

# **INDOOR AIR QUALITY AND THE HEALTH IMPLICATIONS ON SCHOOL CHILDREN IN MALAYSIA**

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**UPM**  
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BERILMU BERBAKTI

## PROTECTING **CHILDREN** FROM THE ENVIRONMENT

**Environmental exposures start in the womb, and can have effects throughout life.**



# CHILDREN'S VULNERABILITY

## 1. Outdoor activity

- Their increased exposure, as children in tropical climate spend less than 80% of their time indoors.
- They exert themselves harder than adults when playing outside.

## 2. Size and physiological development

- Children are growing and developing.
- Their lungs are developing, therefore, physiologically not matured.
- Exposure during infancy or childhood could hinder the development of the respiratory system, resulting in decreased lung capacity or size.

## 3. Metabolic rate

- Their metabolic rates are fast, most organs and bodily systems are not matured.
- Children take in more air per unit body weight.
- Asthmatic children in areas with high levels of O<sub>3</sub> and particles, and participate in >3 competitive sports are at greater risk of increased asthma symptoms and attacks

## 4. Early exposure

- Environmental exposure of children starts in the womb and can have affect throughout their lives

# FGD on Priority List of EH Issues for Malaysia (9 Aug 2018)

- 1st FGD at UPM (9 Aug 2018)
- 2nd FGD at KKM (22 April 2019)
- 12 + 8 = 20 FGD participants
- 7 TWG10 members (did not participate in ranking)



## 20 FGD members

- 3 Environmental physicians
- 2 Occupational physicians
- 1 Family health physician
- 1 Paediatrician
- 3 Environmental health officers
- 4 Public/environmental health engineers
- 1 Environmental engineer
- 2 Environmental managers
- 1 Vector control specialist
- 1 Air quality specialist
- 1 Disaster scientist



# 2nd FGD on Priority List of EH Issues for Malaysia

(22 April 2019)



## Review Article

Jamal Hisham Hashim, Zailina Hashim\*, Rozita Hod, Juliana Jalaludin, Norlen Mohamed, Subramaniam Karuppannan, Ahmad Riadz Mazeli, Suhaily Sahrani and Zairul Ain Zulkafli

## A priority list of environmental health issues for Malaysia

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## Abstract

**Objectives:** Environmental risk factors contribute to 24% of the global burden of disease from all causes in disability-adjusted life years (DALYs), and to 23% of all global deaths. Malaysia being an advanced developing country, there is a need to prioritise environmental health issues to enable environmental health practitioners to focus on the most significant and urgent environmental health concerns.

**Content:** This project was undertaken by a Thematic Working Group on Environmental Health Experts (TWG 10) under the Malaysian National Environmental Health Action Plan. Sixteen pre-selected environmental health issues were presented to a two focus group discussions among 20 environmental health and related professionals who then scored each issue on its magnitude and severity scale.

**Summary:** The total of these scores generated a list of priority environmental health issues for Malaysia. Children environmental health came out as the environmental health issue of the highest priority.

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**Outlook:** We hope that this list of priority environmental health issues will be used for prioritising academic and professional manpower training, research funding allocation and planning for intervention programmes by various stakeholders.

**Keywords:** environmental health issues; focus group discussion; Malaysia; priority.

### Introduction

Environmental health comprises those aspects of human health, including quality of life, that are determined by physical, chemical, biological, social and psychosocial factors in the environment. It also refers to the theory and practice of assessing, correcting, controlling, and preventing those factors in the environment that can potentially affect adversely the health of present and future generations [1]. A more recent definition is that environmental health is the science and practice of preventing human injury and illness and promoting well-being by identifying and evaluating environmental sources and hazardous agents and limiting exposures to hazardous physical, chemical and biological agents in air, water, soil, food and other environmental media or settings that may adversely affect human health [2].

Environmental risk factors contribute to 24% of the global burden of disease from all causes (in disability-adjusted life years (DALYs)), and to 23% of all global deaths [3]. The environmental attributable fraction is slightly higher for men (25%) than for women (22%), partly because occupational risks were higher in men. Most of these

During the FGD, each of the 20 participants were asked to score each environmental health issue based on what they think is its magnitude and severity score. Magnitude scoring was based on the size of the population that will be impacted by the issue. Severity scoring was based on the seriousness of the outcome of the health impact on the population. Both magnitude and severity scoring were based on a Likert Scale of 1–5 (1=very low, 2=low, 3=moderate, 4=high and 5=very high).

Guidelines were given to the participants on the scoring of the magnitude of each environmental health issue as follows:

- Very low (1): affects only a very localised population like a few villages or mukims (sub-districts).
- Low (2): affects an entire district or a few neighbouring districts.
- Moderate (3): affects population statewide and may even affect neighbouring states.
- High (4): affects several states or hotspots throughout the nation.
- Very high (5): affect population nationwide and may even be transnational.

Similarly, guidelines were also given to the participants on the scoring of the severity of each environmental health issue as follows:

- Very low (1): causes mainly nuisance (e.g. odour) or mild discomfort.
- Low (2): causes acute reactions like respiratory tract infections, airway and skin irritation.
- Moderate (3): moderate health effects like respiratory impairment and reversible organ dysfunctions.
- High (4): may lead to acute or chronic health effects that may require hospitalisation (e.g. dengue, severe asthmatic attack).
- Very high (5): may lead to permanent disability (like chronic obstructive pulmonary disease or COPD), chronic effects like cancer or renal failure, heart attack and fatality.

| Old Rank | New Rank | Top 10 Environmental Health Issues in Malaysia  | Total Score |
|----------|----------|---|-------------|
| 1        | 1        | <b>Children environmental health (birth cohort study, impact of indoor environment). Formulate intervention strategies on how to manage, e.g. schools/homes/childcare centres.</b>              | <b>169</b>  |
| 4        | 2        | Vector borne diseases (e.g. dengue and Aedes breeding in junk yards/abandoned places/no man's land; re-emergence of malaria).   | 168         |
| 3        | 3        | Contamination of drinking water sources and emerging water pollutants [e.g. endocrine disrupting chemicals (EDCs), pharmaceutical drugs (antiseptics, antimicrobials)].                         | 167         |
| 2        | 4        | Urban health issues (housing and sanitation, poor drainage, air pollution, migrants, urban poor, crime and security, related diseases).   | 166         |
| 9        | 5        | Climate change adaptation strategies and neglected health issues.   | 162         |
| 5        | 6        | Food safety and contamination issues (e.g. recycled cooking oil, untrained food handlers especially foreigners, incomplete food labelling on food allergens, non-compliance to food standards). | 160         |
| 6        | 7        | Pesticides contamination in air, water and food.  | 155         |
| 8        | 8        | Human exposure to environmental chemicals (e.g. e-waste, industries and lead in paint/consumer products).   | 155         |
| 7        | 9        | Zoonotic diseases (use ecosystem approach on malaria ( <i>Plasmodium knowlesi</i> ), rabies, leptospirosis, melioidosis).   | 152         |
| 10       | 10       | Exposure to ionizing and non-ionizing radiation <sup>1</sup> .  | 144         |

<sup>1</sup> Issue added during first FGD

# Researches on Indoor Air Quality in Malaysian Schools

This presentation will discuss on the findings of studies conducted on secondary schools students in the areas of :

- Kuala Lumpur, WP (PM<sub>10</sub> and school air lead)
- **Kajang and Bangi, Selangor (school indoor air, respiratory health and allergy)**
- **Kota Kinabalu, Sabah (school indoor air, respiratory health and allergy)**
- Island and Mainland, Penang (school indoor air, respiratory health and allergy)
- Johor Baru, Johor (school indoor air, respiratory health and allergy)
- K. Terengganu, Terengganu (school indoor air, respiratory health and allergy)
- **Tanjung Karang, Selangor (pesticides, IQ and neurobehavioral performance)**
- **Kuantan, Pahang (bauxite, respiratory health and allergy and bioaccumulation)**
- **Pasir Gudang, Johor Baru (school indoor air, respiratory health)**

In Malaysian schools, the indoor air quality is almost the same as the ambient outdoor air because the classes were open air and equipped with fans for ventilation without having any air conditioning system

# School environment

- Poor IAQ in schools can affect students' health, productivity and ability to perform specific mental task requiring concentration
- They may appear sleepy, coughing, dizzy and experienced other respiratory illnesses (Moglia et al. 2006)



# Respirable particulate PM10: Urban vs rural

- Urban asthmatic children also had significantly higher respiratory symptoms than those in suburban areas (Zailina et al. 2004, **Khairul Nizam et al. 2020**).
- Significantly higher lung function impairment, more frequent asthmatic attacks and lung inflammation in urban children than the suburban areas (**Junaidah et al. 2012, Khairul Nizam et al. 2021**)



Article

## The Effects of Indoor Pollutants Exposure on Allergy and Lung Inflammation: An Activation State of Neutrophils and Eosinophils in Sputum

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**Abstract:** Background: To explore the inflammation phenotypes following indoor pollutants exposure based on marker expression on eosinophils and neutrophils with the application of chemometric analysis approaches. Methods: A cross-sectional study was undertaken among secondary school students in eight suburban and urban schools in the district of Hulu Langat, Selangor, Malaysia. The survey was completed by 96 students at the age of 14 by using the International Study of Asthma

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## Asthma Severity and Environmental Health Risk Factor among Asthmatic Primary School Children in the Selected Areas

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**Abstract: Problem statement:** The purpose of this study was to assess the severity of asthma and associated risk factors among asthmatic primary school children in the selected urban, industrial and rural areas of Selangor and Kuala Lumpur. **Approach:** A total of 207 respondents were involved in this study, in which 87 were children from the urban areas, 67 children were from the industrial areas and another 53 children were from rural areas. The selection of respondents was based on purposive sampling method, where only asthmatic children who had been diagnosed by physicians were involved. Health records of the children were obtained from the school administration office. Respondents were children from Standard 2 to Standard 5, with informed consent from their parents. A modified ISAAC Questionnaire translated into the Malay language was administered to the children and then completed by the parents. Peak Expiratory Flow (PEF) readings were measured using a peak

# Indoor air Quality of a Selangor School (Khairul et al 2021)

| Parameter                              | Urban<br>(Median±IQR) | Sub-urban<br>(Median±IQR) | p        |
|--|-----------------------|---------------------------|----------|
|  | n=16                  | n=16                      |          |
| Temperature (°C)                       | 29 (28-30)            | 27 (27-28)                | <0.001** |
| Relative Humidity (%)                  | 74.6 (67.7-77.2)      | 80.4 (79.6-87.1)          | <0.001** |
| CO <sub>2</sub> (ppm)                  | 452 (425-458)         | 456 (435-462)             | 0.068    |
| NO <sub>2</sub> (µg/m <sup>3</sup> )   | 32 (30-35)            | 20 (18-47)                | <0.001** |
| PM <sub>10</sub> (µg/m <sup>3</sup> )  | 41.00 (37.60-44.90)   | 36.70 (34.80-37.50)       | <0.001** |
| PM <sub>2.5</sub> (µg/m <sup>3</sup> ) | 24.30 (23.10-25.60)   | 21.90 (21.20-23.30)       | <0.001** |
| Formaldehyde (mg/m <sup>3</sup> )      | 13.45 (10.20-17.75)   | 3.10 (2.60-9.00)          | <0.001** |

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## The Impact of Exposure to Indoor Pollutants on Allergy and Lung Inflammation among School Children in Selangor, Malaysia: An Evaluation Using Factor Analysis

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Environmental equipment



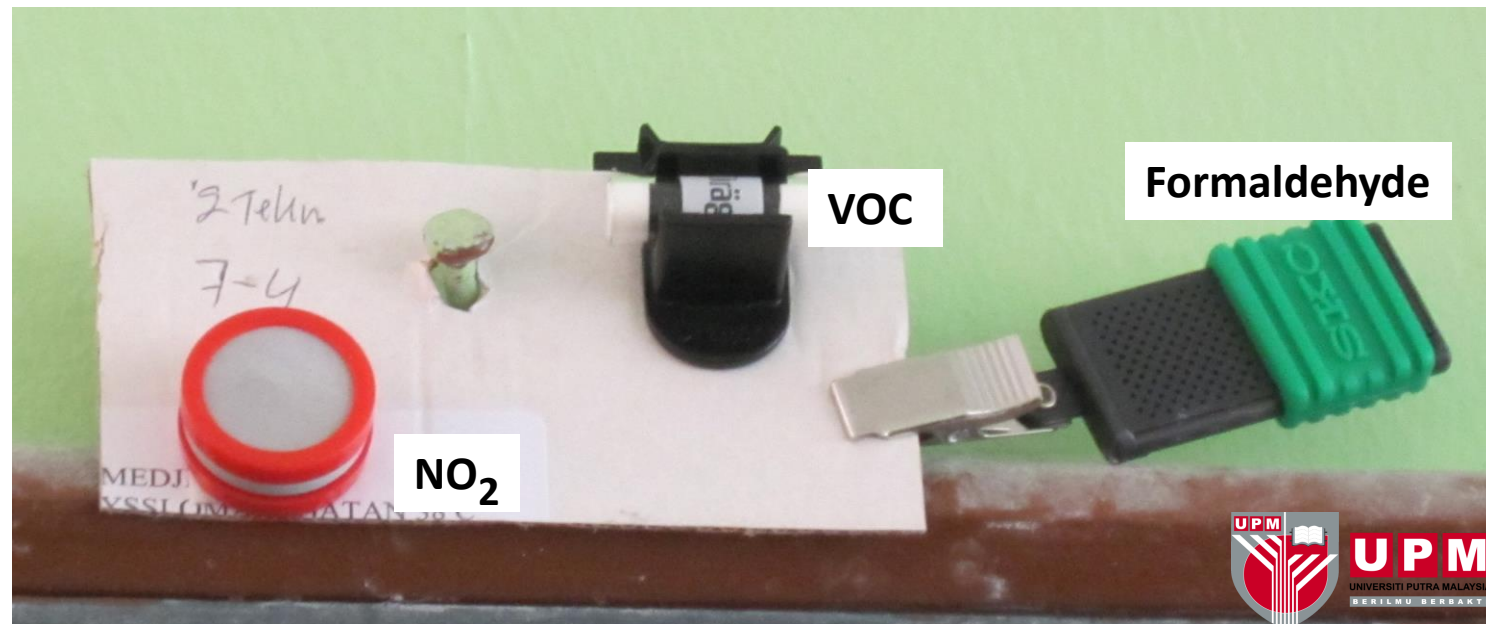
Microbe Sampling



Formaldehyde

VOC

NO<sub>2</sub>



## Asthma in Malaysia

- Air pollution has been recognized as one of the major concerns that have high potential for deleterious effects on asthmatic children's health (Junaidah et al. 2010, Junaidah et al. 2012, Jamal et al. 2004, Juliana et al. 2002, Zailina et al. 2004, Zailina et al. 1997, Zailina et al. 1996b, Khairul Nizam et al. 2020 and 2021).
- A study on asthmatic children in Kuala Lumpur showed more asthmatic attacks on days with high PM<sub>10</sub> and NO<sub>2</sub> (Zailina et al. 1997).

