 332
N (Environmental data) = 24
Chi-square Test
*significant at $p<0.05$

COPYRIGHT UPM

Table 4.26: Relationship between Lung Inflammations (FeNO) with Heavy Metals in Settled Dusts

Elements	Concentration of FeNO		χ^2	p	OR (95% CI)
	Abnormal (≥20ppb)	Normal (<20ppb)			
Chromium (Cr)					
High	85 (48.6)	90 (51.4)	0.611	0.434	0.842 (0.547 - 1.296)
Low	83 (52.9)	74 (47.1)			
Manganese (Mn)					
High	95 (47.5)	105 (52.5)	1.937	0.164	0.731 (0.470 - 1.137)
Low	73 (55.3)	59 (44.7)			
Nickel (Ni)					
High	78 (45.3)	94 (54.7)	3.941	**0.047***	0.645 (0.418 - 0.995)
Low	90 (56.3)	70 (43.8)			
Lead (Pb)					
High	83 (45.4)	100 (54.6)	4.491	**0.034***	0.625 (0.404 - 0.966)
Low	85 (57.0)	64 (43.0)			
Arsenic (As)					
High	79 (45.4)	95 (54.6)	3.955	**0.047***	0.645 (0.418 - 0.995)
Low	89 (56.3)	69 (43.7)			
Cadmium (Cd)					
High	78 (51.7)	73 (48.3)	0.123	0.726	1.080 (0.701 - 1.664)
Low	90 (49.7)	91 (5.3)			

N (respondents) = 332
N (Environmental data) = 24
Chi-square Test
*significant at $p<0.05$

© COPYRIGHT UPM

4.6.5 Relationship between Lung Inflammations (FeNO) with Socio-demographic Characteristics, Air Quality Parameters and Heavy Metals in Indoor Air and Dusts.

Table 4.27 shows the relationship between personal risk factor with the lung inflammations. Multilevel logistic regression were used to identify the risk factors which significantly related to lung inflammations (FeNO).

Risk factors such as gender and smoking status of the participants showed significant relationship with the lung inflammations. The other risk factors in the socio-demographic background such as race, family smoking status, parent's education background and family income were not significantly correlate with the results of lung inflammations.

Next, based on Table 4.28, lead (Pb) which was found in the indoor air of the school environment was significantly related with the lung inflammations. However, the other elements of heavy metals such as chromium (Cr), manganese (Mn), nickel (Ni), arsenic (As) and cadmium (Cd) in indoor air were not significantly related with the lung inflammations.

Table 4.27: Association between Lung Inflammations (FeNO) with Socio-demographic Characteristics

Variables	FeNO	
	OR (95% CI)	p
Gender (Male)	1.866 (1.175 - 2.963)	**0.008****
Race	0.915 (0.795 - 1.053)	0.217
Smoking Status	2.830 (1.186 - 6.752)	**0.019***
Family Smoking Status	1.087 (0.700 - 1.689)	0.71

The model was analyzed by a Multilevel Logistic Regression with mutual adjustment keeping gender, race, smoking status (participant) and family smoking status in the model
N=332
*significant at p<0.05
**significant at p<0.01

Table 4.28: Association between Lung Inflammations (FeNO) with Heavy Metals in Indoor Air

Variables	FeNO	
	OR (95% CI)	p
Chromium (Cr)	0.683 (0.381 - 1.222)	0.199
Manganese (Mn)	1.089 (0.616 - 1.924)	0.769
Nickel (Ni)	1.065 (0.567 - 2.002)	0.845
Lead (Pb)	1.971 (1.049 - 3.703)	**0.035***
Arsenic (As)	0.923 (0.458 - 1.862)	0.823
Cadmium (Cd)	1.696 (0.676 - 4.257)	0.261

Multilevel Logistic Regression
N (variables) = 24
*significant at p<0.05

© COPYRIGHT UPM

4.6.6 Relationship between Respiratory Symptoms with Socio-demographic Characteristics, Air Quality Parameters and Heavy Metals in Indoor Air and Dusts.

The associations between respiratory symptoms with the socio-demographic of the participants are shown in Table 4.29. The results shows that there were a significantly correlation between gender with influenza symptoms, sore throat and also breathing difficulty. However, all of the respiratory symptoms does not related with the risk factor of race. Meanwhile, smoking status shows many results on significant correlation with dry throat, sore throat, irritating cough, breathing difficulty and also respiratory infection.

Table 4.30 shows the association between respiratory symptoms with air quality parameters. There were significant correlation between PM_{10} (Gravimetric) with diagnosed asthma. The concentration of CO_2 were significantly related with influenza symptoms and irritating cough reported by the participants. Next, VOCs shows a significant correlation with the respiratory infection.

Based on Table 4.31, the association between respiratory symptoms with heavy metals in indoor gives a significant results of Mn with the diagnosed asthma. Lastly, heavy metals in settled dust were shown in Table 4.32. There were significant correlation between Mn with influenza symptoms, Pb with irritating cough and As with irritating cough and respiratory infection. Other than that, the elements that is not stated does not relates to the reported respiratory symptoms.

Table 4.29: Association between Respiratory Symptoms with Socio-demographic Characteristics

Variables	Gender		Race		Smoking Status	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Wheezing for past 12 Months	1.262 (0.626 - 2.544)	0.516	1.129 (0.912 - 1.397)	0.264	0.892 (0.236 - 3.370)	0.866
Dry Throat	1.511 (0.842 - 2.423)	0.087	1.049 (0.908 - 1.211)	0.517	4.388 (1.608 - 11.973)	**0.004****
Influenza Symptoms	1.612 (1.002 - 2.593)	**0.049***	1.017 (0.879 - 1.177)	0.817	2.267 (0.913 - 5.626)	0.078
Sore Throat	2.952 (1.817 - 4.795)	**<0.001*****	1.059 (0.916 - 1.224)	0.439	3.742 (1.525 - 9.188)	**0.004****
Irritating Cough	1.307 (0.757 - 2.257)	0.336	1.069 (0.907 - 1.261)	0.422	3.864 (1.582 - 9.441)	**0.003****
Breathing Difficulty	2.139 (1.192 - 3.836)	**0.011***	0.996 (0.842 - 1.177)	0.963	3.238 (1.295 - 8.093)	**0.012***
Diagnosed Asthma	0.979 (0.478 - 2.005)	0.955	1.255 (0.997 - 1.580)	0.053	0.243 (0.031 - 1.942)	0.183
Respiratory Infection	1.253 (0.761 - 2.061)	0.374	1.125 (0.967 - 1.309)	0.124	3.399 (0.780 - 2.076)	**0.016***

Multilevel Logistic Regression
Each model was adjusted for gender, race and smoking status of participants
N (respondents) = 332
N (Environmental data) = 24
*significant at $p<0.05$
**significant at $p<0.01$
***significant at $p<0.001$

Table 4.30: Association between Respiratory Symptoms with Indoor Air Quality

Variables	PM10 (Gravimetric)		CO2		VOCs	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Wheezing for past 12 Months	1.600 (0.825 - 3.104)	0.164	0.788 (0.307 - 2.023)	0.621	0.952 (0.441 - 2.059)	0.902
Dry Throat	1.011 (0.649 - 1.575)	0.961	0.885 (0.473 - 1.657)	0.703	0.884 (0.530 - 1.473)	0.636
Influenza Symptoms	0.679 (1.287 - 2.777)	0.099	0.506 (0.258 - 0.993)	**0.048***	1.354 (0.798 - 2.297)	0.261
Sore Throat	0.776 (0.498 - 1.209)	0.262	0.781 (0.419 - 1.455)	0.436	1.251 (0.753 - 2.079)	0.388
Irritating Cough	0.785(0.432 - 1.328)	0.333	0.382 (0.200 - 0.730)	**0.004****	0.937 (0.531 - 1.655)	0.824
Breathing Difficulty	0.839 (0.499 - 1.4120	0.509	1.289 (0.590 - 2.814)	0.524	1.087(0.578 - 2.011)	0.790
Diagnosed Asthma	0.443 (0.203 - 0.965)	**0.040***	1.629 (0.529 - 5.019)	0.395	1.510 (0.657 - 3.473)	0.332
Respiratory Infection	1.254(0.680 - 2.314)	0.469	0.651 (0.306 - 1.382)	0.264	0.538 (0.294 - 0.985)	**0.045***

Multilevel Logistic Regression
N (respondents) = 332
N (Environmental data) = 24
*significant at $p<0.05$
**significant at $p<0.01$

© COPYRIGHT UPM

Table 4.31: Association between Respiratory Symptoms with Heavy Metals in Indoor Air

Variables	Manganese (Mn)	
	OR (95% CI)	p
Wheezing for past 12 Months	0.442 (0.107 - 1.825)	0.259
Dry Throat	0.906 (0.341 - 2.406)	0.843
Influenza Symptoms	0.903 (0.360 - 2.264)	0.808
Sore Throat	1.253 (0.501 - 3.136)	0.629
Irritating Cough	0.800 (0.241 - 2.656)	0.716
Breathing Difficulty	0.652 (0.225 - 1.884)	0.429
Diagnosed Asthma	0.176 (0.039 - 0.790)	**0.023***
Respiratory Infection	1.739 (0.613 - 4.931)	0.298

Multilevel Logistic Regression
N (Respondents) = 24
N (Environmental Data) = 332
*significant at $p<0.05$

© COPYRIGHT UPM

Table 4.32: Association between Respiratory Symptoms with Heavy Metals in Settled Dusts

Variables	Manganese (Mn)		Lead (Pb)		Arsenic (As)	
	OR (95% CI)	p	OR (95% CI)	p	OR (95% CI)	p
Wheezing for past 12 Months	1.805 (0.737 - 4.418)	0.196	0.865 (0.295 - 2.531)	0.791	0.916 (0.371 - 2.260)	0.848
Dry Throat	1.256 (0.693 - 2.275)	0.453	1.325 (0.653 - 2.689)	0.435	1.136 (0.628 - 2.054)	0.673
Influenza Symptoms	1.879 (1.020 - 3.462)	**0.043***	0.680 (0.326 - 1.421)	0.305	1.664 (0.891 - 3.108)	0.110
Sore Throat	1.256 (0.693 - 2.275)	0.453	1.325 (0.653 - 2.689)	0.435	1.136 (0.628 - 2.054)	0.673
Irritating Cough	1.101 (0.555 - 2.182)	0.783	0.411 (0.183 - 0.923)	**0.031***	2.142 (1.074 - 4.275)	**0.031***
Breathing Difficulty	1.043 (0.521 - 2.088)	0.906	0.932 (0.410 - 2.122)	0.867	0.994 (0.498 - 1.985)	0.987
Diagnosed Asthma	1.144 (0.440 - 2.977)	0.782	0.946 (0.322 - 2.776)	0.919	0.601 (0.247 - 1.464)	0.262
Respiratory Infection	0.678 (0.359 - 1.281)	0.232	1.205 (0.562 - 2.583)	0.633	2.615 (1.387 - 4.930)	**0.003****

Multilevel Logistic Regression
N (Respondents) = 332
N (Environmental Data) = 24
*significant at p<0.05
**significant at p<0.01

© COPYRIGHT UPM

CHAPTER 5

DISCUSSION

5.1 Individual Characteristics of the Respondents

This study involved 332 number of respondents were selected from randomly 6 different secondary schools in Kota Kinabalu, Sabah and fulfilled the inclusion criteria with the returned consent form from parents. The socio-demography, reported health symptoms and health status of the respondents were obtained through the questionnaire interview. In selecting the respondents, inclusion criteria were important as the respondents must from Form 2 (non-examination class) students which stayed in the same school for at least one year and obtained consent form from their parents to participate in this study. Individual that having diseases such as heart disease, hypertension, chronic asthma and congenital physical chest abnormality were not included in the study as all the respondents were going through health screening before carrying out the data collection.

Based on Table 4.1, findings showed that the race group is mostly from Bajau. According to Thomas Brinkhoff (2019), Kota Kinabalu made up from a mix of diverse

ethnicities and nationalities with the most ethnic found in Sabah were Kadazan-Dusun, Bajau and Murut as well as Malay. Other than that, the education level of respondents' parents were mostly secondary schools and very least of them had no formal education.

Lifestyle information such as participants and the other family members smoking status were taken into account when interpreting lung inflammation (FeNO Levels). For their lifestyle information, most of the respondents were not a smoker but, School E had the highest number of participants smoking status which is 24.6%. According to (Norbäck et al., 2017), smoking status of the respondents had a significant associations with the prevalence of respiratory health and symptoms.

5.2 Relationship between Air Quality Parameters with Respiratory Symptoms

Children who exposed to the indoor air pollutants might possessed a higher risk of health problems as children is very susceptible (Buonanno et al., 2012). Hence, the indoor air pollutants can be harmful and produced discomfort and also increasing the absenteeism of the school children (Mendell & Heath, 2005). There are 7 types of indoor air pollutants measured in this study which is $PM_{2.5}$, PM_{10}, PM_{10} (Gravimetric), NO_2, CO_2, VOCs and lastly, formaldehyde. The indoor air pollutants were measured in 4 different classes of each schools.

Table 4.9 and Table 4.10 shows that $PM_{2.5}$ and PM_{10} has significant correlation with the wheezing for past 12 months. Meanwhile, PM_{10} (Gravimetric) in Table 4.11 shows a significant result with diagnosed asthma among the school children. The particulate matters are primarily comes from a wide range of sources which includes road dust, agriculture dust, river beds, construction sites, mining operations and similar activities (Juda-Rezler et al., 2011). The delayed deposition of fine or coarse particles induced turbulence that created by occupant's movement with the reduced ventilation of the classroom could also affected the dispersion of fine and coarse particles (Madureira et al., 2015). It was found that most of the schools were near the heavily traffic road and also a construction sites nearby. Traffic is known as the major sources of particulate matter originates from the wear of vehicle components including tires and brakes as well as suspension of the road dust (de Kok et al., 2006).

The increased levels of PM_{10} were associated with respiratory symptoms such as regular cough, chronic cough or phlegm and wheezing and breathlessness (Bae & Hong, 2018). Previous study had found that the schools that located near to a heavily traffic (<500m) and also close to a car park (<100m) is expected that the ambient air is contributing to the indoor air particulate matters in the classrooms (Madureira et al., 2015). The health problems that associate with inhaling the particulate matters are found to include the shortness of breath (dyspnea), chest discomfort and pain, and also coughing and wheezing (Guaita et al., 2011).

© COPYRIGHT UPM

The children cannot exposed to the excess level of particulate matter as they will be in significantly high risk of respiratory symptoms, asthma medication use, and reduced lung function (Gold et al., 1999). (McCormack et al., 2011) found there were a statistically significant correlation with both coarse and fine particulate matter levels with the asthma symptoms in both atopic and non-atopic asthmatic children.

Table 4.12 shows the significant relationship of VOCs with the respiratory infection. In the other hand, Table 4.14 also shows the statistically significant relationship between formaldehyde with the respiratory infection. (Madureira et al., 2015) stated that the total VOC concentration was related with the chronic airways and also with the presence of asthma and allergic rhinitis. VOCs also found to be the main indoor settings pollutants which affected the respiratory and are limited to asthma and bronchitis (Annesi-Maesano et al., 2013). VOC also has been linked to allergic and respiratory health of the respondents.

There were plenty of studies stated that the formaldehyde in indoor air is pollutants that affecting the respiratory health (Madureira et al., 2012). Formaldehyde has the potential in developing asthma and other allergic symptoms (Mendell, 2007). There were studies that focuses on the respiratory effects of formaldehyde exposure in indoor air revealed an increased risk of asthma related with the elevated concentration of indoor pollutants (Norbäck et al., 2017). Moreover, the asthma-like symptoms including

wheezing in the past 12 months and irritating cough was related with the indoor exposure towards formaldehyde (Madureira et al., 2015). In addition, the chronic airways was related with the total VOCs concentration in indoor air (Godri et al., 2016).

Table 4.13 shows the relationship between CO_2 with the influenza symptoms and have a strong correlation with irritating cough among the school children. Carbon dioxide have a strong correlation with the particulate matters if both of them were measured in the same room (Ramalho et al., 2015). This possess a great risk of health effect toward the school children as they spent most of their time indoors.

5.3 Relationship between Heavy Metals in Indoor Air and Settled Dusts with Respiratory Symptoms

Table 4.15 until Table 4.18 shows the relationship between heavy metals in indoor air with the reported respiratory symptoms among the school children. Meanwhile, Table 4.19 until Table 4.23 shows the relationship between heavy metals in settled dusts with reported respiratory symptoms among the school children in Kota Kinabalu, Sabah. The sources of the heavy metals merely comes from traffic emission, industrial emission, waste incineration, city construction and demolition activities and residential burning (Xu et al., 2018). Furthermore, the atmospheric deposition has been found as a major pathway for a long distance transport of heavy metal pollutants which accumulate in the atmospheric dusts (Liu et al., 2015). Moreover, the Copper-Nickel mining activities that

happens in Ranau which was only 117 km away from Kota Kinabalu is one of the major concern on the heavy metals concentration. The mining activities was located on higher land and the dusts will travel by wind downhill.

Chromium were found significantly correlate with diagnosed asthma in both indoor air and settled dust but only significantly correlate with respiratory infection in indoor air. Meanwhile, Mn were significantly related with diagnosed asthma and respiratory infection in indoor air while also significantly related with influenza symptoms in the settled dusts. In addition, there were relationship between Pb with influenza symptoms and respiratory infection in settled dusts but does not significantly correlate with any respiratory symptoms in indoor dusts.

Next, Ni was significantly correlate with wheezing for the past 12 months among the school children. Arsenic shows the strong correlation with respiratory infection in settled dusts and also were significantly related with dry throat in indoor air, while also significantly related with influenza symptoms and irritating cough in the settled dusts. Lastly, Cd were significantly related with the diagnosed asthma among the school children.

Heavy metals can affect human body by entering through ingestion, inhalation and dermal contact (Al-Rajhi et al., 1996). The heavy metals in indoor air is from the fine dust particles that may be inhaled into the lungs of the school children due to the wind and air

suspension (Latif et al., 2014). Harmful effects such as cancers can caused by the widespread environmental pollutants which includes heavy metals such as As, Cd, Cr and Pb (Sanborn et al., 2002). Previous studies has revealed that exposure towards heavy metal is associated with lower lung function and higher prevalence of the respiratory symptoms (Duong & Lee, 2011).

There were evidence that shows Cu, Cd and Pb emitted from the road traffic and the heavy metals mainly derived from the break wear rather than from the combustion itself (Sternbeck et al., 2002). In addition, Cd, Cu and Pb are a good indicators of soil contamination as they appear in the gasoline, car components, oil lubricants, industrial and also incinerator emissions (Alloway, 2003).

Pb were emitted from fuel and motor oil combustion, road dust and break wear (Young et al, 2002). Furthermore, Pb is one of a cumulative heavy metal toxicant and is ubiquitoes in the environment which can be absorbed into the human bodies through two ways which is inhalation and also ingestion of food, water or soil (Zheng et al., 2010). The source of Pb has been found plenty in many urban areas by the use of leaded fuel, a resuspension soil previously contaminated with Pb (Young et al., 2002). Cd is a cumulative toxic metal as the kidney is the main target for Cd toxicity health effects (De Burbure et al., 2003). Moreover, lung cancer is a major concern for chronic effects of Cr that it can causes tissue damage in the lungs (Shrivastava et al., 2002).

5.4 Association between Lung Inflammations (FeNO) and reported respiratory symptoms with Heavy Metals in Indoor Air and Settled Dusts

Table 4.25 shows the relationship between lung inflammations with heavy metals concentration in indoor air and there is significant difference between Pb with lung inflammations (p=0.023). Meanwhile, Table 4.26 shows the relationship between lung inflammation with heavy metals in settled dusts and there were significant correlations with Ni, Pb and As with significant value of (p=0.047), (p=0.034) and (p=0.047) respectively. This means that, the lead concentration and the concentration of Ni, Pb and also As in settled dusts influenced the lung inflammation.

Referring to Table 4.31, the result shows the association between respiratory symptoms with heavy metals in indoor air of the schools environment. There was significant correlation between manganese with diagnosed asthma. Table 4.32 shows that the exposure towards manganese will lead to the increase number of asthma prevalence among the children. Other than that, Mn in settled dusts also shows significant correlation with the influenza symptoms. This means that, the exposure towards manganese affected the influenza symptoms. In addition, Pb and As also shows a significant correlation of results with irritating cough. These shows that the occurrence of irritating cough among the children is related with the lead exposure. Meanwhile, arsenic also have significant correlation with the respiratory infection among the school children.

ATSDR (2003) have investigated that Ni have harmful effects of exposure towards human lungs and also causes various respiratory disorders. The increase in number of industrialization is the major sources that lead to increment of environmental pollutants including Ni and also their increased health hazards. Although Ni is considered to be one of the important element for various vital body functions, but the prolonged exposure may lead to the toxic levels in the human bodies (Haber et al., 2002). Ni has been classified as a carcinogenic towards human health by the IARC (International Agency for Research on Cancer, 1990). The respiratory system disorders involving Ni were mostly pneumoconiosis and asthma that are caused by the chronic inhalational exposure (Rehman et al., 2018).

