

**Indoor air parameters, heavy metals in school indoor air particulate matter and dust: relationship with respiratory symptoms and lung inflammation among students in Kota Kinabalu, Sabah**

**ABSTRACT**

Indoor air quality significantly impacts public health due to extensive indoor activity and the presence of hazardous substances. This study examines the association between indoor air quality parameters (fine particulate matter less than 2.5 microns [PM<sub>2.5</sub>], respirable particulate matter less than 10 microns [PM<sub>10</sub>], nitrogen dioxide [NO<sub>2</sub>], volatile organic compound [VOCs]) and heavy metal concentrations (chromium [Cr], manganese [Mn], nickel [Ni], lead [Pb], arsenic [As], and cadmium [Cd]) in indoor air particulate matter and dust from school environments, with students' respiratory health and lung inflammation in Kota Kinabalu, Sabah, Malaysia.

**Materials and methods:** Data were collected from 332 students across 24 Form 2 classrooms in six secondary schools. Data on respiratory symptoms and health were collected by questionnaire, while lung inflammation was assessed using fractional exhaled nitric oxide (FeNO) measurements. Dust from classrooms was vacuumed using specific filters, digested for heavy metals with the aqua regia method, and analysed with inductively coupled plasma mass spectrometry (ICP-MS).

**Results:** From the questionnaire, 13% reported wheezing for the past 12 months, 51.5% throat dryness, 60.8% influenza symptoms, 50.6% sore throat, 27.7% irritating cough, 23.8% breathing difficulty, 11.4% asthma, and 55.1% respiratory infections. Heavy metals concentrations in the indoor air particulate matter in descending order is Cr>Pb>Mn>Ni>As>Cd, while in the settled dust was Mn>Pb>As>Ni>Cr>Cd. Approximately 49.4% of students exhibited lung inflammation, with FeNO levels exceeding 20 parts per billion (ppb).

**Conclusion:** Air Mn, Pb, As, PM<sub>10</sub>, CO<sub>2</sub>, and VOCs are related to lung inflammation and reported respiratory symptoms among school students especially among male.