A Study of Health Impact and Risk Assessment of Urban Air Pollution in the Klang Valley, Malaysia

Article - October 2004

CITATIONS

READS

### Allergy to Air Pollution and Frequency of Asthmatic Attacks among Asthmatic Primary School Children

<sup>1</sup>Junaidah Zakaria, <sup>1</sup>Mum Sann, Lye, <sup>2</sup>Jamal H. Hashim and <sup>1</sup>Zailina Hashim

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**Abstract:** A cross-sectional comparative study was conducted on asthmatic primary school children in 3 areas in Kuala Lumpur and Selangor in Malaysia. The main objective was to study the relationship between air pollutants and frequency of asthmatic attacks. A total of 207 asthmatic children comprising of 87 from the urban, 67 from the industrial and another 53 from the rural areas were involved. Only asthmatic children diagnosed by medical professionals were selected with reference to the medical records provided by the school. These 2<sup>nd</sup> to 5<sup>th</sup> grade students had written consent from their parents. A modified ISAAC Questionnaire was completed by the parents. Continuous ambient air pollutants data was obtained from the Department of Environment. The prevalence of asthma was higher in urban and industrial children. In 2008, the annual mean PM<sub>10</sub> in the industrial areas (64.9 µg/m<sup>3</sup>) was slightly higher than the Malaysian Ambient Air Quality Guideline. SO<sub>2</sub> was significantly higher in the industrial area (0.003ppm), while CO (1.31ppm) and NO<sub>2</sub> (0.03 ppm) were higher in the urban area. Significant association between the prevalence of respiratory symptoms with locations found. Urban children have more respiratory symptoms such as difficulty in breathing (p=0.01), chest tightness

**Table 2 : Final model of the risk factors associated with respiratory symptoms and allergies among secondary students in Selangor**

|  | <b>OR (95% CI)</b> | <b>p</b> |
|--|--------------------|----------|
| <b>Wheezing</b>                            |                    |          |
| <b>Atopic</b>                              | 2.33 (1.41-3.83)   | 0.005*   |
| <b>Female</b>                              | 2.62 (1.19-5.78)   | 0.024*   |
| <b>Diagnosed asthma</b>                    | 6.55 (4.22-10.16)  | <0.001** |
| <b>PM10</b>                                | 1.37 (0.65-2.90)   | 0.354    |
| <b>Daytime breathlessness</b>              |                    |          |
| <b>Diagnosed asthma</b>                    | 2.56 (1.55-4.23)   | 0.003*   |
| <b>Urban schools</b>                       | 0.34 (0.17-0.68)   | 0.008*   |
| <b>NO<sub>2</sub></b>                      | 1.42 (1.12-1.80)   | 0.010*   |
| <b>Nocturnal attacks of breathlessness</b> |                    |          |
| <b>Diagnosed asthma</b>                    | 4.57 (1.49-13.97)  | 0.015*   |
| <b>Rhinitis in the past 12 months</b>      |                    |          |
| <b>Parental asthma/allergy</b>             | 1.60 (1.18-2.19)   | 0.009*   |
| <b>Formaldehyde</b>                        | 1.47 (1.09-1.99)   | 0.018*   |
| <b>Skin allergic in the past 12 months</b> |                    |          |
| <b>CO<sub>2</sub></b>                      | 5.54 (0.82-37.43)  | 0.072    |
| <b>PM10</b>                                | 2.66 (1.33-5.30)   | 0.012*   |

## The Effects of Indoor Pollutants Exposure on Allergy and Lung Inflammation: An Activation State of Neutrophils and Eosinophils in Sputum

Khairul Nizam Mohd Isa <sup>1,2</sup>, Zailina Hashim <sup>1,\*</sup>, Juliana Jalaludin <sup>1</sup>,  
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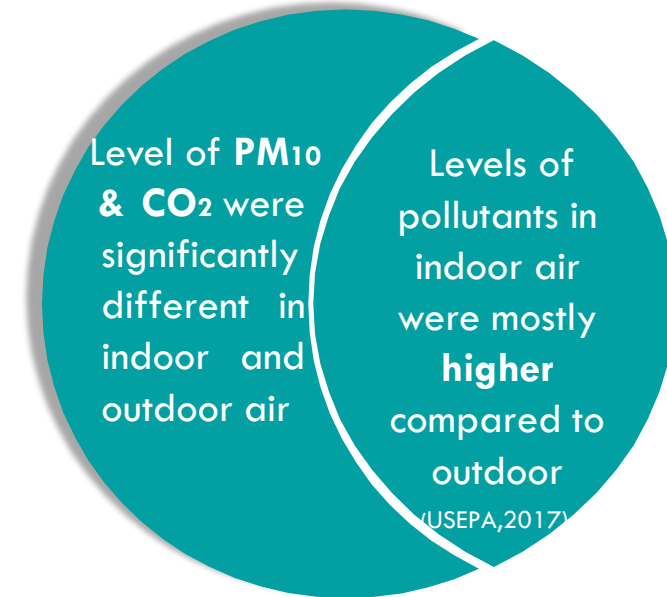
**Table 3: Air pollutant levels in indoor and outdoor in Kota Kinabalu secondary schools (Zailina et al., 2022)**

| Variables                              | Indoor<br>(N=24) | Outdoor<br>(N=6) | Z      | p         | I/O<br>ratio |
|--|------------------|------------------|--------|-----------|--------------|
|  | Median (IQR)     |                  |        |           |              |
| PM <sub>2.5</sub> (µg/m <sup>3</sup> ) | 22.0(8.0)        | 20.5(8.0)        | -1.862 | 0.063     | 1.07         |
| PM <sub>10</sub> (µg/m <sup>3</sup> )  | 30.79(8.98)      | 26.0(12)         | -2.233 | 0.026*    | 1.18         |
| Total VOC (ppm)                        | 0.56(0.22)       | 0.55(5.67)       | -0.083 | 0.934     | 1.01         |
| CO <sub>2</sub> (ppm)                  | 464(85)          | 401(16)          | -4.304 | <0.001*** | 1.16         |
| Formaldehyde (ppm)                     | 0.007(0.024)     | 0.008            | -0.625 | 0.532     | 0.88         |
| NO <sub>2</sub> (µg/m <sup>3</sup> )   | 18.0 (6.0)       | 15.0(9.0)        | -1.032 | 0.302     | 1.19         |
| Temperature (°C)                       | 26.3(4.9)        | 26.5(6.40)       | -0.851 | 0.393     | 0.99         |
| Relative Humidity (%)                  | 66.4 (6.4)       | 64.4(9.4)        | -1.237 | 0.216     | 1.03         |

Mann-Whitney U Test

\* Significant at  $p < 0.05$

\*\*\* Significant at  $p < 0.001$



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RESEARCH PAPER

**School Indoor Air Pollutants: In Relation to Allergy and Respiratory Symptoms among School Children in Urban Areas**

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**Table 3: Association between air pollutants level and lung function in Kota Kinabalu school children (Nor Syahira et al., 2019)**

| Variables           | Air Pollutants   |         |                   |         |                 |        |
|---------------------|------------------|---------|-------------------|---------|-----------------|--------|
|                     | PM <sub>10</sub> |         | PM <sub>2.5</sub> |         | NO <sub>2</sub> |        |
|                     | r                | p       | r                 | p       | r               | p      |
| FVC(liter)          | -0.104           | 0.054   | -0.001            | 0.988   | -0.053          | 0.365  |
| FEV1 (liter)        | -0.002           | 0.976   | -0.093            | 0.085   | 0.019           | 0.742  |
| FEV1/FVC (ratio)    | -0.141           | 0.009** | -0.125            | 0.020*  | 0.125           | 0.032* |
| FVC% predicted      | 0.081            | 0.135   | 0.060             | 0.264   | -0.121          | 0.037* |
| FEV1 % predicted    | -0.041           | 0.445   | -0.055            | 0.305   | -0.032          | 0.582  |
| FEV1/FVC% predicted | -0.155           | 0.004** | -0.140            | 0.009** | 0.132           | 0.023* |

Spearman Correlation  
 \* Significant at  $p < 0.05$   
 \*\*Significant  $p < 0.01$

Particulate matter significantly correlate with the FEV<sub>1</sub>/FVC% predicted of the student.

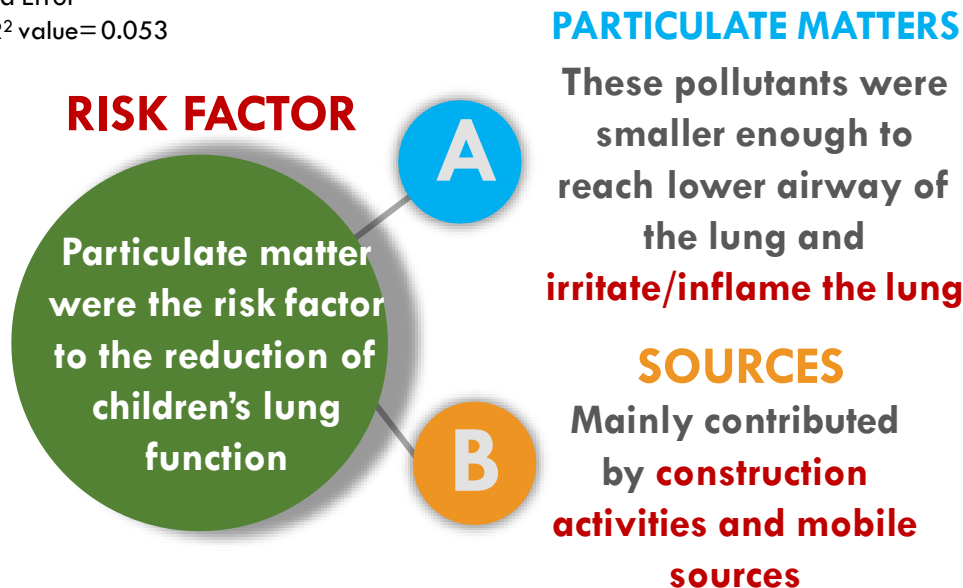
Sources of the pollutants were mainly released from the outdoor activities primarily **mobile sources**.

Kampa & Castanas (2008)

**Table 5: Risk factors that influenced FEV<sub>1</sub>/FVC% predicted among the Kota Kinabalu students (Nur Syahira et al., 2019)**

| Independent Variables | B       | S.E   | p      | 95% CI          |
|-----------------------|---------|-------|--------|-----------------|
| Constant              | 107.719 | 4.600 | <0.001 | 98.666-116.772  |
| PM <sub>2.5</sub>     | 1.413   | 0.712 | 0.048* | 0.012-2.813     |
| PM <sub>10</sub>      | -1.484  | 0.553 | 0.008* | -2.572-(-0.395) |
| NO <sub>2</sub>       | -0.033  | 0.186 | 0.860  | -0.399-0.333    |

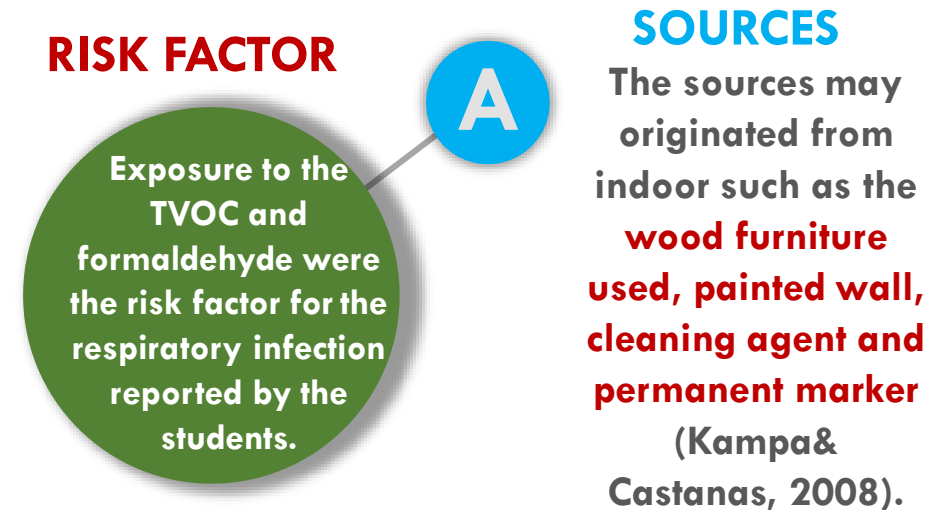
β= Standardized Coefficient  
 S.E= Standard Error  
 Nagelkerke R<sup>2</sup> value=0.053



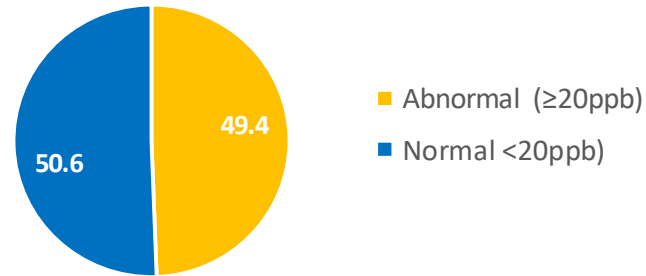
**Table 6: Risk factors which contributed to the reported respiratory infection among the Kota Kinabalu students (Nur Syahira et al., 2019)**

| Independent Variables( | β      | S.E   | p         | OR    | 95% CI      |
|------------------------|--------|-------|-----------|-------|-------------|
| Constant               | -0.547 | 0.185 | 0.003     | 0.578 | -           |
| Total VOC              | 0.473  | 0.230 | 0.04*     | 1.604 | 1.022-2.517 |
| Formaldehyde           | 0.887  | 0.223 | <0.001*** | 2.427 | 1.567-3.758 |

β= Regression Coefficient  
 S.E= Standard Error  
 Nagelkerke R<sup>2</sup> value=0.08



## Prevalence of FeNO Levels among the KKinabalu Students






The FeNO level indicated the lung inflammation in the pulmonary systems. 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).

