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Original Research Article

EFFECT OF HOUSEHOLD SMOKING ON THE DEVELOPMENT OF ACUTE OTITIS MEDIA IN CHILDREN BETWEEN THE AGES OF 6 TO 10 YEARS IN RURAL SOUTH INDIA

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Abstract

Background: Acute Otitis Media (AOM) is a leading cause of pediatric morbidity, particularly in low-resource settings. Household smoking has been identified as a significant risk factor for AOM, predisposing children to recurrent infections, increased healthcare utilization, and potential hearing loss. This study aims to evaluate the impact of secondhand smoke exposure on AOM development in children aged 6–10 years in rural South India. **Materials and Methods:** A case-control study was conducted over 12 months, enrolling 100 children (50 cases with household smoking exposure and 50 controls without exposure). Data collection involved structured interviews, otoscopic examinations, and pure tone audiometry (PTA) to assess hearing loss. Statistical analysis was performed using chi-square and t-tests, with a p-value < 0.05 considered significant. **Result:** Children exposed to household smoking had a significantly higher number of AOM episodes per year (4.5 ± 1.2 vs. 1.4 ± 0.2, $p < 0.001$), greater antibiotic use (3.8 ± 1.1 vs. 1.3 ± 0.1, $p < 0.001$), and more frequent hospital admissions (1.2 ± 0.5 vs. 0.0, $p < 0.001$). Hearing loss was notably higher in cases, with only 20% retaining normal hearing compared to 96% in controls ($p < 0.001$). **Conclusion:** Addressing household smoking as a modifiable risk factor may significantly reduce AOM burden and improve long-term hearing outcomes in children.

INTRODUCTION

Acute otitis media (AOM) is one of the most common childhood infections worldwide, particularly in low- and middle-income countries (LMICs), where it remains a significant cause of morbidity and healthcare utilization. Characterized by inflammation and infection of the middle ear, AOM often presents with symptoms such as ear pain, fever and hearing loss. In severe or recurrent cases, it can lead to complications like tympanic membrane perforation, chronic suppurative otitis media, and even permanent hearing impairment. Hearing loss, in turn, can adversely affect a child's speech, language development, academic performance and overall quality of life. Despite advances in healthcare, AOM continues to pose a substantial burden on families and healthcare systems, especially in resource-limited settings like rural South India.

Environmental factors play a critical role in the development and recurrence of AOM. Among these, exposure to household smoking has emerged as a significant risk factor. Secondhand smoke contains numerous toxic chemicals that can impair the respiratory epithelium, reduce mucociliary clearance, and promote inflammation in the upper respiratory tract. These effects can lead to Eustachian tube dysfunction, creating an environment conducive to bacterial colonization and middle ear infections. Children in whom the immune systems and anatomical structures are still developing are particularly vulnerable to the harmful effects of secondhand smoke. AOM is the most common type of ear infection among children. With roughly 13.6 million visits per year worldwide, it is the second most common childhood illness after upper respiratory tract viral infections and a major reason for pediatric consultations.[1,2] According to research, more than 80% of children get AOM more than once before they turn three,[3] making it the main reason preverbal-aged kids get antibiotic prescriptions.[4] Conductive hearing loss, otalgia, sleep disorders, appetite loss and behavioral problems are all possible outcomes of Otitis Media. The quality of life for impacted children and their families may be greatly impacted by these symptoms, which may

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subsequently hinder the development of speech, language, balance, and learning abilities.[5] In the US, the estimated yearly direct medical cost of OM is $4.04 billion.[6] Sophia et al from Tamil Nadu showed a prevalence rate of 8.6% of AOM in school going kids which was almost half of what it was a decade earlier.[7] The primary objective of this study is to investigate the effect of household smoking on the development of AOM in children aged 6–10 years in rural South India and it's impact on hearing threshold. By comparing children exposed to household smoking (cases) with those who are not exposed (controls), we aim to determine the extent to which secondhand smoke contributes to the incidence and severity of AOM. Additionally, we seek to explore the clinical outcomes associated with AOM, such as the frequency of episodes, antibiotic use, hospital admissions, and hearing loss, to provide a comprehensive understanding of the disease burden in this population.

