

Association between environmental tobacco smoke exposure and wheezing disorders in Austrian preschool children

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Summary

Questions: Passive smoking is a problem in children and adults, but recent studies found the impact to be strongest in the developing foetus and the first years of life. In this cross sectional study we investigated the effect of environmental tobacco smoke (ETS) on atopic and wheezing disorders in Austrian preschool children.

Methods: 1737 Austrian preschool children participated in a cross sectional questionnaire survey about passive smoking and the impact on wheezy bronchitis, asthma, hay fever and atopic dermatitis.

Results: Up to 46% of the participating children were exposed to ETS at some stage in their life. Children of lower socioeconomic status were at exceptionally risk.

ETS exposure during pregnancy resulted in a significantly increased risk for wheezing in the first year of life (OR 1.6; 95% CI 1.0–2.6), wheez-

ing in the past 12 months (OR 1.5; 95% CI 1.0–2.4) and doctor diagnosed asthma (OR 2.1; 95% CI 1.0–4.1). Furthermore, breastfeeding and consumption of fruits and vegetables were less common in smoking families.

Conclusions: Our study confirms previous studies, that in particular prenatal ETS exposure is a risk factor for wheezing and asthma in preschool children. Despite this, children exposed to ETS also live a “less healthier life” in terms of breast feeding and antioxidant intake. In the light of recent studies reporting increased oxidative stress in children exposed to passive smoking, the low intake of fruits and vegetables is a further concern.

Key words: passive smoking; children; nutrition; wheezing; asthma; hay fever

Introduction

Environmental tobacco smoke (ETS) is a major risk factor for respiratory disease in children and the most important source of ETS exposure is within the home [1–4]. ETS exposure during pregnancy and the first years of life has been consistently found to have an impact on the respiratory system including symptoms such as wheezing, cough, bronchitis, RSV bronchiolitis, otitis media and asthma, but also on intrauterine growth, sudden infant death, behaviour and cognitive functioning [5, 6]. Studies, which have evaluated the impact of passive smoking, have found the impact to be strongest to the developing foetus and in the first years of life [7, 8].

There is increasing evidence that ETS exposure in utero and during early childhood is strongly associated with persistent wheezing and asthma [9], the results regarding atopy are some-

what conflicting [10–12]. Asthma and atopy have genetic determinants but genetic changes in populations would be too slow to cause the rapid change in prevalence noted over the past decades [13]. Instead, genetic predisposition and environmental exposure are thought to lead to the increase of these diseases, and ETS exposure is one of the factors amenable to interventions.

In this cross sectional study we investigated the effect of ETS exposure during pregnancy and early life on the prevalence of wheezing and atopic diseases (asthma, hay fever, atopic dermatitis) in Austrian preschool children taking into account age, sex, a family history of atopy, parental

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Abbreviations

ETS environmental tobacco smoke.

education, family size, pets, breast feeding and nutrition as potential confounders or effect modifiers.

Furthermore we wanted to identify paediatric subpopulations at increased risk for passive smoke exposure with the aim of primary prevention.

Methods

In Tyrol, a federal state of Austria, 17560 children are attending one of 435 kindergartens. In the first step we sought the agreement and support of the kindergarten authority of Tyrol. 100 kindergartens (n = 4109 children) were randomly selected for our survey. In a second step the kindergarten teachers were informed by a telephone call, asked for participation and subsequently the questionnaires posted to the participating kindergartens. The questionnaires were distributed by the kindergarten teachers to the parents and the parents directly returned the filled in questionnaires to our hospital in a stamped addressed envelope.

Symptoms of wheezing, hay fever and atopic dermatitis were reported by the parents using the ISAAC (International Study of Asthma and Allergies in Childhood) questionnaire [14]. The ISAAC questionnaire is a standardized, validated and internationally used questionnaire to assess the prevalence of wheezing, asthma, hay fever and atopic dermatitis in the community.

We further asked for doctor diagnosed asthma, hay fever and atopic dermatitis (Question: Have you ever been informed by a doctor that your child has asthma/hay fever/atopic dermatitis?)

Questions about ETS and some lifestyle factors were added. ETS exposure was evaluated by asking the following questions: Was your child exposed to passive smoking on a regular basis within the home during the past 12 months? Was your child exposed to passive smoking on a regular basis within the home during its first year of life? Did the mother smoke on a regular basis during pregnancy?