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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 

Dan Norbäck <sup>a,\*</sup>, Jamal Hisham Hashim <sup>b,c</sup>, Zailina Hashim <sup>d</sup>, Gui-Hong Cai <sup>a</sup>, Vinoshini Sooria <sup>e</sup>, Syazwan Aizat Ismail <sup>e,f</sup>, Gunilla Wieslander <sup>a</sup>

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Results shows that there were 50.6% Kota Kinabalu students 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 (Zailina et al. 2022)

## Table 6 : Association between respiratory health among students in Penang and fungal DNA and dust in the classroom. (Norback et al., 2017)

**Table 4**  
Associations between respiratory health among pupils ( $N = 368$ ) in Penang, Malaysia and fungal DNA and amount of fine dust in the classroom.

| Type of exposure                          | Wheeze OR (95% CI)              | Current asthma OR (95% CI) <sup>a</sup> | Daytime attacks of breathlessness OR (95% CI) | Nocturnal attacks of breathlessness OR (95% CI) | Respiratory infections OR (95% CI) | Elevated FeNO (>20 ppb) OR (95% CI) | Antilog FeNO beta (95% CI)      |
|---|---------------------------------|---|---|---|------------------------------------|-------------------------------------|---------------------------------|
| Amount of fine dust                       | 0.83 (0.68–1.02) <sup>(*)</sup> | 0.79 (0.65–0.96) <sup>*</sup>           | 0.90 (0.79–1.03)                              | 0.98 (0.81–1.17)                                | 1.01(0.81–1.28)                    | 0.95 (0.85–1.07)                    | 0.98 (0.94–1.03)                |
| Fungal DNA in dust (target copies/g dust) |                                 |   |   |   |                                    |                                     |                                 |
| <i>Asp/Pen</i> DNA                        | 1.26 (0.38–4.20)                | 1.34 (0.53–3.34)                        | 0.99 (0.48–2.04)                              | 1.18 (0.47–3.00)                                | 1.80 (0.54–5.97)                   | 1.41 (0.77–2.57)                    | 1.24 (0.97–1.57) <sup>(*)</sup> |
| <i>A. versicolor</i> DNA                  | 1.57 (1.14–2.17) <sup>**</sup>  | 1.43 (1.09–1.99) <sup>*</sup>           | 1.20 (0.79–1.63)                              | 1.14 (0.79–1.63)                                | 1.79 (1.19–2.69) <sup>**</sup>     | 1.27 (1.01–1.61) <sup>*</sup>       | 1.12(1.02–1.23) <sup>*</sup>    |
| <i>Streptomyces</i> DNA                   | 1.13 (0.82–1.55)                | 0.78 (0.46–1.32)                        | 0.91 (0.67–1.24)                              | 1.27 (0.95–1.71)                                | 1.2 (0.73–1.42)                    | 0.90 (0.69–1.17)                    | 1.00 (0.92–1.09)                |
| Total fungal DNA                          | 1.25 (0.61–2.52)                | 1.13 (0.64–1.98)                        | 0.83 (0.54–1.27)                              | 1.23 (0.70–2.16)                                | 1.31 (0.64–2.75)                   | 1.21 (0.85–1.74)                    | 1.13 (0.99–1.31) <sup>(*)</sup> |

*Asp/Pen*: *Aspergillus/Penicillium*, *A. versicolor*: *Aspergillus versicolor*.

Odds Ratio (OR) and 95% Confidence Interval (CI) were calculated by 3-level hierarchic logistic regression models adjusted for gender, ethnicity (M/NM), tobacco smoking, heredity and a history of atopy.

For FeNO as continuous variable, beta values with 95% Confidence Interval (CI) were calculated for 10logFeNO by linear mixed models adjusted for gender, ethnicity, tobacco smoking, heredity and a history of atopy. Data in the table are antilog-values.

(OR calculated for 1000 mg increase in fine dust).

(OR calculated for 10<sup>5</sup> target copies/g dust increase in total fungal DNA in vacuumed dust).

(OR calculated for 10<sup>5</sup> target copies/g dust increase in *Asp/Pen* DNA in vacuumed dust).

(OR calculated for 100 target copies/g dust increase in *A. versicolor* DNA in vacuumed dust).

(OR calculated for 10 target copies/g dust increase in *Streptomyces* DNA in vacuumed dust).

<sup>a</sup> Current asthma medication, asthma attacks last 12 months or wheeze with breathlessness last 12 months.

\*  $P = 0.05$ .

\*  $p < 0.05$ .

\*\*  $p < 0.01$ .



### 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

Dan Norbäck <sup>a,\*</sup>, Jamal Hisham Hashim <sup>b,c</sup>, Zailina Hashim <sup>d</sup>, Gui-Hong Cai <sup>a</sup>, Vinoshini Sooria <sup>e</sup>, Syazwan Aizat Ismail <sup>e,f</sup>, Gunilla Wieslander <sup>a</sup>

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#### HIGHLIGHTS

- Elevated FeNO, a marker of lower airway inflammation, was found in many students.
- Signs of dampness in the classroom were related to airway infections among students.
- Students in classrooms with signs of dampness had 31% higher FeNO values.

#### GRAPHICAL ABSTRACT



# Discussions on urban vs rural areas

- The health impact of indoor air pollution from these studies include respiratory symptoms, lung function impairment, lung inflammation, allergies and dermal problems.
- The indoor air pollutants in urban schools were not only made up of chemical substances but were also microbiological (bacteria, virus, fungus) in nature.
- Urbanization is good for the economic development and employment but the most pressing problems facing the cities today are poverty and environmental degradation. With the rapid urbanization, industrialization and transportation, there is a concern if our environmental development is sustainable.

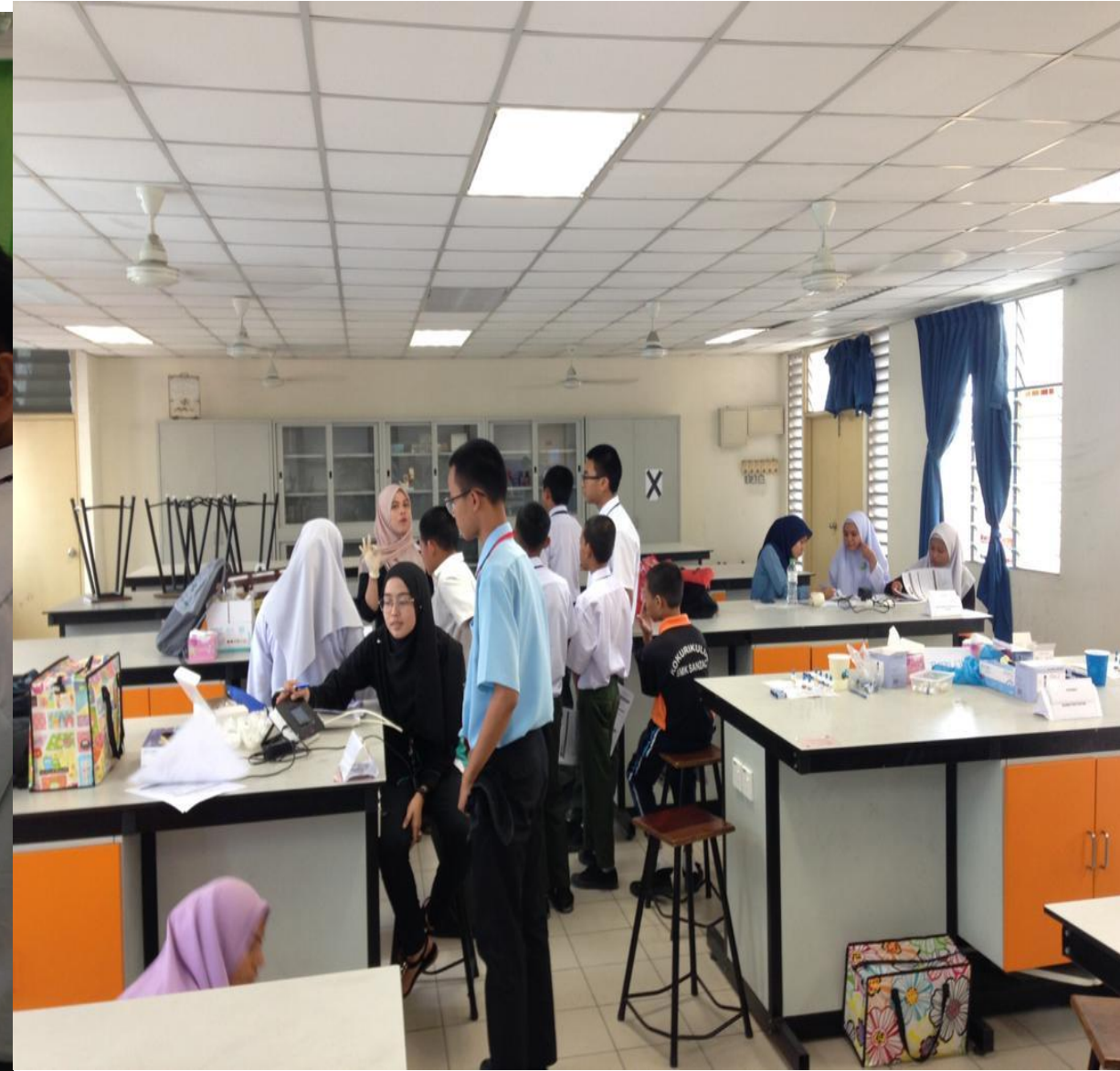
# Sabah School Study



Questionnaire responses,  
Allergy and Lung Function Test



**Lung inflammation (FeNO) test**



**Lung function test**

# INHALATION HEALTH RISK ASSESSMENT OF ATMOSPHERIC PM<sub>10</sub> AND HEAVY METALS FROM BAUXITE MINING AREAS IN KUANTAN, MALAYSIA



**Prof. Dr. Zailina Hashim**  
**Dept. of Environmental and Occupational Health**  
**Faculty of Medicine and Health Sciences**  
**Universiti Putra Malaysia**

## ORIGINAL ARTICLE

### Respirable Particulate (PM<sub>10</sub>) and Its Heavy Metals Concentrations from Bauxite Mining in the Vicinity of Urban Kuantan, Malaysia: Inhalation Health Risk Assessment

Intan Nor Lyana Sajali<sup>1</sup>, Zailina Hashim<sup>1</sup>, Jamal Hisham Hashim<sup>2</sup>

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#### ABSTRACT

**Introduction:** Bauxite ore contain various heavy metals especially aluminum, if exposed excessively is detrimental to the respiratory system. **Objective:** This study aimed at determining the PM<sub>10</sub> and its Al, As, Cd, Cr, Ni and Pb content and assessing the inhalation health risk assessment (HRA) among the community. **Method:** This cross-sectional study was conducted in Kuantan on 162 randomly selected respondents in three residential areas; Felda Bukit Goh (FBG), Jalan Besar Bukit Goh (JBBG) and Kuantan Port Consortium Flat (KPCF). Questionnaires were used to obtain the background information and health symptoms. PM<sub>10</sub> with its heavy metals were subsampled for 24 hours using air sampling pumps in 42 randomly sub-sampled households from the 3 areas. **Results:** PM<sub>10</sub> exceeded 150 µg/m<sup>3</sup> and the Al, Cd, As, Cr, Ni and Pb levels exceeded the standard limit. The hazard quotient (HQ) of Cd in JBBG (4.13), Cr in FBG (74.06), JBBG (84.41), KPCF (76.87) and Ni in FBG (60.53), JBBG (66.95) and KPCF (58.81) exceeded the HQ value of 1. The lifetime cancer risk (LCR) exceeded the level of 0.0000001 for Cr in FBG (0.0252), JBBG (0.0288) and KPCF (0.0262), as well as for Ni in the FBG (0.000184), JBBG (0.000204), and KPCF (0.000179) areas. **Conclusion:** The PM<sub>10</sub> levels exceeded the USEPA guidelines while Al, Cd, As, Cr, Ni and Pb exceeded the ATSDR limit. The Cd, Cr and Ni posed non-carcinogenic and carcinogenic health risks. Therefore, health risks from the PM<sub>10</sub>, Cd, Cr and Ni exposures were found in this study.

**Keywords:** PM<sub>10</sub>, Respiratory symptoms, Non-carcinogenic and carcinogenic health risks assessments

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first nine months of 2014 (4). The mining of bauxite ore in Kuantan, Pahang had started on a small scale in Balok since early 2013, which later expanded to other areas like Bukit Goh and Sungai Karang. Based on a report by The Star newspaper on 19 December 2015, mining

# Scientists give NST a peek at report for Pahang govt

test of three fish samples ranged from 70.8 to 104.5g/kg, more than a 100-fold exceeding 1000 times the permissible limit for arsenic in fish and fishery products of 1mg/kg, under the Malaysian Food Regulation 1985.

"We should be reminded that the lack of evidence of destruction and harm to the environment and humans should not be used as an excuse not to act or to delay action."

"When there is potential harm to the environment or humans, we should be proactive and not reactive in our approach."

"This approach of harm avoidance is based on the Precautionary Principle, which states that where human activities may lead to morally unacceptable harm that is scientifically plausible but uncertain, actions shall be taken to avoid or diminish that harm."

"They said the authorities should not dismiss such reports without investigating for themselves."

"A recent news report in the NST (Dec 29) showed a disturbing photo of a young man collecting clams (rimba) from the bauxite-contaminated Sungai Pengarak and two children playing in the bauxite-contaminated sea waters off Batu Hitam beach."

"If heavy metals are present in the river water as we strongly suspect, they will be easily concentrated in the clams, which are bivalves and filter feeders."

"Wading and swimming in the contaminated waters are also dangerous as heavy metals in the water can penetrate human skin, eyes and mucous linings. Swimmers will also ingest water," they warned.

"While the state authorities have played down the risks posed by bauxite mining, the state Fisheries Department had, on Dec 31, warned the public against consuming seafood obtained from bauxite-contaminated waters off Pahang."

His director, Adnan Hussain Adnan, also advised against fishing, which he said was not suitable in these areas due to the high level of turbidity. It is understood that the group will also forward their report to Putrajaya.

"It is absolutely imperative that the state government address the issues by controlling every single mining operation at the source. Only then can they be made sustainable in the long run."

"A populated area cannot be transformed into a huge mining area without serious consequences to the population of 400,000."

"The state government cannot abdicate its responsibility to look after the well-being and health of those people."

"Justifying extensive mining in a well-populated area simply because they give income to a small group of people is totally wrong and unheard of in this day and age."

"In developed countries, this will undoubtedly result in civil suits," they said.

**Page 2 pic: Red sediment off the coast of Tanjung Gebang believed to be washed from bauxite ore stockpile near Kuantan Port. Pic courtesy of Pertubuhan Pelindang Khazanah Alam Malaysia**

**Bauxite mining**  
Residents living close to bauxite mines risk being exposed to dust and most contaminating toxic heavy metals. Bauxite washing is done near rivers as it is convenient to get water for washing. The sediment-laden wash water flows back into the river. Some of the smaller streams have been dammed up for this purpose.

Both the extraction of river water and heavy pollution of rivers are illegal activities, which need to be stopped.

The wash water, which also contains high levels of heavy metals, will enter the river system and contaminate the raw water that feeds water treatment plants downstream.

Heavy metals in the water will be available for uptake by aquatic organisms, which may become food sources for the public.

After washing, the bauxite ore is transported to the Gebeng Industrial Estate to be stockpiled before being shipped off to China via Kuantan Port. The bauxite ore is not covered and can generate windblown dust. There is also no proper drainage system around the stockpile. When there is heavy rainfall, runoff laden with bauxite sediment flows into nearby rivers and residential areas.

**Atmospheric environment**  
From the bauxite mines to the bauxite washing sites and finally to the Gebeng Industrial Estate and Kuantan Port, bauxite ore is transported by lorries which use unpaved as well as regular public roads. Residents are exposed daily to bauxite dust from the lorries which, when suspended in the air, permeates their homes. There have been numerous complaints of respiratory and skin rash problems from people living along these transport routes.

**Road safety**  
There have been several road accidents involving lorries transporting bauxite, some of which were fatal. Even though they may be using designated routes, these public roads go through neighbourhoods and urban areas. Some of the accidents are caused by operators trying to rush their loads to the port, as they are paid according to the number of trips they make.

