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ASTHMA IN CHILDREN AND INDOOR AIR POLLUTANTS: ASSOCIATIONS IN RESIDENTIAL AND SCHOOL ENVIRONMENTS

Guilherme Ferreira[1], Rosa Oliveira[2], Hugo Santos[2], Catarina F. Castro[1,2]
[1]Faculty of Engineering of the University of Porto, Porto, Portugal
[2]Institute of Science and Innovation in Mechanical and Industrial Engineering, Porto, Portugal
[(*)]*Email:* ccastro@fe.up.pt

ABSTRACT

Asthma has become the most common, childhood chronic disease in the industrialized world, and environmental factors are likely to be important in explaining the overall increasing trend towards asthma's prevalence. Health risks have received considerable attention during recent years, namely, regarding their potential effect on asthmatic children. Indoor factors are of particular interest because children spend more than 80% of their time indoors globally. An ongoing analysis investigating the association of potential health effects and indoor exposures to pollutants, allergens and irritants, dampness and mould and more general indoor comfort parameters is addressed here. The statistical results demonstrate the importance of evaluating indoor home environmental air pollution sources as risk factors for asthma like symptoms.

Keywords: Indoor environment; Air pollution; Health; Asthma; School children.

INTRODUCTION

Indoor Air Quality (IAQ) has an important role on the human health and overall well-being, such that it keeps on raising attention of the scientific community and general public. A great number of studies came up showing that the exposure to chemicals, particles and microbiological agents as well as inadequate conditions of temperature and humidity are associated with the development of asthma and allergies. Asthma is one of the most predominant chronic diseases among young children, affecting more than one third in Europe (Oliveira Fernandes et al., 2008). Additionally, Sun et al. (2009) and Zhao et al. (2008) state that the prevalence of asthma has increased in recent decades at a rate that, according to Masoli et al. (2004) and Etzel (2007), is probably due to changes in environmental exposures and cannot be simply justified by genetic deviations.

Children spend up to 90% of their time in indoor environments, with the majority of that time split between home and school (Annesi-Maesano et al., 2013). Given the wide range of indoor pollutants, many studies have come out investigating their impact on health. Important indoor air pollution determinants of asthma include among others fine (PM2.5) and coarse (PM2.5-10) particulate matter, carbon monoxide (CO) and polycyclic aromatic hydrocarbons. There is increasing evidence that mould growth in damp buildings is an important risk factor for respiratory illness (Etzel, 2007). Comfort parameters such as temperature, dampness and visible mould, relative humidity and air ventilation measurements have been reported as associated to asthma exacerbation. The aim of this research project is to investigate the association between home and school's indoor air quality and the development of respiratory complaints among children contributing with further information on school and home environments in Portugal and in particular in the city of Porto.

METHODS

The "SINPHONIE" project, coordinated by the IDMEC in partnership with other European partners and under the recommendations of the World Health Organization and the European Environment and Health Action Plan, aimed at expanding the knowledge of the environmental sources and possible associations with the development of respiratory problems in school-age children and also to find new or better strategies to prevent and reduce the impacts of indoor air pollution. Between November 2011 and January 2012, a case-control study was conducted with sixty-eight children (thirty-eight cases and thirty controls) aged between 7 and 10 years living in the urban area of Porto, Portugal, in order to assess associations between their personal daily exposure to air pollutants and the risk of developing asthma. Indoor measurements of volatile organic compounds (VOC), formaldehyde, acetaldehyde, carbon monoxide (CO), PM2.5, PM10, carbon dioxide (CO_2), temperature, relative humidity, bacteria and fungi were conducted both at home and school. In the present study a significant number of schools and homes were situated close to a heavily trafficked road or close to a car park it is expected that outdoor ambient air contribute to the indoor concentration measurements. The Statistical Package for the Social Sciences (SPSS) was used for the analysis. To estimate possible associations, simple chi-square statistical tests and Mann-Whitney tests were applied for initial comparisons. Multiple logistic regression analysis was used to test the association between air quality and asthma risk factors, adjusting for the effective exposure time in each of the environments, home and school.