However, lead (Pb) was merely found in the earth crust and has also been used for many years in agricultural and industrial fields (Rehman et al., 2018). The Pb poisoning are more prone to cause effects towards children because while playing, they are exposed to deteriorated Pb in dusts (Lanphear et al., 2002). Most of the symptoms due to Pb poisoning are including lack of attention, headache and also memory loss and there is also a study revealed that prolonged exposure could results in progressive decreased in both verbal and non-verbal memory (Rehman et al., 2018). There is found that blood Pb levels is associated with the death due to the cardiovascular disease as there is increased in blood

pressure (Sykes et al., 2009). Since children have a smaller body size as compared to adults so chances of rapid absorption of Pb in children are higher than adults.

Arsenic (As) is also one of the carcinogenic heavy metals towards human health. The route of entry of the As into body does include inhalational and dermal exposure (WHO, Solasaari-Pekki, & Lehtinen, 1996). Prolonged exposure might affect the cardiovascular system that may cause toxicity to CNS and causing death (Rehman et al., 2018). Studies also revealed that exposure towards As could increase the rates of lung cancers (Tan et al., 2016).

5.5 Association between Respiratory Symptoms with Socio-demographic Characteristics

Table 4.29 shows the result of association between respiratory symptoms with socio-demographic characteristics of the respondents. The male gender and respondent's smoking status were significantly associated with the respiratory problems which were listed as dry throat, influenza symptoms, sore throat, irritating cough, breathing difficulty and also respiratory infection. This shows male and respondents who were smoking was at higher risk of getting the respiratory problems.

Exposure to tobacco smoke can cause several health hazards include higher risk of getting asthma among children (Pietinalho, Pelkonen, & Rytilä, 2009). Children are especially the most vulnerable to the harmful effects of tobacco smoke as they were also exposed as passive smoker at home where mother, father and other family members were also smoking. People who were smoking was strongly associate with the respiratory health problems (Lindström et al., 2001). There were higher percentage of cigarette smoking of national average for men as compared for women (Higgins, Keller, & Metzner, 1977).

As regard to children, one of the most harmful elements that was associate with the respiratory problems was tobacco smoke (Pietinalho et al., 2009). Moreover, there was study found that children whom parents were smoking was at approximately twice the risk of having a serious respiratory infection (Li et al, 1999). In addition, tobacco smokes were the risk factors of similar magnitude of chronic productive cough and the association between smoking with chronic productive cough were also well known in the study (Lindström et al., 2001).

© COPYRIGHT UPM

CHAPTER 6

CONCLUSION, STUDY LIMITATION AND RECOMMENDATIONS

6.1 Conclusion

From the findings, it could be concluded that prevalence of the reported respiratory symptoms of respondents obtained for influenza symptoms was the highest symptoms with 60.8% prevalence. 13.0% experienced wheezing for the past 12 months. Only 11.4% who had diagnosed asthma and 51.5% had dry throat. 50.6% had sore throat whereas 27.7% reported on the occurrence of irritating cough and 23.8% experienced difficulty in breathing.

The order of the mean heavy metals concentration for the total of 6 different schools were Cr>Pb>Mn>Ni>As>Cd. Meanwhile, the mean heavy metals concentrations in settled dusts in 6 different schools were Mn>Pb>As>Ni>Cr>Cd in descending order. Other than that, results shows that there were 50.6% had a normal value of FeNO which is less than 20 ppb while the other 49.4% of the respondents had lung inflammation which the FeNO values exceeded 20 ppb.

© COPYRIGHT UPM

The relationship between air quality parameters with respiratory symptoms shows significant correlation between $PM_{2.5}$ and PM_{10} with wheezing for past 12 months, PM_{10} (Gravimetric) with diagnosed asthma, VOCs and formaldehyde with respiratory infection and also CO2 with influenza symptoms and irritating cough.

School B recorded the highest median for both Pb and Cd while School A had the highest median for Ni. The relationship between heavy metals in settled dusts showed significant correlation between Cr and Cd with diagnosed asthma, Mn, Pb, and As with influenza symptoms, Pb and As with respiratory infection and lastly, As with irritating cough.

The relationship between lung inflammations (FeNO) with heavy metals in indoor air only showed significant relationship between Pb with lung inflammation while heavy metals in settled dusts showed significant relationship with Ni, Pb, and As. The association between lung inflammations showed significant association with the male and also the respondents' smoking status.

For respiratory symptoms reported, the male gender showed significant association with influenza symptoms, sore throat and breathing difficulty while their smoking status showed significant association with dry throat, sore throat, irritating cough, breathing difficulty and also respiratory infection.

6.2 Study Limitation

There are some limitation throughout the study which are listed as below:

1. The study design is cross-sectional, hence precluding any causal inferences.
2. The self-reporting system of the symptoms by the respondents may lead to information biases as it can be when the respondents could not remember some important information related to the study or their answer given and not reflecting their actual situation.
3. Short duration and changing of weather might also influenced the data collection especially the temperature, humidity and the indoor air parameters.
4. There were only few study published on the association between lung inflammations with heavy metals, hence, difficult to find the references for the data interpretations.

UPM
© COPYRIGHT UPM

6.3 Recommendation

6.3.1 Recommendation for Further Study

1. Cohort studies is suggested to be done to follow up with the children health status.
2. It is suggested that when taking FeNO measurement as a screening tool for asthmatic children, other diseases such as allergic rhinitis, need to be considered as nearly half of the respondents had lung inflammations in this study.
3. It is recommended to select skin prick test as the other dependent variables to find the association of skin allergies with the concentration of dusts present in the school environment.
4. For further research, suggestion was to compare the health status of the school children between urban and sub-urban areas in Kota Kinabalu, Sabah.

© COPYRIGHT UPM

6.3.2 Recommendation for the School Management, Parents and Respondents

It is essential to take up action aimed to minimizing risk of the health problems of the school children. Some of the actions that are recommended for the school management, parents and also school children of the schools are as below:

1. School management should educate the students to clean the classrooms more often by doing housekeeping of the school building to reduce accumulated dusts contained of heavy metals in the classrooms.
2. School management also can provide more cleaners and cleaning materials to regularly cleaned the school building as it can decreased the level of exposure from the dusts contamination.
3. Students should also do less outdoor activities especially during hazy weather because they are more prone to inhale more heavy metals in dusts when they are doing exercise due to faster heartbeat and respiration rate.
4. Parents and family members of the school children is advised to stop smoking or smoking far from the children to protect their lung from contaminated with the smoke thus, caused inflammation that lead to asthmatic problems.
5. The students who are smoking are also advised to stop smoking as it can cause severe lung inflammation and lead to many other health and respiratory problems.

REFERENCES

Air Pollution Information System (APIS) (2018). Heavy Metals. Retrieved October 11, 2018 from http://www.apis.ac.uk/overview/pollutants/overview_HM.htm

Acosta, J. A., Faz, Á., Kalbitz, K., Jansen, B., & Martínez-Martínez, S. (2011). Heavy metal concentrations in particle size fractions from street dust of Murcia (Spain) as the basis for risk assessment. Journal of Environmental Monitoring, 13(11), 3087–3096. https://doi.org/10.1039/c1em10364d

Al-Rajhi, M. A., Seaward, M. R. D., & Al-Aamer, A. S. (1996). Metal levels in indoor and outdoor dust in Riyadh, Saudi Arabia. Environment International, 22(3), 315–324. doi:10.1016/0160-4120(96)00017-7

Al-Khashman OA (2004) Heavy metal distribution in dust, street dust and soils from the work place in Karak Industrial Estate, Jordan. Atmospheric Environment 38:6803–6812

Al-Khashman OA (2007). The investigation of metal concentrations in street dust samples in Aqaba city, Jordan. Environment Geochemical Health 29:197–207

Alloway, B. J. (2003). Heavy Metals in Soils. TrAC Trends in Analytical Chemistry, 22(2), VIII–IX. https://doi.org/10.1016/s0165-9936(96)90032-1

Annesi-Maesano, I., Hulin, M., Lavaud, F., Raherison, C., Kopferschmitt, C., de Blay, F., Denis, C. (2012). Poor air quality in classrooms related to asthma and rhinitis in primary schoolchildren of the French 6 Cities Study. Thoraxic, 67(8), 682–688. doi:10.1136/thoraxjnl-2011-200391

© COPYRIGHT UPM

Annesi-Maesano, I., Baiz, N., Banerjee, S., Rudnai, P., Rive, S., & the SINPHONIE Group. (2013). Indoor Air Quality and Sources in Schools and Related Health Effects. Journal of Toxicology and Environmental Health, Part B, 16(8), 491–550. doi:10.1080/10937404.2013.853609

Asher MI, Montefort S, Bjorksten B, Lai CK, Strachan DP, W. S. (2006). Worldwide time trends in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and eczema in childhood. Lancet, 368, 733–743.

Atkinson, R. W., Fuller, G. W., Anderson, H. R., Harrison, R. M., & Armstrong, B. (2010). Urban Ambient Particle Metrics and Health. Epidemiology, 21(4), 501–511. doi:10.1097/ede.0b013e3181debc88

ATSDR. Agency for toxic substances and disease registry. Toxicological Profile for Nickel. U.S. Department of Health and Human Services, Public Health Service, ATSDR. Atlanta, Georgia, USA: U.S. Government Printing Office; 2003. 5–16.

Bae, S., & Hong, Y. C. (2018). Health effects of particulate matter. Journal of the Korean Medical Association, 61(12), 749–755. https://doi.org/10.5124/jkma.2018.61.12.749

Banerjee ADK (2003) Heavy metal levels and solid phase speciation in street dusts of Delhi, India. Environment Pollution 123:95–105

Bazilio, A. & Weinrich, J. (2012). The Easy Guide To: Inductively Coupled Plasma Mass Spectrometry (ICP-MS). Retrieved December 27, 2018 from http://www.ecs.umass.edu/eve/facilities/equipment/ICPMS/ICPMS%20quick%20guide.pdf

Brown, D. M. (2000). Increased inflammation and intracellular calcium caused by ultrafine carbon black is independent of transition metals or other soluble components. Occupational and Environmental Medicine, 57(10), 685–691. doi:10.1136/oem.57.10.685

Bragoszewska, E., Mainka, A., Pastuszka, J. S., Lizończyk, K., & Desta, Y. G. (2018). Assessment of bacterial aerosol in a preschool, primary school and high school in Poland. Atmosphere, 9(3), 1–15. https://doi.org/10.3390/atmos903008

Buonanno, G., Marini, S., Morawska, L., & Fuoco, F. C. (2012). Individual dose and exposure of Italian children to ultrafine particles. Science of the Total Environment, 438, 271–277. https://doi.org/10.1016/j.scitotenv.2012.08.074

Burney, C. Luczynska, S. Chinn, D. J. (1994). The European Community Respiratory Health Survey II. European Respiratory Journal, 20(5), 1071–1079. https://doi.org/10.1183/09031936.02.00046802

Cadelis, G., Tourres, R., & Molinie, J. (2014). Short-term effects of the particulate pollutants contained in Saharan dust on the visits of children to the emergency department due to asthmatic conditions in Guadeloupe (French archipelago of the Caribbean). PLoS ONE, 9(3). https://doi.org/10.1371/journal.pone.0091136

Carroll, W. D. (2016). NIOX VERO: Individualized Asthma Management in Clinical Practice. Pulmonary Therapy, 2(2), 171–188. https://doi.org/10.1007/s41030-016-0018-y

Clausen, G., Toftum, J., Beko, G., 2009. Indoor Environment and Children's Health (IECH) - an ongoing epidemiological investigation on the association between

indoor environmental factors in homes and kindergartens and children's health and wellbeing. In: Paper read at 9th International Healthy Building at Syracuse, NY

Coastal Wiki (2018). Heavy Metals. Retrieved October 11, 2018 from http://www.coastalwiki.org/wiki/Heavy_metals

Duzgoren-Aydin NS, Wong CSC, Aydin A, Song Z, You M, Li XD (2006) Heavy metal contamination and distribution in the urban environment of Guangzhou, SE China. Environment Geochemical Health 28:375–391

De Burbure, C., Buchet, J. P., Bernard, A., Leroyer, A., Nisse, C., Haguenoer, J. M., … Mutti, A. (2003). Biomarkers of renal effects in children and adults with low environmental exposure to heavy metals. Journal of Toxicology and Environmental Health - Part A, 66(9), 783–798. https://doi.org/10.1080/15287390306384

de Kok, T. M. C. M., Driece, H. A. L., Hogervorst, J. G. F., & Briedé, J. J. (2006). Toxicological assessment of ambient and traffic-related particulate matter: A review of recent studies. Mutation Research - Reviews in Mutation Research, 613(2–3), 103–122. https://doi.org/10.1016/j.mrrev.2006.07.001

Department of Occupational Safety and Health (DOSH) (2005). Indoor Air Quality. Retrieved November 7, 2018 from http://www.dosh.gov.my/index.php/en/chemical-management/indoor-air-quality

Diane R. Gold, Andrew I. Damokosh, C. Arden Pope, Douglas W. Dockery, W. F. M. (1999). Particulate and Ozone Pollutant Effects on the Respiratory Function of

Children in Southwest Mexico City.

Duong, T. T. T., & Lee, B. K. (2011). Determining contamination level of heavy metals in road dust from busy traffic areas with different characteristics. Journal of Environmental Management, 92(3), 554–562. https://doi.org/10.1016/j.jenvman.2010.09.010

Dweik, R., Boggs, P., Erzurum, S., & Irvin, C. (2011). American Thoracic Society Documents-An Official ATS Clinical Practice Guideline: Interpretation of Exhaled Nitric Oxide Levels (FENO) for. American Thoracic Society Documents, 184, 602–615. https://doi.org/10.1164/rccm.912011ST

Environmental Protection Agency (USEPA) (2018). Fundamentals of Indoor Air Quality in Buildings. Retrieved October 11, 2018 from https://www.epa.gov/indoor-air-quality-iaq/fundamentals-indoor-air-quality-buildings

Esworthy R. (2013). Air quality: EPA's 2013 changes to the particulate matter (PM) standard. Congressional Research Service 7-5700, n. R42934; 2013. p. 6

Faiz Y, Tufail M, Javed MT, Chaudhry MM, Siddique N (2009) Road dust pollution of Cd, Cu, Ni, Pb and Zn along Islamabad Expressway, Pakistan. Microchemical Journal 92:186–192

Faiz, Y., Tufail, M., Javed, M. T., Chaudhry, M. M., & Naila-Siddique. (2009). Road dust pollution of Cd, Cu, Ni, Pb and Zn along Islamabad Expressway, Pakistan. Microchemical Journal, 92(2), 186–192. doi:10.1016/j.microc.2009.03.009

Godish, T. (2004) Air Quality, 4th edition, Boca Raton, FL, Lewis Publisher

Godri Pollitt, K. J., Maikawa, C. L., Wheeler, A. J., Weichenthal, S., Dobbin, N. A., Liu, L., & Goldberg, M. S. (2016). Trace metal exposure is associated with increased exhaled nitric oxide in asthmatic children. Environmental Health: A Global Access Science Source, 15(1), 1–11. https://doi.org/10.1186/s12940-016-0173-5

Guaita, R., Pichiule, M., Mate, T., Linares, C., & Diaz, J. (2011). Short-term impact of particulate matter (PM2.5) on respiratory mortality in Madrid. International Journal of Environmental Health Research, 21(4), 260–274. https://doi.org/10.1080/09603123.2010.544033

Guo, H., Lee, S.C., Li, W.M. and Cao, J.J. (2003) Source characterization of BTEX in indoor microenvironments in Hong Kong, Atmospheric Environment., 37, 73–82

Guo, H., Kwok, N. H., Cheng, H. R., Lee, S. C., Hung, W. T., & Li, Y. S. (2009). Formaldehyde and volatile organic compounds in Hong Kong homes: Concentrations and impact factors. Indoor Air, 19(3), 206–217. https://doi.org/10.1111/j.1600-0668.2008.00580.x

Han YM, Cao JJ, Posmentier ES, Fung K, Tian H, An ZS (2008) Particulate-associated potentially harmful elements in urban road dusts in Xi'an, China. Application Geochemical 23:835–845

Haber, L. T., Erdreicht, L., Diamond, G. L., Maier, A. M., Ratney, R., Zhao, Q., & Dourson, M. L. (2002). Hazard Identification and Dose Response of Inhaled Nickel-Soluble Salts. Regulatory Toxicology and Pharmacology, 31(2), 210–

230. https://doi.org/10.1006/rtph.2000.1377

Hasheminassab, S., Daher, N., Schauer, J. J., & Sioutas, C. (2013). Source apportionment and organic compound characterization of ambient ultrafine particulate matter (PM) in the Los Angeles Basin. Atmospheric Environment, 79, 529–539. doi:10.1016/j.atmosenv.2013.07.040

Health Effects Institute Special Report 17, 2010. Traffic-related Air Pollution: a Critical Review of the Literature on Emissions, Exposure, and Health Effects

Higgins, M. W., Keller, J. B., & Metzner, H. L. (1977). Smoking, Socioeconomic Status, and Chronic Respiratory Disease 12. 116, 403–410.

IARC. IARC Monograph on the Evaluation of Carcinogenic Risks to Humans. Lyans, France: International Agency for Research on Cancer; 1990. 318–411.

Janson, C., Kalm-Stephens, P., Foucard, T., Norbäck, D., Alving, K., & Nordvall, S. L. (2005). Exhaled nitric oxide levels in school children in relation to IgE sensitisation and window pane condensation. Respiratory Medicine, 99(8), 1015–1021. https://doi.org/10.1016/j.rmed.2005.02.003

Juda-Rezler, K., Reizer, M., & Oudinet, J. P. (2011). Determination and analysis of PM10 source apportionment during episodes of air pollution in Central Eastern European urban areas: The case of wintertime 2006. Atmospheric Environment, 45(36), 6557–6566. https://doi.org/10.1016/j.atmosenv.2011.08.020

Journal of Lung Disease & Treatment (2018). Lung Inflammation. Retrieved October 11, 2018 from https://www.omicsonline.org/scholarly/lung-inflammation-and-

treatment-journals-articles-ppts-list.php

Kelly, F. J., & Fussell, J. C. (2012). Size, source and chemical composition as determinants of toxicity attributable to ambient particulate matter. Atmospheric Environment, 60, 504–526. https://doi.org/10.1016/j.atmosenv.2012.06.039

Kim, Y.M., Harrad, S. and Harrison, R.M. (2001) Concentrations and sources of VOCs in urban domestic and public microenvironments, Environmental Science Technology, 35, 997–1004

Lai, H.K., Kendall, M., Ferrier, H., Lindup, I., Alm, S., Ha¨ nninen, O., Jantunen, M., Mathys, P., Colvile, R., Ashmore, M.R., Cullinan, P. and Nieuwenhuijsen, M.J. (2004) Personal exposures and microenvironment concentrations of PM2.5, VOC, NO2 and CO in Oxford, UK, Atmospheric Environment, 38, 6399–6410.

Lanphear, B., Matte, T., Rogers, J., Clickner, R. P., Dietz, B., Bornschein, R. L., et al. (1998). The contribution of leadcontaminated house dust and residential soil to children's blood lead levels: a pooled analysis of 12 epidemiologic studies. Environmental Research, 79, 51–68

Lanphear, B. P., Matte, T. D., Rogers, J., Clickner, R. P., Dietz, B., Bornschein, R. L., … Jacobs, D. E. (2002). The Contribution of Lead-Contaminated House Dust and Residential Soil to Children's Blood Lead Levels. Environmental Research, 79(1), 51–68. https://doi.org/10.1006/enrs.1998.3859

Latif, M. T., Yong, S. M., Saad, A., Mohamad, N., Baharudin, N. H., Mokhtar, M. B., & Tahir, N. M. (2013). Composition of heavy metals in indoor dust and their possible exposure: a case study of preschool children in Malaysia. Air Quality,

Atmosphere & Health, 7(2), 181–193. Doi:10.1007/s11869-013-0224-9

Legret, M., Pagotto, C., (1999). Evaluation of pollutant loadings in the runoff waters from a major rural highway. Science of the Total Environment 235, 143e150

Leung, R., and Ho, P., 1994, Asthma, allergy, and atopy in three soutneast Asian populations Thorax 49:1205-1210

Li JS, Peat JK, Xuan W, & Berry G. (1999). Meta-analysis on the association between environmental tobacco smoke (ETS) exposure and the prevalence. Pediatric Pulmonology, 27(1), 5–13.