**River water quality**  
Mining and related activities are taking place in the Sungai Kuantan basin. Water from Sungai Kuantan and its tributaries are abstracted and treated for

domestic water supply. Several water intake points are located downstream of the bauxite mines. The mining activities are causing severe water pollution. Loose earth is washed into rivers during rain, increasing the levels of suspended solids and turbidity. Besides making the water murky, siltation and sedimentation also decrease water depth, particularly in the case of smaller streams. This will damage aquatic habitats, elevate flood risks and potentially disrupt the operations of water treatment plants. Deposits on road surfaces during the transport of bauxite will also be picked up by runoff. The process of "bauxite washing" generates effluent, which also enters watercourses. The heavy metals that enter the river system can adversely affect human health if consumed over an extended period of time.

In fact, on one occasion, data from the Department of Environment showed mercury levels upstream of the Bukit Goh intake to be 0.0093mg/L. This is almost 10 times higher than the permissible limit of 0.0010mg/L for raw water sources adopted by the Health Ministry. The levels of mercury, arsenic and manganese in other rivers were also high. Conventional water treatment systems are not designed to effectively remove these metals. There is a risk that these metals will escape the treatment plant and enter the water distribution network, reaching people's drinking water.

**Aquatic ecosystem**  
Water quality degradation caused by uncontrolled bauxite mining will have a major impact on aquatic biodiversity. The high sediment loads and heavy metal contamination that accompany bauxite mining are destructive to these populations. Sediment can choke fish by clogging their gills, bury bottom invertebrates that are an important part of the food chain and prevent photosynthesis by cutting sunlight penetration. Those that survive will be poisoned by the heavy metal contamination.

Flocculation of these sediments is likely to occur in estuary and nearshore areas, strangling mangroves and coastal vegetation, as well as burying benthic invertebrates that are an important part of the marine food web. The net result is nearshore fisherman will have to accept losses in their catch.

→ Turn to Page 6



trems that the fundamental habitat qualities that support our local biodiversity would be lost and we would be left with a degraded ecosystem," they cautioned.

The group also revealed that they had, on Dec 26 and 27, monitored the 24-hour PM10 levels in Bukit Goh, Beserah (just outside residents' houses), and the Gebeng Industrial Estate, adjacent to Kuantan Port.

The result of the 24-hour PM10 levels recorded outside the houses were at 222.18 g/m<sup>3</sup> (Bukit Goh) and 164.05 g/m<sup>3</sup> (Beserah).

The sampling carried out in Gebeng showed a reading of 206.79g/m<sup>3</sup>. All three exceeded the standard levels underlined under the 24-hour Malaysian Ambient Air Quality Standard for PM10, which is 150 g/m<sup>3</sup>.

Samples at the house in Beserah, located close to a bauxite mine and along a bauxite transport route, were taken on a day when the transportation of bauxite had ceased.

PM10 dust can easily penetrate the human lower respiratory tract and cause or trigger respiratory problems like asthma, lower respiratory tract infections, pneumonia, chronic bronchitis and emphysema. Depending on the chemical content of the PM10 dust, they may also experience other health problems.

The scientists highlighted the NST's August reports on the high levels of arsenic in fish caught in Sungai Pengarak. The arsenic con-





# RESULT

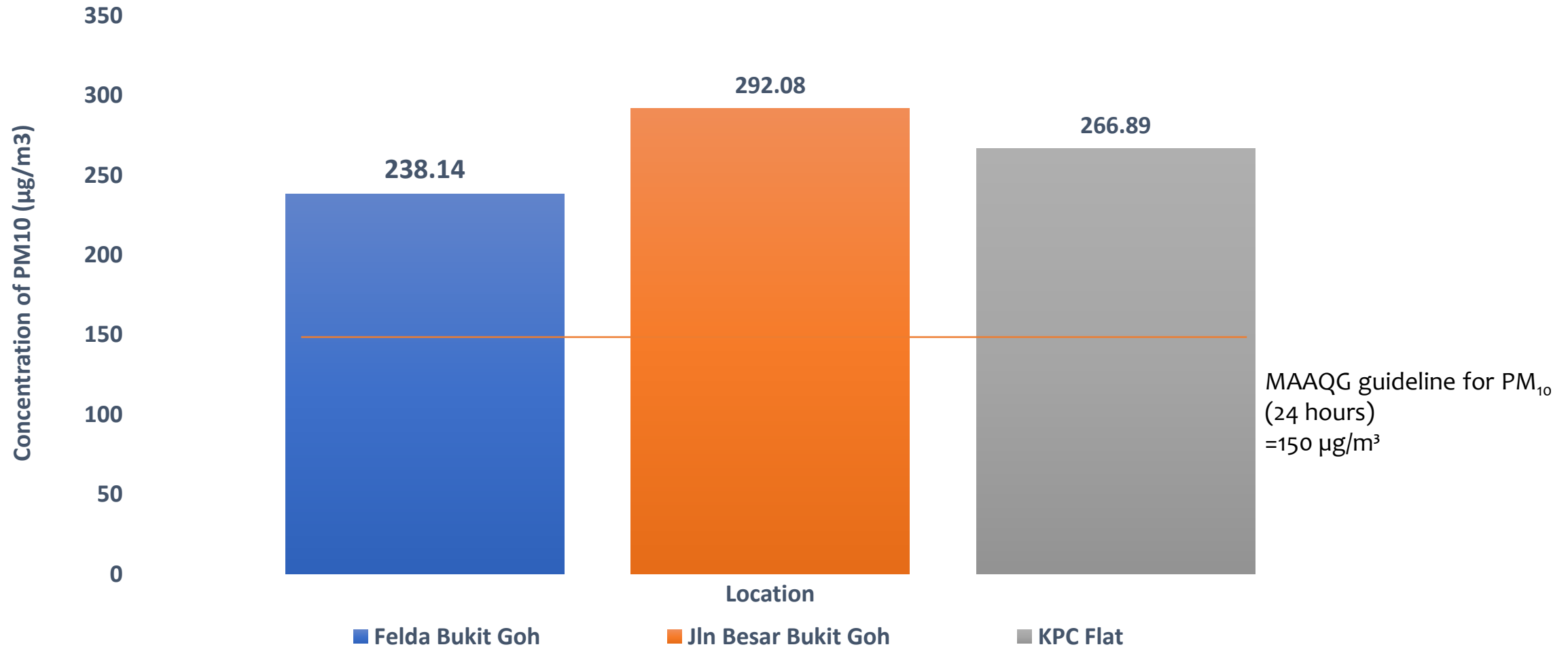
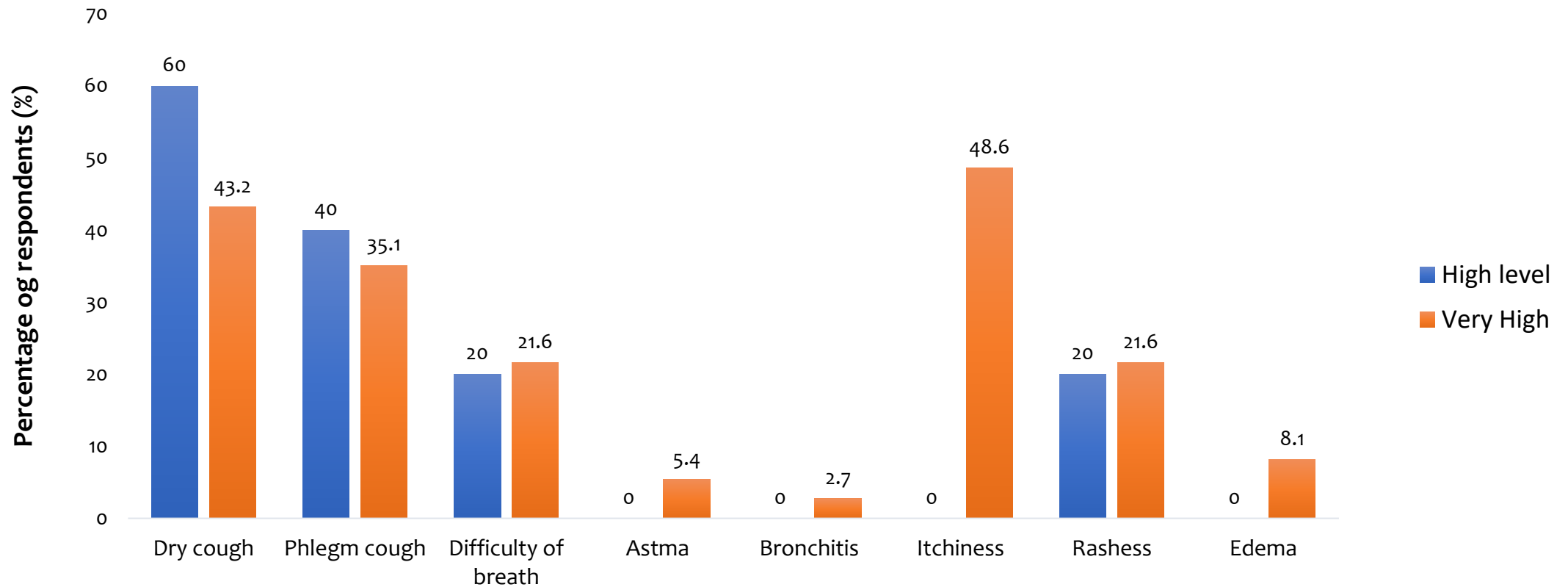


Figure 1 : Level of PM<sub>10</sub>(µg/m<sup>3</sup>) within mining areas (2016) in Kuantan and comparison with Malaysian Ambient Air Quality Guidelines.



Key: High : Particulate matter level between 150-200  $\mu\text{g}/\text{m}^3$   
 Very High : Particulate matter level more than 200  $\mu\text{g}/\text{m}^3$

**Figure 2: Number of Reported Respiratory and Dermal Symptoms among Study Group with Different Level of Particulate Matter in Mining Areas, Kuantan**

# Microbes in classroom

- Nor Husna et al. (2011) found high indoor bio-aerosol conc. in Selangor schools which reflected poor indoor air quality and over crowdedness.
- 56% of the indoor bacteria conc. exceeded the ACGIH and WHO recommended level of 500 CFU/m<sup>3</sup>
- 33.8% of the indoor fungal samples exceeded the recommended level of 200 CFU/m<sup>3</sup>
- Fungal DNA was common in the studied Malaysian schools and there was high prevalence of both doctor-diagnosed asthma and respiratory symptoms among the pupils (Cai, et al. 2011)

## Characterization of Bacteria and Fungi Bioaerosol in the Indoor Air of Selected Primary Schools in Malaysia

Nor Husna Mat Hussin<sup>a</sup> Lye Munn Sann<sup>a</sup>  
Mariana Nor Shamsudin<sup>b</sup> Zailina Hashim<sup>a</sup>

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### Key Words

Bacteria and fungi bioaerosol · Indoor air · Primary

respectively. The ratio of i

concentration was below 1

## Fungal DNA, allergens, mycotoxins and associations with asthmatic symptoms among pupils in schools from Johor Bahru, Malaysia

Gui-Hong Cai<sup>1</sup>, Jamal Hisham Hashim<sup>2</sup>, Zailina Hashim<sup>3</sup>, Faridah Ali<sup>4</sup>, Erica Bloom<sup>5,6</sup>, Lennart Larsson<sup>6</sup>, Erik Lampa<sup>1</sup> & Dan Norbäck<sup>1</sup>

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### Keywords

allergens; fungal DNA; quantitative PCR; bacteria; mycotoxins; respiratory symptoms; asthma; school environments; indoor environments.

### Correspondence

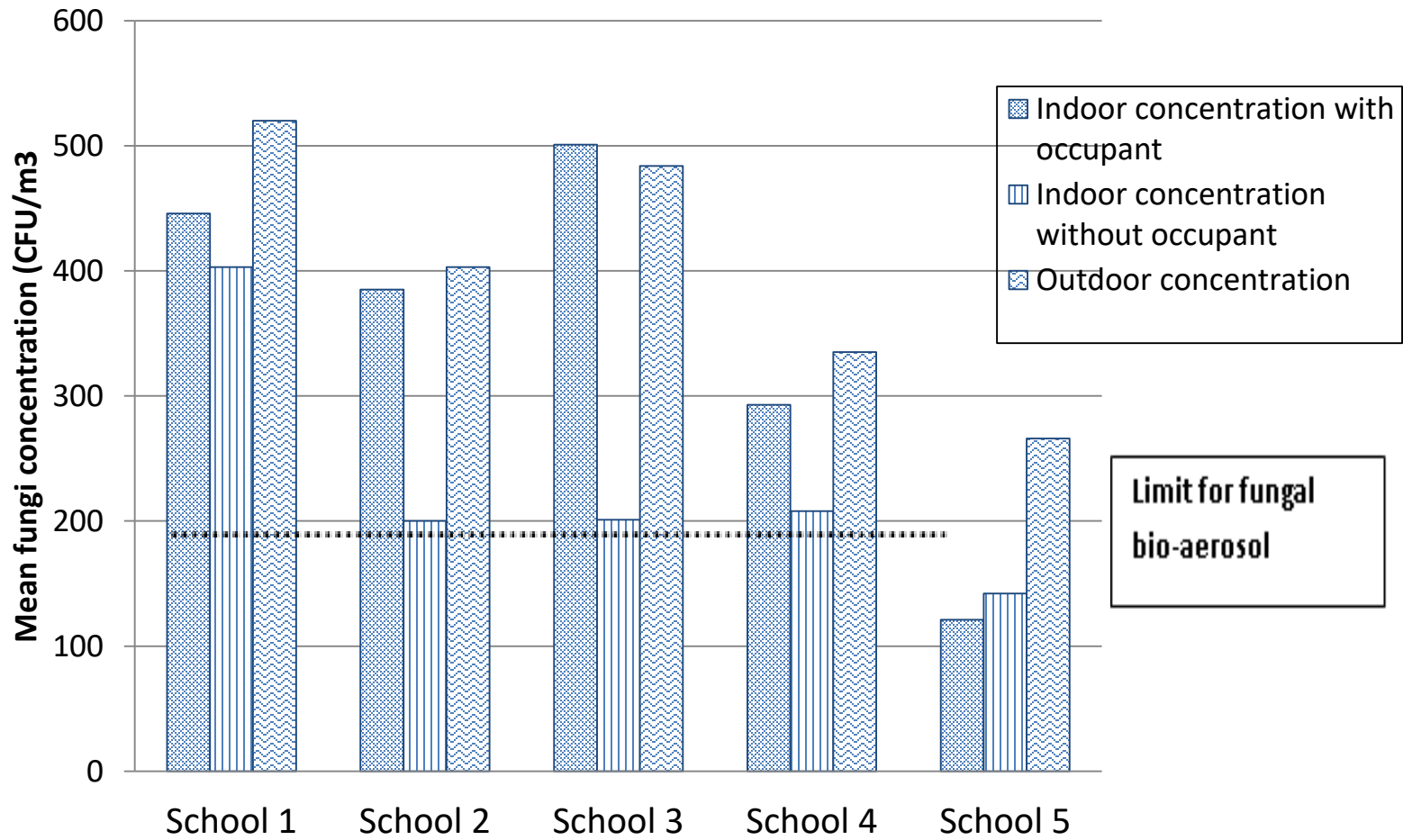
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### Abstract