RESULTS

Consistent associations were observed between asthma and environment parameters. Chemical, physical and microbiological IAQ parameters collected from the houses and classrooms of 68 primary school children studying in the city of Porto. From the 68 children, 38 presented symptoms or diagnosed asthma and the other 30 showed no symptoms at all. Different statistical approaches were considered in order to clarify possible associations between IAQ and asthma like symptoms. Available data was analized. As an example, boxplots and outlier identifications for temperature (left) and relative humidity (right) differentiating control (no symptoms) and case (asthma like symptoms) group are presented in Figure 1.

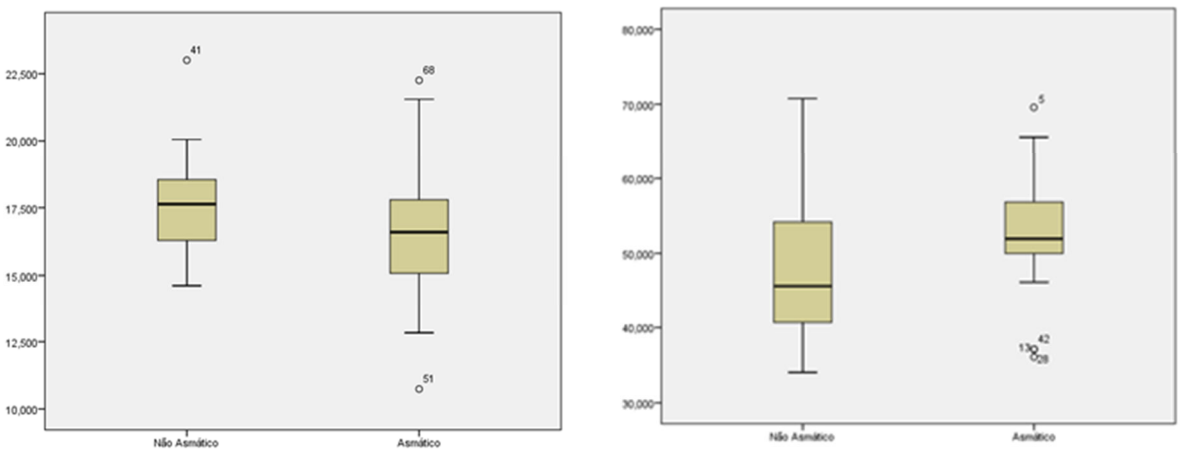

Fig. 1 - Boxplots with outliers identification for temperature (left) and relative humidity (right) differentiating control and case group.

Boxplots and outlier identifications for carbon monoxide exposure (left) and ventilation (right) differentiating control and case group are presented in Figure 2.

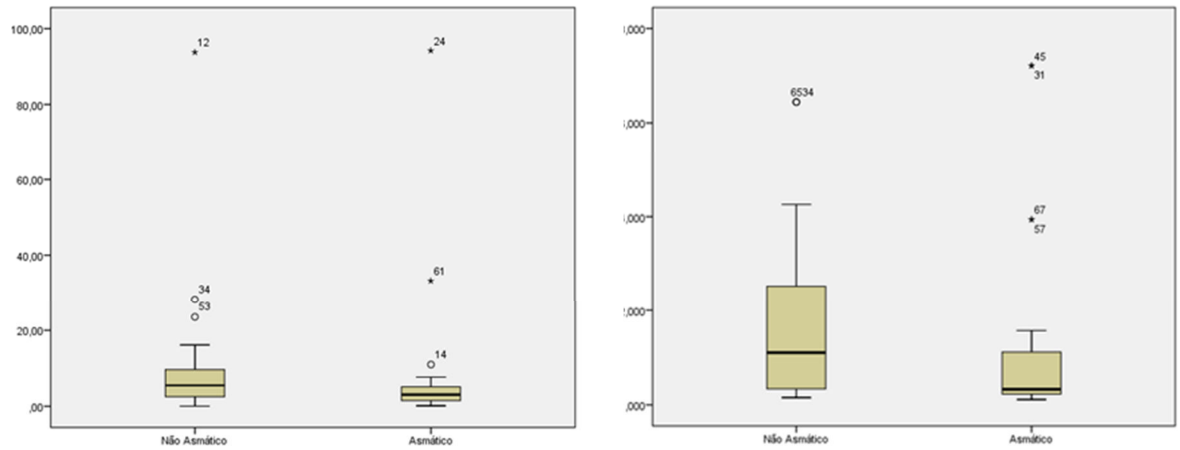

Fig. 2 - Boxplots and outlier identification for carbon monoxide exposure (left) and ventilation (right) differentiating control and case group.