Lim, F. L., Hashim, Z., Md Said, S., Than, L. T. L., Hashim, J. H., & Norbäck, D. (2015). Sick building syndrome (SBS) among office workers in a Malaysian university - Associations with atopy, fractional exhaled nitric oxide (FeNO) and the office environment. Science of the Total Environment, 536, 353–361. https://doi.org/10.1016/j.scitotenv.2015.06.137

Lindström, M., Kotaniemi, J., Jönsson, E., & Lundbäck, B. (2001). Smoking, respiratory symptoms, and diseases: A comparative study between northern Sweden and northern Finland: Report from the FinEsS study. Chest, 119(3), 852–861. https://doi.org/10.1378/chest.119.3.852

Liu, X., Zhai, Y., Zhu, Y., Liu, Y., Chen, H., Li, P., … Zeng, G. (2015). Mass concentration and health risk assessment of heavy metals in size-segregated airborne particulate matter in Changsha. Science of the Total Environment, 517, 215–221. https://doi.org/10.1016/j.scitotenv.2015.02.066

Lu X, Wang L, Li LY, Lei K, Huang L, Kang D (2010) Multivariate statistical analysis of heavy metals in street dust of Baoji, NW China. Journal Hazard Mater 173:744–749

Madureira, J., Paciência, I., & Fernandes, E. de O. (2012). Levels and Indoor–Outdoor Relationships of Size-Specific Particulate Matter in Naturally Ventilated Portuguese Schools. Journal of Toxicology and Environmental Health, Part A, 75(22-23), 1423–1436. doi:10.1080/15287394.2012.721177

Madureira, J., Paciência, I., Rufo, J., Ramos, E., Barros, H., Teixeira, J. P., & de Oliveira Fernandes, E. (2015). Indoor air quality in schools and its relationship with children's respiratory symptoms. Atmospheric Environment, 118, 145–156. https://doi.org/10.1016/j.atmosenv.2015.07.028

Malinovschi, A., Alving, K., Kalm-Stephens, P., Janson, C., & Nordvall, L. (2012). Increased exhaled nitric oxide predicts new-onset rhinitis and persistent rhinitis in adolescents without allergic symptoms. Clinical and Experimental Allergy, 42(3), 433–440. https://doi.org/10.1111/j.1365-2222.2011.03947.x

Massolo, L., Rehwagen, M., Porta, A., Ronco, A., Herbarth, O., & Mueller, A. (2009). Indoor-outdoor distribution and risk assessment of volatile organic compounds in the atmosphere of industrial and urban areas. Environmental Toxicology, 25(4), 339–349. doi:10.1002/tox.20504

McCormack, M. C., Breysse, P. N., Matsui, E. C., Hansel, N. N., Peng, R. D., Curtin-Brosnan, J., ... Diette, G. B. (2011). Indoor particulate matter increases asthma morbidity in children with non-atopic and atopic asthma. Annals of Allergy,

Asthma and Immunology, 106(4), 308–315. https://doi.org/10.1016/j.anai.2011.01.015

MedicineNet (2018). Medical Definition of Health Risk. Retrieved October 11, 2018 from https://www.medicinenet.com/script/main/art.asp?articlekey=205099

Mendell, M. J. (2007). Indoor residential chemical emissions as risk factors for respiratory and allergic effects in children: A review. Indoor Air, 17(4), 259–277. https://doi.org/10.1111/j.1600-0668.2007.00478.x

Mendall, M. J., & Heath, G. A. (2005). Do indoor pollutants and thermal conditions in schools influence student performance? A critical review of the literature. Indoor Air, 15(1), 27–52.

Meza-Figueroa D, De la O-Villanueva M, De la Parra ML (2007) Heavy metal distribution in dust from elementary schools in Hermosillo, Sonora, Me ´xico. Atmospheric Environment 41:276–288

Mitchell, C. S., Zhang, J., Sigsgaard, T., Jantunen, M., Lioy, P. J., Samson, R., & Karol, M. H. (2007). Current state of the science: Health effects and indoor environmental quality. Environmental Health Perspectives, 115(6), 958–964. https://doi.org/10.1289/ehp.8987

National Centre for Biotechnology Information (NCBI) (2014). Heavy Metals Toxicity and the Environment. Retrieved October 11, 2018 from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4144270/

Norbäck, D., Hashim, J. H., Hashim, Z., & Ali, F. (2017). Volatile organic compounds

(VOC), formaldehyde and nitrogen dioxide (NO2) in schools in Johor Bahru, Malaysia: Associations with rhinitis, ocular, throat and dermal symptoms, headache and fatigue. Science of the Total Environment, 592, 153–160. https://doi.org/10.1016/j.scitotenv.2017.02.215

Norbäck, D., Hashim, J. H., Hashim, Z., Cai, G. H., Sooria, V., Ismail, S. A., & Wieslander, G. (2017). Respiratory symptoms and fractional exhaled nitric oxide (FeNO) among students in Penang, Malaysia in relation to signs of dampness at school and fungal DNA in school dust. Science of the Total Environment, 577, 148–154.

Pietinalho, A., Pelkonen, A., & Rytilä, P. (2009). Linkage between smoking and asthma. Allergy: European Journal of Allergy and Clinical Immunology, 64(12), 1722–1727. https://doi.org/10.1111/j.1398-9995.2009.02208.x

Pike, K., Selby, A., Price, S., Warner, J., Connett, G., Legg, J., … Roberts, G. (2013). Exhaled nitric oxide monitoring does not reduce exacerbation frequency or inhaled corticosteroid dose in paediatric asthma: A randomised controlled trial. Clinical Respiratory Journal, 7(2), 204–213. https://doi.org/10.1111/j.1752-699X.2012.00306.x

Querol, X., Alastuey, A., Moreno, T., Viana, M. M., Castillo, S., Pey, J., … Sánchez de la Campa, A. (2008). Spatial and temporal variations in airborne particulate matter (PM 10 and PM 2.5) across Spain 1999-2005. Atmospheric Environment, 42(17), 3964–3979. https://doi.org/10.1016/j.atmosenv.2006.10.071

Ramalho, O., Wyart, G., Mandin, C., Blondeau, P., Cabanes, P. A., Leclerc, N., …

Redaelli, M. (2015). Association of carbon dioxide with indoor air pollutants and exceedance of health guideline values. Building and Environment, 93(P1), 115–124. https://doi.org/10.1016/j.buildenv.2015.03.018

Rasmussen, P., Subramanian, K., & Jessiman, B. (2001). A multielement profile of house dust in relation to exterior dust and soils in the city of Ottawa, Canada. Science of the Total Environment, 267, 125–140

Rehman, K., Fatima, F., Waheed, I., & Akash, M. S. H. (2018). Prevalence of exposure of heavy metals and their impact on health consequences. Journal of Cellular Biochemistry, 119(1), 157–184. https://doi.org/10.1002/jcb.26234

Samet, J., and D. Krewski. 2007. Health effects associated with exposure to ambient air pollution. Journal Toxicology Environmental Health A 70: 227–242.

Sanborn MD, Abelsohn A, Campbell M, Weir E (2002). Identifying and managing adverse environmental health effects: 3. Lead exposure. Can Medical Association Journal 166:1287–92

Sawant, A.A., Na, K., Zhu, X., Cocker, K., Butt, S., Song, C. and Cocker, D.R., III. (2004) Characterization of PM2.5 and selected gas-phase compounds at multiple indoor and outdoor sites in Mira Loma, California, Atmospheric Environment, 38, 6269– 6278

Science Daily (2018). Heavy Metals. Retrieved October 11, 2018 from https://www.sciencedaily.com/terms/heavy_metals.htm

Shrivastava, R., Upreti, R. K., Seth, P. K., & Chaturvedi, U. C. (2002). Effects of

chromium on the immune system. FEMS Immunology and Medical Microbiology, 34(1), 1–7. https://doi.org/10.1016/S0928-8244(02)00345-0

Silkoff, P. E. (1999). Recommendations for standardized procedures for the online and offline measurement of exhaled lower respiratory nitric oxide and nasal nitric oxide in adults and children-1999. American Journal of Respiratory and Critical Care Medicine, 160(6), 2104–2117. https://doi.org/10.1164/ajrccm.160.6.ats8-99

Simoni, M., Annesi-Maesano, I., Sigsgaard, T., Norback, D., Wieslander, G., Nystad, W., Canciani, M., Sestini, P., Viegi, G., 2010. School air quality related to dry cough, rhinitis and nasal patency in children. European Respiratory Journal 35 (4), 742e749

Skoog, D. A., Holler, F. J., & Crouch, S. R. (2007). The easy guide to: Inductively Coupled Plasma Mass Spectrometery (ICP-MS). Principles of Instrumental Analysis, (December), 1–11. https://doi.org/10.1088/0957-4484/24/4/045303

Smedje, G. (1997). Subjective indoor air quality in schools in relation to exposure. Indoor Air, 7(2), 143–150. https://doi.org/10.1111/j.1600-0668.1997.00009.x.

Son B, Breysse P, Yang W. (2003). Volatile organic compounds concentration in residential indoor and outdoor and its personal exposure in Korea. Environmental International 29:79–85

Sternbeck, J., Sjödin, Å., & Andréasson, K. (2002). Metal emissions from road traffic and the influence of resuspension - Results from two tunnel studies. Atmospheric Environment, 36(30), 4735–4744. https://doi.org/10.1016/S1352-2310(02)00561-7

Sykes, C. P., Claeys-Thoreau, F., & Petit, D. (2009). Blood lead levels and cosmetics. International Journal of Cosmetic Science, 22(6), 395–397. https://doi.org/10.1111/j.1468-2494.2000.00077.x

Tan, S. Y., Praveena, S. M., Abidin, E. Z., & Cheema, M. S. (2016). A review of heavy metals in indoor dust and its human health-risk implications. Reviews on Environmental Health, 31(4), 447–456. https://doi.org/10.1515/reveh-2016-0026

Tchounwou PB, Patlolla AK, Centeno JA. Carcinogenic and systemic health effects associated with arsenic exposure – a critical review. Toxicology Pathology 2003;31:575–88

Thakur M, Deb MK, Imai S, Suzuki Y, Ueki K, Hasegawa A (2004) Load of heavy metals in the airborne dust particulates of an urban city of central India. Environmental Monitoring Assess 95:257–268

Thomas Brinkhoff (2019). Kota Kinabalu. District in Malaysia. Retrieved 7 April 2019 from https://www.citypopulation.de/php/malaysia-admin.php?adm2id=1207

Tong STY, Lam KC (1998) Are nursery schools and kindergartens safe for our kids? The Hong Kong study. Science Total Environment 216:217–225

Turner, A., & Ip, K. (2007). Bioaccessibility of metals in dust from the indoor environment: application of a physiologically based extraction test. Environmental Science & Technology, 41, 7851–7856

Wang S, Ang HM, Tade MO. (2007). Volatile organic compounds in indoor environment and photocatalytic oxidation: State of the art. Environmental

International 33 694–705

Wang, P., & Zhao, W. (2008). Assessment of ambient volatile organic compounds (VOCs) near major roads in urban Nanjing, China. Atmospheric Research, 89(3), 289–297. https://doi.org/10.1016/j.atmosres.2008.03.013

World Health Organization (WHO). Health effects of particulate matter. Policy implications for countries in Eastern Europe, Caucasus and central Asia. Copenhagen: WHO Regional Office for Europe; 2013 [http://www.euro.who.int/__data/assets/pdf_file/0006/189051/Health-effects-of-particulate-matter-final-Eng.pdf, accessed October 25, 2018]

WHO, Solasaari-Pekki, T., & Lehtinen, S. (1996). Biological Monitoring of Chemical Exposure in the Workplace Guidelines World Health Organization Geneva 1996 (Vol. 1). Retrieved from http://apps.who.int/iris/bitstream/10665/41856/1/WHO_HPR_OCH_96.1.pdf

Xu, H., Guinot, B., Cao, J., Li, Y., Niu, X., Ho, K. F., … Gao, J. (2018). Source, health risk and composition impact of outdoor very fine particles (VFPs) to school indoor environment in Xi'an, Northwestern China. Science of the Total Environment, 612, 238–246. https://doi.org/10.1016/j.scitotenv.2017.08.101

Yaaqub, R.R., Davies, T.D., Jickells, T.D. & Miller, J.M. (1991). Trace elements in daily collected aerosols at a site in south-eastern England. Atmospheric Environment, 25: 985-996

Yip, F. Y., Keeler, G. J., Dvonch, J. T., Robins, T. G., Parker, E. A., Israel, B. A., & Brakefield-Caldwell, W. (2004). Personal exposures to particulate matter among

children with asthma in Detroit, Michigan. Atmospheric Environment, 38(31), 5227–5236. https://doi.org/10.1016/j.atmosenv.2004.06.006

Young, T. M., Heeraman, D. A., Sirin, G., & Ashbaugh, L. L. (2002). Resuspension of soil as a source of airborne lead near industrial facilities and highways. Environmental Science and Technology, 36(11), 2484–2490. https://doi.org/10.1021/es015609u

Zhao, Z., Huang, C., Zhang, X., Xu, F., Kan, H., Song, W., … Norback, D. (2013). Fractional exhaled nitric oxide in Chinese children with asthma and allergies-A two-city study. Respiratory Medicine, 107(2), 161–171. https://doi.org/10.1016/j.rmed.2012.11.001

Zheng, N., Liu, J., Wang, Q., & Liang, Z. (2010). Health risk assessment of heavy metal exposure to street dust in the zinc smelting district, Northeast of China. Science of the Total Environment, 408(4), 726–733. https://doi.org/10.1016/j.scitotenv.2009.10.075

UPM
© COPYRIGHT UPM

Appendix A

Gantt Chart

© COPYRIGHT UPM

Gantt Chart

Month / Milestone	September	October	November	December	January	February	March	April	May	June
Proposal Preparation										
Proposal Submission to Ethical Committee										
Presentation to Ethical Committee										
Permission from Ministry of Education										
Questionnaire Administration										
Clinical Measurement										
Environmental Measurement										
Data Analysis										
Report Writing										
Publication										

Appendix B

Ethics Approval UPM

© COPYRIGHT UPM

ETHICS COMMITTEE FOR RESEARCH INVOLVING HUMAN SUBJECTS
(JKEUPM)
UNIVERSITI PUTRA MALAYSIA

Research title	:	**Pollutants and Heavy Metals Concentration In Indoor Air And Dusts From School Environment in Kota Kinabalu, Sabah: Association With Lung Inflammation and Other Reported Health Symptoms Among The Students**
Study Site	:	**Kota Kinabalu, Sabah**
JKEUPM Ref No.	:	**JKEUPM-2018-365**
Researcher	:	**Nur Haslyna binti Mohd Hamizul**
Supervisor	:	**Prof. Dr. Zailina binti Hashim**

Documents received and reviewed with reference to the above study:

1. Ethics Application Form, Version 1 dated 29/10/2018
2. Respondent Information Sheet & Guardian's/Parent's Consent (Malay), Version 2 dated 3/1/2019
3. Respondent Information Sheet & Consent (Malay), Version 2 dated 3/1/2019
4. Proposal (English), Version 2 dated 3 /1/2019
5. Questionnaires/ Interviews (Malay), Version 1 dated 29/10/2018
6. Curriculum Vitae of:
    a. Prof. Dr. Zailina binti Hashim
    b. Assoc Prof. Dr. Shamsul Bahari bin Shamsudin

The University Research Ethics Committee, Universiti Putra Malaysia (JKEUPM) operates in accordance to the ICH-GCP Guidelines.

Decision by JKEUPM:

[X] Approved

[X] **Permission MUST BE OBTAINED from the respective hospitals/ institutions before conducting the research**

[ ] Disapproved

Please note that the approval is **VALID UNTIL 7 JANUARY 2020**

© COPYRIGHT UPM

Approved at JKEUPM Meeting on 19 December 2018, attended by:

NAME	DESIGNATION	GENDER	TICK IF PRESENT
Prof. Dr Zamberi Sekawi	Professor of Medical Microbiology & Deputy Dean of Academic (Medicine), Faculty of Medicine and Health Sciences	Male	√
Prof. Dr. Johnson Stanslas	Professor of Pharmacology, Department of Medicine, Faculty of Medicine and Health Sciences	Male	
Assoc Prof. Dr. Hejar Abd Rahman	Associate Professor of Public Health Medicine, Department of Community Health, Faculty of Medicine and Health Sciences	Female	
Assoc. Prof. Dr. Normala Ibrahim	Associate Professor of Psychiatry & Deputy Dean (Research and Internationalization), Faculty of Medicine and Health Sciences	Female	√
Assoc. Prof. Dr. Wan Aliaa Wan Sulaiman	Associate Professor of Neurology, Department of Medicine, Faculty of Medicine and Health Sciences	Female	
Assoc. Prof Dr Shamala Paramasivam	Associate Professor of English Language, Department of English, Faculty of Modern Languages and Communication	Female	√
Assoc. Prof Dr Muhamamd Najib Mohamad Alwi (Independent Member)	Associate Professor of Psychiatry and Psychiatric Consultant, Cyberjaya University College of Medical Sciences (CUCMS)	Male	√
Dr. Salmiah Md. Said	Senior Lecturer of Public Health Medicine Specialist, Department of Community Health, Faculty of Medicine and Health Sciences	Female	
Dr. Hayati Kadir@Shahar	Senior Lecturer of Public Health Medicine Specialist, Department of Community Health, Faculty of Medicine and Health Sciences	Female	
Dr. Rosliza Abdul Manaf	Senior Lecturer of Public Health Medicine Specialist, Department of Community Health, Faculty of Medicine and Health Sciences	Female	
Dr. Rojanah Kahar	Senior Lecturer of Human Development and Family Studies, Faculty of Human Ecology	Female	
Dr. Syamsiah Mashohor	Senior Lecturer of Computer Engineering, Department of Computer and Communication Systems, Faculty of Engineering	Female	√
Dr. Zatul Himmah binti Adnan	Senior Lecturer of Development of Government and Civilisation Studies, Faculty of Human Ecology	Female	√
En. Subramaniam s/o Appavoo (Independent Member/Layperson)	Retired Teacher	Male	√
Assoc Prof. Dr. Juliana Jalaludin	Senior Lecturer of Department of Environmental and Occupational Health, Faculty of Medicine and Health Sciences	Female	√

Appendix C

Approval from Ministry of Education

© COPYRIGHT UPM

KEMENTERIAN PENDIDIKAN MALAYSIA
BAHAGIAN PERANCANGAN DAN PENYELIDIKAN DASAR PENDIDIKAN
ARAS 1-4, BLOK E8
KOMPLEKS KERAJAAN PARCEL E
PUSAT PENTADBIRAN KERAJAAN PERSEKUTUAN
62604 PUTRAJAYA

TEL : 0388846591
FAKS : 0388846579

Ruj. Kami : KPM.600-3/2/3-eras(2484)
Tarikh : 29 November 2018

NUR HASLYNA BINTI MOHD HAMIZUL
NO. KP : 960307055160

NO 401 BLOK 2, KUARTERS INSTITUSI PENDIDIKAN SEKSYEN 17,
JALAN KAP 17/17A, SEKSYEN 17, SHAH ALAM 40200 SHAH ALAM
SELANGOR

Tuan,

KELULUSAN UNTUK MENJALANKAN KAJIAN DI SEKOLAH, INSTITUT PENDIDIKAN GURU, JABATAN PENDIDIKAN NEGERI DAN BAHAGIAN DI BAWAH KEMENTERIAN PENDIDIKAN MALAYSIA

Perkara di atas adalah dirujuk.

2. Sukacita dimaklumkan bahawa permohonan tuan untuk menjalankan kajian seperti di bawah telah diluluskan.

" KANDUNGAN ZARAH TERAMPAI (PM10) DAN LOGAM BERAT DALAM KUALITI UDARA DAN DEBU DARIPADA PERSEKITARAN SEKOLAH DI KOTA KINABALU, SABAH : HUBUNGAN ANTARA KERADANGAN PARU-PARU DAN RISIKO KESIHATAN YANG LAIN DALAM KALANGAN PELAJAR. "

3. Kelulusan adalah berdasarkan kepada kertas cadangan penyelidikan dan instrumen kajian yang dikemukakan oleh tuan kepada bahagian ini. Walau bagaimanapun kelulusan ini bergantung kepada kebenaran Jabatan Pendidikan Negeri dan Pengetua / Guru Besar yang berkenaan.

4. Surat kelulusan ini sah digunakan bermula dari **14 Januari 2019** hingga **8 Februari 2019** .

5. Tuan dikehendaki menyerahkan senaskhah laporan akhir kajian dalam bentuk *hardcopy* bersama salinan *softcopy* berformat pdf dalam CD kepada Bahagian ini.Tuan juga diingatkan supaya mendapat kebenaran terlebih dahulu daripada Bahagian ini sekiranya sebahagian atau sepenuhnya dapatan kajian tersebut hendak diterbitkan di mana-mana forum, seminar atau diumumkan kepada media massa.

Sekian untuk makluman dan tindakan tuan selanjutnya. Terima kasih.

"BERKHIDMAT UNTUK NEGARA"

Saya yang menjalankan amanah,

Ketua Sektor
Sektor Penyelidikan dan Penilaian
b.p. Pengarah
Bahagian Perancangan dan Penyelidikan Dasar Pendidikan
Kementerian Pendidikan Malaysia

salinan kepada:-

JABATAN PENDIDIKAN SABAH

• SURAT INI DIJANA OLEH KOMPUTER DAN TIADA TANDATANGAN DIPERLUKAN •

© COPYRIGHT UPM

Appendix D

Approval from District of Education Office, Kota kinabalu, Sabah

© COPYRIGHT UPM

Appendix E

Consent Form

© COPYRIGHT UPM

JAWATANKUASA ETIKA UNIVERSITI UNTUK
PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

BORANG 2.5: PENERANGAN DAN PERSETUJUAN IBUBAPA/PENJAGA

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1.TAJUK KAJIAN

Faktor kualiti udara serta kesan alahan dan asma dalam kalangan pelajar sekolah di Malaysia.

