Published in final edited form as:
Int J Pediatr Otorhinolaryngol. 2012 July ; 76(7): 989–993. doi:10.1016/j.ijporl.2012.03.017.

Relationship of environmental tobacco smoke to otitis media (OM) in children

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Abstract

Introduction—Many, but not all, studies have found a correlation between environmental tobacco smoke (ETS) and acute otitis media (AOM) and other adverse otologic outcomes. Given its high personal and societal costs and the divergent findings of the effect of ETS on middle ear disease, the aim of the current study was to assess the impact and possible determinant factors of ETS on recurrent (two or more) episodes of AOM.

Methods—The study was performed at Heim Pal Children's Hospital, Ear, Nose and Throat (ENT) Department, Budapest, Hungary. Caregivers of a convenience sample of 412 children attending the ENT outpatient clinic were surveyed via a 22-item questionnaire regarding demographics, socioeconomics, and smoking behaviours of the child's family; as well as caregivers' self report of the number of AOM episodes of the child.

Results—Of the 412 participants, 155 (38%) children's parents smoked. In bivariate analysis, two or more episodes of AOM correlated with reported hearing problems, day care enrolment, parental employment and increased age of the child. In multivariate logistic regression, parental smoking more than doubled a child's risk for recurrent AOM while increased maternal employment (e.g. part-time or full-time vs. unemployed) boosted risk up to fourfold. Among children whose parents smoked, half-packs of cigarettes smoked per day and day care attendance doubled or nearly tripled, respectively, the risk of recurrent AOM episodes.

Conclusions—Childhood exposure to ETS is high among an ENT clinic population of Hungarian children. Such exposure correlates with AOM episodes, ENT operations and conductive hearing loss. Data such as these argue for strict laws smoke-free laws not only in Hungary, but also in Europe and around the world.

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Conflict of interest statement: The authors declare no competing financial interests.

Keywords

children; environmental tobacco smoke; otitis media; secondhand smoke

Introduction

Otitis media (OM) is the most common disease of childhood, with 90 percent incidence in the first two years of life [1]. The etiology and pathogenesis of this disease is multifactorial, but its high incidence represents a major health problem associated with increased health care costs for society (over $5 billion annually in the US) [2]. These issues support research on and eventual elimination of modifiable risk factors potentially involved in the pathogenesis of OM.

Although numerous studies have established a relationship between environmental tobacco smoke (ETS) and the development of many pediatric otolaryngologic conditions—[3-10], including OM [3,4, 5,11,12]—other studies have not documented these findings [13-18]. Nonetheless, a causal relationship between exposure to cigarette smoke and middle ear disease is biologically plausible with investigations documenting ETS effects on middle ear histology [19], gene expression [20, 15], inflammation [21], and, recently, sensorineural hearing loss among non-smoking adults [22]. Alpert et al., in particular, found at the population level a decreased outpatient rate of paediatric visits for OM which was attributable to changes in household smoke-free policies as well at pneumococcal vaccination [3].

Given its high personal and societal costs [23] and the divergent findings of the effect of ETS on middle ear disease, the aim of the current study was to assess the impact and possible determinant factors of ETS on acute OM (AOM). Smoking prevalence among Hungarian adults was recently measured at 33.2% [24], and Hungary has a relatively high level of reported ETS exposure [25]. We report the results of a survey of 412 patients at a large paediatric otolaryngology clinic in Budapest, Hungary. While our results are local, these data have international implications regarding the effect of ETS on middle ear disease, and the need for further policy changes or enforcement of existing law in European countries such as Hungary.

Patients and method

The study was performed at Heim Pal Children's Hospital, Ear, Nose and Throat (ENT) Department, Budapest, Hungary during the 24-month period from January 2009 to December 2010. Heim Pal is the largest children's hospital in Hungary. Otolaryngology patients are referred here by general practice physicians (GPs) as well as other ENT departments from around the country. In addition to its national referral status, the clinic also provides primary ENT care for children, with many patients self-referring for diagnosis and treatment of otolaryngology problems.

A questionnaire was constructed for the parents or caregivers of children who presented at the ENT clinic with or without middle ear diseases. The questionnaire contained items addressing six main domains: a chief complaint of ear-problems (5 items); hearing-problems (2 items); smoking habits by caregivers and household members (6 items); maternal smoking during pregnancy (1 item); SES-socioeconomic status (3 items);, and maternal education (1 item). In constructing the questionnaire, risk factors for AOM and standardized questionnaire items concerning OM and assessment of ETS exposure from the medical literature were considered [4,26]. The institutional review board approved the protocol.