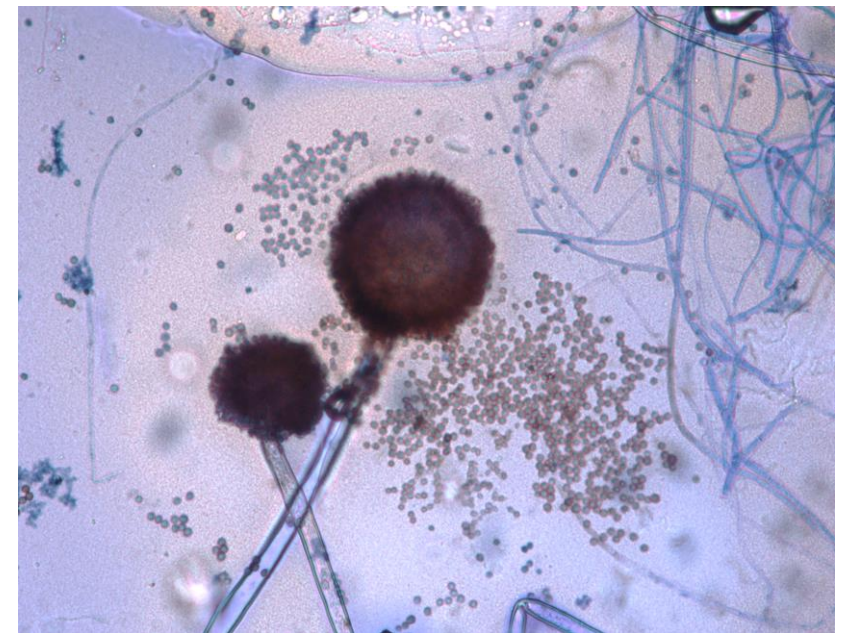
While there is a large variation of prevalence of asthma symptoms worldwide, what we do know is that it is on the rise in developing countries. However, there are few studies on allergens, moulds and mycotoxin exposure in schools in tropical countries. The aims were to measure selected fungal DNA, furry pet allergens and mycotoxins in dust samples from schools in Malaysia and to study associations with pupils' respiratory health effects. Eight secondary schools and 32 classrooms in Johor Bahru, Malaysia were randomly selected. A questionnaire with standardized questions was used for health assessment in 15 randomly selected pupils from each class. The school buildings were inspected and both indoor and outdoor climate were measured. Dust samples were collected by cotton swabs and Petri dishes for fungal DNA, mycotoxins and allergens analysis. The participation rate was 96% (462/480 invited pupils), with a mean age of 14 yr (range 14–16). The pupils mostly reported daytime breathlessness (41%), parental asthma or allergy (22%), pollen or pet allergy (21%) and doctor-diagnosed asthma (13%) but rarely reported nighttime breathlessness (7%), asthma in the last 12 months (3%), medication for asthma (4%) or smoking (5%). The inspection showed that no school had any mechanical ventilation system, but all classrooms had openable windows that were kept open during lectures. The mean building age was 16 yr (range 3–40) and the mean indoor and outdoor CO<sub>2</sub> levels were 492 ppm and 408 ppm, respectively. The mean values of indoor and outdoor temperature and relative humidity were the same, 29°C and 70% respectively. In cotton swab dust samples, the Geometric Mean (GM) value for total fungal DNA and *Aspergillus/Penicillium (Asp/Pen)* DNA in swab samples (Cell Equivalents (CE)/m<sup>2</sup>) was 5.7\*10<sup>8</sup> and 0.5\*10<sup>8</sup>, respectively. The arithmetic mean (CE/m<sup>2</sup>) for *Aspergillus versicolor* DNA was 8780, *Stachybotrys chartarum* DNA was 26 and *Streptomyces* DNA was 893. The arithmetic means (pg/m<sup>2</sup>) for the mycotoxins sterigmatocystin and verrucol were 2547 and 17, respectively. In Petri dish dust samples, the GM value for total fungal DNA and *Asp/Pen* DNA (CE/m<sup>2</sup> per day) was 9.2\*10<sup>6</sup> and 1.6\*10<sup>6</sup>, respectively. The arithmetic mean (CE/m<sup>2</sup> per day) for *A. versicolor* DNA was 1478, *S. chartarum* DNA was 105 and *Streptomyces* DNA was 1271, respectively. The GM value for cat (Fel d1) allergen was 5.9 ng/m<sup>2</sup> per day. There were positive associations between *A. versicolor* DNA, wheeze and daytime breathlessness and between *Streptomyces* DNA and doctor-diagnosed asthma. However, the associations were inverse between *S. chartarum* DNA and daytime breathlessness and between verrucol and daytime breathlessness. In conclusion, fungal DNA and cat allergen contamination were common in



**Figure 3: Mean indoor and outdoor fungi concentrations with and without indoor occupants**



**Mold/fungus on ceiling**



**Fungus in schools**

- This study provided epidemiological evidence that higher FeNO levels among asthmatic school children than non-asthmatic which reflect a higher degree of airway inflammation (about 35 ppb).
- Similar results were observed in Peninsular Malaysia (Ma'pol et al., 2019; Norbäck et al., 2017a; Norbäck et al., 2017b, Zailina et al. 2022) and China (Xu et al., 2011).
- In summary, findings on the exploratory analysis showed the relative abundance of *A. clavatus*, *B. acaciae*, *C. parapsilosis*, *H. aloes*, *H. multicystidium*, *H. shearii*, *S. meliponinorum*, *V. prosopidis* and PM<sub>2.5</sub> conc. were significant predictors of increased lung inflammation among asthma group (Khairul Nizam et al. 2022).

## Fungi composition in settled dust associated with fractional exhaled nitric oxide in school children with asthma



Khairul Nizam Mohd Isa<sup>a,b</sup>, Juliana Jalaludin<sup>a,\*</sup>, Zailina Hashim<sup>a</sup>, Leslie Thian Lung Than<sup>c</sup>, Jamal Hisham Hashim<sup>d</sup>, Dan Norbäck<sup>e</sup>

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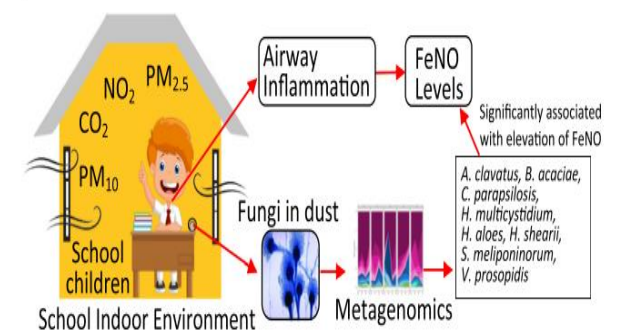
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### HIGHLIGHTS

- We explore the susceptibility of children with asthma to the fungi composition in settled dust.
- The relative abundance of unculturable fungi was associated with FeNO levels.
- PM<sub>2.5</sub> exposure was associated with FeNO levels among school children with asthma.
- Unculturable fungi taxa have the potential to exacerbate airway inflammation.

### GRAPHICAL ABSTRACT



### ARTICLE INFO

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FeNO  
Asthma  
School children  
School

### ABSTRACT

Fungi exposure has been significantly linked to respiratory illness. However, numerous fungi taxa that are potentially allergenic still undocumented and leave a barrier to establishing a clear connection between exposure and health risks. This study aimed to evaluate the association of fungi composition in settled dust with fractional exhaled nitric oxide (FeNO) levels among school children with doctor-diagnosed asthma. A cross-sectional study was undertaken among secondary school students in eight schools in the urban area of Hulu Langat, Selangor, Malaysia. A total of 470 school children (aged 14 years old) were randomly selected and their FeNO levels were measured and allergic skin prick tests were conducted. The settled dust samples were collected and analysed by using metagenomic technique to determine the fungi composition. The general linear regression with complex sampling was employed to determine the interrelationship. In total, 2645 fungal operational taxonomic units (OTUs) were characterised from the sequencing



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**RELATIONSHIP BETWEEN BLOOD  
CHOLINESTERASE LEVELS AND LEARNING  
ABILITY (IQ)  
OF CHILDREN IN A PADDY FARMING AREA,  
SELANGOR, MALAYSIA**

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**Blood Cholinesterase Level and Learning Ability of  
Primary School Children in an Agricultural Village,  
Tanjung Karang, Malaysia**

**Nurul Husna Miswon<sup>1</sup>, Zailina Hashim<sup>1\*</sup>, Vivien How<sup>1</sup> and Raihanah Chokeli<sup>1</sup>**

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**Authors' contributions**

*This work was carried out in collaboration between all authors. Author NHM wrote the protocol, managed the literature searches and drafted the manuscript. Author ZH contributed to the research concept, and to the methodological design. Author VH managed the laboratory analyses and experimental process of the study. Author RC managed the field sample collection. All authors read and approved the final manuscript.*

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# Pesticide Exposure: Environmental settings in homes and schools

Agricultural children is more vulnerable compare to non-agricultural children due to **multi pathway**

## Drift

- Off-target physical movement of pesticide sprayed through air (Lu et al, 2000),

## Take-home

- Contaminated clothing
- Pesticide containers brought home (Curl et al, 2002).

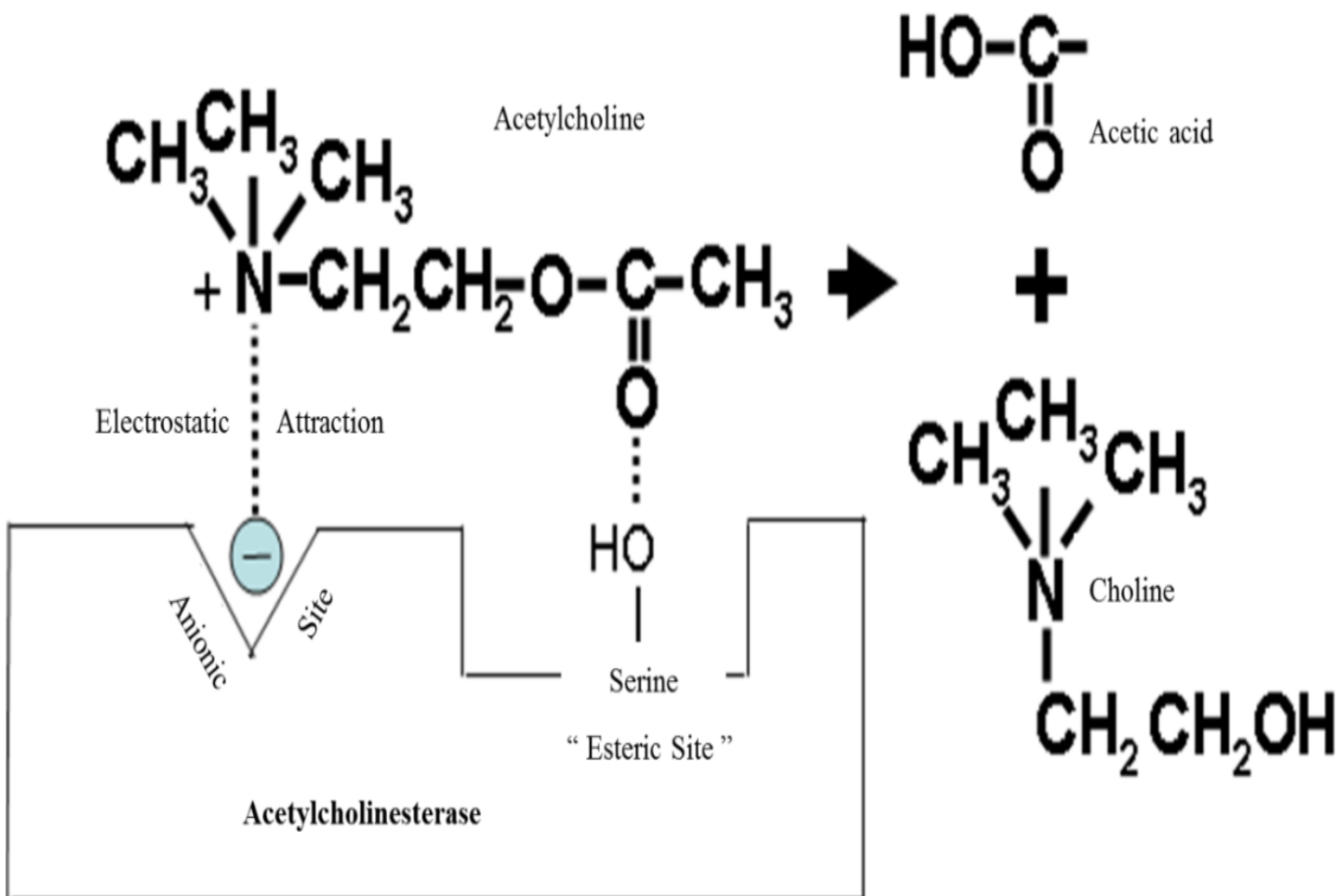


# LOVIBOND 412670 AF267 Cholinesterase Test Kit

- Rapid test cholinesterase test kit Model LOVIBOND 412670 AF267
- Required 0.01 ml of blood sample
- The finger prick technique-medical assistant.



# Reaction of acetylcholinesterase



Cholinesterase is a family of enzymes that **catalyzes the hydrolysis of the neurotransmitter acetylcholine (ACh) into choline and acetic acid**, a reaction necessary to allow a cholinergic neuron to return to its resting state after activation.

The primary role of AChE is to **terminate neuronal transmission and signaling between synapses to prevent ACh dispersal and activation of nearby receptors**. AChE is inhibited by organophosphates and is an important component of pesticides and nerve agents

# The correlation between blood cholinesterase level with learning ability.

| Variables                                  | Blood Cholinesterase (%) |        |                              |       |                          |         |
|--|--------------------------|--------|------------------------------|-------|--------------------------|---------|
|  | Study Group<br>(n=150)   |        | Comparative<br>Group (n=100) |       | Combine Group<br>(n=250) |         |
|  | r                        | p      | r                            | p     | r                        | p       |
| <b>Verbal (V)</b>                          | 0.155                    | 0.058  | 0.046                        | 0.652 | 0.344                    | <0.001* |
| <b>Perceptual (P)</b>                      | 0.181                    | 0.027* | 0.008                        | 0.939 | 0.359                    | <0.001* |
| <b>Quantitative (Q)</b>                    | 0.261                    | 0.001* | 0.040                        | 0.690 | 0.300                    | <0.001* |
| <b>General Cognitive<br/>Index (V+P+Q)</b> | 0.238                    | 0.003* | -0.112                       | 0.267 | 0.263                    | <0.001* |
| <b>Memory (Mem)</b>                        | 0.202                    | 0.013* | -0.018                       | 0.862 | 0.252                    | <0.001* |
| <b>Motor (Mot)</b>                         | 0.176                    | 0.031* | 0.114                        | 0.582 | 0.329                    | <0.001* |



## Blood Cholinesterase Level and Cognitive Functioning among Primary School Children near Paddy Field in TanjungKarang, Selangor

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Pesticides, Human health, Environmental Exposure, Biomarker

### ABSTRACT

**Background:** Paddy is the third most widely planted crop in Malaysia after oil palm and rubber. The use of pesticides lead to increase in yields by protecting the plantation from any pest and unwanted plants. The extensive use of insecticide, may affect the human health especially from occupational and environmental exposures. Children are a vulnerable group to exposures of insecticides because of less-developed metabolism and the on-going maturation of their organ systems. Blood cholinesterase activity is the most effective biomarkers to measure the level of exposure for various pesticides. **Objective:** The purpose of this study is to determine the relationship between blood cholinesterase levels with cognitive function of selected primary schoolchildren. **Results:** Highest percentage of schoolchildren had normal (52.7%) exposure. About 92.9% reported watery eyes as signs and symptoms of pesticide exposure. Most of the school children school children were in the average scores (44.6%) of cognitive function test. All scales in the McCarthy Scale Cognitive Abilities (MSCA) showed significant correlation with blood cholinesterase levels ( $p < 0.05$ ). **Conclusion:** There were significant relationship between blood cholinesterase levels with cognitive function in all the MSCA scales. No school children was reported with mentally retarded cognitive function. Finally, gender, mother's education and blood cholinesterase showed significant relationship with memory and motor scales in the MSCA.

