

TECHNICAL NOTE

Contribution of air-proof doors and windows to asthma in Campania Plain (Italy)

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The relation between the prevalence of doctor-diagnosed asthma in children and the presence of air-proof doors and windows (doors and windows with rubber gaskets) in their homes was investigated by a cross-sectional survey in the area of Campania Plain, South Italy. Information on the occurrence of asthma and home/family characteristics, including parental smoking habit and level of education, was obtained by a questionnaire given to school children, aged 8–14 years, and their parents. After possible confounders were controlled, the risk of developing asthma was found to be significantly higher in children living in houses equipped with air-proof doors and windows (Odds ratio = 1.30, 95% Confidence interval = 1.1–1.5). By reducing the air exchange, these fixtures are likely to produce increased levels of indoor pollutants. No interaction was found between the two variables ‘air-proof doors and windows’ and ‘parental smoking habit’.

Keywords: Indoor air pollution; asthma; doors; windows.

Introduction

It is increasingly recognized that indoor air quality may be an important factor affecting respiration (Krieger and Higgins 2002; Daisey *et al.* 2003). Children in Northern Europe and North America spend most of the time indoors (Gold 1992), either at home, at school, or travelling, so the quality of indoor air is at least as important or more important than that of outdoor air. Many recent surveys have shown associations between childhood asthma and indoor pollutants products, notably passive smoking (Dales *et al.* 2002; Forastiere *et al.* 2002), volatile solvents present in glues (Ziem and McTamney 1997), a variety of consumer (Norback *et al.* 1995; Jaakkola *et al.* 2000), methods of cooking and heating (Ciuk *et al.* 2001), and allergens such as dust mites (Sporik *et al.* 1990; Arshad *et al.* 2002) and pet allergens (McConnell *et al.* 2002). However, the quantitative increase of the relative risk for children to be get asthma is affected by the climate and flora of the region where they live, on their own and on their parents’ life style, as well as on characteristics of their house and home town.

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The objective of this study was to estimate the relationship between the prevalence of doctor-diagnosed asthma and house building characteristics, notable the occurrence of air-proof doors and windows (doors and windows with rubber gaskets). The oil crisis of the mid 1970s led to the development of more energy-efficient buildings which are often equipped with these fixtures. Unlikely traditional fixtures, rubber-sealed windows and doors effectively prevent air exchange between indoor and outdoor environment.

To the best of our knowledge, this is the first study on the adverse health effects of air-proof doors and windows. Recent studies (Smedje and Norbäck 2000) carried out in Sweden have shown a reduction of asthmatic symptoms in children attending schools where the ventilation system had been improved.

This study was carried out between October 2001 and May 2002 in eight towns with less than 30,000 inhabitants, located in the inland of Campania Plain, South Italy. This plain is characterized by a pleasant climate with relatively high average temperatures and moderate rainfall, as typical of the mid Mediterranean area. Forced ventilation systems are uncommon in private buildings. Moreover, the selected towns usually have low level of outdoor air pollution because of low traffic levels and absence of major industrial plants.

Methods

Four thousand and four hundred schoolchildren, aged 8–14 years, attending the primary and intermediate schools of the following towns were enrolled in this epidemiological study: Barra (Napoli), Curti, Casagiove, Centurano (Caserta), Frattamaggiore, Maddaloni, Marcianise and S. Arpino. A self-administered questionnaire was distributed through the schools to the children and their parents in order to get the following information: doctor-diagnosed asthma (the parents were asked to answer the question: Have you ever been told by a doctor that your child had asthma?), parents' education, the presence of air-proof doors and windows, dampness problems and presence of pets at home, number of persons sleeping in the same room, age and sex of the child.

Statistical analysis

χ^2 statistical test was used to analyse possible differences in the prevalence of asthma between opposite samples. Odds ratios and 95% confidence intervals, corrected for the confounding variables, were estimated with multiple logistic regression models, using the statistic package Statistica, StatSoft, Inc. The dichotomous variables 0 or 1 was used to indicate absence or presence of a specific parameter. A discrete variable, from 0 to 4, was used to quantify the parent's instruction.

Results and discussion

Table 1 reports the prevalence of doctor-diagnosed asthma in the entire sample studied, and in sub-samples characterized by the specific potential risk factors assessed, with the fraction of children exposed to the risk factor.