2. PENGENALAN

Penyelidikan ini akan dijalankan untuk mengkaji hubungan di antara pendedahan terhadap pencemaran udara dengan asma, alahan dan simptom-simptom pernafasan dikalangan kanak-kanak sekolah menengah.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Penyertaan dalam kajian ini adalah secara sukarela dan tidak akan ada sebarang pembayaran dikenakan. Persetujuan dari ibu bapa atau penjaga diperlukan bagi setiap peserta sebelum menyertai kajian ini. Semua peserta akan menerima satu cenderamata sebagai tanda penghargaan menyertai sesi penyelidikan ini. Tiada pampasan tambahan akan diberikan.

Peserta yang memenuhi kriteria inklusi akan menjalani beberapa prosedur penyelidikan termasuk:

1. Isikan soal selidik yang dibantu oleh penyelidik.
2. Ujian penilaian nitrogen oksida dalam hembusan nafas (FeNO), pelajar akan diminta untuk menarik nafas sedalam-dalam dan menghembus nafas dengan aliran berterusan ke dalam alat penganalisa. Pelajar akan mengulangi proses ini selama tiga kali untuk mendapatkan hasil purata. Prosedur ini hanya mengambil masa 5 minit.
3. Ujian untuk mengukur kadar masa bagi selaput mata untuk pulih, satu alat khas akan didekatkan kepada mata dan pelajar akan diminta untuk melihat ke dalam alat tersebut. Penilaian akan dibuat oleh penyelidik. Prosedur ini tidak menyakitkan dan hanya mengambil masa dalam 5 minit.
4. Ujian fungsi paru-paru, pelajar akan bernafas melalui mulut yang dipasang pada alat rakaman (spirometer). Pelajar akan melakukan ujian selama 3 kali untuk hasil purata.
5. Ujian alahan (hama rumah, debunga yang berkaitan, kucing dan lipas) hanya akan dilakukan pada kulit tangan peserta. Jumlah kecil alergen (hama rumah, debunga yang berkaitan, kucing, dan lipas) dalam bentuk cecair akan dimasukkan ke dalam lapisan atas kulit dengan membuat tusukan kecil. Pelajar akan dipantau dengan teliti untuk melihat bagaimana reaksi kulit terhadap alergen selama 20 minit. Prosedur ini akan dijalankan oleh pegawai perubatan yang pengalaman.

© COPYRIGHT UPM

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Subjek yang mempunyai fizikal yang normal dan sihat boleh menyertai kajian ini secara sukarela selepas mendapat keizinan daripada ibu/bapa atau penjaga. Subjek mestilah pelajar Tingkatan 2 yang telah bersekolah di sekolah yang sama sejak Tingkatan 1. Selain itu, individu yang mempunyai penyakit kronik seperti penyakit jantung, hipertensi dan kelainan dada fizikal kongenital tidak akan dimasukkan dalam kajian ini.

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANAK/JAGAAN SAYA SEBAGAI PESERTA?

Hasil kajian yang bakal diperolehi daripada ujian kesihatan percuma yang akan dijalankan boleh membantu pelajar dan ibu bapa untuk mengetahui status keadaan kesihatan pelajar tanpa sebarang kos. Pihak pengurusan sekolah juga akan mendapat manfaat maklumat kadar pencemaran udara di sekolah dan tahap kesihatan pelajar tanpa perlu mengeluarkan sebarang kos. Di samping itu, kami berharap hasil kami akan menambah pengetahuan mengenai hubungkait persekitaran sekolah terhadap alergi dan asma.

b) KEPADA PENYELIDIK?

Hasil dari kajian ini akan memberikan maklumat penting dalam usaha untuk membina pangkalan data komprehensif untuk memantau kualiti udara dalaman di kalangan kanak-kanak. Selain itu,melalui kajian ini juga akan memberikan pemahaman yang lebih baik dan keupayaan yang lebih baik untuk mengenal pasti pencemar toksik semasa dan mengesyorkan strategi yang berkesan untuk mengurangkan pencemaran udara dalaman.

6. ADAKAH IA BERISIKO?

Peserta tidak akan mengalami apa-apa risiko dalam menghadiri set soal selidik yang hanya memerlukan anda menyatakan butiran peribadi, sejarah perubatan, pendedahan kepada alergen dan gejala yang berpengalaman berkaitan dengan pencemaran udara dalaman.

Begitu juga dengan ujian kadar nitrogen oksida dalam hembusan nafas (FeNO), ujian fungsi paru-paru dan ujian kadar masa bagi selaput mata untuk pulih, tidak ada sebarang risiko yang akan berlaku sepanjang prosedur-prosedur ini dijalankan. Semua prosedur yang bakal dijalankan adalah seragam dan selamat.

Prosedur ini akan dilakukan oleh ahli perubatan dan teknologi yang telah terlatih dan mempunyai pengalaman yang mencukupi dalam prosedur. Pegawai perubatan akan berada di tempat proses mengaruhkan kahak setiap masa semasa prosedur dijalankan.

Manakala untuk prosedur ujian alahan, terdapat risiko anafilaksi (reaksi di dalam salur darah) yang sangat rendah. Prosedur ini akan dijalankan oleh pegawai perubatan yang terlatih dan sebagai langkah keselamatan ubat alahan akan disediakan jika berlaku anafilaksi. Disamping itu pemantauan akan dibuat terhadap semua peserta untuk tempoh 40 minit selepas prosedur dijalankan.

Secara keseluruhannya, pihak penyelidik akan menggunakan pegawai perubatan dan ahli teknologi perubatan yang terlatih dan berpengalaman untuk menjalankan semua prosedur klinikal terhadap peserta. Pihak penyelidik juga akan menyediakan ambulance sebagai langkah berjaga-jaga jika berlaku sebarang risiko yang tidak diingini.

Pihak penyelidik juga akan menyediakan Insuran Liabiliti Awam untuk setiap peserta jika berlaku sebarang kecelakaan sepanjang tempoh prosedur klinikal ini dijalankan. Sebarang tuntutan boleh dibuat berdasarkan terma dan syarat yang telah ditetapkan oleh pihak pembekan Insuran Liabiliti Awam tersebut.

Diakhir proses penyelidikan, semua peserta akan diberi cenderamata sebagai tanda penghargaan daripada pihak penyelidik di atas kesudian menjadi peserta secara sukarela.

7. ADAKAH MAKLUMAT DAN IDENTITI ANAK/JAGAAN SAYA KEKAL RAHSIA?

Semua maklumat peserta adalah rahsia. Hanya penyelidik yang terlibat dalam kajian ini dan mereka yang bertanggungjawab untuk penyelidikan akan mempunyai akses kepada maklumat yang anda berikan. Keputusan umumnya akan diterbitkan sebagai ringkasan perbincangan, bukan transkrip / balasan individu. Bahan penerbitan tidak akan dikenal pasti nama atau dengan apa cara lain yang mana peserta dapat dikenal pasti oleh pembaca laporan tersebut.

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN TAMBAHAN SEPANJANG PENYELIDIKAN INI?

Jika anda mempunyai pertanyaan, sila hubungi:

No	Nama	Alamat	No Tel.Bimbit/ No Tel. Pejabat	E-mail
1	Prof. Dr. Zailina Hashim	Jabatan Kesihatan Persekitaran & Pekerjaan Faculti Perubatan & Sains Kesihatan, UPM Serdang	017- 6361367/ 03-947240	zailina@upm.edu.my
2	Nur Haslyna binti Mohd Hamizul	Jabatan Kesihatan Persekitaran & Pekerjaan Faculti Perubatan & Sains Kesihatan, UPM Serdang	018-2182320	nurhaslynamh@gmail.com
3	Nur Shahira binti Mohamad Fadzil	Jabatan Kesihatan Persekitaran & Pekerjaan Fakulti Perubatan & Sains Kesihatan, UPM Serdang	011-40685226	nurshahirafadzil@gmail.com
4	Siti Raihan binti Mohd Fuad	Jabatan Kesihatan Persekitaran & Pekerjaan Fakulti Perubatan & Sains Kesihatan, UPM Serdang	017-7527076	sitiraihanmohdfuad@gmail.com
5	Anis Zahira binti Zainudin	Jabatan Kesihatan Persekitaran & Pekerjaan Fakulti Perubatan & Sains Kesihatan, UPM Serdang	013-2803841	anisiera95@gmail.com

Nota: Borang penerangan dan persetujuan ibu bapa ini adalah gabungan daripada empat (4) kajian pelajar.

Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini.....

© COPYRIGHT UPM

9. PERSETUJUAN

Saya..... No Kad Pengenalan. .....
beralamat.....
.....dengan ini secara sukarela bersetuju membenarkan *anak / jagaan saya ..... menyertai **penyelidikan tersebut di atas *(klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).**

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti yang tercatat dalam Helaian Penerangan). Saya memahami bahawa *anak / jagaan saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti *anak / jagaan saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang **melibatkan** *anak / jagaan saya.

I setuju/tidak bersetuju untuk imej/gambar/rakaman video/ rakaman suara berkaitan dengan anak/ jagaan saya digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan .....
(*Ibubapa/ Penjaga*)

Tarikh :.....

Tandatangan .....
(*Saksi*)

Nama :.....

No. K/P: .....

Saya mengesahkan bahawa saya telah menerangkan kepada ibubapa/penjaga responden mengenai sifat dan tujuan penyelidikan tersebut di atas.

Tarikh .....

Tandatangan .....
(*Penyelidik*)

MAKLUMAT TAMBAHAN

Berikut adalah maklumat tambahan mengenai prosedur-prosedur terlibat. Peserta akan menjalani penilaian klinikal yang mudah pada nitrogen oksida (NO) dalam hembusan nafas (FeNO) dengan menggunakan alat penganalisa seperti dicadangkan American Thoracic Society (ATS). Peserta akan diminta untuk menarik nafas sedalam-dalam dan menghembus nafas dengan aliran berterusan ke dalam corong mulut khas alat penganalisa. Peserta perlu mengulangi proses ini selama tiga kali untuk mendapatkan hasil purata. Prosedur ini hanya mengambil masa 5 minit.

Ujian Spirometry (ujian fungsi paru-paru) dilakukan selepas seperti yang dicadangkan oleh American Thoracic Society, 1987. Spirometer telah dikalibrasi terlebih dahulu dengan menyuntikkan 3 liter udara ke dalam spirometer menggunakan jarum 3L. Untuk ujian, pelajar akan bernafas melalui mulut yang dipasang pada alat rakaman (spirometer). Untuk mendapatkan hasil yang terbaik, semua responden melakukan ujian selama 3 kali. Maklumat yang dikumpul oleh spirometer dicetak pada carta yang disebut spirogram.

Peserta akan menjalani satu ujian klinikal yang mudah dan selamat menggunakan alatan khas, Tearscope Plus untuk mengukur kadar masa bagi selaput mata untuk pulih (Tear Film Break Up Time). Peserta akan diberi penerangan dan alatan khas ini akan didekatkan kepada mata dan peserta akan diminta untuk melihat kedalam alat tersebut. Penilaian akan dibuat oleh penyelidik. Prosedur ini tidak menyakitkan dan hanya mengambil masa dalam 5 minit.

Penilaian klinikal ujian alergi hanya akan dilakukan pada kulit peserta. Jumlah kecil alergen (hama rumah, debunga yang berkaitan, kucing dan lipas) dalam bentuk cecair akan dimasukkan ke dalam lapisan atas kulit dengan membuat tusukan kecil. Peserta akan dipantau dengan teliti untuk melihat bagaimana reaksi kulit terhadap alergen. Selepas 20 minit, diameter wheal akan diukur. Prosedur ini akan dijalankan oleh pegawai perubatan yang pengalaman.

Selain langkah keselamatan yang dijelaskan seperti di atas, pihak penyelidik akan menyediakan pegawai perubatan, penolong pegawai perubatan/ jururawat yang terlatih dan bertauliah untuk membantu dan memantau semua prosedur klinikal yang dinyatakan di atas. Pihak penyelidik juga akan menyediakan insuran liabiliti untuk setiap peserta jika berlaku sebarang perkara yang tidak diingini. Sebagai langkah keselamatan yang terakahir, sebuah ambulance akan ditempatkan di lokasi persempalan setiap masa.

© COPYRIGHT UPM

JAWATANKUASA ETIKA UNIVERSITI UNTUK PENYELIDIKAN MELIBATKAN MANUSIA (JKEUPM)
UNIVERSITI PUTRA MALAYSIA, 43400 UPM SERDANG,
SELANGOR, MALAYSIA

BORANG 2.4: PENERANGAN DAN PERSETUJUAN RESPONDEN

Sila baca maklumat berikut dengan teliti. Sekiranya anda mempunyai sebarang pertanyaan, sila kemukakan kepada penyelidik.

1.TAJUK KAJIAN

Faktor kualiti udara serta kesan alahan dan asma dalam kalangan pelajar sekolah di Malaysia.

2. PENGENALAN

Penyelidikan ini akan dijalankan untuk mengkaji hubungan di antara pendedahan terhadap pencemaran udara dengan asma, alahan dan simptom-simptom pernafasan dikalangan kanak-kanak sekolah menengah.

3. APAKAH YANG PERLU ANDA LAKUKAN?

Penyertaan dalam kajian ini adalah secara sukarela dan tidak akan ada sebarang pembayaran dikenakan. Persetujuan dari ibu bapa atau penjaga diperlukan bagi setiap peserta sebelum menyertai kajian ini. Semua peserta akan menerima satu cenderamata sebagai tanda penghargaan menyertai sesi penyelidikan ini. Tiada pampasan tambahan akan diberikan.

Peserta yang memenuhi kriteria inklusi akan menjalani beberapa prosedur penyelidikan termasuk:

6. Isikan soal selidik yang dibantu oleh penyelidik.
7. Ujian penilaian nitrogen oksida dalam hembusan nafas (FeNO), pelajar akan diminta untuk menarik nafas sedalam-dalam dan menghembus nafas dengan aliran berterusan ke dalam alat penganalisa. Pelajar akan mengulangi proses ini selama tiga kali untuk mendapatkan hasil purata. Prosedur ini hanya mengambil masa 5 minit.
8. Ujian untuk mengukur kadar masa bagi selaput mata untuk pulih, satu alat khas akan didekatkan kepada mata dan pelajar akan diminta untuk melihat ke dalam alat tersebut. Penilaian akan dibuat oleh penyelidik. Prosedur ini tidak menyakitkan dan hanya mengambil masa dalam 5 minit.
9. Ujian fungsi paru-paru, pelajar akan bernafas melalui mulut yang dipasang pada alat rakaman (spirometer). Pelajar akan melakukan ujian selama 3 kali untuk hasil purata.
10. Ujian alahan (hama rumah, debunga yang berkaitan, kucing dan lipas) hanya akan dilakukan pada kulit tangan peserta. Jumlah kecil alergen (hama rumah, debunga yang berkaitan, kucing, dan lipas) dalam bentuk cecair akan dimasukkan ke dalam lapisan atas kulit dengan membuat tusukan kecil. Pelajar akan dipantau dengan teliti untuk melihat bagaimana reaksi kulit terhadap alergen selama 20 minit. Prosedur ini akan dijalankan oleh pegawai perubatan yang pengalaman.

4. SIAPA YANG TIDAK BOLEH MENYERTAI KAJIAN INI?

Subjek yang mempunyai fizikal yang normal dan sihat boleh menyertai kajian ini secara sukarela selepas mendapat keizinan daripada ibu/bapa atau penjaga. Subjek mestilah pelajar Tingkatan 2 yang telah bersekolah di sekolah yang sama sejak Tingkatan 1. Selain itu, individu yang mempunyai penyakit kronik seperti penyakit jantung, hipertensi dan kelainan dada fizikal kongenital tidak akan dimasukkan dalam kajian ini.

5. APAKAH FAEDAH MENYERTAI KAJIAN INI?

a) KEPADA ANDA SEBAGAI PESERTA?

Hasil kajian yang bakal diperolehi daripada ujian kesihatan percuma yang akan dijalankan boleh membantu pelajar dan ibu bapa untuk mengetahui status keadaan kesihatan pelajar tanpa sebarang kos. Pihak pengurusan sekolah juga akan mendapat manfaat maklumat kadar pencemaran udara di sekolah dan tahap kesihatan pelajar tanpa perlu mengeluarkan sebarang kos. Di samping itu, kami berharap hasil kami akan menambah pengetahuan mengenai hubungkait persekitaran sekolah terhadap alergi dan asma.

b) KEPADA PENYELIDIK?

Hasil dari kajian ini akan memberikan maklumat penting dalam usaha untuk membina pangkalan data komprehensif untuk memantau kualiti udara dalaman di kalangan kanak-kanak. Selain itu,melalui kajian ini juga akan memberikan pemahaman yang lebih baik dan keupayaan yang lebih baik untuk mengenal pasti pencemar toksik semasa dan mengesyorkan strategi yang berkesan untuk mengurangkan pencemaran udara dalaman.

6. ADAKAH IA BERISIKO?

Peserta tidak akan mengalami apa-apa risiko dalam menghadiri set soal selidik yang hanya memerlukan anda menyatakan butiran peribadi, sejarah perubatan, pendedahan kepada alergen dan gejala yang berpengalaman berkaitan dengan pencemaran udara dalaman.

Begitu juga dengan ujian kadar nitrogen oksida dalam hembusan nafas (FeNO), ujian fungsi paru-paru dan ujian kadar masa bagi selaput mata untuk pulih, tidak ada sebarang risiko yang akan berlaku sepanjang prosedur-prosedur ini dijalankan. Semua prosedur yang bakal dijalankan adalah seragam dan selamat.

Prosedur ini akan dilakukan oleh ahli perubatan dan teknologi yang telah terlatih dan mempunyai pengalaman yang mencukupi dalam prosedur. Pegawai perubatan akan berada di tempat proses mengaruhkan kahak setiap masa semasa prosedur dijalankan.

Manakala untuk prosedur ujian alahan, terdapat risiko anafilaksi (reaksi di dalam salur darah) yang sangat rendah. Prosedur ini akan dijalankan oleh pegawai perubatan yang terlatih dan sebagai langkah keselamatan ubat alahan akan disediakan jika berlaku anafilaksi. Disamping itu pemantauan akan dibuat terhadap semua peserta untuk tempoh 40 minit selepas prosedur dijalankan.

Secara keseluruhannya, pihak penyelidik akan menggunakan pegawai perubatan dan ahli teknologi perubatan yang terlatih dan berpengalaman untuk menjalankan semua prosedur klinikal terhadap peserta. Pihak penyelidik juga akan menyediakan ambulance sebagai langkah berjaga-jaga jika berlaku sebarang risiko yang tidak diingini.

Pihak penyelidik juga akan menyediakan Insuran Liabiliti Awam untuk setiap peserta jika berlaku sebarang kecelakaan sepanjang tempoh prosedur klinikal ini dijalankan. Sebarang tuntutan boleh dibuat berdasarkan terma dan syarat yang telah ditetapkan oleh pihak pembekan Insuran Liabiliti Awam tersebut.

Diakhir proses penyelidikan, semua peserta akan diberi cenderamata sebagai tanda penghargaan

daripada pihak penyelidik di atas kesudian menjadi peserta secara sukarela.

7. ADAKAH MAKLUMAT DAN IDENTITI SAYA KEKAL RAHSIA?

Semua maklumat peserta adalah rahsia. Hanya penyelidik yang terlibat dalam kajian ini dan mereka yang bertanggungjawab untuk penyelidikan akan mempunyai akses kepada maklumat yang anda berikan. Keputusan umumnya akan diterbitkan sebagai ringkasan perbincangan, bukan transkrip / balasan individu. Bahan penerbitan tidak akan dikenal pasti nama atau dengan apa cara lain yang mana peserta dapat dikenal pasti oleh pembaca laporan tersebut.

8. SIAPA YANG SAYA PERLU HUBUNGI SEKIRANYA SAYA MEMPUNYAI SOALAN TAMBAHAN SEMASA MENGIKUTI PENYELIDIKAN INI?

Jika anda mempunyai pertanyaan, sila hubungi:

No	Nama	Alamat	No Tel.Bimbit/ No Tel. Pejabat	E-mail
1	Prof. Dr. Zailina Hashim	Jabatan Kesihatan Persekitaran & Pekerjaan Faculti Perubatan & Sains Kesihatan, UPM Serdang	017- 6361367/ 03-947240	zailina@upm.edu.my
2	Nur Haslyna binti Mohd Hamizul	Jabatan Kesihatan Persekitaran & Pekerjaan Faculti Perubatan & Sains Kesihatan, UPM Serdang	018-2182320	nurhaslynamh@gmail.com
3	Nur Shahira binti Mohamad Fadzil	Jabatan Kesihatan Persekitaran & Pekerjaan Fakulti Perubatan & Sains Kesihatan, UPM Serdang	011-40685226	nurshahirafadzil@gmail.com
4	Siti Raihan binti Mohd Fuad	Jabatan Kesihatan Persekitaran & Pekerjaan Fakulti Perubatan & Sains Kesihatan, UPM Serdang	017-7527076	sitiraihanmohdfuad@gmail.com
5	Anis Zahira binti Zainudin	Jabatan Kesihatan Persekitaran & Pekerjaan Fakulti Perubatan & Sains Kesihatan, UPM Serdang	013-2803841	anisiera95@gmail.com

Nota: Borang penerangan dan persetujuan ibu bapa ini adalah gabungan daripada empat (4) kajian pelajar.