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## Selected variables that influenced the learning ability scales.

| Variable                        | p-value           |                   |                   |                     |                   |               |
|---------------------------------|-------------------|-------------------|-------------------|---------------------|-------------------|---------------|
|                                 | Verbal            | Perceptual        | Quantitative      | Gen-Cognitive Index | Memory            | Motor         |
| Father's Education              |                   |                   |                   |                     |                   |               |
| Degree/Master/PhD               |                   |                   | -                 | -                   | -                 |               |
| Diploma/STPM                    | 0.836             | 0.622             | -                 | -                   | -                 | 0.103         |
| SPM                             | 0.253             | 0.624             | -                 | -                   | -                 | 0.186         |
| PMR                             | 0.575             | 0.917             | -                 | -                   | -                 | 0.316         |
| Primary School                  | 0.555             | 0.854             | -                 | -                   | -                 | 0.310         |
| Mother's Education              |                   |                   |                   |                     |                   | -             |
| Degree/Master/PhD               |                   |                   | -                 | -                   |                   |               |
| Diploma/STPM                    | 0.683             | 0.513             | -                 | -                   | 0.329             |               |
| SPM                             | 0.739             | 0.871             | -                 | -                   | 0.265             |               |
| PMR                             | 0.770             | 0.929             | -                 | -                   | 0.562             |               |
| Primary School                  | 0.574             | 0.521             | -                 | -                   | 0.173             |               |
| Father's Occupation             | -                 | <b>&lt;0.001*</b> | 0.915             | <b>&lt;0.001*</b>   | 0.122             | <b>0.003*</b> |
| Mother's Occupation             | -                 | 0.115             | 0.092             | -                   | 0.273             | 0.293         |
| Household income                |                   |                   |                   |                     |                   |               |
| >3000                           |                   |                   |                   |                     |                   |               |
| 2001-3000                       | 0.338             | 0.485             | 0.561             | 0.156               | 0.804             | 0.103         |
| 1000-2000                       | <b>0.047*</b>     | 0.116             | 0.226             | 0.830               | 0.666             | 0.898         |
| <1000                           | <b>0.007*</b>     | 0.377             | 0.160             | 0.583               | 0.773             | 0.460         |
| No. of Siblings                 | 0.294             | 0.479             | -                 | 0.379               | <b>0.040*</b>     | 0.542         |
| <b>Low Blood Cholinesterase</b> | <b>&lt;0.001*</b> | <b>&lt;0.001*</b> | <b>&lt;0.001*</b> | <b>0.004*</b>       | <b>&lt;0.001*</b> | <b>0.002*</b> |



Laboratory analysis



Blood sample by pricking children's finger



# Neuro-core Test Battery (NCTB)

- Recommended by World Health Organisation (WHO)
- Conducted in series to monitor the neurobehavioral performance of samples exposed and unexposed group.
- Pencil and Paper Test and Physical Movement



## Neurobehavioral Core Test Battery(NCTB): Santa Ana Manual Dexterity



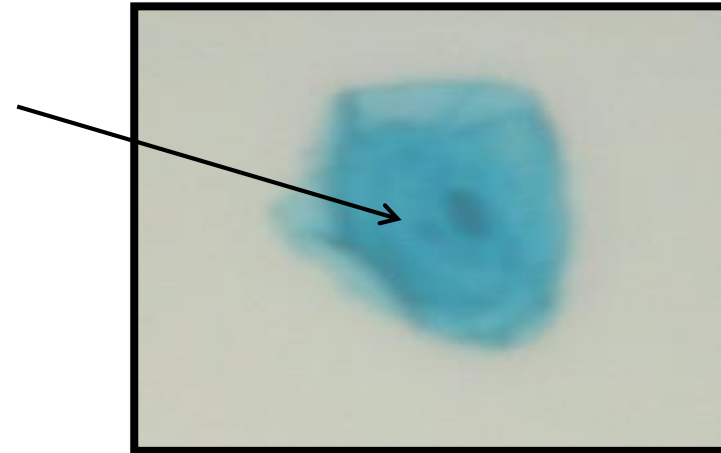
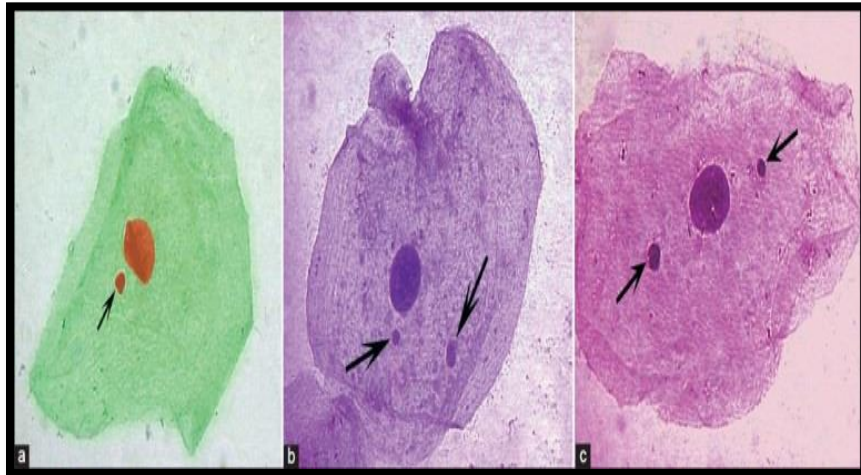


# The relationship between the blood cholinesterase levels and the neurobehavioral performance

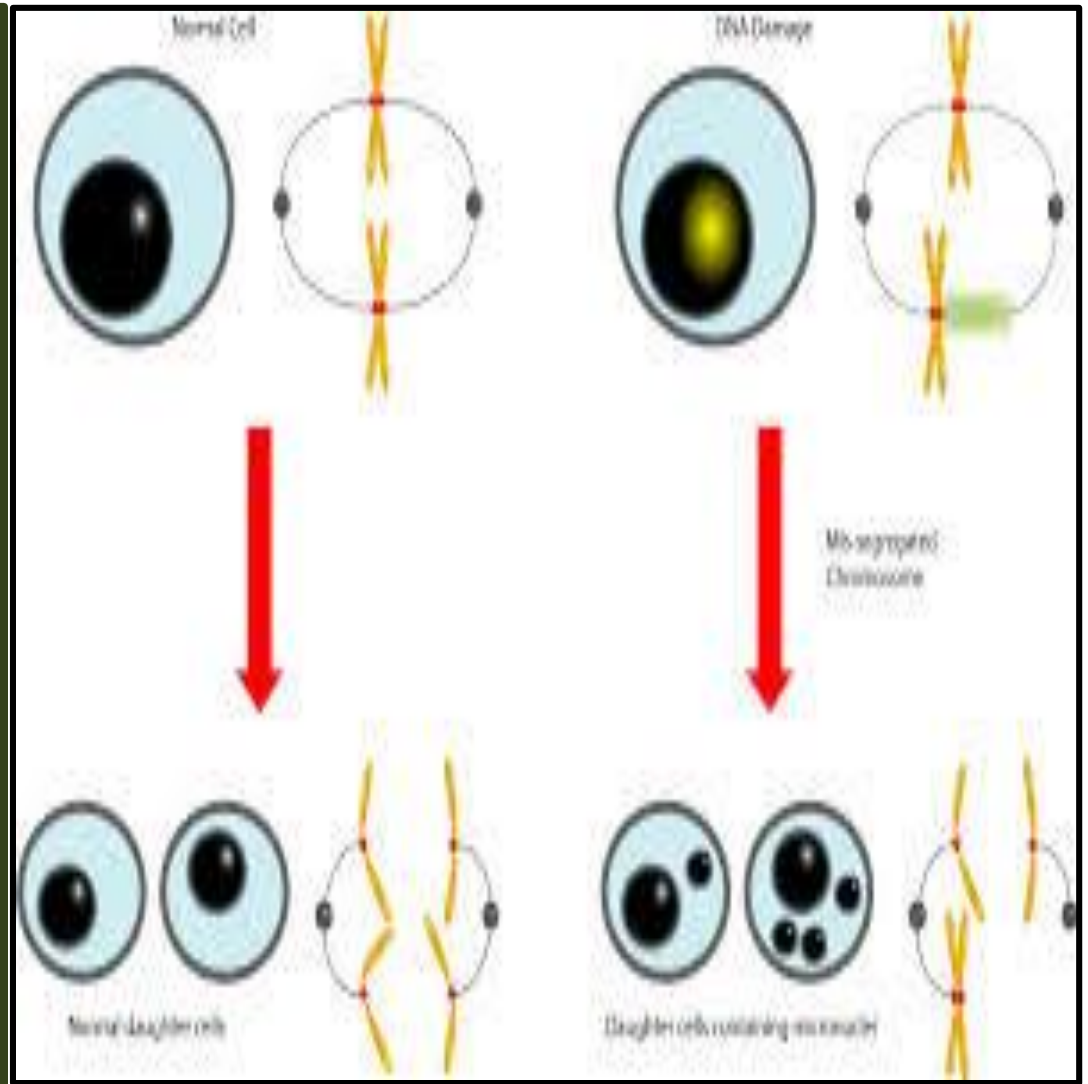
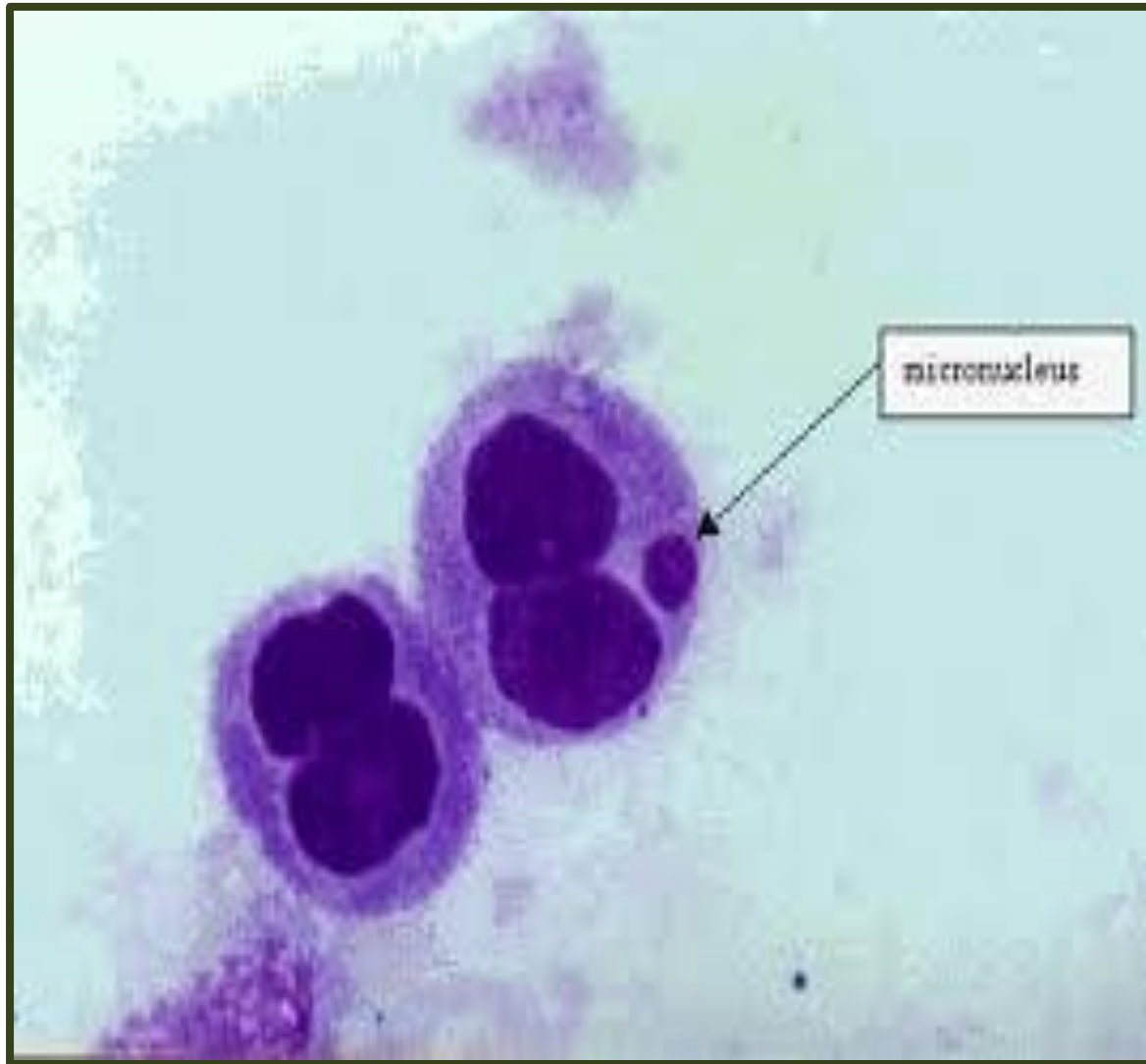
| Variable                     | Blood Cholinesterase Level |        |                     |       |
|------------------------------|----------------------------|--------|---------------------|-------|
|                              | Studied (n=150)            |        | Comparative (n=100) |       |
|                              | r                          | p      | r                   | p     |
| Benton Visual Retention Test | 0.140                      | 0.088  | 0.075               | 0.461 |
| Pursuit Aiming Test          | 0.164                      | 0.044* | 0.012               | 0.907 |
| Simple Reaction Time         | 0.256                      | 0.002* | 0.175               | 0.081 |
| Santa Ana Dominant Hand      | 0.229                      | 0.005* | 0.178               | 0.077 |
| Santa Ana Non-Dominant Hand  | 0.179                      | 0.029* | 0.176               | 0.080 |
| Trail Making Test            | 0.014                      | 0.805  | 0.060               | 0.953 |
| Digit Span Test              | 0.014                      | 0.864  | 0.097               | 0.336 |
| Digit Symbol Test            | 0.017                      | 0.865  | 0.097               | 0.336 |

# Micronuclei Assay

- Tests that detect and identify the micronuclei in the cytoplasm of interphase cells.
- MN are either acentric chromosome fragments or whole chromosome that are left behind during mitotic cellular division and appear in the cytoplasm of interphasic cells as small additional nuclei (Surrales et al, 1995).
- The biological sample used was buccal cell.