Inclusion criteria for this study comprised all children between 6 months and 18 years old presenting for their first visit, self-referred or referred by GPs to the ENT department, with or without middle ear problems. The survey addressed the main issue of AOM prevalence and ETS correlations, besides previous or prospective ENT operations (adenoidectomy, tonsillectomy and ventilation tube insertion) and conductive hearing problems due to MEE. All children underwent otorhinolaryngological examination performed by two ENT specialists at the clinic. An AOM episode was defined as a diagnosis by previous physician; or the history of severe earache and fever. Conductive hearing loss was confirmed by audiometry and tympanometry. Children referred by another ENT clinic with middle ear problems and those with sensorineural hearing loss or conductive hearing loss due to ossicular chain fixation were excluded. A non-random (convenience) sample was obtained during the time investigators (ZC, GK) worked in clinic. After obtaining adult informed consent, the questionnaire was administered to the parents or caregiver by trained research personnel. Three percent of eligible patients' parents or caregivers refused to participate.

Statistical analyses were performed on collected data using bivariate analysis and logistic regression. Bivariate analyses evaluated frequency of AOM infections by patient and household characteristics featured in Table 1 if $p<0.20$. In the logistic regression analysis, because we were interested in *recurrent* OM, the dependent variable was OM infection (none or one versus 2 or more). Logistic regression analyses were carried out in the whole sample as well as the subsample of patients whose parents smoked. All models controlled for patient age, gender, family socioeconomic status, and maternal education. Significance was set at $p<0.05$.

Results

A total of 412 subjects were recruited for the study. Parents/caregivers of twelve patients refused participation, yielding a sample of 412 subjects (97% participation rate). A total of 155 (37.6%) children had parents who smoked. Bivariate analysis in Table 1 reveals characteristics of children with one or no episodes of AOM. Parental smoking was not a significant predictor of AOM in the bivariate analysis ($p=0.14$). However, statistically significant correlates of AOM episodes included hearing problems noticed by parents or officially diagnosed (both $p<0.001$); day care enrolment ($p=001$); mother's employment ($p=0.02$); father's employment ($p=0.03$); and patient's age ($p<0.001$).

Logistic regression analyses are listed in Tables 2 and 3. Among all children (n=412), factors positively associated with two or more episodes of AOM infections included and parental smoking (Adjusted Odds ratio [AOR] 2.19, 95% confidence interval [95% CI] = 1.17-4.07); and mother's part time (AOR=3.77; 95% CI= 1.40-16.1) or full time (AOR=2.18, 95% CI=1.09-4.35) employment. (Table 2).

Among children whose parents smoked (n=155), maternal smoking during pregnancy was inversely associated with increased AOM episodes (AOR=0.29; 95% CI=0.085-0.047). Episodes of AOM was also associated with day care attendance (AOR=2.74, 95% CI=1.59-4.74). Increased half-packs of cigarettes smoked per day by parent(s) who smoked was borderline statistically significant (AOR=2.03; 95% CI=0.99-4.14).

Discussion

In the first study of its kind in Hungary, we have found that among children visiting an outpatient ENT clinic in Budapest, Hungary, parental smoking by one or both parents more than doubled the risk of recurrent AOM infections (none or one vs. 2 or more) and mother's employment status increased the risk of recurrent AOM infections up to nearly 4-fold (for

part-time employment). In addition, among the 155 children whose parents smoked, parental cigarettes smoked per day doubled the risk of AOM infections for each increase in half pack increments; and day care attendance nearly tripled this risk. Concerning cigarettes smoked per day, the borderline statistically significant data indicate that a child whose parent(s) was (were) a pack-a-day smoker (e.g., 2 half-pack increments) had a four-fold increase in AOM infections

It is not surprising that parental smoking predicted recurrent episodes of AOM. Alpert et al. [3] have documented that household smoking policies are associated with increased office visits for AOM at the population level. We have extended these findings to the individual level among ambulatory paediatric patients attending an otolaryngology clinic in Hungary.

The role of day care attendance has been documented in the development of respiratory illnesses as well as AOM [27]. Although we did not note this result among all 412 patients, our findings extend this risk factor to children of parents who smoke. On the other hand, mother's part time or full time employment did predict recurrent AOM infections up to nearly fourfold (for part-time employment) in these 412 patients. This might be a surrogate measurement of day attendance, since it would appear logical that mothers who work might be more likely to place their children in day care.