Sila tandatangan di sini sekiranya anda telah membaca dan memahami kandungan halaman ini _____

© COPYRIGHT UPM

9. PERSETUJUAN

Saya..... No Kad Pengenalan. .....
beralamat.....
.....dengan ini bersetuju untuk mengambil bahagian secara sukarela dalam penyelidikan yang tersebut di atas *(kajian klinikal/percubaan ubat-ubatan/rakaman video/kumpulan sasaran/temuduga/ soal selidik).

Saya telah diberi penjelasan secara menyeluruh mengenai penyelidikan ini dari segi metodologi, risiko dan komplikasi (seperti tertulis pada Helaian Penerangan Responden). Saya memahami bahawa saya berhak menarik diri dari penyelidikan ini pada bila-bila masa tanpa memberi sebarang alasan.Saya juga memahami bahawa sebarang maklumat yang berkaitan identiti saya akan dirahsiakan.

Saya* berminat / tidak berminat untuk mengetahui keputusan kajian yang melibatkan saya.

I setuju/tidak bersetuju untuk imei/gambar/rakaman video/ rakaman suara digunakan dalam apa jua bentuk penerbitan atau pembentangan. (sekiranya berkaitan).

*potong yang tidak berkenaan

Tandatangan .....
(*Responden*)

Tarikh :.....

Tandatangan .....
(*Saksi*)

Nama :.....

No. K/P: .....

Saya mengesahkan bahawa saya telah menerangkan kepada responden ini sifat dan tujuan penyelidikan yang tersebut di atas.

Tarikh .....

Tandatangan .....
(*Penyelidik*)

© COPYRIGHT UPM

MAKLUMAT TAMBAHAN

Berikut adalah maklumat tambahan mengenai prosedur-prosedur terlibat. Peserta akan menjalani penilaian klinikal yang mudah pada nitrogen oksida (NO) dalam hembusan nafas (FeNO) dengan menggunakan alat penganalisa seperti dicadangkan American Thoracic Society (ATS). Peserta akan diminta untuk menarik nafas sedalam-dalam dan menghembus nafas dengan aliran berterusan ke dalam corong mulut khas alat penganalisa. Peserta perlu mengulangi proses ini selama tiga kali untuk mendapatkan hasil purata. Prosedur ini hanya mengambil masa 5 minit.

Ujian Spirometry (ujian fungsi paru-paru) dilakukan selepas seperti yang dicadangkan oleh American Thoracic Society, 1987. Spirometer telah dikalibrasi terlebih dahulu dengan menyuntikkan 3 liter udara ke dalam spirometer menggunakan jarum 3L. Untuk ujian, pelajar akan bernafas melalui mulut yang dipasang pada alat rakaman (spirometer). Untuk mendapatkan hasil yang terbaik, semua responden melakukan ujian selama 3 kali. Maklumat yang dikumpul oleh spirometer dicetak pada carta yang disebut spirogram.

Peserta akan menjalani satu ujian klinikal yang mudah dan selamat menggunakan alatan khas, Tearscope Plus untuk mengukur kadar masa bagi selaput mata untuk pulih (Tear Film Break Up Time). Peserta akan diberi penerangan dan alatan khas ini akan didekatkan kepada mata dan peserta akan diminta untuk melihat kedalam alat tersebut. Penilaian akan dibuat oleh penyelidik. Prosedur ini tidak menyakitkan dan hanya mengambil masa dalam 5 minit.

Penilaian klinikal ujian alergi hanya akan dilakukan pada kulit peserta. Jumlah kecil alergen (hama rumah, debunga yang berkaitan, kucing dan lipas) dalam bentuk cecair akan dimasukkan ke dalam lapisan atas kulit dengan membuat tusukan kecil. Peserta akan dipantau dengan teliti untuk melihat bagaimana reaksi kulit terhadap alergen. Selepas 20 minit, diameter wheal akan diukur. Prosedur ini akan dijalankan oleh pegawai perubatan yang pengalaman.

Selain langkah keselamatan yang dijelaskan seperti di atas, pihak penyelidik akan menyediakan pegawai perubatan, penolong pegawai perubatan/ jururawat yang terlatih dan bertauliah untuk membantu dan memantau semua prosedur klinikal yang dinyatakan di atas. Pihak penyelidik juga akan menyediakan insuran liabiliti untuk setiap peserta jika berlaku sebarang perkara yang tidak diingini. Sebagai langkah keselamatan yang terakahir, sebuah ambulance akan ditempatkan di lokasi persempalan setiap masa.

© COPYRIGHT UPM

Appendix F

Questionnaire

© COPYRIGHT UPM

BORANG SOAL SELIDIK KAJIAN

MAKLUMAT KEPADA PESERTA KAJIAN

Assalammualaikum dan salam sejahtera,

Persekitaran sekolah akan memberi kesan terhadap gejala-gejala asma, alahan dan pernafasan di kalangan pelajar sekolah menengah di Kota Kinabalu, Sabah.

Tujuan kajian ini adalah untuk memperolehi maklumat mengenai kadar prevalens asma, alahan dan gejala pernafasan di kalangan pelajar sekolah ini, dan hubungannya dengan persekitaran sekolah, persekitaran rumah dan makanan.

Anda telah terpilih sebagai peserta dalam kajian ini. Kerjasama anda adalah amat penting bagi menjamin kejayaan kajian ini. Adalah diharapkan bahawa anda boleh menjawab soalselidik ini dengan benar dan jawapannya perlu diisi dengan tepat. Semua maklumat yang diberikan dalam soalselidik ini akan dirahsiakan dari segi identiti pemberi maklumat, dan hanya akan digunakan untuk tujuan penyelidikan sahaja. Jutaan terima kasih untuk segala kerjasama yang akan anda berikan. Adalah diharapkan bahawa kajian ini akan memberi manfaat bagi perancangan program-program kesihatan di sekolah-sekolah di Sabah pada masa hadapan.

Jika terdapat sebarang kemushkilan atau soalan mengenai kajian atau soalselidik ini, sila bertanya kepada para penyelidik yang mengendalikan kajian ini di sekolah anda.

Sekian, terima kasih.

Ketua Penyelidik

Prof Dr Zailina Hashim

Universiti Putra Malaysia

© COPYRIGHT UPM

BORANG SOALSELIDIK KAJIAN

BAHAN PENCEMAR DAN LOGAM BERAT DALAM KUALITI UDARA DAN DEBU DARIPADA PERSEKITARAN SEKOLAH DI KOTA KINABALU, SABAH : HUBUNGAN ANTARA KERADANGAN PARU-PARU DAN RISIKO KESIHATAN YANG LAIN DALAM KALANGAN PELAJAR.

JANUARY 2019

ADALAH DIMAKLUMKAN BAHAWA ANDA TELAH TERPILIH UNTUK MENYERTAI KAJIAN INI. SILA JAWAB SEMUA SOALAN DENGAN TEPAT DAN LENGKAP

NAMA RESPONDEN : _____

KELAS : _____

SEKOLAH : _____

NO RESPONDEN : _____

NAMA PENYELIDIK : _____

TARIKH : _____

TERIMA KASIH DI ATAS KERJASAMA ANDA

© COPYRIGHT UPM

MAKLUMAT PERIBADI PELAJAR DAN KELUARGA

Sila isi tempat kosong yang disediakan atau tandakan (√) pada pilihan yang sesuai

1. Jantina : ☐ Lelaki ☐ Perempuan

2. Bangsa ☐ Melayu ☐ Cina ☐ India ☐ Lain-lain

3. Tahap Pendidikan Bapa

☐ Sekolah Rendah ☐ PMR/SRP ☐ SPM ☐ STPM/ Diploma ☐ Ijazah/Master/PHD

4. Tahap Pendidikan Ibu

☐ Sekolah Rendah ☐ PMR/SRP ☐ SPM ☐ STPM/ Diploma ☐ Ijazah/Master/PHD

5. Pekerjaan Bapa : _____

6. Pekerjaan Ibu : _____

7. Pendapatan Bapa : RM_____ sebulan

8. Pendapatan Ibu : RM_____ sebulan

9. Pendapatan isi rumah : RM_____ sebulan

10. Apakah kenderaan yang digunakan oleh anda untuk ke sekolah?

☐ Kereta ☐ Basikal ☐ Bas ☐ Motosikal ☐ Berjalan kaki

11. Lokasi rumah dari jalan raya

© COPYRIGHT UPM

☐ < 100 meter dari jalan raya

☐ > 100-500 meter dari jalan raya

☐ > 500-1000 meter dari jalan raya

☐ > 1000 meter dari jalan raya

12. Adakah anda menggunakan bahan tertentu untuk mengelakkan serangan nyamuk dirumah?

☐ Ya ☐ Tidak

12a. Jika Ya, jenis apakah yang selalu digunakan?

☐ Lingkaran Biasa ☐ Semburan Aerosol ☐ Elektrik (Vapor) ☐ Lain-lain (nyatakan): _____

12b. Berapa kerapkah anda menggunakannya dalam seminggu?_____kali seminggu

12c. Dimanakah ianya ditempatkan di dalam rumah?

☐ Di ruang tamu sahaja ☐ Di bilik tidur ☐ Di bilik tidur dan ruang tamu

© COPYRIGHT UPM

ARAHAN : SILA <u>BULATKAN</u> JAWAPAN YANG SESUAI, KECUALI DIBERI ARAHAN LAIN

Contoh : Pernahkah anda mengalami dada berbunyi dan bersiul dalam tempoh **12 bulan yang lepas**? _____ Ya (1) Tidak (0)

SOALAN TENTANG ASMA DAN ALAHAN (ALERGI)

<u>Dada berbunyi dan bersiul</u>

1. Pernahkah anda mengalami dada berbunyi dan bersiul dalam tempoh **12 bulan yang lepas**? _____ Ya (1) Tidak (0)

<u>Jika "Tidak", teruskan ke soalan 5, jika "Ya" jawab soalan di bawah :</u>

2. Pernahkah anda mengalami kesesakan nafas apabila dada anda berbunyi? _____ Ya (1) Tidak (0)

3. Pernahkah anda mengalami dada berbunyi apabila anda *tidak* menghidap selsema? _____ Ya (1) Tidak (0)

4. Pernahkah anda mengalami kesempitan dada apabila anda bangun dari tidur dalam tempoh **12 bulan yang lepas**? _____ Ya (1) Tidak (0)

<u>Kesukaran bernafas</u>

5. Pernahkah anda mengalami serangan kesesakan nafas di siang hari ketika anda berehat pada bila-bila masa dalam tempoh **12 bulan yang lepas**? _____ Ya (1) Tidak (0)

6. Pernahkah anda mengalami serangan kesesakan nafas setelah anda melakukan aktiviti lasak pada bila-bila masa dalam tempoh **12 bulan yang lepas**? _____ Ya (1) Tidak (0)

7. Pernahkah anda terjaga dari tidur akibat serangan kesesakan nafas dalam tempoh **12 bulan yang lepas**? _____ Ya (1) Tidak (0)

<u>Asma</u>

8.1. Pernahkah anda menghidapi asma? _____ Ya (1) Tidak (0)

8.2. <u>Jika ya</u>, adakah penyakit asma itu telah didiagnosis oleh doktor? _____ Ya (1) Tidak (0)

<u>Jika ya</u>, berapakah umur anda apabila anda didiagnosis oleh doktor? _____tahun

<u>Jika ya</u>, berapakah umur anda pada kali **pertama** anda diserang asma? _____tahun

Jika ya, berapakah umur anda apabila anda diserang asma yang terkini? _____tahun

9. Adakah anda mangalami serangan asma dalam tempoh **12 bulan yang lepas**? _____ Ya (1) Tidak (0)

10. Adakah anda kini mengambil ubatan asma? (semburan, serbuk sedutan, ubat pil)_____ Ya (1) Tidak (0)

Alahan (alergi) hidung

11. Pernahkah anda mengalami masalah bersin, hidung berair atau hidung tersumbat dalam keadaan anda tidak selsema dalam tempoh masa **12 bulan yang lalu?**_____ Ya (1) Tidak (0)

Jika Ya, adakah masalah ini berlaku beserta mata berair atau gatal? Ya Tidak

_____ (1) (0)

Ekzema atau alergi kulit

12. Pernahkah anda mengalami ruam gatal yang wujud dan sembuh dalam tempoh masa ***sekurang-kurangnya 6 bulan***? _____ Ya (1) Tidak (0)

Jika Ya,

12.1 Pernahkah anda mengalami ruam gatal ini dalam tempoh masa **12 bulan yang lalu**? _____ Ya (1) Tidak (0)

12.2 Pernahkah ruam gatal ini berlaku **pada bila-bila masa** di kawasan seperti di lipatan siku, lipatan lutut, di buku lali, di bawah punggung atau di sekitar leher, telinga dan mata?_____ Ya (1) Tidak (0)

COPYRIGHT UPM

SOALAN TENTANG KESIHATAN DAN ALAHAN (ALERGI) YANG DIALAMI SEKARANG

1. Berapa kalikah anda mengalami jangkitan saluran pernafasan dalam tempoh **3 bulan yang lepas**? _____kali

2. Pernahkah anda mengambil antibiotik (contoh penicillin)

	Tidak pernah (0)	Ya, sekali (1)	Ya, lebih dari sekali (2)
untuk masalah jangkitan saluran pernafasan dalam tempoh **12 bulan yang lepas**?			

3. Pernahkah anda menghidapi penyakit yang memerlukan anda berjumpa dengan doktor dalam tempoh **12 bulan yang lepas**? _____ Ya (1) Tidak (0)

   Jika ya, apakah penyakit tersebut? _____

4. Adakah anda merokok? _____ Ya (1) Tidak (0)

5. Adakah anda hipersensitif/alahan terhadap **kucing**? _____ Ya (1) Tidak (0) Tidak pasti (kosong)

6. Adakah anda hipersensitif/alahan terhadap **anjing**? _____ Ya (1) Tidak (0) Tidak pasti (kosong)

7. Adakah anda hipersensitif/alahan terhadap **barangan berkulat**? ___ Ya (1) Tidak (0) Tidak pasti (kosong)

8. Adakah anda hipersensitif/alahan terhadap **debunga**? _____ Ya (1) Tidak (0) Tidak pasti (kosong)

9. Adakah anda hipersensitif/alahan terhadap makanan? _____ Ya (1) Tidak (0) Tidak pasti (kosong)

   Jika ya, nyatakan jenis makanan yang anda alahan terhadapnya ? _____

_____

© COPYRIGHT UPM

MASALAH ALAHAN (ALERGI) DI KALANGAN AHLI KELUARGA LAIN

1.1. Bilangan adik beradik yang lebih tua daripada anda : _____ orang

1.2. Bilangan adik beradik yang lebih tua yang menetap di rumah bersama anda, sekarang : _____ orang

2.1. Bilangan adik beradik yang lebih muda daripada anda, jumlah : _____ orang

2.2. Bilangan adik beradik yang lebih muda yang menetap di rumah bersama anda sekarang : _____ orang

3. Adakah di antara ahli keluarga anda yang mengalami masalah alahan? **Tandakan √** pada ruangan yang berkenaan, sama ada mereka pernah atau tidak mengalami masalah alahan.

	Bapa	Ibu	Adik beradik
Asma	( ) Ya 1 ( ) Tidak 0	( ) Ya 1 ( ) Tidak 0	( ) Ya 1 ( )Tidak 0
Simptom alahan hidung	( ) Ya 1 ( ) Tidak 0	( ) Ya 1 ( ) Tidak 0	( ) Ya 1 ( )Tidak 0
Ekzema	( ) Ya 1 ( ) Tidak 0	( ) Ya 1 ( ) Tidak 0	( ) Ya 1 ( )Tidak 0

SOALAN MENGENAI ZAMAN KANAK-KANAK

	Ya	Tidak
1.1. Adakah anda disusui ibu semasa zaman kanak-kanak?_____	(1)	(0)

1.2. Jika ya, sehingga anda berusia_____bulan.

2. Adakah ahli keluarga anda yang merokok sejak anda dilahirkan sehingga anda berusia satu tahun? **Tandakan** √ pada ruangan yang berkenaan, sama ada mereka pernah atau tidak merokok ketika itu.

Ayah merokok	( ) Ya 1 ( ) Tidak 0
Emak merokok	( ) Ya 1 ( ) Tidak 0
Ahli keluarga lain merokok	( ) Ya 1 ( ) Tidak 0

	Ya, lebih dari 3 tahun	Ya, 1-3 tahun	Ya, kurang dari 1 tahun	Tidak, Tidak pernah
3.1. Pernahkah anda menghadiri tempat asuhan kanak-kanak?	(3)	(2)	(1)	(0)

© COPYRIGHT UPM

3.2. Jika ya, pada umur berapakh anda mula menghadiri tempat asuhan tersebut?
Kurang dari 1 tahun (0) 1-2 tahun(1) Lebih dari 2 tahun(2)

SOALAN MENGENAI KEADAAN PERSEKITARAN RUMAH SEMASA

1. Apakah jenis bangunan kediaman anda sekarang? (Bulatkan hanya satu jawapan yang paling sesuai).

Rumah teres	Rumah sebuah	Apartment	Ladang	Lain-lain
(0)	(1)	(2)	(3)	(4)

	Ya	Tidak
2.1. Adakah anda tinggal di kediaman yang sama sejak lahir? _____	(1)	(0)

2.2. Jika tidak, pada tahun berapakah anda berpindah ke kediaman sekarang? _____(tahun)

3. Pada tahun berapakah (anggaran) kediaman anda sekarang dibina? _____(tahun)

4. Berapa meter persegikah keluasan kediaman anda sekarang?_____(m^2)

5. Bahan apakah yang digunakan untuk membina bangunan kediaman anda sekarang? (Bulatkan satu atau lebih jawapan yang sesuai).

Batu(0) Konkrit(1) Bata(2) Kayu(3) bahan lain (4)

	Ya	Tidak
6.1. Adakah bahagian dalaman rumah anda yang telah dicat dalam tempoh **12 bulan yang lepas**?_____	(1)	(0)

6.2. Jika ya, bilakah ia dicat?_____(bulan)_____(tahun)

	Ya	Tidak
7. Adakah lantai di dalam rumah anda telah ditukar dalam tempoh **12 bulan yang lepas**?_____	(1)	(0)

	Ya	Tidak
8.1. Adakah terdapat haiwan peliharaan di kediaman anda ?_____	(1)	(0)

8.2. Jika ya, nyatakan jenis haiwan peliharaan anda: _____

© COPYRIGHT UPM

9. Pernahkah salah satu daripada perkara di bawah berlaku di kediaman anda dalam tempoh **12 bulan lepas**?

	Ya	Tidak
a. *kebocoran air atau kerosakan air pada dinding, lantai atau siling dalam rumah*	(1)	(0)
b. *Buih atau warna kekuningan pada lantai plastik atau kehitaman pada lantai parket*	(1)	(0)
c. *Kulat yang tumbuh pada dinding, lantai atau siling rumah*	(1)	(0)
d. *Bau kulat dalam satu atau dua bilik*	(1)	(0)
e. *Bau lain yang terdapat di rumah, sila nyatakan:*	(1)	(0)

	Ya	Tidak
10. Pernahkah terdapat masalah kelembapan atau kerosakan air berlaku di kediaman anda dalam tempoh **5 tahun lepas**?	(1)	(0)

Jika ya, sila terangkan sebab masalah kelembapan atau kerosakan air: _____

_____

	Ya, Setiaphari	Ya, selalu 1-4 kali/ minggu	Ya, kadang-kadang 1-3 kali/bulan	Tidak pernah
12. Adakah sesiapa merokok di dalam kediaman anda sekarang?	(3)	(2)	(1)	(0)

SIMPTOM SEMASA : ADAKAH ANDA MENGALAMI SIMPTOM-SIMPTOM TERSEBUT DALAM TEMPOH TIGA BULAN YANG LEPAS? (TANDAKAN √ PADA RUANGAN YANG BERKENAAN).