The study was approved by the local ethics committee and informed consent was obtained from all participating parents.

For analysis the children were categorised into the following groups: ETS exposure during pregnancy, ETS exposure during the first year of life, ETS exposure during the past 12 months.

Statistical analyses

Originally, it was planned to recruit 4000 children into this study in order to estimate prevalence of wheezing with a precision of less than $\pm 1.0\%$, assuming an expected prevalence of 10%. With the present sample size of 1737 children precision of estimate for the main outcome symptoms is reduced to approximately $\pm 1.5\%$.

Prevalence estimates were performed taking into account the two-stage cluster sampling process [15]. Effects of ETS exposure (during pregnancy, during the first year of life and during the past 12 months) on wheezing, asthma and atopic diseases were analysed using a survey logit regression model taking into account the complex survey design [16]. Selection of covariates for the logistic model was based on previously known clinical relevant associations. The same model was fitted for all outcomes and the three predictors of interest (ETS during pregnancy, ETS during the first year of life, ETS during the past 12 months), taking into account the following eligible confounding or effect modifying variables: age, sex, a family history of atopy, parental education, family size, growing up with pets, breast feeding >4 months and nutrition. Statistical analyses were carried out using STATA SE 9.0 for Windows.

Results

Of the 100 randomly selected kindergartens 98 kindergartens (n = 4109 children) agreed to participate. Participation rate of the parents within the kindergartens ranged from 12% to

100% (mean 47%) and data are available for 1737 children (42%). Table 1 gives the demographic data of the participating subjects. Comparing the educational level of our parents with data from the Austrian Statistical Authority revealed that participation rate in parents with the highest educational level being primary school was low accounting for only 11% of the data, representative for the middle classes and high in parents with a high school or university degree accounting for 43% of the data. The mean age of the cohort was 5.0 years (SD 0.8), 49% of the children were male.

Table 2 shows the estimated proportions of wheezing, atopic diseases and smoking habits of the population. Overall 25% of the children had had wheezing at sometime in their life. Wheezing in the first year of life was more common in boys than in girls (13% versus 6%) and boys had also suffered more wheezing in the past 12 months (16% versus 12%). Regarding doctor diagnosed asthma there was no difference between boys and girls (4% versus 2%).

Table 1

Demographic characteristics of the study participants, including known protective and risk factors from the literature.

descriptive parameters	n	(%)
total number of children	1737	(100)
male sex	847	(49)
family history of atopic disease	708	(41)
parental history of atopic disease	569	(33)
siblings	1421	(82)
family size >4 persons	471	(27)
grown up with pets	702	(40)
breast feeding >4 months	899	(52)
parental education: primary school	194	(11)
apprenticeship	501	(29)
vocational school	267	(15)
high school	520	(30)
university	218	(13)

Table 2

Estimated prevalence (%) and 95% confidence intervals (95% CI) of symptoms and environmental tobacco smoke exposure (ETS) in our sample.

	Estimated Proportion		
	%	(n)	95% CI
wheezing in the first year of life	9	(161/1717)	7.5-10.2
wheezing in the past 12 months	14	(240/1737)	10.9-15.2
asthma	3	(52/1683)	2.1-3.7
hay fever	7	(126/1691)	5.3-8.1
atopic dermatitis	12	(201/1687)	10.0-13.3
ETS during pregnancy	14	(239/1720)	11.7-16.0
ETS during the first year of life	17	(299/1714)	14.8-20.0
ETS during the past 12 months	20	(351/1717)	17.4-23.3

Having parents with an atopic disease increased the prevalence of wheezing in the past 12 months from 12% to 18%. A further increase to 29% was noted when the mother suffered from asthma, whereas paternal asthma did not influence the prevalence of childhood wheezing.

Depending on the educational status of the parents up to 45% of the participating children were exposed to ETS at some stage in their life, and educational level showed a direct relationship to the smoking habits of the parents. Children growing up in a family with the definitive education level being primary school were at highest risk to be exposed to ETS during all stages of their life, whereas children from parents with university degree were at lowest risk (fig. 1).