This study also uncovered a high prevalence of children exposed to ETS. One hundred fifty-five children had parents who smoked (37.6%). Additionally, 45.4% of children were exposed to a smoker at least once a week; and 25.5% of children were exposed to a smoker daily. We cannot explain the discrepancy between 37.6% of children having parents who smoked and 25.5% of children exposed to a smoker daily, but we suspect that smoking parents may underestimate how “exposed” their child is to parental second hand smoke. Indeed, reported smoking nearer the child (e.g., outside versus inside in another room or inside in the same room) negatively correlated with reported exposure of the child to ETS once a week (data not shown; correlation coefficient= -0.21; $p<0.01$) and reported exposure of the child to ETS one hour a day (data not shown; correlation coefficient= -0.13; $p<0.01$). This would imply under-reporting of a child's exposure to ETS by parents who smoked. While some evidence suggests under reporting of childhood exposure to parental tobacco smoke [28], other data suggest a moderate correlation [29], allowing researchers to generally trust what parents say about the second hand smoke exposure of their child. In addition, parents who smoked were more likely to believe that their smoking harmed their child if the mother smoked during pregnancy (data not shown; AOR 4.16, 95% CI=1.35-12.8) and if the child had asthma (data not shown; AOR=11.9, 95% CI=1.39-100.6). These findings show that smoking parents at least acknowledged some harm to their child from their smoking, making their self-reported smoking appear more reliable, even if their reported place of smoking may be less reliable.

Our findings on second hand smoke exposure (parental smoking = 37.6%) are somewhat lower than those of Boldo et al. [30]. Using a variety of databases, these investigators estimated ETS exposure among Hungarian children (0-14 years of age) ranging from 41 to 58% during the period 2002 – 2005. By comparison, Bulgaria had the highest estimated ETS rates (44-76%) while Sweden had the lowest (19−30%). Germany's rates were comparable to Hungary's (37-57%), as were Poland's (38-59%), Slovakia's (41-55%) and Croatia's (34-59%) [30]. The current study's findings are also somewhat less than those from the Central European Study on Air Pollution and Respiratory health (CESAR) [31, 32] in which Hungary had an estimated ETS exposure rate among children of 59%. Notably, in these studies, these levels of ETS exposure strongly correlated with respiratory symptoms. And finally, the current findings are nearly consistent with the reported 43% home ETS exposure rate obtained through the 2008 Global Youth Tobacco Survey of more than 3,000 13-15

year-old Hungarian schoolchildren, [33] although it should be noted that the mean age of the children in this study was approximately 6 years old.

This study is subject to a number of limitations. The first limitation deals with generalizability. The sample was non-randomly selected from an urban ENT clinic in a national referral hospital. Mitigating this limitation to some extent is the fact that only children who were referred by GPs—or who self-referred—were eligible to participate in the study. Moreover, the prevalence of ETS exposure among these children and of smoking during pregnancy generally matched those found in other studies carried out in Hungary [30-33]. This latter fact improves confidence that these data are representative of Hungary. Moreover, these results are also on par with smoking rates and childhood ETS exposure among other European nations, particularly those in Central and Eastern Europe. A second limitation is the study's reliance on self-report. Parents might be reluctant to reliably report a child's exposure to ETS, particularly in the setting of an ENT clinic where cigarette smoking is more likely to be perceived as harmful to the child. On the other hand, parents who smoked were willing to admit that their smoking harmed their child increasing our confidence in the self-reported data. The diagnosis of OM itself was also based on parental or caregiver report; however, report of OM by parents has been found to be valid by other investigators [34, 35]. In fact, misclassification likely biases toward the null [35], strengthening our findings. Additionally, this study did not determine the exact living situation of the children evaluated. Recent evidence suggests that even children without known ETS exposure can still show biochemical evidence of ETS exposure if they live in multi-unit housing flats [36]. It is possible that there was some misclassification of ETS exposure among the flat-dwelling children in this study due to drifting, “neighbour smoke” [37]. Such misclassification would again bias towards the null and strengthen these findings. Further, we did not ask about smoking of the child, which might be relevant, for example, among adolescents. Finally, biochemical validation of the children's exposure to ETS, such as urinary cotinine levels, would have greatly strengthened our findings.

Hungary has shown concern for childhood harm from ETS both at home and elsewhere. In 2001, Hovell reviewed clinical, legislative, media and other efforts undertaken by Hungary to address this problem [38]. He argued strongly for further research into “cultural tailoring [of interventions] needed to be effective in Hungary.” The results of our study further highlight this national need. Moreover, despite having adopted in 2005 and lately, in 2011 strong smoke-free policies covering various indoor public spaces, compliance with these laws in Hungary is inconsistent, even in hospital settings [39].