	Ya, Setiap hari	Ya, selalu 1-4 kali/ minggu	Ya, sekali sekala 1-3 kali/bulan	Tidak, tidak pernah
1. Ruam pada tangan atau lengan?	( )3	( )2	( )1	( )0
2. Ruam pada muka atau tekak?	( )3	( )2	( )1	( )0
3. Kemerahan kulit? Jika ya, dimana?	( )3	( )2	( )1	( )0
4. Gatal pada muka atau tekak?	( )3	( )2	( )1	( )0
	Ya, Setiap hari	Ya, selalu 1-4 kali/ minggu	Ya, sekali sekala 1-3 kali/bulan	Tidak, tidak pernah
5. Gatal pada tangan atau lengan?	( )3	( )2	( )1	( )0

6. Kepedihan mata (kemerahan, kering,gatal)?__( )3 ( )2 ( )1 ( )0

7. Kelopak mata bengkak?_____( )3 ( )2 ( )1 ( )0

8. Pening kepala?_____( )3 ( )2 ( )1 ( )0

9. Rasa loya/mual?_____( )3 ( )2 ( )1 ( )0

10. Hidung berair/katari hidung?_____( )3 ( )2 ( )1 ( )0

11. Rongga hidung tersekat/hidung tersumbat?__( )3 ( )2 ( )1 ( )0

12. Tekak kering?_____( )3 ( )2 ( )1 ( )0

13. Terasa akan menghidapi selsema?_____( )3 ( )2 ( )1 ( )0

14. Sakit tekak?_____( )3 ( )2 ( )1 ( )0

15. Batuk yang beriritasi?_____( )3 ( )2 ( )1 ( )0

16. Susah bernafas?_____( )3 ( )2 ( )1 ( )0

17. Berasa letih dan tidak bermaya?_____( )3 ( )2 ( )1 ( )0

Adakah simptom-simptom di atas menjadi reda	Ya	Tidak	Tidak tahu
18 Apabila anda **tidak berada di sekolah**?_____	(1)	(0)	(kosong)

19 Jika ya, simptom yang mana satu? (tuliskan nombor bagi soalan berkenaan) :_____

_____

Adakah simptom-simptom di atas terdapat peningkatan	Ya	Tidak	Tidak tahu
20. Apabila anda **tidak berada di rumah**?_____	(1)	(0)	(kosong)

21. Jika ya, simptom yang mana satu? (tuliskan nombor bagi soalan berkenaan) :_____

_____

Appendix G

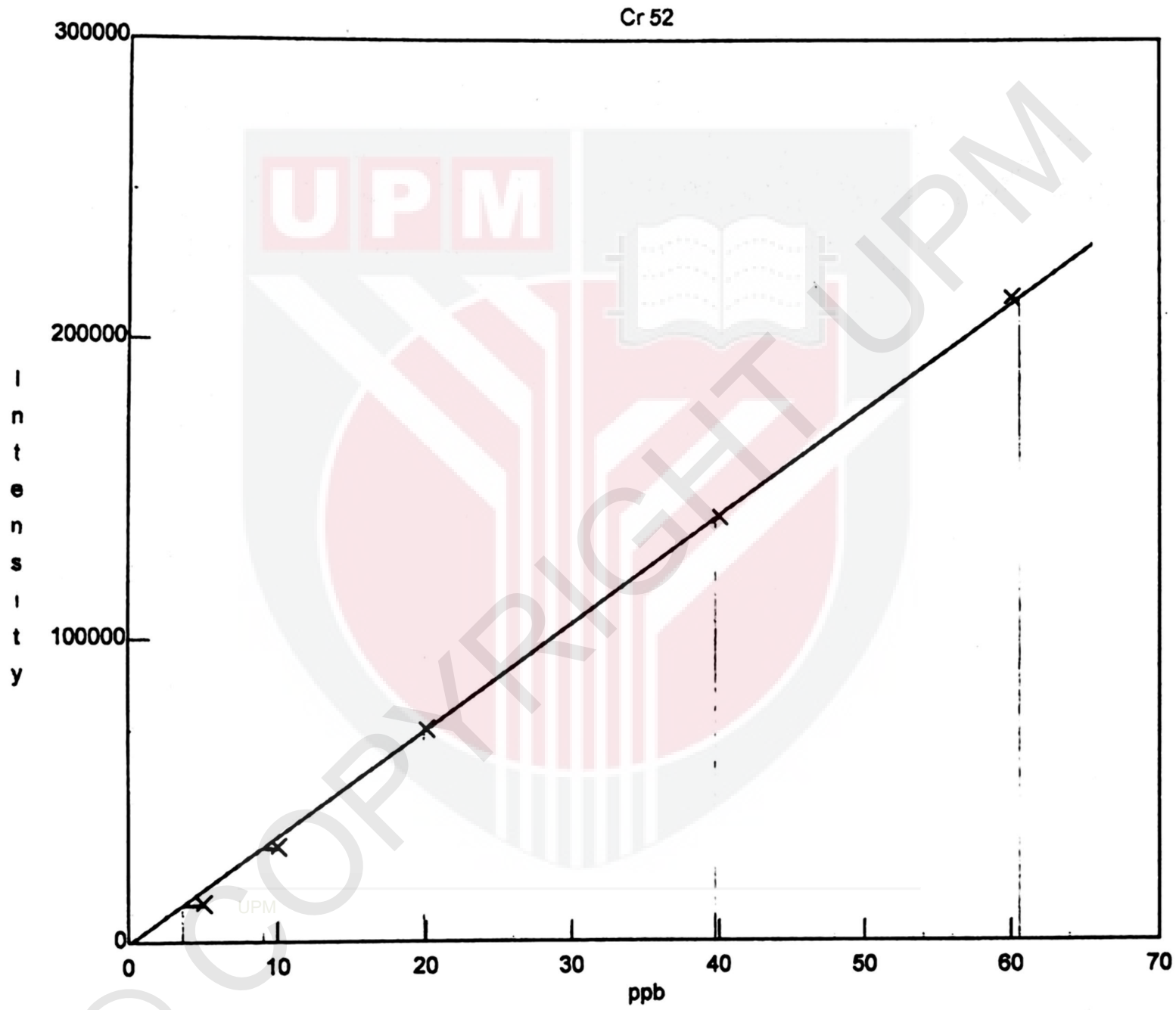
Calibration Curve Report

UPM
COPYRIGHT UPM

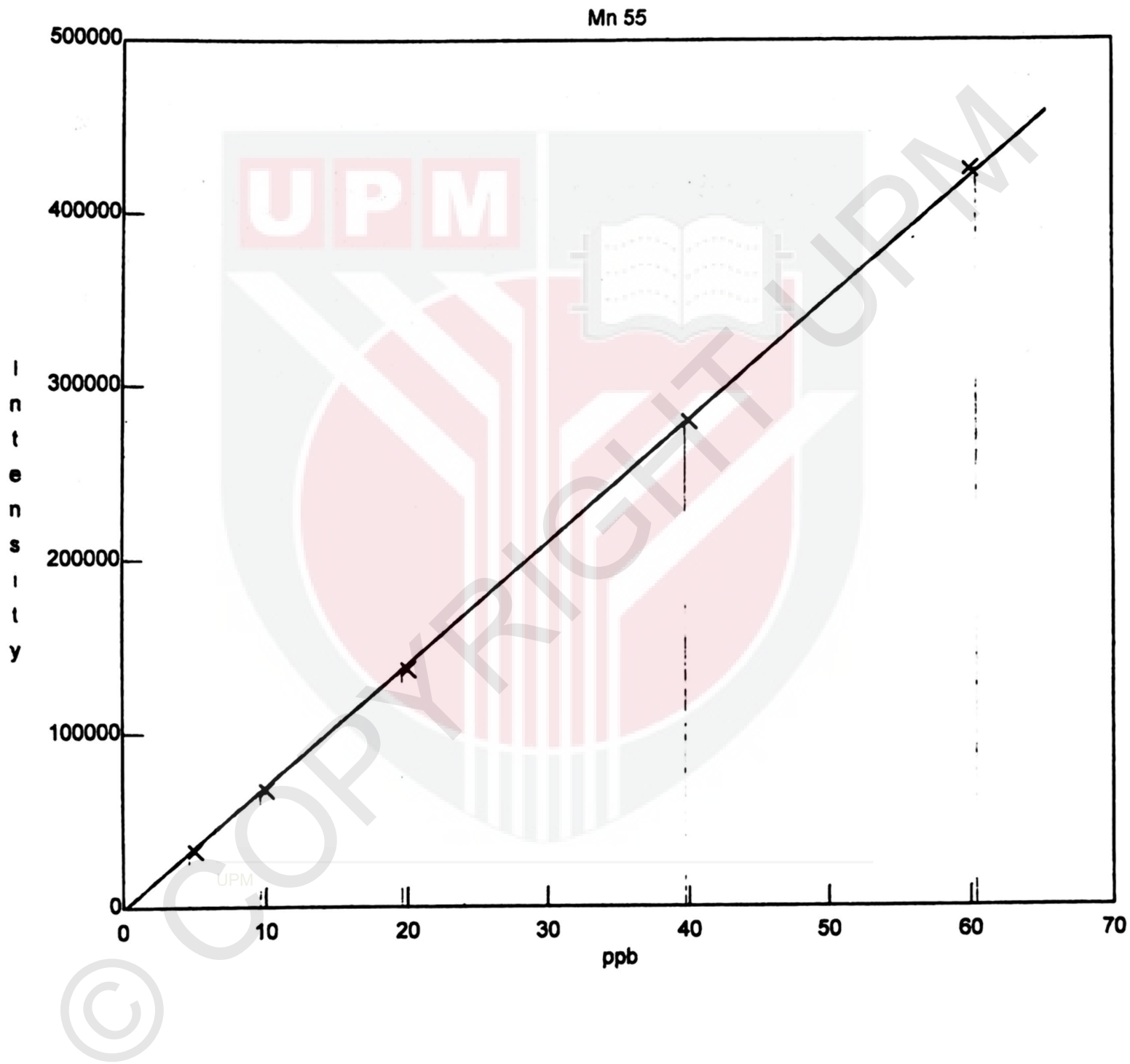
Calibration Report

Analyte	Mass	Curve Type	Slope	Intercept	Corr Coeff
Cr	51.941	Linear Thru Zero	3549.070685	0.000	0.999744
Mn	54.938	Linear Thru Zero	7040.690717	0.000	0.999942
Ni	59.933	Linear Thru Zero	1528.779225	0.000	0.999940
Pb	207.977	Linear Thru Zero	6986.631425	0.000	0.999828
As.	74.922	Linear Thru Zero	1434.571454	0.000	0.999725
Cd	110.904	Linear Thru Zero	3290.478393	0.000	0.999962