Odds ratios of wheezing, asthma, hay fever and atopic dermatitis in children with ETS exposure during pregnancy adjusted for sex, age, family history, education, family size, pets, breastfeeding and nutrition are presented in table 3. *ETS exposure during pregnancy* significantly increased the risk for wheezing in the first year of life, wheezing in the past 12 months and doctor diagnosed asthma. Additionally we noted a trend for doctor diagnosed hay fever, although not statistically significant. A positive family history for atopic disease was a significant risk factor for wheezing, doctor diagnosed asthma, hay fever and

atopic dermatitis. Female sex, greater family size and breastfeeding showed some protective features depending on the outcome variable.

ETS during the first year of life did not show any significant association with wheezing or atopic diseases: wheezing in the first year of life, OR 1.4 (95% CI 1.0-1.2, p = 0.076); wheezing in the past 12 months, OR 1.2 (95% CI 0.8-1.7); doctor diagnosed asthma, OR 1.5 (95% CI 0.7-3.1); doctor diagnosed hay fever, OR 1.2 (95% CI 0.6-2.1); doctor diagnosed atopic dermatitis, OR 1.0 (95% CI 0.6-1.7). The same was true for *ETS during the past 12 months*: wheezing in the past 12 months, OR 1.2 (95% CI 0.9-1.8); doctor diagnosed asthma, OR 1.2 (95% CI 0.5-2.3); doctor diagnosed hay fever, OR 1.4 (95% CI 0.8-2.3); doctor diagnosed atopic dermatitis, OR 1.1 (95% CI 0.7-1.7).

In addition to the smoking habits and as indicators for a more “healthy lifestyle”, we also evaluated breast feeding and nutrition. 10% of the children in non-smoking families were never breastfed versus 21% in smoking families and breast feeding duration was shorter (breast feeding >4 months: 58% in non smokers versus 40% in smokers). This effect was even more pronounced when the mother smoked during pregnancy (breastfeeding never: 29%, breastfeeding >4 months: 29%). Breastfeeding for more than 4 months resulted in a decreased risk for doctor diagnosed asthma, irrespectively whether the ETS exposure happened during pregnancy, OR 0.5 (95% CI 0.3-1.0); during the first year of life, OR 0.5 (95% CI 0.2-0.9) or during the past 12 months, OR 0.5 (95% CI 0.2-0.9).

Currently smoking families (smoking during the past 12 months) also practice a “less healthier nutrition”, they eat less fruits and vegetables, eat more fast food and pay less attention to “biological food”, although the latter was surprisingly high in both groups (fig. 2).

Figure 1

Percentage of parents smoking with regard to the highest parental educational level during several periods of life (pregnancy, first year of their child’s life, past 12 months), n = 1737.