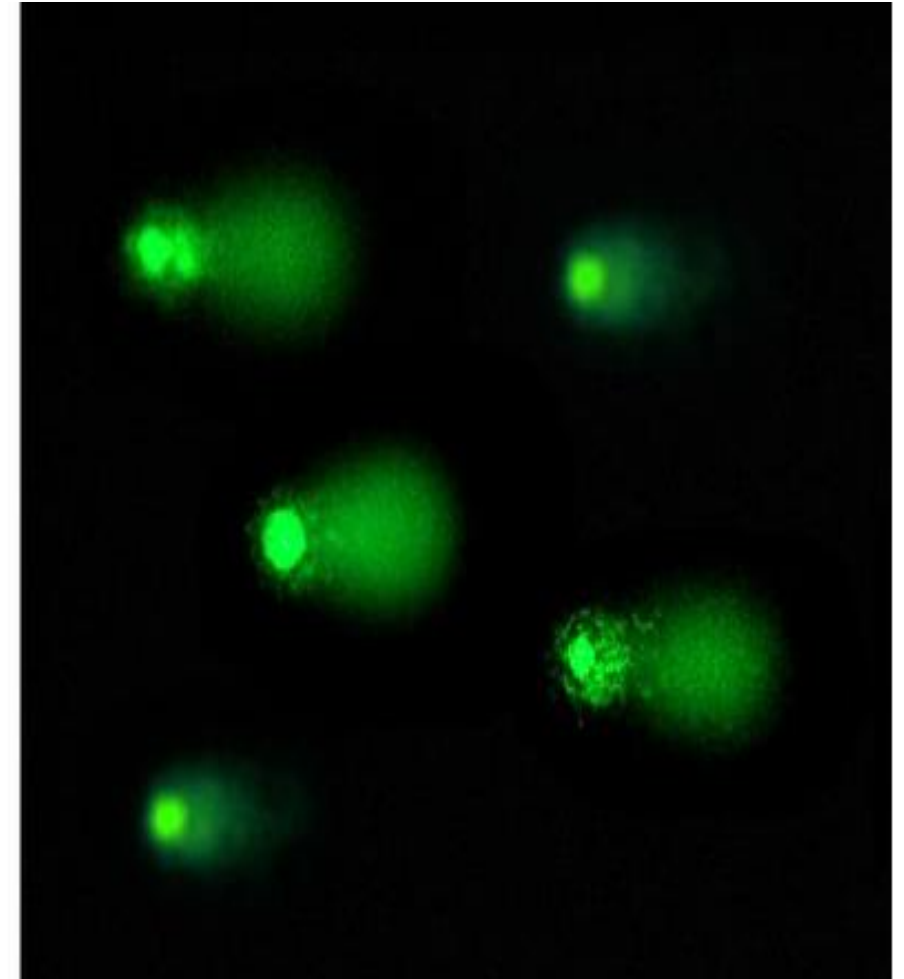


# Micronuclei frequency (per 1000 cells)

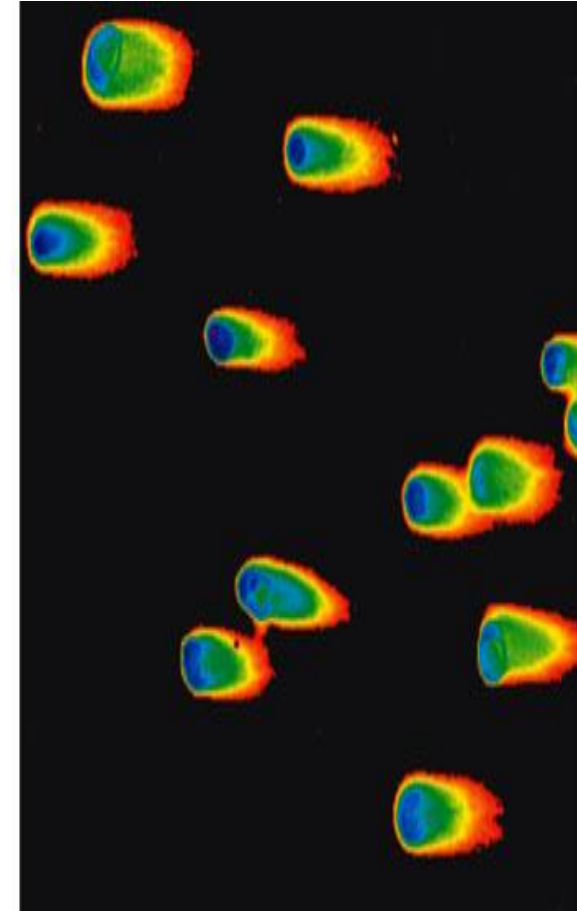
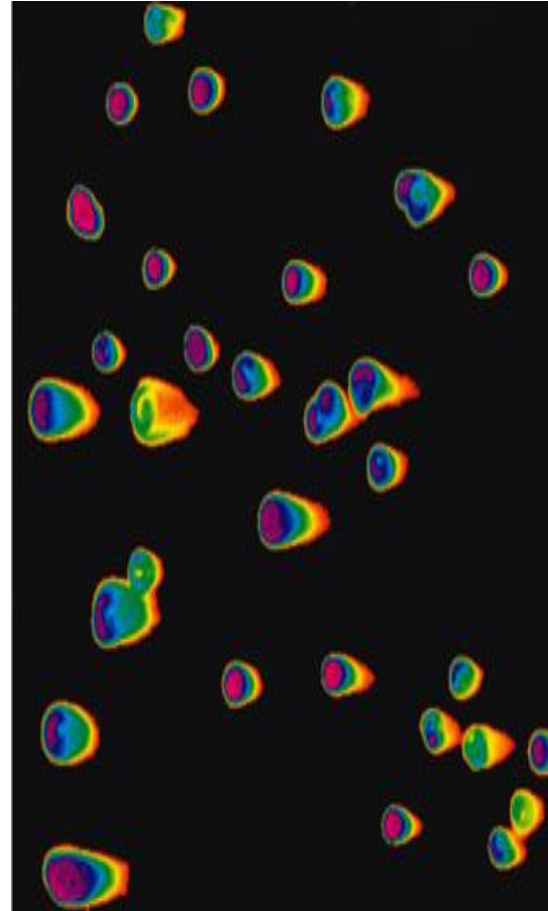
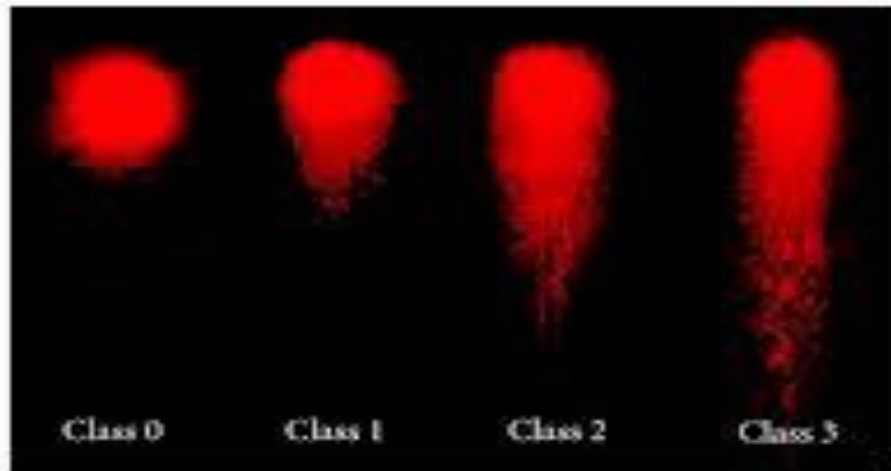
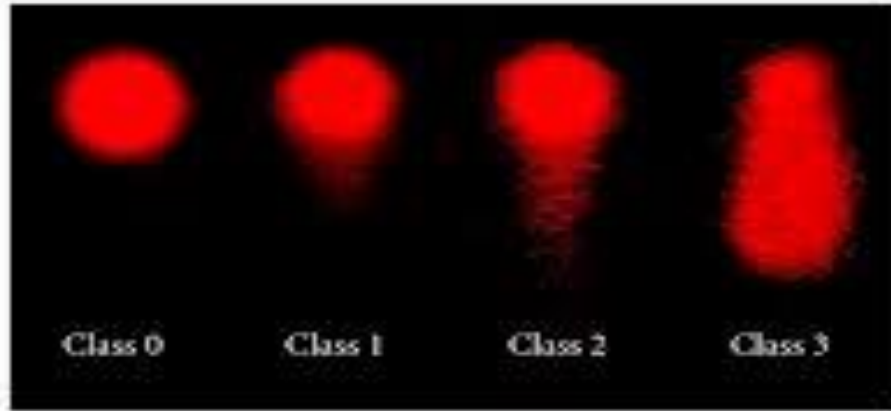


# Comet Assay

- The single cell gel electrophoresis or comet assay is a state of the art technique for quantitating DNA damage
- Technique that directly measures DNA damage in individual cells
- Analysis of comets, in order to determine the level of DNA damage, includes measurement of such parameters as: comet tail length (Collins A.R, 2008).
- The biological sample used was buccal cell.



# Comet Assay-DNA damage



| Variable   | B      | Micronuclei Frequency |        |       |               | Comet tail length |       |        |        |               |
|--|--------|-----------------------|--------|-------|---------------|-------------------|-------|--------|--------|---------------|
|  |        | COR                   | 95% CI |       | p             | B                 | AOR   | 95% CI |        | p             |
|  |        |                       | Lower  | Upper |               |                   |       | Lower  | Upper  |               |
| <b>Low Blood Cholinesterase Distance from house to paddy field</b> | 0.619  | 1.858                 | 1.049  | 3.290 | <b>0.034*</b> | 0.371             | 1.449 | 0.800  | 2.625  | 0.221         |
| >1000m (Ref)   |        |                       | 1      |       |               |                   |       | 1      |        |               |
| 500-1000m  | -0.590 | 0.554                 | 0.134  | 2.295 | 0.415         | 1.478             | 4.383 | 1.110  | 17.302 | <b>0.035*</b> |
| 100-500m   | 1.277  | 3.584                 | 1.383  | 9.288 | <b>0.009*</b> | 1.114             | 3.045 | 1.117  | 8.305  | <b>0.030*</b> |
| <100m  | 0.780  | 2.180                 | 1.020  | 4.662 | <b>0.044*</b> | 0.755             | 2.128 | 1.957  | 4.731  | <b>0.006*</b> |
| <b>Distance from house to school</b>                               |        |                       |        |       |               |                   |       |        |        |               |
| >1000m (Ref)   |        |                       |        |       |               |                   |       | 1      |        |               |
| 500-1000m  | -      | -                     | -      | -     | -             | 0.298             | 1.347 | 0.618  | 2.936  | 0.453         |
| 100-500m   | -      | -                     | -      | -     | -             | 0.316             | 1.371 | 0.639  | 2.944  | 0.418         |
| <100m  | -      | -                     | -      | -     | -             | 0.329             | 1.389 | 0.570  | 3.383  | 0.469         |
| <b>Transportation to school</b>                                    |        |                       |        |       |               |                   |       |        |        |               |
| Car  |        |                       | 1      |       |               |                   |       | 1      |        |               |
| Motorcycle   | 0.247  | 1.280                 | 0.667  | 2.458 | 0.457         | -0.015            | 0.985 | 0.503  | 1.929  | 0.966         |
| Bicycle  | 0.160  | 1.173                 | 0.464  | 2.964 | 0.736         | -0.777            | 0.460 | 0.166  | 1.276  | 0.136         |
| Walking  | -0.403 | 0.668                 | 0.062  | 7.210 | 0.740         | -0.578            | 0.561 | 0.045  | 6.983  | 0.653         |

KHAS > Covid-19

## Covid-19: KKM kesan enam kluster baharu pendidikan

20 Ogos 2022 10:18am

Masa membaca: 2 minit



Sebanyak 7,063 kluster dikesan sejak pandemik Covid-19 melanda negara lebih dua tahun lalu. - Foto Bernama

*Telegram dan LIKLOK kami*

KUALA LUMPUR - Enam daripada 12 kluster baharu yang dilaporkan oleh Kementerian Kesihatan Malaysia (KKM) sepanjang minggu ini adalah kluster pendidikan.

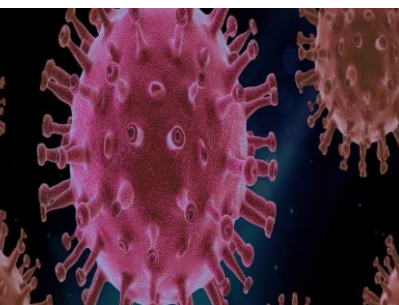
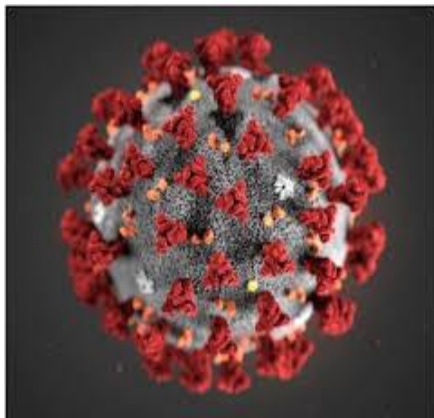
Kluster pendidikan ini dikesan di Perak, Selangor, Kelantan, Negeri Sembilan, WP Kuala Lumpur dan WP Putrajaya.

Antara kluster pendidikan yang dilaporkan termasuk Kluster Jalan Rektor Nilai 2 di Seremban, Negeri Sembilan (39 kes) dan Kluster Jalan Pantai Endah 2, Lembah Pantai (WP Kuala Lumpur) dengan 14 kes.

Lima kluster baharu lain adalah kluster kumpulan berisiko tinggi (Selangor, Johor, Perak dan Pulau Pinang) dan satu kluster pusat tahanan (Perak).

# CURRENT ISSUES:

Implications on COVID 19 control of transmissions in schools among teachers, students and support staff.