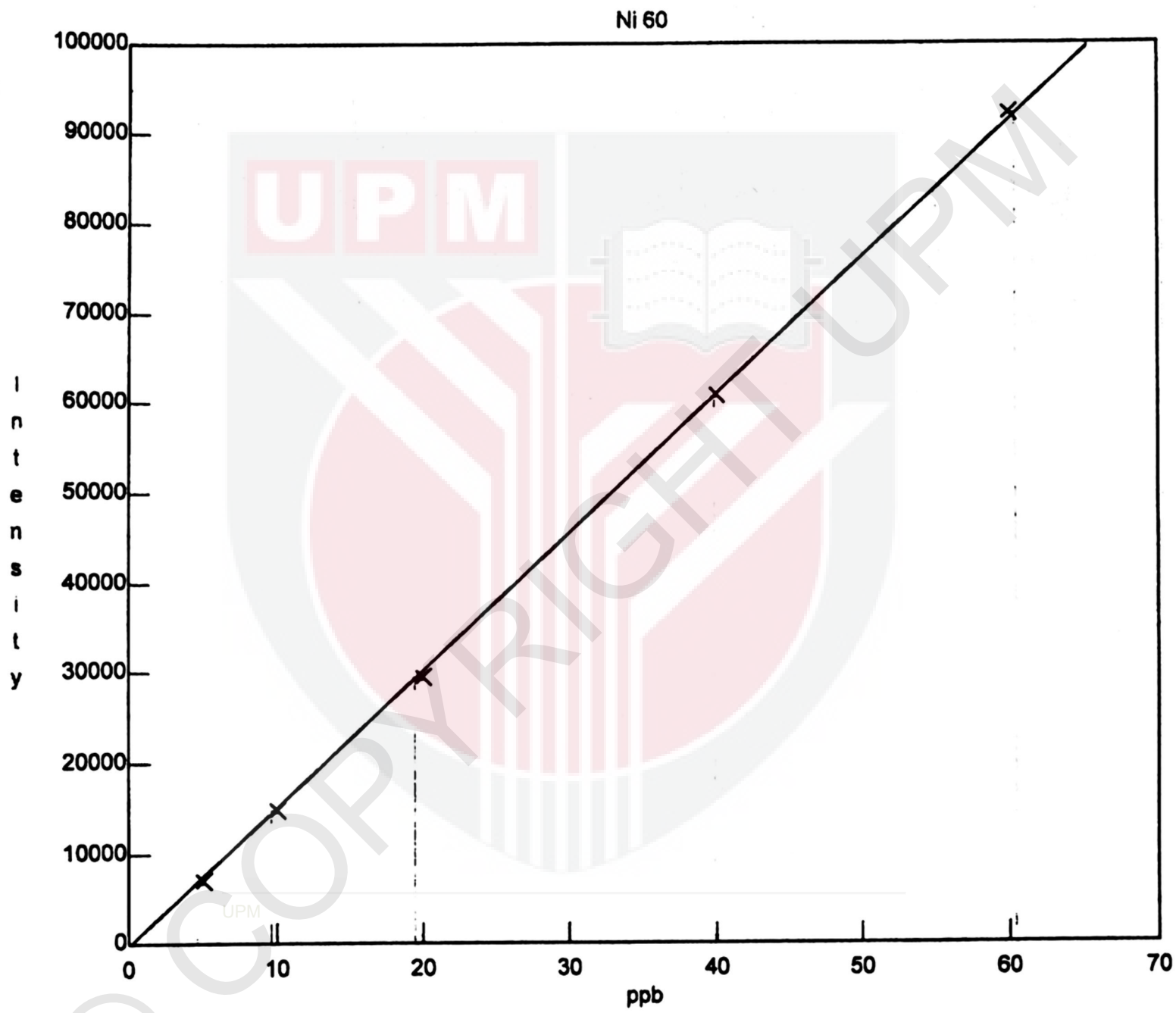
UPM
COPYRIGHT UPM

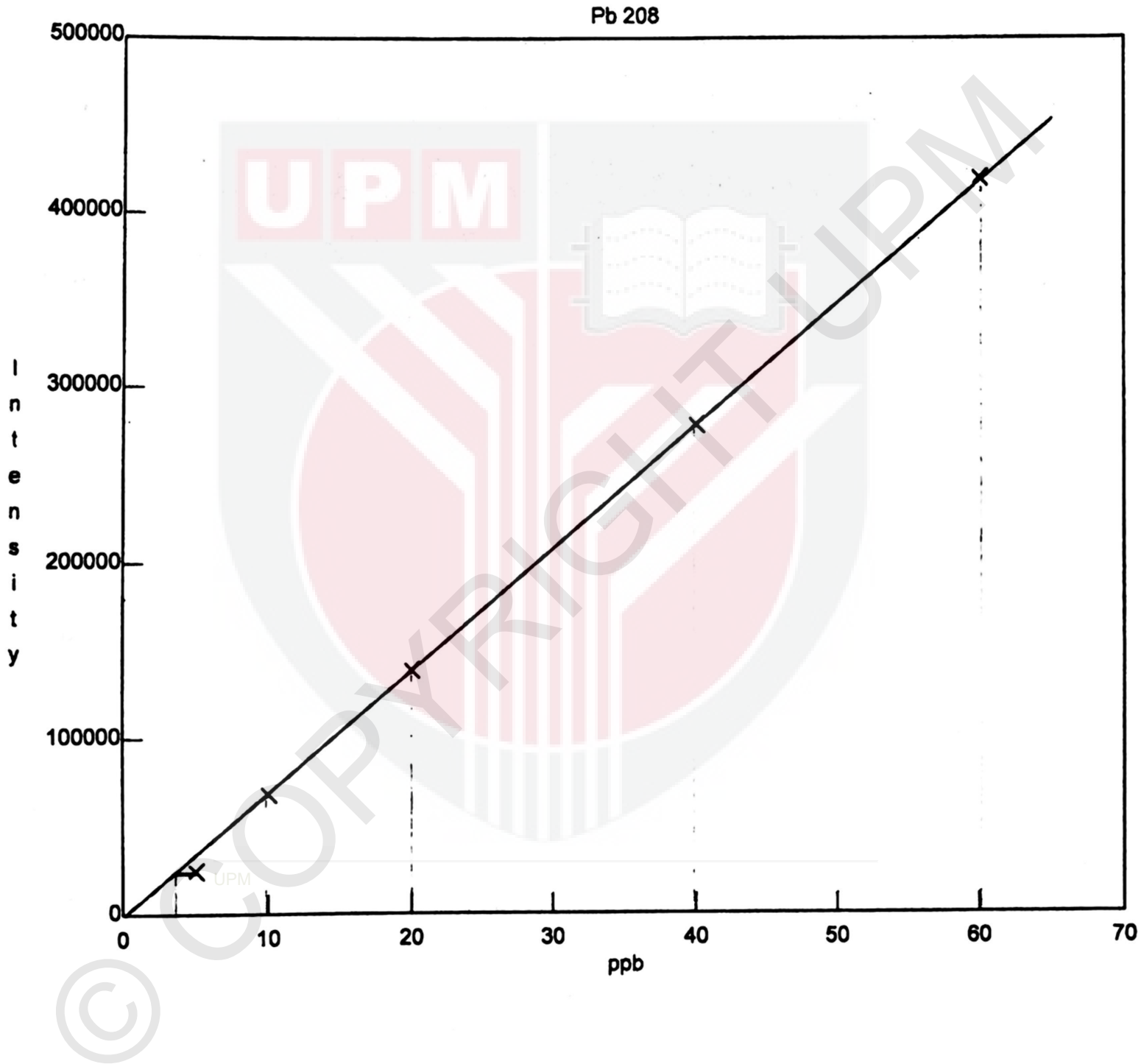


© COPYRIGHT UPM

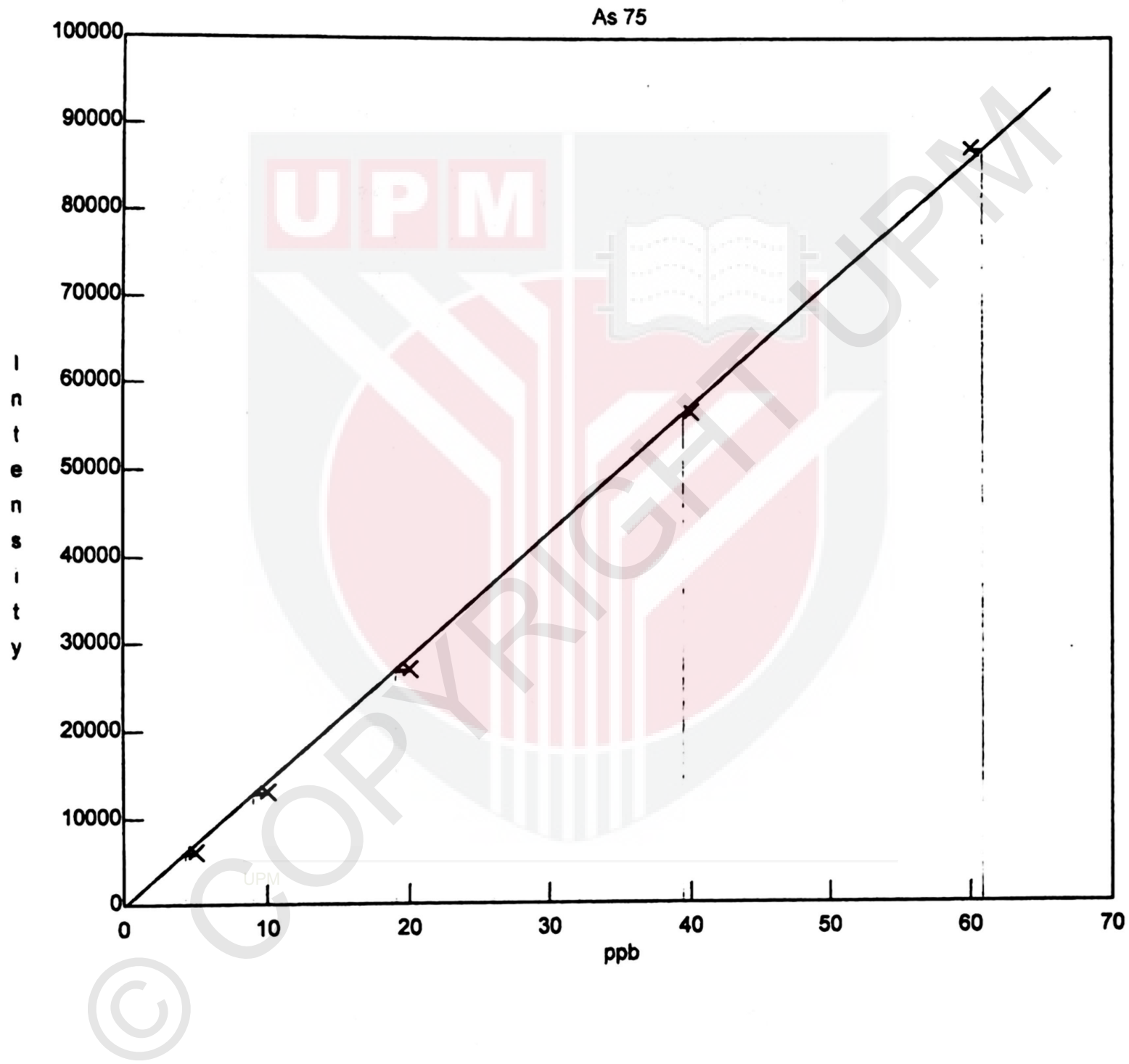


UPM
UPM COPYRIGHT UPM

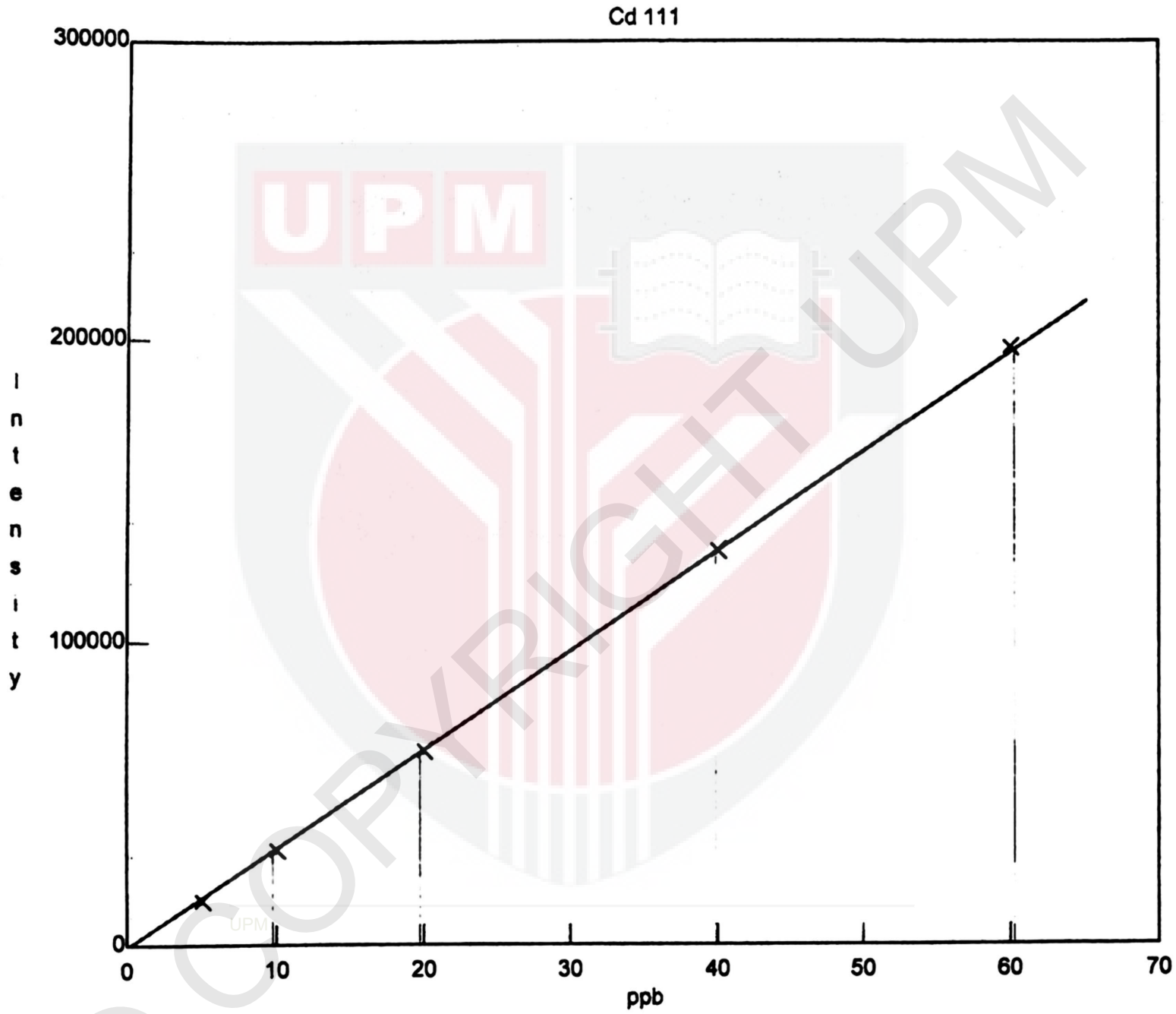

Ni 60
100000
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
Intensity
0
10
20
30
40
50
60
70
ppb



© COPYRIGHT UPM



© COPYRIGHT UPM



© COPYRIGHT UPM

Appendix H

ICP-MS Report

UPM
© COPYRIGHT UPM

Quantitative Analysis - Summary Report
Sample ID: A13
Sample Date/Time: Tuesday, March 19, 2019 14:27:27
Dual Detector Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\A13.845
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	**Sample Unit**
Cr	52	96784.38	**49.663**	2.8	5.6	**ppb**
Mn	55	23154.22	**6.49**	0.38	5.9	**ppb**
Ni	60	1720.179	**2.307**	0.15	6.6	**ppb**
Pb	208	59503.5	**5.239**	0.01	0.1	**ppb**
As	75	511.017	**0.854**	0.13	14.7	**ppb**
Cd	111	518.016	**0.341**	0.07	19.1	**ppb**

Quantitative Analysis - Summary Report
Sample ID: A19
Sample Date/Time: Tuesday, March 19, 2019 14:28:29
Dual Detector Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\A19.846
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	**Sample Unit**
Cr	52	54738.91	**28.088**	1.27	4.5	**ppb**
Mn	55	31713.22	**8.89**	0.19	2.1	**ppb**
Ni	60	1753.185	**2.351**	0.02	0.9	**ppb**
Pb	208	26840.56	**2.363**	0	0	**ppb**
As	75	625.024	**1.045**	0.03	2.9	**ppb**
Cd	111	307.006	**0.202**	0.02	8.8	**ppb**

UPM
© COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: A29

Sample Date/Time: Tuesday, March 19, 2019 14:29:28

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\Dataset\MAC 2019\A29.847

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	**Sample Unit**
Cr	52	124983.5	**64.133**	3.56	5.6	**ppb**
Mn	55	27662.92	**7.754**	0.31	4.1	**ppb**
Ni	60	2957.509	**3.967**	0.27	6.8	**ppb**
Pb	208	54661.89	**4.812**	0.04	0.8	**ppb**
As	75	921.051	**1.54**	0.13	8.4	**ppb**
Cd	111	563.018	**0.37**	0.01	3.8	**ppb**

Quantitative Analysis - Summary Report

Sample ID: A30

Sample Date/Time: Tuesday, March 19, 2019 14:30:29

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\Dataset\MAC 2019\A30.848

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	**Sample Unit**
Cr	52	100525.7	**51.583**	1.95	3.8	**ppb**
Mn	55	32228.09	**9.034**	0.42	4.6	**ppb**
Ni	60	2648.412	**3.552**	0.31	8.8	**ppb**
Pb	208	55341.03	**4.872**	0.01	0.1	**ppb**
As	75	765.036	**1.279**	0.03	2	**ppb**
Cd	111	711.029	**0.468**	0.02	3.8	**ppb**

UPM COPYRIGHT ©

Quantitative Analysis - Summary Report

Sample ID: A5 [B]

Sample Date/Time: Tuesday, March 19, 2019 14:32:10

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\Dataset\MAC 2019\A5 [B].850

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	**Sample Unit**
Cr	52	92770.92	**47.603**	1.98	4.1	**ppb**
Mn	55	28360.06	**7.95**	0.1	1.3	**ppb**
Ni	60	14400.54	**19.314**	0.57	3	**ppb**
Pb	208	43763.33	**3.853**	0.03	0.8	**ppb**
As	75	888.048	**1.485**	0.12	8	**ppb**
Cd	111	601.021	**0.395**	0.03	7.8	**ppb**

Quantitative Analysis - Summary Report

Sample ID: A7 [B]

Sample Date/Time: Tuesday, March 19, 2019 14:33:09

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\Dataset\MAC 2019\A7 [B].851

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	**Sample Unit**
Cr	52	79151.46	**40.615**	2.51	6.2	**ppb**
Mn	55	26591.68	**7.454**	0.24	3.2	**ppb**
Ni	60	5427.671	**7.28**	0.2	2.8	**ppb**
Pb	208	24881.85	**2.191**	0.02	0.9	**ppb**
As	75	585.022	**0.978**	0	0.2	**ppb**
Cd	111	325.006	**0.214**	0.02	7.4	**ppb**

UPM COPYRIGHT ©

Quantitative Analysis - Summary Report

Sample ID: A14 [B]

Sample Date/Time: Tuesday, March 19, 2019 14:34:07

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\Dataset\MAC 2019\A14 [B].852

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	Conc. Mean	Conc. SD	Conc. RSD	Sample Unit
Cr	52	52336.51	**26.855**	1.29	4.8	**ppb**
Mn	55	24506.77	**6.87**	0.24	3.4	**ppb**
Ni	60	1689.173	**2.266**	0.07	3.1	**ppb**
Pb	208	26921.8	**2.37**	0.01	0.6	**ppb**
As	75	593.022	**0.991**	0.02	2.1	**ppb**
Cd	111	318.006	**0.209**	0	0.9	**ppb**

Quantitative Analysis - Summary Report

Sample ID: A36 [B]

Sample Date/Time: Tuesday, March 19, 2019 14:35:10

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\Dataset\MAC 2019\A36 [B].853

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	Conc. Mean	Conc. SD	Conc. RSD	Sample Unit
Cr	52	68550.05	**35.175**	1.61	4.6	**ppb**
Mn	55	24231.03	**6.792**	0.29	4.2	**ppb**
Ni	60	1918.22	**2.573**	0.01	0.4	**ppb**
Pb	208	23069.95	**2.031**	0.02	0.9	**ppb**
As	75	661.027	**1.105**	0.04	4.1	**ppb**
Cd	111	301.005	**0.198**	0.01	3.3	**ppb**

UPM COPYRIGHT

Quantitative Analysis - Summary Report
Sample ID: **A2**
Sample Date/Time: Tuesday, March 12, 2019 10:54:12
Dual Detector Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\DataSet\MAC 2019\A2.627
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	163330.451	**46.021**	0.61	1.3	ppb
Mn	55	46773.026	**6.643**	0.08	1.1	ppb
Ni	60	3880.503	**2.538**	0.08	3.1	ppb
Pb	208	74564.234	**10.672**	0.03	0.3	ppb
As	75	1404.784	**0.979**	0.02	2.2	ppb
Cd	111	1103.401	**0.335**	0.01	2.5	ppb

Quantitative Analysis - Summary Report
Sample ID: **A3**
Sample Date/Time: Tuesday, March 12, 2019 10:55:34
Dual Detector Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\DataSet\MAC 2019\A3.628
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	187205.541	**52.748**	0.47	0.9	ppb
Mn	55	65161.181	**9.255**	0.14	1.6	ppb
Ni	60	19936.546	**13.041**	0.12	0.9	ppb
Pb	208	100862.487	**14.436**	0.09	0.6	ppb
As	75	1455.792	**1.015**	0	0.1	ppb
Cd	111	885.377	**0.269**	0	1.5	ppb

© COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: **A4**

Sample Date/Time: Tuesday, March 12, 2019 10:57:36

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A4.629

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc . SD	Conc . RSD	Sampl e Unit
Cr	52	212949.303	**60.001**	0.87	1.4	ppb
Mn	55	92684.463	**13.164**	0.24	1.8	ppb
Ni	60	51368.535	**33.601**	0.69	2.1	ppb
Pb	208	43651.565	**6.248**	0.03	0.5	ppb
As	75	1382.78	**0.964**	0.03	3	ppb
Cd	111	987.055	**0.3**	0.01	3.4	ppb

Quantitative Analysis - Summary Report

Sample ID: **A6**

Sample Date/Time: Tuesday, March 12, 2019 10:59:39

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A6.630

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc . SD	Conc . RSD	Sampl e Unit
Cr	52	155461.397	**43.803**	0.45	1	ppb
Mn	55	54174.969	**7.695**	0.16	2.1	ppb
Ni	60	7421.711	**4.855**	0.08	1.6	ppb
Pb	208	17775.033	**2.544**	0.01	0.4	ppb
As	75	1350.775	**0.942**	0.05	5.2	ppb
Cd	111	550.017	**0.167**	0.01	3.4	ppb

© COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: **A11**

Sample Date/Time: Tuesday, March 12, 2019 11:01:00

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A11.631

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	182008.529	**51.283**	0.7	1.4	ppb
Mn	55	70343.137	**9.991**	0.14	1.4	ppb
Ni	60	5754.833	**3.764**	0.05	1.4	ppb
Pb	208	664755.84	**95.147**	0.49	0.5	ppb
As	75	1308.102	**0.912**	0.02	2.6	ppb
Cd	111	20796.783	**6.32**	0.07	1	ppb

Quantitative Analysis - Summary Report

Sample ID: **A15**

Sample Date/Time: Tuesday, March 12, 2019 11:02:39

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A15.632

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	184789.9	**52.067**	0.2	0.4	ppb
Mn	55	73685.96	**10.466**	0.18	1.7	ppb
Ni	60	4151.958	**2.716**	0.11	4	ppb
Pb	208	219422.69	**31.406**	0.29	0.9	ppb
As	75	1373.779	**0.958**	0.01	0.6	ppb
Cd	111	4747.577	**1.443**	0.01	1	ppb

© COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: **A18**

Sample Date/Time: Tuesday, March 12, 2019 11:03:56

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A18.633

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc . SD	Conc . RSD	Sampl e Unit
Cr	52	241834.218	**68.14**	0.74	1.1	ppb
Mn	55	63531.94	**9.024**	0.04	0.4	ppb
Ni	60	6804.227	**4.451**	0.1	2.2	ppb
Pb	208	44424.297	**6.358**	0.04	0.6	ppb
As	75	1338.107	**0.933**	0.04	4	ppb
Cd	111	1757.838	**0.534**	0.01	1	ppb

Quantitative Analysis - Summary Report

Sample ID: **A23**

Sample Date/Time: Tuesday, March 12, 2019 11:06:16

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A23.634

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc . SD	Conc . RSD	Sampl e Unit
Cr	52	98212.562	**27.673**	0.35	1.3	ppb
Mn	55	52795.807	**7.499**	0.11	1.4	ppb
Ni	60	6236.152	**4.079**	0.08	1.8	ppb
Pb	208	104504.94	**14.958**	0.03	0.2	ppb
As	75	789.372	**0.55**	0.01	1.4	ppb
Cd	111	1053.395	**0.32**	0.01	2	ppb

© COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: **A24**

Sample Date/Time: Tuesday, March 12, 2019 11:07:53

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A24.635

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	137069.408	**38.621**	0.21	0.5	ppb
Mn	55	75539.11	**10.729**	0.09	0.8	ppb
Ni	60	8023.891	**5.249**	0.12	2.4	ppb
Pb	208	152262.26	**21.793**	0.12	0.5	ppb
As	75	1017.396	**0.709**	0.02	2.3	ppb
Cd	111	5449.972	**1.656**	0.02	1.3	ppb

Quantitative Analysis - Summary Report

Sample ID: **A25 [B]**

Sample Date/Time: Tuesday, March 12, 2019 11:09:10

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A25 [B].636

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	227939.497	**64.225**	0.59	0.9	ppb
Mn	55	60218.365	**8.553**	0.06	0.7	ppb
Ni	60	4164.963	**2.724**	0.03	1.1	ppb
Pb	208	12213.203	**1.748**	0.01	0.7	ppb
As	75	1629.489	**1.136**	0.02	1.5	ppb
Cd	111	530.016	**0.161**	0.01	3.4	ppb

© COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: **A27**

Sample Date/Time: Tuesday, March 12, 2019 11:10:50

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A27.637

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc . SD	Conc . RSD	Sampl e Unit
Cr	52	256878.931	**72.379**	1.14	1.6	ppb
Mn	55	74165.147	**10.534**	0.1	1	ppb
Ni	60	7736.975	**5.061**	0.11	2.1	ppb
Pb	208	59909.443	**8.575**	0.03	0.4	ppb
As	75	1588.815	**1.108**	0.03	2.5	ppb
Cd	111	969.719	**0.295**	0.01	1.8	ppb

Quantitative Analysis - Summary Report

Sample ID: **A28 [B]**

Sample Date/Time: Tuesday, March 12, 2019 11:12:22

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A28 [B].638

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc . SD	Conc . RSD	Sampl e Unit
Cr	52	258178.154	**72.745**	0.55	0.8	ppb
Mn	55	70414.349	**10.001**	0.13	1.3	ppb
Ni	60	5830.882	**3.814**	0.08	2.1	ppb
Pb	208	14256.174	**2.04**	0.01	0.5	ppb
As	75	1412.785	**0.985**	0.03	2.9	ppb
Cd	111	571.018	**0.174**	0	0.5	ppb

UPM COPYRIGHT

Quantitative Analysis - Summary Report

Sample ID: **A31**

Sample Date/Time: Tuesday, March 12, 2019 11:13:53

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A31.639

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	281840.507	**79.412**	0.42	0.5	ppb
Mn	55	80450.857	**11.427**	0.09	0.8	ppb
Ni	60	7721.962	**5.051**	0.08	1.7	ppb
Pb	208	21346.373	**3.055**	0.01	0.4	ppb
As	75	1594.816	**1.112**	0.03	2.9	ppb
Cd	111	599.354	**0.182**	0	2.5	ppb

Quantitative Analysis - Summary Report

Sample ID: **A34**

Sample Date/Time: Tuesday, March 12, 2019 11:15:34

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A34.640

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	316861.276	**89.28**	0.96	1.1	ppb
Mn	55	84570.22	**12.012**	0.19	1.6	ppb
Ni	60	6493.666	**4.248**	0.05	1.3	ppb
Pb	208	55553.582	**7.951**	0.06	0.8	ppb
As	75	1633.49	**1.139**	0.01	1.1	ppb
Cd	111	3187.896	**0.969**	0.04	3.9	ppb

UPM COPYRIGHT UPM ©

Quantitative Analysis - Summary Report

Sample ID: **A37**

Sample Date/Time: Tuesday, March 12, 2019 11:17:46

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A37.641

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc SD	Conc RSD	Sample Unit
Cr	52	273231.51	**76.987**	1.46	1.9	ppb
Mn	55	73174.776	**10.393**	0.01	0.1	ppb
Ni	60	5997.325	**3.923**	0.13	3.3	ppb
Pb	208	23426.822	**3.353**	0.03	1	ppb
As	75	1565.478	**1.091**	0.02	1.8	ppb
Cd	111	663.692	**0.202**	0.01	3	ppb

Quantitative Analysis - Summary Report

Sample ID: **A39**

Sample Date/Time: Tuesday, March 12, 2019 11:18:54

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A39.642

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	1847633.23	**520.596**	9.92	1.9	ppb
Mn	55	171988.412	**24.428**	0.28	1.2	ppb
Ni	60	10217.427	**6.683**	0.03	0.5	ppb
Pb	208	76155.344	**10.9**	0.04	0.4	ppb
As	75	2059.913	**1.436**	0.03	2.1	ppb
Cd	111	1700.494	**0.517**	0.02	4.1	ppb

UPM
COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: **A40**

Sample Date/Time: Tuesday, March 12, 2019 11:21:16

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A40.643

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	211714.733	**59.654**	1.27	2.1	ppb
Mn	55	82271.446	**11.685**	0.07	0.6	ppb
Ni	60	6163.435	**4.032**	0.07	1.8	ppb
Pb	208	19142.139	**2.74**	0.02	0.6	ppb
As	75	1557.476	**1.086**	0.01	1.1	ppb
Cd	111	947.05	**0.288**	0.02	5.4	ppb

Quantitative Analysis - Summary Report

Sample ID: **A41**

Sample Date/Time: Tuesday, March 12, 2019 11:23:07

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A41.644

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	341022.53	**96.088**	1.13	1.2	ppb
Mn	55	92434.528	**13.129**	0.15	1.1	ppb
Ni	60	7361.995	**4.816**	0.07	1.4	ppb
Pb	208	17374.594	**2.487**	0.02	0.7	ppb
As	75	2092.921	**1.459**	0.06	4.3	ppb
Cd	111	759.699	**0.231**	0.01	3.1	ppb

UPM
COPYRIGHT

Quantitative Analysis - Summary Report

Sample ID: **A42**

Sample Date/Time: Tuesday, March 12, 2019 11:24:34

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A42.645

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	243062.447	**68.486**	1.56	2.3	ppb
Mn	55	76000.295	**10.794**	0.12	1.1	ppb
Ni	60	6151.427	**4.024**	0.01	0.3	ppb
Pb	208	36500.477	**5.224**	0.04	0.8	ppb
As	75	1889.541	**1.317**	0.01	0.9	ppb
Cd	111	1209.748	**0.368**	0.01	2.2	ppb