MATERIALS AND METHODS

Study Design: This is a case-control study conducted over 12 months in rural South India. The study population included children aged 6–10 years attending primary healthcare centers or schools. Participants are divided into two groups: cases (with household smoking exposure) and controls (no household smoking exposure). A sample size of 100 children (50 cases and 50 controls) was determined to achieve adequate statistical power.

Data Collection: Data was collected through structured interviews, clinical examinations and audiometric testing. Parents/guardians provided information on household smoking, AOM episodes, antibiotic use, and hospital admissions. Clinical diagnosis of AOM was confirmed by otoscopic examination. Pure tone audiometry (PTA) was performed to assess hearing loss, which was graded as normal (≤25 dB), mild (26–40 dB), moderate (41–60 dB), or severe/profound (>60 dB). Data were recorded in a standardized format and entered into a secure database.

Data Analysis: Data were analyzed using statistical software (SPSS or R). Descriptive statistics were used to summarize demographic and clinical variables. Chi-square tests and t-tests were used to compare categorical and continuous variables, respectively, between cases and controls. A p-value < 0.05 was considered statistically significant. Multivariate logistic regression was performed to adjust for potential confounders, such as age, gender, and socioeconomic status.

Inclusion Criteria

- Children aged 6–10 years with a clinical diagnosis of AOM.
- History of household smoking exposure (at least one smoker in the household) for cases and no smoking exposure for controls.
- Willingness of parents/guardians to provide informed consent.

Exclusion Criteria

- Children with congenital hearing loss or other ear abnormalities.
- Children with chronic systemic illnesses (e.g., immunodeficiency, cystic fibrosis).
- Children with a history of tympanostomy tube placement or ear surgery.
- Refusal to participate or incomplete data.
- Children with Chronic Suppurative Otitis Media (CSOM) of any type and Chronic Adenotonsillitis.

Ethical Considerations

The study protocol was approved by the Institutional Ethics Committee. Written informed consent was obtained from parents/guardians. Participation was voluntary, and confidentiality of data was maintained.

RESULTS

The age and gender distribution between cases and controls showed no significant difference, indicating comparability between the groups. However, household smoking exposure was present in all cases (100%) and absent in controls (0%), with a highly significant p-value (<0.001), confirming its role as a key differentiating factor. 86% of the fathers were smokers in the case group with 32% of mothers smoking too. Among others, the most smokers found were the brothers of the father which accounted for 38% of the others smoking apart from mother and father. Children exposed to household smoking in cases experienced significantly more AOM episodes (4.5 ± 1.2 vs. 1.4 ± 0.2, $p < 0.001$), required more frequent antibiotic use (3.8 ± 1.1 vs. 1.3 ± 0.1, $p < 0.001$), and had higher hospital admission rates (1.2 ± 0.5 vs. 0.0 ± 0.0, $p < 0.001$) compared to controls. These findings highlight the substantial impact of household smoking on disease severity and healthcare burden. None of the children in the control group had a hospital admission for the same. Hearing loss was significantly higher in cases, with only 20% having normal hearing compared to 96% in controls. Mild (40%), moderate (30%), and severe (10%) hearing loss were significantly more common in cases, indicating a strong link between AOM due to household smoking and auditory impairment.

Table 1: Demographic Data.

Variable	Cases (n=50)	Controls (n=50)	p-value
Age (years)	8.2 ± 1.3	8.1 ± 1.4	0.72 (NS)
Gender (Male:Female)	28:22	26:24	0.84 (NS)
Household Smoking	50 (100%)	0 (0%)	<0.001*

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Variable	Cases (n=50)	Controls (n=50)	p-value
Smoker at home (Father|Mother|Others)	43|16|58	0|0|0	<0.001*

Table 2: Clinical Outcomes

Variable	Cases (n=50)	Controls (n=50)	p-value
Number of AOM Episodes (times/year)	4.5 ± 1.2	1.4 ± 0.2	<0.001*
Antibiotic Use (times/year)	3.8 ± 1.1	1.3 ± 0.1	<0.001*
Hospital Admissions (times/year)	1.2 ± 0.5	0.0 ± 0.0	<0.001*