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f t i KemPendidikan

# Comprehensive Control of COVID19 Transmissions

1. Behavioral, 2. Physical, 3. Vaccination, 4. Sanitization and 5. Ventilation

## 1. Behavioral



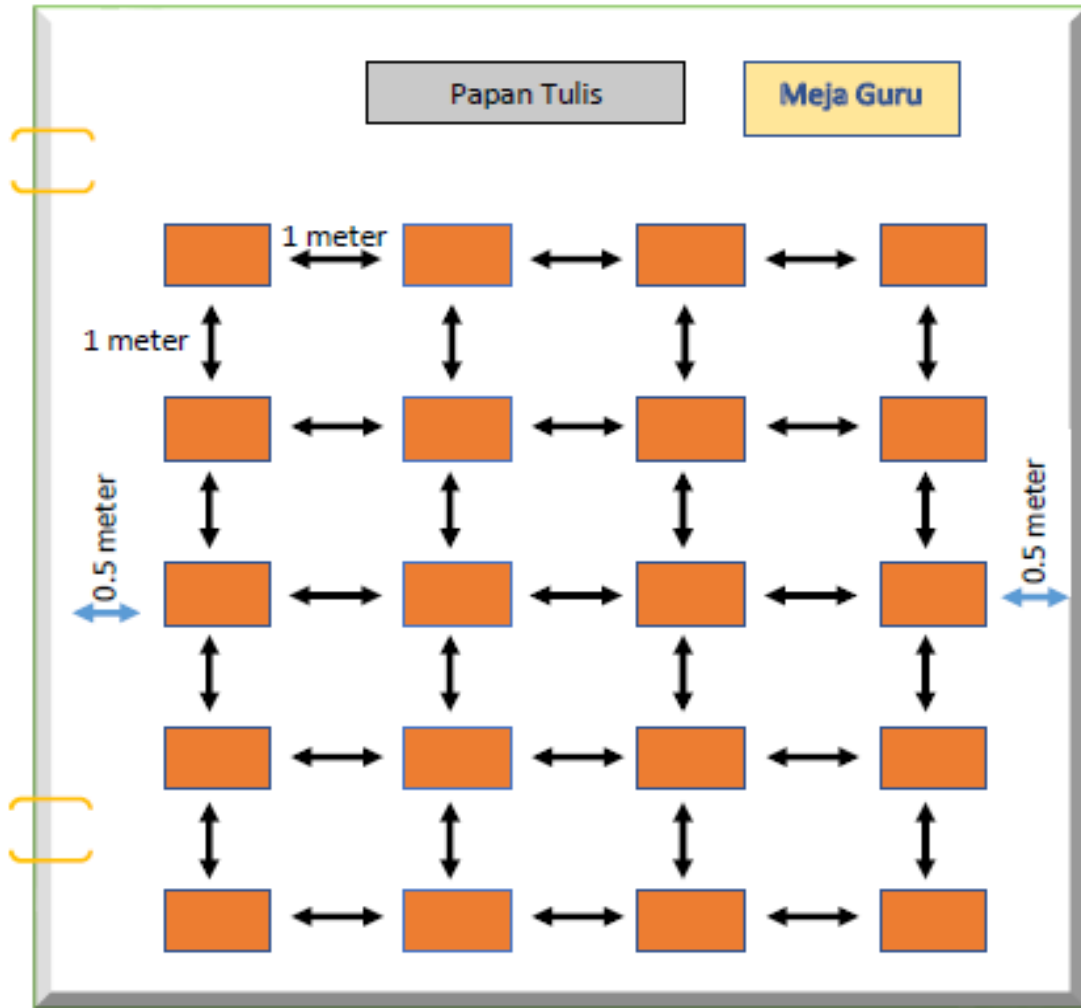
- Students must clean their hands with soap or hand sanitizer .
- Do not touch the eyes or nose unless hands are clean

## 1. Behavioral



Places to clean their hands

## 2. Physical Aspect of Control



## 3. Sanitization of school classes, library, canteen, toilets etc

- Carry out sanitization everyday or alternate days if possible.
- Moping of floors and wiping all surfaces every day.



Perbadanan Putrajaya

# 4. Vaccination:

School children, teachers & support staffs in schools.



# Comprehensive Control of COVID19 Transmissions: Behavioral, Physical, Vaccination, Sanitization and **Ventilation**

## Ventilation: *Most important but neglected*

Cai et al. (2011), stated that the inspections showed that no school in the study had any mechanical ventilation system, but all classrooms had openable windows that were kept open during lectures (

### Particulate matter (PM<sub>2.5</sub>) as a potential SARS-CoV-2 carrier

Norefrina Shafinaz Md Nor<sup>1</sup>, Chee Wai Yip<sup>1</sup>, Nazlina Ibrahim<sup>1,2</sup>, Mohd Hasni Jaafar<sup>2</sup>, Zetti Zainol Rashid<sup>3</sup>, Norlaila Mustafa<sup>4</sup>, Haris Hafizal Abd Hamid<sup>5</sup>, Kuan Chandru<sup>7</sup>, Mohd Talib Latif<sup>5</sup>, Phei Er Saw<sup>5</sup>, Chin Yik Lin<sup>8</sup>, Kemal Maulana Alhasa<sup>6</sup>, Jamal Hisham Hashim<sup>9</sup> & Mohd Shahrul Mohd Nadzir<sup>5,10</sup>

The rapid spread of the SARS-CoV-2 in the COVID-19 pandemic had raised questions on the route of transmission of this disease. Initial understanding was that transmission originated from respiratory droplets from an infected host to a susceptible host. However, indirect contact transmission of viable virus by fomites and through aerosols has also been suggested. Herein, we report the involvement of fine indoor air particulates with a diameter of  $\leq 2.5 \mu\text{m}$  (PM<sub>2.5</sub>) as the virus's transport agent. PM<sub>2.5</sub> was collected over four weeks during 48-h measurement intervals in four separate hospital wards containing different infected clusters in a teaching hospital in Kuala Lumpur, Malaysia. Our results indicated the highest SARS-CoV-2 RNA on PM<sub>2.5</sub> in the ward with number of occupants. We suggest a link between the virus-laden PM<sub>2.5</sub> and the ward's design. Patients' symptoms and numbers influence the number of airborne SARS-CoV-2 RNA with PM<sub>2.5</sub> in an enclosed environment.

The Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2) is primarily transmitted via respiratory droplets of various sizes<sup>1-3</sup>. Large respiratory droplets ( $> 5 \mu\text{m}$ ) transmission occur when a person is in close contact with someone<sup>4</sup> who has respiratory symptoms such as coughing or sneezing<sup>5</sup>. Whereas, finer virus-laden respiratory droplets and particulate matters ( $\leq 5 \mu\text{m}$ ) can remain in the air for an extended period and be carried over greater distances<sup>6</sup>  $> 6 \text{ m}$  (such as the outbreak of tuberculosis, measles, and chickenpox)<sup>7</sup>. Despite numerous studies that have demonstrated the transmission route of SARS-CoV-2 via respiratory droplets, evidence on aerosols-borne transmission remains limited<sup>1,8,9</sup>.

Transmission of SARS-CoV-2 in a range of particulate matter (PM) from submicrometer and/or supermicrometer have been reported<sup>1,10</sup>. This suggests that the virus can be transported via solid aerosols. PM<sub>2.5</sub> is fine solids with a particle diameter of  $\leq 2.5 \mu\text{m}$  that is suspended in ambient air aerosols.

No correlation was found between the virus concentration and PM's diameter. Nevertheless, positive correlations between PM<sub>2.5</sub> and other respiratory viruses such as the influenza virus have been reported<sup>11</sup>, emphasizing the possibility of particulate matter as a transport carrier for SARS-CoV-2.

PM<sub>2.5</sub> is fine solid aerosols with a particle diameter of  $\leq 2.5 \mu\text{m}$  that is suspended in ambient air. PM<sub>2.5</sub> in indoor environments is mainly derived from common outdoor sources such as motor-vehicles, biomass burning, and industrial emissions<sup>12-14</sup>. Prolonged exposure to PM<sub>2.5</sub> is particularly detrimental to human health as this fine particulate matter can be easily inhaled and penetrate deep into the lungs<sup>15,16</sup>. PM<sub>2.5</sub> is known to have a significantly longer lifetime in the air where it can be suspended at an extended period compared to respiratory liquid droplets. This longer lifetime of particles may pose a significant viral exposure to healthcare personnel, especially in indoor environments. PM<sub>2.5</sub> can also be deposited in indoor environments such as hospitals' flooring<sup>17,18</sup> and any surface materials<sup>19,20</sup>. This fine particulate matter is readily propagated by tiny turbulent eddies in the

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# Ventilation:

since the COVID19 virus is transmitted through minute particulates (PM10 and PM2.5) and droplets.

- Increase the introduction of outdoor air:
  - Open windows and doors, when weather conditions allow, to increase outdoor air flow..
- Use fans to increase the effectiveness of open windows:
  - Vary based on room configuration. Avoid blowing contaminated air directly from one person to another.
  - Ensure ventilation systems operate properly and acceptable indoor air quality for occupancy level (CO2 <1000 ppm)
- Generate clean-to-less-clean air movement by repositioning as necessary, the supply louvers, exhaust air grilles, and/or damper settings.
- Ensure restroom exhaust fans are functional and operating at full capacity when the building is occupied.
- Inspect and maintain exhaust ventilation systems in areas such as canteens, toilets, etc.
- Adjust HVAC systems in air conditioned teachers, office, to increase total airflow.
- Use portable high-efficiency particulate air (HEPA) fan/filtration systems to enhance air cleaning (especially in higher risk areas)

# Conclusion

- From previous findings, there are existing challenges with regard to the school indoor air quality and children's exposure, in term of particulate matters, volatile organics and microbes.
- The health impacts of indoor air pollutant exposure ranged from respiratory symptoms, allergy, lung inflammation, impaired lung and cognitive functions, neurobehavioral performance deficit and genotoxicity.
- With the emergence of COVID 19, the children's health are at higher risk. If we are able to improve the air quality, which are threats to their health, as shown in our studies, then, we will not have problem in controlling COVID 19 transmission.

# Recommendations

1. Zoning due to open air system in schools. Avoid heavy traffic and industrial areas.
2. Improved ventilation with fans, exhaust fans, open windows etc
3. Frequent cleaning, moping and wiping of surfaces to eliminate particulate and dust
4. Prevent leaking as dampness will promote fungal and microbes growth
5. Annual environmental monitoring for chemical and biological agents in schools
6. Annual health check for asthmatic children or those with chronic respiratory diseases with lung function or lung inflammation tests
7. Profiling techniques to characterize rare and unculturable indoor fungi which may influence airway inflammation.
8. Future studies, for a better understanding of long term airway inflammatory response due to variability of exposure patterns (geographical, seasonal and latitudes)



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## Ocular symptoms and tear film break up time (BUT) among junior high school students in Penang, Malaysia – Associations with fungal DNA in school dust



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## Association between indoor microbiome exposure and sick building syndrome (SBS) in junior high schools of Johor Bahru, Malaysia

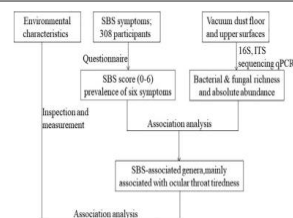
Xi Fu<sup>a,b</sup>, Dan Norbäck<sup>c</sup>, Qianqian Yuan<sup>a,d,e</sup>, Yanling Li<sup>a,d,e</sup>, Xunhua Zhu<sup>a,d,e</sup>, Jamal Hisham Hashim<sup>f</sup>, Zailina Hashim<sup>g</sup>, Faridah Ali<sup>h</sup>, Qiansheng Hu<sup>b</sup>, Yiqun Deng<sup>a,d,e</sup>, Yu Sun<sup>a,d,e,\*</sup>

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HIGHLIGHTS

- First association study between indoor microbiome and sick building syndrome (SBS)
- Eight microbial genera were associated with ocular and throat symptoms and tiredness.
- Indoor relative humidity and visible mould were related with SBS-associated bacteria.

GRAPHICAL ABSTRACT



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GRAPHICAL ABSTRACT



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International Journal of Environmental Research and Public Health



Article

## The Effects of Indoor Pollutants Exposure on Allergy and Lung Inflammation: An Activation State of Neutrophils and Eosinophils in Sputum

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**Abstract:** Background: To explore the inflammation phenotypes following indoor pollutants exposure based on marker expression on eosinophils and neutrophils with the application of chemometric analysis approaches. Methods: A cross-sectional study was undertaken among secondary school students in eight suburban and urban schools in the district of Hulu Langat, Selangor, Malaysia. The survey was completed by 96 students at the age of 14 by using the International Study of Asthma and Allergies in Children (ISAAC) and European Community Respiratory Health Survey (ECRHS)



## Indoor microbiome, environmental characteristics and asthma among junior high school students in Johor Bahru, Malaysia

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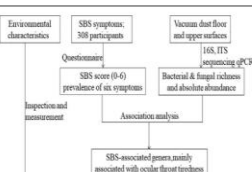
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### HIGHLIGHTS

- First association study between indoor microbiome and sick building syndrome (SBS)
- Eight microbial genera were associated with ocular and throat symptoms and tiredness.
- Indoor relative humidity and visible mould were related with SBS-associated bacteria.

### GRAPHICAL ABSTRACT



## The Impact of Exposure to Indoor Pollutants on Allergy and Lung Inflammation among School Children in Selangor, Malaysia: An Evaluation Using Factor Analysis

Khairul Nizam Mohd Isa<sup>1,2</sup>, Zailina Hashim<sup>1\*</sup>, Juliana Jalaludin<sup>1</sup>, Dan Norbäck<sup>3</sup>, Mohammed Abdulrazzaq Jabbar<sup>4</sup>, Jamal Hisham Hashim<sup>5</sup>

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### ABSTRACT

A cross-sectional study of 470, 14-year-old students from 8 secondary schools located in sub-urban and urban areas in Hulu Langat district, atopy, asthma, ISAAC and ECI and passive sam temperature and



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Article

## Evaluation of the Relationship between Fractional Exhaled Nitric Oxide (FeNO) with Indoor PM<sub>10</sub>, PM<sub>2.5</sub> and NO<sub>2</sub> in Suburban and Urban Schools

Khairul Nizam Mohd Isa<sup>1,2\*</sup>, Juliana Jalaludin<sup>1,\*</sup>, Saliza Mohd Elias<sup>1</sup>, Norlen Mohamed<sup>3</sup>, Jamal Hisham Hashim<sup>4</sup> and Zailina Hashim<sup>1</sup>

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## Associations between species-level indoor microbiome, environmental characteristics, and asthma in junior high schools of Terengganu, Malaysia

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### Abstract

Indoor microbiome exposure is important for asthma development, but current studies characterize the microbiome at the genus or above levels due to technical limitations. We aim to profile bacterial and fungal composition and concentration at the species level and assess its potential health effects. Four hundred sixty-three students from 8 junior high schools in Terengganu, Malaysia, were surveyed for asthma symptoms. Full-length PacBio amplicon sequencing and qPCR were conducted to quantify the absolute microbial concentration in the vacuum dust of the selected classroom. In total, 1358 bacterial and 358 fungal species were characterized, and drastic compositional variation was observed among classrooms. Three-level linear regression analyses revealed that taxa richness in Cyanobacteria were negatively associated with asthma (FDR < 0.001). The absolute concentration of *Nocardioideis exalbidus* was protectively associated with asthma, and four bacteria species were positively associated with asthma (FDR < 0.1). Interestingly, all five species were recently isolated and characterized in Asian countries and never reported to associate with asthma. Indoor NO<sub>2</sub> and formaldehyde concentration were associated with the overall bacterial community variation and fungal richness, respectively (p < 0.05). No environmental characteristics were directly associated with asthma, but indoor relative humidity, CO<sub>2</sub> concentration, and weight of vacuum dust were associated

# THANK YOU