Quantitative Analysis - Summary Report

Sample ID: **A45**

Sample Date/Time: Tuesday, March 12, 2019 11:25:38

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A45.646

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	220791.565	**62.211**	0.28	0.5	ppb
Mn	55	74894.461	**10.637**	0.12	1.1	ppb
Ni	60	11957.889	**7.822**	0.23	3	ppb
Pb	208	86166.48	**12.333**	0.11	0.9	ppb
As	75	1651.16	**1.151**	0.02	1.8	ppb
Cd	111	1666.821	**0.507**	0.01	2.4	ppb

UPM
COPYRIGHT UPM

Quantitative Analysis - Summary Report
Sample ID: **A46**
Sample Date/Time: Tuesday, March 12, 2019 11:26:37
Dual Detector Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\DataSet\MAC 2019\A46.647
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	159911.286	**45.057**	1.31	2.9	ppb
Mn	55	62513.957	**8.879**	0.22	2.4	ppb
Ni	60	8655.472	**5.662**	0.14	2.5	ppb
Pb	208	209737.949	**30.02**	0.11	0.4	ppb
As	75	1240.092	**0.864**	0.03	3.9	ppb
Cd	111	1478.789	**0.449**	0.02	3.9	ppb

Quantitative Analysis - Summary Report
Sample ID: **A47**
Sample Date/Time: Tuesday, March 12, 2019 11:27:39
Dual Detector Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\DataSet\MAC 2019\A47.648
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	413952.281	**116.63 7**	2.13	1.8	ppb
Mn	55	111406.596	**15.823**	0.17	1.1	ppb
Ni	60	22296.359	**14.584**	0.22	1.5	ppb
Pb	208	37553.418	**5.375**	0.03	0.6	ppb
As	75	1777.184	**1.239**	0.02	1.7	ppb
Cd	111	1490.79	**0.453**	0.01	1.5	ppb

UPM COPYRIGHT ©

Quantitative Analysis - Summary Report

Sample ID: **A48 [B]**

Sample Date/Time: Tuesday, March 12, 2019 11:28:58

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\DataSet\MAC 2019\A48 [B].649

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	360101.285	**101.464**	1.35	1.3	ppb
Mn	55	85042.887	**12.079**	0.04	0.4	ppb
Ni	60	5266.203	**3.445**	0.09	2.6	ppb
Pb	208	10945.589	**1.567**	0.01	0.5	ppb
As	75	1215.089	**0.847**	0.02	2	ppb
Cd	111	459.345	**0.14**	0.01	7.7	ppb

Quantitative Analysis - Summary Report

Sample ID: **BLANK SAMPEL [ACID BLANK]**

Sample Date/Time: Thursday, March 21, 2019 15:39:42

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\Dataset\MAC 2019\BLANK SAMPEL [ACID BLANK].925

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	7213.611	**3.006**	0.07	2.4	ppb
Mn	55	14221.47	**3.192**	0.04	1.3	ppb
Ni	60	1246.43	**1.465**	0.01	0.7	ppb
Pb	208	10390.26	**0.831**	0	0.5	ppb
As	75	142.335	**0.2**	0.05	25.8	ppb
Cd	111	108.001	**0.048**	0	4.8	ppb

Sample ID: **BLANK SAMPEL [ACID BLANK]**
Sample Date/Time: Thursday, March 21, 2019 15:40:55
Dual Detector Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\BLANK SAMPEL [ACID BLANK].926
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	7366.185	**3.069**	0.07	1.1	ppb
Mn	55	15988.78	**3.589**	0.04	1	ppb
Ni	60	1624.826	**1.909**	0.06	3.3	ppb
Pb	208	16107.1	**1.289**	0.01	1	ppb
As	75	123.335	**0.174**	0	1.6	ppb
Cd	111	330.342	**0.148**	0.01	9.6	ppb

Quantitative Analysis - Summary Report
Sample ID: A39
Sample Date/Time: Thursday, March 21, 2019 15:43:11
Dual Detector Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\A39 .928
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
			51.49			
Cr	52	123589	**7**	0.95	1.8	ppb
Mn	55	17146.25	**3.849**	0.04	0.9	ppb
Ni	60	2066.586	**2.428**	0.03	1.3	ppb
Pb	208	19798.16	**1.584**	0.01	0.5	ppb
As	75	923.053	**1.3**	0.09	7	ppb
Cd	111	425.346	**0.19**	0.01	5.9	ppb

Sample ID: **BLANK SAMPLE [ACID SAMPLE] 1**
Sample
Date/Time: Thursday, March 21, 2019 16:00:34
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\BLANK SAMPLE [ACID SAMPLE] 1.939
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	49636.26	**17.534**	0.52	3	ppb
Mn	55	15277.89	**2.991**	0.1	3.4	ppb
Ni	60	2805.124	**2.964**	0.01	0.5	ppb
Pb	208	9789.924	**0.832**	0.05	6.3	ppb
As	75	118080.1	**143.148**	1.52	1.1	ppb
Cd	111	199.67	**0.075**	0.01	13.9	ppb

Quantitative Analysis - Summary Report
Sample ID: **BLANK SAMPLE [ACID SAMPLE] 2**
Sample
Date/Time: Thursday, March 21, 2019 16:01:36
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\BLANK SAMPLE [ACID SAMPLE] 2.940
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	58887.7	**20.802**	0.54	2.6	ppb
Mn	55	32160.93	**6.297**	0.08	1.3	ppb
Ni	60	3599.412	**3.803**	0.2	5.3	ppb
Pb	208	7046.619	**0.599**	0	0.7	ppb
As	75	129257.9	**156.699**	0.71	0.5	ppb
Cd	111	121.668	**0.045**	0.01	28.2	ppb

© COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: **BLANK SAMPLE [ACID SAMPLE] 4**

Sample Date/Time: Thursday, March 21, 2019 16:06:04

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\Dataset\MAC 2019\BLANK SAMPLE [ACID SAMPLE] 4.944

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	47444.77	**16.148**	0.09	0.6	ppb
Mn	55	14605.42	**2.751**	0.06	2	ppb
Ni	60	3115.227	**3.141**	0.01	0.3	ppb
Pb	208	8832.245	**0.772**	0.05	6.4	ppb
As	75	119138.4	**137.504**	1.66	1.2	ppb
Cd	111	250.339	**0.091**	0	4.2	ppb

Quantitative Analysis - Summary Report

Sample ID: **BLANK SAMPLE [ACID SAMPLE] 3**

Sample Date/Time: Thursday, March 21, 2019 16:07:04

Dual Detector Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\Dataset\MAC 2019\BLANK SAMPLE [ACID SAMPLE] 3.945

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	61193.24	**20.827**	0.28	1.3	ppb
Mn	55	20553.07	**3.871**	0.1	2.7	ppb
Ni	60	3529.382	**3.559**	0.05	1.3	ppb
Pb	208	9488.248	**0.83**	0.01	0.9	ppb
As	75	128694.2	**148.533**	2.97	2	ppb
Cd	111	81.001	**0.029**	0.01	22.9	ppb

COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: D-2 CEMERLANG
Sample
Date/Time: Thursday, March 21, 2019 16:08:35
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 CEMERLANG.946
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	1209882	**411.787**	9.69	2.4	ppb
Mn	55	15726045	**2961.76 7**	24.98	0.8	ppb
Ni	60	313408.5	**315.996**	3.47	1.1	ppb
Pb	208	5673120	**496.139**	3.24	0.7	ppb
As	75	769552.6	**888.185**	9.6	1.1	ppb
Cd	111	13348.22	**4.83**	0.07	1.4	ppb

Quantitative Analysis - Summary Report

Sample ID: D-2 GENIUS
Sample
Date/Time: Thursday, March 21, 2019 16:09:49
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 GENIUS.947
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	5342472	**1818.32 4**	29.47	1.6	ppb
Mn	55	15028534	**2830.40 1**	30.58	1.1	ppb
Ni	60	357359.7	**360.31**	6.74	1.9	ppb
Pb	208	38921510	**3403.85 8**	58.98	1.7	ppb
As	75	820936.9	**947.49**	30.24	3.2	ppb
Cd	111	15157.74	**5.485**	0.02	0.3	ppb

Quantitative Analysis - Summary Report
Sample ID: D-2 BERJAYA
Sample
Date/Time: Thursday, March 21, 2019 16:11:35
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 BERJAYA.948
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	1351616	**460.026**	13.26	2.9	ppb
			6784.08			
Mn	55	36021364	**8**	73.85	1.1	ppb
Ni	60	422491.8	**425.98**	3.6	0.8	ppb
Pb	208	8555508	**748.217**	5.69	0.8	ppb
			1220.84			
As	75	1057777	**1**	14.55	1.2	ppb
Cd	111	26529.85	**9.599**	0.16	1.7	ppb

Quantitative Analysis - Summary Report
Sample ID: **D-2 'ARIF**
Sample
Date/Time: Thursday, March 21, 2019 16:12:51
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 ARIF.949
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	1367337	**465.377**	15.06	3.2	ppb
			2695.56			
Mn	55	14312598	**5**	81.52	3	ppb
Ni	60	583432.4	**588.249**	11.9	2	ppb
Pb	208	6522801	**570.448**	6.61	1.2	ppb
As	75	525509.6	**606.521**	12.96	2.1	ppb
Cd	111	103262.9	**37.364**	0.29	0.8	ppb

COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: D-2 AMAL
Sample
Date/Time: Thursday, March 21, 2019 16:13:53
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 AMAL.950
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	1595311	**542.968**	15.83	2.9	ppb
Mn	55	1.46E+08	**27446.8**	374.4	1.4	ppb
Ni	60	383905.5	**387.075**	3.72	1	ppb
Pb	208	8226573	**719.45**	11.16	1.6	ppb
As	75	319986.7	**369.315**	6.72	1.8	ppb
Cd	111	30727.06	**11.118**	0.09	0.8	ppb

Quantitative Analysis - Summary Report

Sample ID: D-2 ALIM
Sample
Date/Time: Thursday, March 21, 2019 16:14:55
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 ALIM.951
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	1285901	**437.66**	10.25	2.3	ppb
Mn	55	19290410	**3633.062**	78.43	2.2	ppb
Ni	60	1837733	**1852.906**	30.14	1.6	ppb
Pb	208	15448272	**1351.02**	11.57	0.9	ppb
As	75	414485	**478.381**	5.65	1.2	ppb
Cd	111	36227.3	**13.108**	0.09	0.6	ppb

UPM
COPYRIGHT

Quantitative Analysis - Summary Report

Sample ID: D-2 ADIB
Sample
Date/Time: Thursday, March 21, 2019 16:18:23
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 ADIB.952
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	1042597	**354.85**	9.94	2.8	ppb
Mn	55	15530648	**2924.96**	82.97	2.8	ppb
Ni	60	393048.6	**396.294**	6.99	1.8	ppb
Pb	208	4130814	**361.258**	3.38	0.9	ppb
As	75	438222.9	**505.778**	4.76	0.9	ppb
Cd	111	46335.12	**16.766**	0.11	0.6	ppb

Quantitative Analysis - Summary Report

Sample ID: D-2 BLOSSOM
Sample
Date/Time: Thursday, March 21, 2019 16:19:42
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 BLOSSOM.953
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	959170.8	**326.456**	5.48	1.7	ppb
Mn	55	13741437	**2587.99**	20.57	0.8	ppb
Ni	60	291592.5	**294**	1.56	0.5	ppb
Pb	208	1934984	**169.223**	1.24	0.7	ppb
As	75	555011.7	**640.571**	7.32	1.1	ppb
Cd	111	65755.77	**23.793**	0.15	0.6	ppb

COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: D-2 EVERLASTING
Sample
Date/Time: Thursday, March 21, 2019 16:20:52
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 EVERLASTING.954
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	1158925	**394.443**	11.45	2.9	ppb
Mn	55	10249817	**1930.4**	56.95	2.9	ppb
Ni	60	344804.8	**347.652**	11.61	3.3	ppb
Pb	208	2979834	**260.6**	1.08	0.4	ppb
As	75	563445	**650.304**	13.83	2.1	ppb
Cd	111	51711.37	**18.711**	0.15	0.8	ppb

Quantitative Analysis - Summary Report

Sample ID: D-2 DAISY
Sample
Date/Time: Thursday, March 21, 2019 16:22:07
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 DAISY.955
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	1072606	**365.064**	6.96	1.9	ppb
Mn	55	13102686	**2467.69 6**	49.8	2	ppb
Ni	60	306041.3	**308.568**	4.4	1.4	ppb
Pb	208	2771874	**242.413**	2.66	1.1	ppb
As	75	522111.2	**602.598**	21.28	3.5	ppb
Cd	111	37743.46	**13.657**	0.11	0.8	ppb

COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: D-2 FITTONIA
Sample
Date/Time: Thursday, March 21, 2019 16:23:28
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 FITTONIA.956
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	1397055	**475.491**	9.53	2	ppb
Mn	55	12030818	**2265.82 6**	22.04	1	ppb
Ni	60	317973.7	**320.599**	3.12	1	ppb
Pb	208	4617271	**403.801**	3.12	0.8	ppb
As	75	617453.8	**712.639**	15.53	2.2	ppb
Cd	111	121310	**43.894**	0.54	1.2	ppb

Quantitative Analysis - Summary Report

Sample ID: **D-2 ARIF**
Sample
Date/Time: Thursday, March 21, 2019 16:25:57
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 ARIF.957
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	1310168	**445.919**	4.51	1	ppb
Mn	55	15492131	**2917.71 2**	8.74	0.3	ppb
Ni	60	344637.5	**347.483**	6.56	1.9	ppb
Pb	208	6603538	**577.509**	4.06	0.7	ppb
As	75	299154.7	**345.272**	3.71	1.1	ppb
Cd	111	62265.96	**22.53**	0.11	0.5	ppb

COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: D-2 NILAM
Sample
Date/Time: Thursday, March 21, 2019 16:29:46
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 NILAM.961
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	804382.9	**237.616**	9.08	3.8	ppb
Mn	55	5479503	**832.504**	17.91	2.2	ppb
Ni	60	363203.4	**307.531**	7.91	2.6	ppb
Pb	208	3270457	**266.239**	4.49	1.7	ppb
As	75	375780	**357.618**	5.02	1.4	ppb
Cd	111	11321.46	**3.377**	0.02	0.5	ppb

Quantitative Analysis - Summary Report

Sample ID: D-2 DELIMA
Sample
Date/Time: Thursday, March 21, 2019 16:32:01
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 DELIMA.962
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	1536704	**453.945**	11.74	2.6	ppb
Mn	55	14309083	**2173.988**	48.56	2.2	ppb
Ni	60	10597716	**8973.269**	155.5	1.7	ppb
Pb	208	4796623	**390.48**	1.34	0.3	ppb
As	75	495619.3	**471.666**	13.31	2.8	ppb
Cd	111	17792.52	**5.307**	0.01	0.2	ppb

Quantitative Analysis - Summary Report

Sample ID: D-2 ZAMRUD
Sample
Date/Time: Thursday, March 21, 2019 16:33:42
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 ZAMRUD.963
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	3194934	**943.788**	16.95	1.8	ppb
Mn	55	7705627	**1170.72 1**	13.58	1.2	ppb
Ni	60	590574.4	**500.05**	8.69	1.7	ppb
Pb	208	5365709	**436.808**	9.86	2.3	ppb
As	75	2213228	**2106.26 2**	194.3	9.2	ppb
Cd	111	131456.3	**39.207**	0.46	1.2	ppb

Quantitative Analysis - Summary Report

Sample ID: D-2 MUTIARA
Sample
Date/Time: Thursday, March 21, 2019 16:35:04
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 MUTIARA.964
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	1083372	**320.03**	6.35	2	ppb
Mn	55	8528903	**1295.80 1**	21.93	1.7	ppb
Ni	60	1062835	**899.921**	15	1.7	ppb
Pb	208	3006164	**244.724**	1.53	0.6	ppb
As	75	633066.1	**602.47**	9.58	1.6	ppb
Cd	111	514046.9	**153.315**	1.1	0.7	ppb

© COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: D-2 SEMARAK
Sample
Date/Time: Thursday, March 21, 2019 16:36:15
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 SEMARAK.965
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	3509363	**1036.671**	18.09	1.7	ppb
Mn	55	18353144	**2788.404**	18.23	0.7	ppb
Ni	60	398610.9	**337.511**	0.96	0.3	ppb
Pb	208	25706569	**2092.702**	32.01	1.5	ppb
As	75	1127102	**1072.628**	29.41	2.7	ppb
Cd	111	153738.6	**45.853**	0.61	1.3	ppb

Quantitative Analysis - Summary Report

Sample ID: D-2 CEMPAKA
Sample
Date/Time: Thursday, March 21, 2019 16:38:33
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 CEMPAKA.966
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	4534525	**1339.505**	9.79	0.7	ppb
Mn	55	20204970	**3069.753**	16.95	0.6	ppb
Ni	60	539252.5	**456.594**	7.26	1.6	ppb
Pb	208	32119889	**2614.793**	22.05	0.8	ppb
As	75	1201970	**1143.879**	8.36	0.7	ppb
Cd	111	240453.5	**71.715**	0.95	1.3	ppb

Quantitative Analysis - Summary Report

Sample ID: D-2 DAHLIA

Sample

Date/Time: Thursday, March 21, 2019 16:40:12

Dual Detector

Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 DAHLIA.967

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	2944445	**869.793**	21.22	2.4	ppb
Mn	55	25723606	**3908.203**	56.28	1.4	ppb
Ni	60	583949.4	**494.44**	9.26	1.9	ppb
Pb	208	22165070	**1804.398**	9.87	0.5	ppb
As	75	1112222	**1058.468**	23.33	2.2	ppb
Cd	111	188421.2	**56.197**	0.73	1.3	ppb

Quantitative Analysis - Summary Report

Sample ID: D-2 MAWAR

Sample

Date/Time: Thursday, March 21, 2019 16:39:59

Dual Detector

Mode: Dual

Method File: C:\Elandata\Method\Quantitative Analysis.mth

Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 MAWAR.968

Summary

Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	2420493	**715.017**	15.11	2.1	ppb
Mn	55	17323533	**2631.975**	37.47	1.4	ppb
Ni	60	419033.8	**354.803**	6.16	1.7	ppb
Pb	208	10696570	**870.779**	4.62	0.5	ppb
As	75	1284786	**1222.692**	15.94	1.3	ppb
Cd	111	124219.5	**37.049**	0.35	1	ppb

Quantitative Analysis - Summary Report

Sample ID: D-2 SA
Sample
Date/Time: Thursday, March 21, 2019 16:42:25
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 SA.969
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	3114595	**920.056**	22.46	2.4	ppb
Mn	55	26269752	**3991.17 9**	84.32	2.1	ppb
Ni	60	449577.7	**380.665**	12.09	3.2	ppb
Pb	208	27445286	**2234.24 6**	18.33	0.8	ppb
As	75	2090691	**1989.64 7**	216.1	10.9	ppb
Cd	111	30869.55	**9.207**	0.12	1.3	ppb

Quantitative Analysis - Summary Report

Sample ID: D-2 SF
Sample
Date/Time: Thursday, March 21, 2019 16:43:41
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 SF.970
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	**Conc. Mean**	Conc. SD	Conc. RSD	Sample Unit
Cr	52	3324736	**982.132**	18.88	1.9	ppb
Mn	55	21320711	**3239.26 9**	54.18	1.7	ppb
Ni	60	540243.7	**457.434**	3.52	0.8	ppb
Pb	208	38968751	**3172.34**	24.98	0.8	ppb
As	75	800090.3	**761.422**	15.76	2.1	ppb
Cd	111	186461.9	**55.612**	0.26	0.5	ppb

COPYRIGHT UPM

Quantitative Analysis - Summary Report

Sample ID: D-2 SH
Sample
Date/Time: Thursday, March 21, 2019 16:44:53
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 SH.971
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	Conc. Mean	Conc. SD	Conc. RSD	Sample Unit
Cr	52	2937849	**867.845**	9.53	1.1	ppb
Mn	55	31786194	**4829.29 6**	12.96	0.3	ppb
Ni	60	668865.8	**566.34**	4.05	0.7	ppb
Pb	208	21672500	**1764.29 9**	8.15	0.5	ppb
As	75	1282049	**1220.08 7**	39.61	3.2	ppb
Cd	111	52831.79	**15.757**	0.13	0.8	ppb

Quantitative Analysis - Summary Report

Sample ID: D-2 SK
Sample
Date/Time: Thursday, March 21, 2019 16:46:29
Dual Detector
Mode: Dual
Method File: C:\Elandata\Method\Quantitative Analysis.mth
Dataset File: C:\Elandata\Dataset\MAC 2019\D-2 SK.972
Summary
Concentration Results

Analyte	Mass	Net Intens. Mean	Conc. Mean	Conc. SD	Conc. RSD	Sample Unit
Cr	52	2412964	**712.793**	9.53	1.3	ppb
Mn	55	26667117	**4051.55 1**	32.86	0.8	ppb
Ni	60	609600.1	**516.159**	1.73	0.3	ppb
Pb	208	24787584	**2017.89**	32.63	1.6	ppb
As	75	1243705	**1183.59 6**	45.37	3.8	ppb
Cd	111	51542.42	**15.373**	0.2	1.3	ppb

COPYRIGHT UP