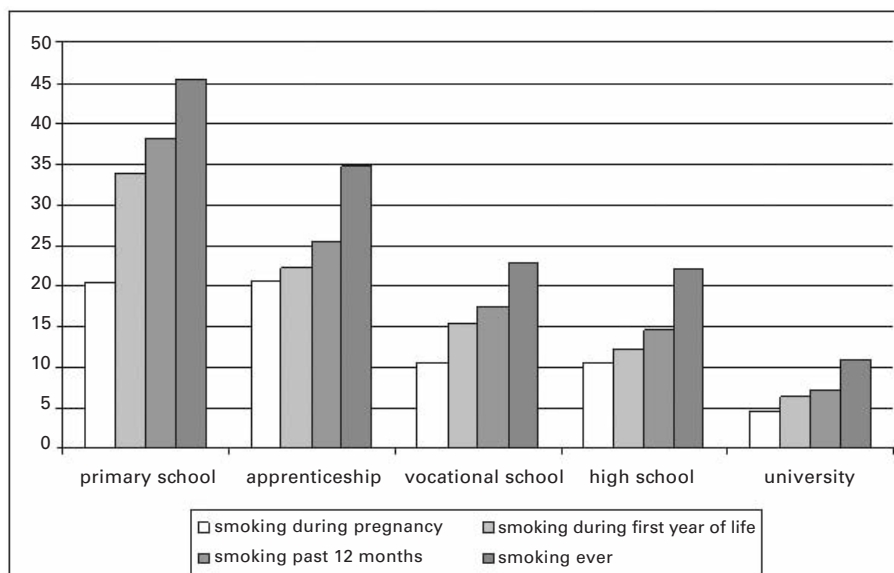


Table 3

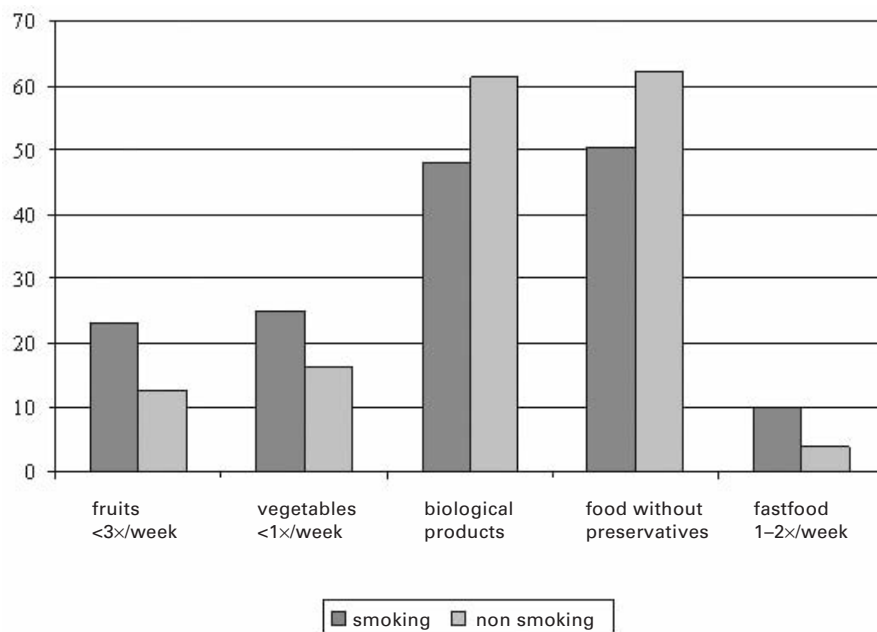
Associations (odds ratios (OR) and 95% confidence interval (95%CI) between sex, age, family history, education, family size, pets, breastfeeding, environmental tobacco smoke exposure during pregnancy and wheezing, asthma, hay fever and atopic dermatitis evaluated through the final survey logit models.

	wheezing in the first year of life OR (95% CI)	wheezing in the past 12 months OR (95% CI)	asthma OR (95% CI)	hay fever OR (95% CI)	atopic dermatitis
female sex	0.5 (0.3–0.7)**	0.7 (0.5–1.0)	0.8 (0.4–1.3)	0.5 (0.4–0.8)**	1.1 (0.8–1.6)
age	0.8 (0.7–1.0)	0.8 (0.6–0.9)*	1.2 (0.8–1.9)	1.1 (0.9–1.4)	0.9 (0.7–1.1)
family history of atopic disease	1.9 (1.3–2.9)**	1.8 (1.3–2.4)**	2.1 (1.1–3.9)*	3.2 (2.0–4.9)**	1.6 (1.2–2.3)**
higher education	0.8 (0.5–1.2)	1.1 (0.8–1.5)	0.6 (0.3–1.2)	0.7 (0.4–1.1)	1.1 (0.8–1.6)
family size >4 persons	0.9 (0.8–1.1)	0.8 (0.7–1.0)*	0.6 (0.4–0.9)*	0.6 (0.5–0.8)**	0.9 (0.8–1.1)
grown up with pets	1.2 (0.8–1.8)	1.0 (0.8–1.4)	1.4 (0.8–2.5)	0.9 (0.6–1.5)	0.9 (0.7–1.3)
breastfeeding >4 months	0.9 (0.6–1.3)	0.8 (0.6–1.1)	0.5 (0.3–1.0)*	1.2 (0.7–1.8)	0.9 (0.6–1.2)
healthy nutrition	1.0 (0.9–1.2)	1.1 (1.0–1.2)	1.2 (0.9–1.5)	1.1 (0.9–1.2)	1.0 (0.9–1.1)
ETS during pregnancy	1.6 (1.0–2.6)*	1.5 (1.0–2.4)*	2.1 (1.0–4.1)*	1.7 (0.9–3.2)	1.4 (0.8–2.2)

* p <0.05, ** p <0.01

Figure 2

Nutritional habits during the past 12 months in currently smoking (n = 351) and non-smoking (n = 1366) families.