Overall, 700 of the 4,400 children (16 %) surveyed had doctored-diagnosed asthma. In line with the results previously reported in the literature, a higher prevalence in boys than in girls (Ehrlich *et al.* 2001) and among children whose mothers smoke (Kurukulaaratchy *et al.* 2002) was observed. Children of male sex and children whose mothers smoke have a greater chance of being affected by asthma. Paternal smoking seems less relevant. Most likely this is due, at least

Table 1. Prevalence of doctor-diagnosed asthma in the whole sample studied and in sub-samples characterized by specific potential risk factors with the fraction of children exposed to the risk factor

	<i>Fraction of children</i>	<i>Prevalence of asthma</i>	<i>p*</i>
Whole sample		0.16	
Smoking mother	0.33	0.20	< 0.0001
Non-smoking mother	0.67	0.14	
Smoking father	0.53	0.17	NS
Non-smoking father	0.47	0.16	
House with air-proof door(s) and window(s)	0.56	0.17	0.021
House without air-proof door(s) and window(s)	0.44	0.15	
Girls	0.51	0.13	< 0.0001
Boys	0.49	0.20	
Cat(s) and/or dog(s) in the home	0.82	0.16	0.18
No cat and/or no dog in the home	0.18	0.18	

NS = not significant. *Differences between the opposite groups (e.g. boys or girls, smoking or non-smoking mother) analysed by χ^2 .

Table 2. Estimated coefficients for a multiple logistic regression model for the occurrence of air-proof windows and doors in the area under study

<i>Variable</i>	<i>Coeff.</i>	<i>Std. Error</i>	<i>p-level</i>
Thousands of inhabitants in town	0.0105	0.003	< 0.0001
Number of rooms in the house	0.190	0.035	< 0.0001
Number of persons living in the house	- 0.120	0.038	0.0016
Mother's education	0.064	0.042	0.127

in this region, to the greater time that women usually spend at home: moreover, men often smoke in a restricted area at home.

Particularly relevant is the higher prevalence of asthma in children living in houses equipped with air-proof doors and windows. In the area examined these devices were installed in 55% of the houses (and their number is rapidly increasing). The common windows and doors, usually leave small cracks open, thus allowing small, but continuous, renewal of the indoor air. This contributes to keeping indoor pollutants at lower concentration values. Forced ventilation systems in private houses are not widespread in the geographic region where this study was carried out.

The relation between the use of air-proof doors and windows and other characteristics of the house and family was analysed by a multiple logistic regression (Jowaheer and Subratty 2003) carried out using the occurrence of air-proof doors and windows as the dichotomous response variable and the parent school education (discrete variable, from 0 to 4), the number of rooms and persons living in the house, and the number of inhabitants in the town as explanatory variables. The results of the regression carried by stepwise selection of the variables (Hosmer and Lemeshow 2000), excluding those with a *P*-value > 0.15, are reported in Table 2.

Table 3. Estimated coefficients for a multiple logistic regression model for the occurrence of doctor-diagnosed asthma in children in the region in study

<i>Variable</i>	<i>Coeff.</i>	<i>Std. Error</i>	<i>P-level</i>	<i>OR^a</i>	<i>95% CI^b</i>
Gender (girl = 1, boy = 0)	− 0.490	0.090	< 0.0001	0.61	0.51–0.74
Air proof doors and windows	0.260	0.092	0.0051	1.30	1.1–1.5
Smoking mother	0.431	0.092	< 0.0001	1.50	1.3–1.8

^aOdds ratio.^b95% confidence interval.

Air-proof doors and windows are more widespread in families with a higher socio-economic status, as can be derived from the dependence on mother's education and number of rooms in the house. Moreover, their diffusion is higher in larger towns and in families with a smaller number of members.

Table 3 reports the results of a multiple logistic regression analysis carried out using the doctor-diagnosed asthma as the dichotomous response variable and all the independent variables surveyed in this study. This final model was obtained by stepwise selection of the variables, excluding those with $P > 0.1$. A discrete variable that determines the specific town has also been introduced.

This study indicates that, independently of the well known higher prevalence of asthma in boys than in girls and the adverse health effect of passive tobacco smoking, the presence of air-proof door(s) and windows in the residence house has a strong additional effect. For a child living in a house equipped with this type of fixtures, the OR, corrected for the possible confondiment variable, of being affected by asthma is 1.3 with a 95% confidence interval of 1.1–1.5.

Moreover, restricting the investigation to children with smoking mother and children with a non-smoking mother, the logistic regression analysis produced very similar results for the variable 'air-proof doors and windows', OR = 1.40, CI = 1.0–1.9 and OR = 1.3, CI = 0.98–1.6, respectively. This results clearly indicated that the variable 'air-proof doors and windows' is a factor that increases the risk of developing asthma, independently of the environmental tobacco.

In conclusion, this study provides strong evidence that in houses lacking an efficient forced ventilation system, air-proof windows and doors have an adverse health effect. These fixtures, by reducing air exchange, and therefore increasing indoor air pollutants, cause a 30% increase in the probability for children to develop asthma.

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