P28. Impact of $PM_{2.5}$ in schools on asthma-related symptoms

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Abstract

Indoor air pollution has a greater impact on children than on adults due to their developing lungs and immune systems and higher inhalation rates. This study aimed to assess the impact of $PM_{2.5}$ exposure on asthma-related symptoms in children attending urban nursery and primary schools. A microenvironmental modelling approach was used to assess individual $PM_{2.5}$ exposure and information on health outcomes such as asthma, wheezing and dyspnea were collected from ISAAC questionnaires. Descriptive statistics and logistic regression models were used for data analysis. Results showed that approximately 40% of children were exposed to $PM_{2.5}$ above the WHO guidelines. This study found evidence of an association between exposure to $PM_{2.5}$ levels above World Health Organization guidelines and wheezing (aOR = 1.68, *p*-value = 0.038) and dyspnea (aOR = 2.07, *p*-value = 0.018). These findings highlight the potential respiratory health risks associated with $PM_{2.5}$ exposure indoors for children in nursery and primary schools.

Author Keywords. $PM_{2.5}$, nursery and primary, children, asthma, wheezing, dyspnea.

1. Introduction

Children are more susceptible to the health effects of indoor air pollution (IAP) than adults due to their still developing lungs and immune systems and their relatively higher amount of air inhalation. Moreover, IAP affects children's respiratory health and it has been linked to respiratory symptoms and chronic diseases like asthma. Although children spend a great part of their day in school, there is still limited research on the effects of IAP exposure on childhood respiratory health. Specifically, concerning $PM_{2.5}$, previous studies in the literature highlighted its negative impact on human respiratory health (Nandasena, Wickremasinghe, and Sathiakumar 2013). Thus, this study mainly aimed to assess the impact of children's exposure to $PM_{2.5}$ in urban nursery and primary schools on asthma-related symptoms.

2. Materials and Methods

The study population consisted of children in the early stages of education (aged 3 to 10), who attended 10 nursery and 10 primary schools located in metropolitan area of Porto. Based on previous studies (Branco et. al 2014), a microenvironmental modelling approach was followed to assess individual children's exposure to air pollution. This approach was based on continuous monitoring of $PM_{2.5}$ in classrooms and time-location patterns obtained from the school timetable. Furthermore, continuous sampling of indoor $PM_{2.5}$ levels was carried out over the first half of 2022 in 39 classrooms, during occupancy periods. $PM_{2.5}$ exposure was dichotomized in "below" or "above" health protection levels, using the cut-off of 25 $\mu g/m^3$ recommended by the World Health Organization (WHO) guidelines, for the association with respiratory health outcomes.

Simultaneously, a total of 649 questionnaires derived from the International Study of Asthma and Allergies in Childhood were completed, allowing to collect parent-reported individual information of sex, age, parental history of asthma, asthma previously diagnosed, and asthma-related symptoms (wheezing and dyspnea). Asthma previously diagnosed, and both active wheezing and dyspnea (reporting at least one episode in the previous year) were considered the main health outcomes in this study. Descriptive statistics were used to express the characteristics of individuals, $PM_{2.5}$ exposure and health outcomes. Multivariate logistic regression models were used to estimate the odds ratio (OR) of the associations between $PM_{2.5}$ exposure and each of the health outcomes

analysed, adjusted for parental history of asthma. Statistical analyses were performed with R Studio software. The level of statistical significance was set at 0.05.

3. Discussion

The findings of this study on children's daily indoor exposures to $PM_{2.5}$ are consistent with previous literature (Branco et. al 2019). The minimum, median, mean and maximum $PM_{2.5}$ exposure levels observed were 13.4 $\mu g/m^3$, 23.2 $\mu g/m^3$, 28.1 $\mu g/m^3$ and 127.4 $\mu g/m^3$, respectively. Approximately 40% of the individuals (71.9% of preschoolers and 25.1% of primary school children) were exposed to $PM_{2.5}$ levels above the threshold suggested by the WHO guidelines. Although the study population was well-balanced for gender, there was a higher proportion of primary school children (68.7%) compared to preschoolers (31.3%) involved in this study. Also, 20.8% of the study studied children had at least one asthmatic parent, and the prevalence of parent-reported asthma was 6.6%, both in accordance with previous studies, despite the variability in estimates of asthma prevalence among pediatric populations (Flores et al. 2022). The prevalence of ever wheezing and dyspnea (at least once in lifetime) was 30.7% and 13.1%, respectively, while the prevalence of active wheezing and dyspnea (at least one episode in the previous year) was 11.9% and 7.6%, respectively. Table 1 summarizes the results from the multivariate logistic regression models representing the association between exposure to $PM_{2.5}$ and each studied health outcome.

Model / Health outcome	crude OR (95% CI)	crude *p*-value	adjusted OR (95% CI)	adjusted *p*-value
Asthma (reported)				
Exposure to $PM_{2.5}$	0.93 (0.49 - 1.76)	0.814	0.99 (0.51 - 1.91)	0.974
Parental history of asthma	4.81 (2.54 - 9.11)	**< 0.001***	4.8 (2.53 - 9.11)	**< 0.001***
Active wheezing				
Exposure to $PM_{2.5}$	1.58 (0.98 - 2.54)	0.062	1.68 (1.03 - 2.73)	**0.038***
Parental history of asthma	2.88 (1.74 - 4.78)	**< 0.001***	2.99 (1.8 - 4.98)	**< 0.001***
Active dyspnea				
Exposure to $PM_{2.5}$	1.98 (1.09 - 3.61)	**0.025***	2.07 (1.13 - 3.8)	**0.018***
Parental history of asthma	2.57 (1.38 - 4.78)	**0.003***	2.67 (1.43 - 5.01)	**0.003***

*Significant at *p*-value < 0.05 calculated by likelihood ratio test.

Table 1: Crude and adjusted odds ratio (OR), and respective 95% confidence intervals (95% CI) and significance (p-value) of the associations between exposure to $PM_{2.5}$ and reported asthma, as well as active wheezing and dyspnea.

Children's exposure to indoor $PM_{2.5}$ in nursery and primary schools was not associated with reported asthma (aOR = 0.99, *p*-value = 0.974). However, concerning asthma-related symptoms, a statistically significant association with $PM_{2.5}$ exposure above the threshold was found, revealing an increase in the odds of having active wheezing and dyspnea in childhood (aOR = 1.68, *p*-value = 0.038 and aOR = 2.07, *p*-value = 0.018, respectively). Evidence from prior studies in the literature demonstrated the negative impact of particulate matter on respiratory health, with children being particularly vulnerable. Specifically, short-term exposures to $PM_{2.5}$ in schools have been associated with higher rates of hospital admissions and emergency department visits due to respiratory symptoms (Yang et al. 2019).

4. Conclusions

This study concluded that children were often exposed to $PM_{2.5}$ levels higher than the WHO threshold inside nursery and primary schools. Moreover, it was identified statistically significant associations between $PM_{2.5}$ exposure and respiratory health outcomes, specifically active wheezing and dyspnea, meaning an increased risk of respiratory symptoms in children exposed to $PM_{2.5}$ concentration above WHO guidelines in schools. These findings highlight the importance of

studying IAP in schools and its potential impact on the respiratory health of children. Further research and interventions may be needed to reduce indoor $PM_{2.5}$ exposure in schools. Also, the analysis should be extended to the $PM_{2.5}$ exposure of a complete day, as well as to physician diagnosed respiratory health outcomes.

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