Given the many adverse health effects of second hand smoke, concern regarding childhood ETS exposure has also been global [40]. In 1999, the World Health Organization convened an International Consultation on Environmental Tobacco Smoke and Child Health, declaring that “that ETS is a real and substantial threat to child health, causing …a wide variety of adverse health effects in children, including…middle ear disease” among many other conditions [41]. Pattenden and colleagues, who reviewed European studies on the adverse health effects of ETS among children, including results from eastern and western Europe, confirmed adverse prenatal and post natal health effects in these populations and recognized that such exposure “needs to be reduced urgently”[42]. In this context, Dell'Orco et al. argue that childhood ETS exposure is “a specific community responsibility” for all of Europe [43]. In concert with the results of these and other analyses, this study highlights this global need.

Conclusion

The results support a relationship between the exposure of ETS and prevalence of recurrent AOM in children. An apparent dose response effect of ETS (e.g., increased risk with

increased parental half-packs smoked per day) on the frequency of AOM in children also supports this correlation. To prevent passive exposure of children to ETS and to support parents and caregivers to quit smoking are a public health priority.

Acknowledgments

This study was made possible by grant number 1 R01 TW007927-01 from the Fogarty International Center, the National Cancer Institute, and the National Institutes on Drug Abuse, within the National Institutes of Health.

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Table 1

Characteristics of children with none or one ear infection vs. two or more ear infections in an outpatient ENT clinic.

	Otitis Media Episodes		
Characteristic	**One or none**	**Two or more**	**p value**
Male gender	140	91	0.10
Parental Smokers	92	63	0.14
Hearing problems noted by caretakers			<0.001
No	220 (60.3%)	90 (60.8%)	
Yes	44 (39.7%)	58 (39.2%)	
Hearing problems officially diagnosed			<0.001
No	217 (82.2%)	94 (63.5%)	
Yes	47 (17.8%)	54 (36.5%)	
Residence			0.29
Budapest	154 (58.3%)	76 (51.4%)	
Rural	82 (31.1%)	50 (33.8%)	
Other	28 (10.6%)	22 (14.9%)	
Flat size			0.26
< 40 m^2	140 (53.0%)	87 (58.8%)	
41-70 m^2	101 (38.3%)	54 (36.5%)	
71 or more m^2	23 (8.7%)	7 (4.7%)	
Child exposed to a smoker at least one hour a week			0.30
No	139 (50.7%)	86 (58.1%)	
Yes	135 (49.3%)	62 (41.9%)	
Child exposed to smoker daily			0.95
No	197 (74.6%)	110 (74.3%)	
Yes	67 (25.4%)	38 (25.7%)	
Daycare enrollment			0.001
No	172 (65.2%)	72 (48.6%)	
Yes	92 (34.8%)	76 (51.4%)	
Mother's Employment			0.02
Unemployed	77 (29.2%)	28 (18.9%)	
Part-time	24 (9.1%)	23 (15.5%)	
Full-time	163 (61.7%)	97 (65.5%)	
Father's employment			0.03
Unemployed	35 (13.3%)	17 (10.8%)	
Part-time	8 (3.0%)	19 (12.0%)	

	Otitis Media Episodes		
Characteristic	**One or none**	**Two or more**	**p value**
Full-time	221 (83.7%)	122 (77.2%)	
Mother's education			0.70
Primary School	28 (10.6%)	14 (9.5%)	
Secondary School	118 (44.7%)	59 (39.9%)	
High School	96 (36.4%)	62 (41.9%)	
Other	22 (8.3%)	13 (8.8%)	
Mother smoking during pregnancy			0.18
None	224 (84.8%)	153 (92.2%)	
Any	40 (15.2%)	13 (7.8%)	
Individual answering questionnaire			0.96
Mother	215 (81.4%)	120 (81.1%)	
Father	39 (14.8%)	23 (15.5%)	
Other	10 (3.8%)	5 (3.4%)	
Median age in months	53	89	na
Mean age in months	60.8+40.3	92.5+40.2	<0.001

Table 2

Logistic regression analysis of predictors of none or one OM episode versus two or more OM episodes among all participants (n=412).

Characteristic	Adjusted Odds Ratio	95% Confidence Interval	p value
Parental smoking	2.19	1.17-4.07	0.014
Mothers employment			
Unemployed	Reference	*****	
Part-time	3.77	1.40-16.1	0.008
Full-time	2.18	1.09-4.35	0.027

Table 3

Logistic regression analysis of predictors of none or one OM episode versus two or more OM episodes among participants whose parents smoked (n=155).

Characteristic	Adjusted Odds Ratio	95% Confidence Interval	p value
Day care attendance	2.74	1.59-4.74	<0.001
Cigarettes smoked per day by household member (in half packs)	2.03	0.99-4.14	0.052