Discussion

A wide variety of factors have been identified as risk factors for respiratory disease in childhood, prominent among these factors is ETS and the most important source of ETS exposure is within the home [17].

According to our study ETS exposure in Austrian children is a major concern. Up to 45% of the participating children were exposed to ETS at some stage in their life and up to 20% during pregnancy with the consequence of an increased risk for wheezing, asthma and hay fever. Our study confirms previous studies that ETS exposure is a risk factor for wheezing disorders and children of lower socioeconomic status are at exceptionally risk. In accordance with our data the SCARPOL study from Switzerland found almost half of all schoolchildren were exposed to ETS, especially those from lower socioeconomic classes, and that respiratory symptoms were significant more common in these children [18]. According to the literature ETS exposure also has a negative impact on

foetal growth, increases preterm delivery, affects lung function and causes chronic respiratory diseases [19–21]. All these harmful effects are preventable by ETS avoidance during pregnancy and childhood. There is now sufficient evidence concerning the adverse health effects of ETS to warrant active intervention to eliminate the exposure of children to ETS, and there is increasing support in many countries for smoking bans in public places to protect non-smokers [22–26].

In our study, children exposed to ETS also had to live a “less healthier life” in terms of breast feeding and nutrition. Breast feeding was less common and duration was shorter and later these children eat less fruit and vegetables. This tendency to unhealthy life style habits in smoking people is a well known phenomenon, supported by a large epidemiological study in adults which found current smokers to have the lowest dietary antioxidant intake – and the children usually adopt their parents’ nutrition habits [27].

In the light of recent studies regarding oxidative stress in children exposed to passive smoking, the low intake of fruit and vegetables is a further concern [28]. Exposure of non-smokers to environmental tobacco smoke results in increased oxidant damage linked to heart and respiratory diseases. In particular children who are exposed to passive smoking are exposed to oxidative stress. Recent published studies assessing the antioxidative status of plasma in infants and children showed that passive smoking had a negative impact on numerous parts of the antioxidant defence system [29, 30]. Contrariwise cross-sectional studies suggest that antioxidant vitamins, particularly vitamin C, have a beneficial effect on lung health. A large study by Harikkhan et al. in 4000 children concluded, that low vitamin C and alpha-carotene intakes are associated with asthma risk in children [31]. Consumption of fruit and vegetables reduces wheezing symptoms in children [32] and appears to have a beneficial effect on lung function [33], whereas frequent consumption of fast food is a risk factor for asthma and bronchial hyperreactivity [34]. These findings demonstrate the importance of fruit and vegetables and antioxidant vitamins such as vitamin C for antioxidant protection. Whether supplementation of vitamin C and other antioxidants should be recommended in subjects with additional oxidative stress challenge, such as exposure to high levels of air pollution, ie ETS is a matter of debate [35].

There are some limitations of this study. Firstly, although 98% of the randomly selected kindergartens agreed to participate, only 42% of the distributed questionnaires were returned. Participation rate in parents with the educational level of primary school was low and contrariwise very high in parents with a high school or university degree. Therefore our data may well underestimate the true prevalence regarding symptoms and ETS exposure. Secondly, the questionnaire

was not anonymous and therefore a possible bias cannot be excluded and thirdly, the lack of ETS quantification might have affected the results. It is difficult to quantify the dose of ETS that passive smokers inhale and from previous studies is known that the contribution of reports regarding cigarette consumption might not always be reliable and parents, in particular when questioned in conjunction with an illness of their children, tend to understate passive smoke exposure [36, 37]. Our Ethics Committee required informed consent from the participating parents and therefore anonymity was not possible. In this setting, we thought it is better to get a true "approximately" ETS answer than a false "number of cigarettes per day", but we are aware that the lack of quantification and the missing objective markers are a limitation of the study. Another reason for not asking in more detail was the retrospective design of the study, including the problem of recall bias, but we are convinced that parents remember reliably whether they smoked *on a regular basis* during pregnancy and the first year of their child.

In conclusion, all physicians caring for pregnant women and children need to increase their efforts to address ETS exposure. According to the present data we are twice challenged, targeting reduction of ETS exposure and targeting nutrition by encouraging breastfeeding and antioxidant intake (fruit and vegetables), in particular in families from lower socioeconomic classes.

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