Interaction effects represent the combined effects of variables on the criterion or dependent measure. When an interaction effect is present, the impact of one variable depends on the level of the other variable. Part of the power of multiple regression is the ability to estimate and test interaction effects when the predictor variables are either categorical or continuous. When interaction effects are present, it means that interpretation of the individual variables may be incomplete or misleading and multiple effects should be studied in research rather than the isolated effects of single variables (Pedhazur and Schmelkin 1991). Using multiple logistic regression analysis suggests controversial asthma prevention in both environments (Aiken and West 1991).

What indoor pollutants and comfort characteristics are risk factors for asthma like symptoms? Logistic regression is able to predict the presence or absence of an outcome based on values of a set of predictor variables. Logistic regression coefficients can be used to estimate odds ratios for each of the independent variables in the model. The stepwise selection method with entry testing based on the significance of the score statistic, and removal testing based on the probability of the Wald statistic and the Hosmer-Lemeshow goodness-of-fit were considered. Using block entry variables as home temperature, TVOC, other VOCs and school CO, α-pinene, relative humidity, bacteria and fungi, and the stepwise forward Wald method, Table 1 presents the p-value of logistic regression, odds ratio or odds ratio (OR) and their 95% confidence interval, OR between lower limit (LI) and upper limit (LS) for the variables of interest. The greater or lesser risk of asthma by a unit increment of embedded variables for the model is given by the OR.

Table 1 - Built-in variables in the multivariate model and p-values, OR and confidence intervals (95%)

		p-value	**OR**	**$IC_{95\%}$**	
				LI	**LS**
School	CO (ppm · h)	0.004	0.660	0.497	0.875
Home	Temperature (ºC)	0.026	0.610	0.395	0.941

CONCLUSIONS

Based on data gathered by the SINPHONIE project, the developed work is a contribution for a better understanding of the relations between IAQ of homes/schools and the prevalence of asthma, allergies and other respiratory symptoms. Interaction effects and associations between asthma risk and measured parameters were considered suggesting controversial contributions from home temperature and school exposure to CO. Further analysis was consistent with the research stating that children are less likely to have asthma when PM2.5, relative humidity and lack of ventilation are reduced. However, several factors could account for inconsistencies, including confounding factors, small effect levels, or chronicity of exposure. Observed associations reinforce and give consistency to the analysis. Research documenting effectiveness of interventions to reduce those exposures and improve asthma outcomes is needed.

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REFERENCES

[1]-Aiken, L. S., West, S. G. Multiple regression: Testing and interpreting interactions. Newbury Park: Sage. 1991.

[2]-Annesi-Maesano, I., Baiz, N., Banerjee, S., Rudnai, P., Rive, S. & The Sinphonie, G. Indoor air quality and sources in schools and related health effects. J Toxicol Environ Health B Crit Rev, 16, 491-550. 2013.

[3]-Etzel, R. A. Indoor and outdoor air pollution: Tobacco smoke, moulds and diseases in infants and children. International J.f Hygiene and Environmental Health, 210**,** 611-616. 2007.

[4]-Masoli, M., Fabian, D., Holt, S. & Beasley, R. The global burden of asthma: executive summary of the GINA Dissemination Committee report. *Allergy* 59**,** 469-78. 2004.

[5]-Oliveira Fernandes, E., Gustafsson, H., Seppänen, O., Crump, D. & Ventura Silva, G. WP3 Final Report on Characterization of Spaces and Sources. EnVIE Project. Brussels: European Commission 6th Framework Programme of Research. 2008.

[6]-Pedhazur, E. J., Schmelkin, L. P. Measurement, design, and analysis: An integrated approach. Hillsdale, NJ: Erlbaum. 1991.

[7]-Sun, Y., Varnel, G. & Sundell, J. 2009. An on-going study on home environment and asthma and allergy among children in North East Texas, USA. Syracuse, NY USA: 9th International Conference Healthy Buildings 2009.

[8]-Zhao, Z. H., Zhang, Z., Wang, Z. H., Ferm, M., Liang, Y. L. & Norbäck, D. Asthmatic symptoms among pupils in relation to winter indoor and outdoor air pollution in schools in Taiyuan, China. Environmental Health Perspectives, 116**,** 90-97. 2008.