Table 3: Pure Tone Audiometry Results

Hearing Loss Grade	Cases (n=50)	Controls (n=50)	p-value
Normal (≤25 dB)	10 (20%)	48 (96%)	<0.001*
Mild (26–40 dB)	20 (40%)	2 (4%)	<0.001*
Moderate (41–60 dB)	15 (30%)	0 (0%)	<0.001*
Severe (61-80 dB)	5 (10%)	0 (0%)	0.02*
Profound (>80 dB)	0 (0%)	0 (0%)	-

DISCUSSION

Our study reveals a strong association between household smoking and increased incidence of AOM in children between 6-10 years. The exposed group had significantly more AOM episodes per year, hearing loss, greater severity of infections, and higher antibiotic use compared to the control group.

Cases required more frequent antibiotic use and had a higher rate of hospital admissions compared to controls in our present study. This indicates that AOM in children exposed to household smoking tends to be more severe and recurrent, necessitating medical intervention. The increased use of antibiotics raises concerns about antimicrobial resistance, a growing public health challenge in LMICs. Hospital admissions further strain already limited healthcare resources in rural areas. The study conducted by Charu et al,[8] involved 160 children, with 87 (54.4%) being male and 73 (45.6%) females. Among these children, 30 (18.8%) presented with ear-related complaints at the outpatient department, while 50 (31.2%) caregivers reported a history of ear issues in their children. The most frequently reported complaints included foreign body in the ear (14.37%), hearing loss (11.24%), and ear discharge (5.62%). The study found no significant association between the occurrence of ear complaints and factors such as the child's age, gender, or the educational level of the caregivers.

In our study, Audiometric testing showed a significantly higher prevalence of hearing loss among children exposed to household smoking. Only 20% of cases had normal hearing compared to 96% in controls ($p < 0.001$), with mild, moderate, and severe hearing loss being more frequent in cases. Moderate hearing loss (30%) and severe hearing loss (10%) were absent in controls**,** highlighting the impact of secondhand smoke. These findings emphasize the need for early detection and intervention to prevent long-term effects on speech, language, and cognitive development.

A study in 2012 by Jones et al. concluded that the pooled OR for any Middle Ear Disease (MED) was 1.62 (95% CI: 1.33–1.97), indicating a 62% higher risk in children exposed to parental smoking. They also concluded that children exposed to parental smoking had a 37% higher risk of AOM (OR: 1.37; 95% CI: 1.10–1.71). This can explain that smoking effects on middle ear was not just limited to AOM. This is concurrent to our study too.[9]

The study by Strachan and Cook,[10] conducted a systematic review of epidemiological studies and found that children exposed to parental smoking had a significantly increased risk of developing MED, especially AOM. The pooled OR for AOM in children exposed to parental smoking was 1.48 (95% confidence interval [CI]: 1.32–1.65), indicating a 48% higher risk compared to unexposed children. Additionally, the study found that children exposed to secondhand smoke were more likely to undergo adenotonsillectomy, with a pooled OR of 1.34 (95% CI: 1.18–1.52).

In a study conducted by Ilicali et al,[11] passive smoking was identified as a major risk factor for Otitis Media with Effusion (OME) and Recurrent Otitis Media (ROM). The case group had a higher exposure to cigarette smoke, averaging 19.6 cigarettes per day, compared to 14.4 cigarettes per day in the control group **(**$p < 0.004$). Maternal smoking was the only significant contributor **(**$p < 0.001$**)**, while no correlation was observed with paternal smoking. A prospective follow-up of the case group revealed no significant difference in the progression of OME and ROM between children exposed to maternal smoking and those who were not.

A study by Zhou et al,[12] found that healthcare visits and antibiotic prescriptions for acute otitis media (AOM) in privately insured young children declined more than expected after the introduction of routine 7-valent pneumococcal conjugate vaccine (PCV7) immunization**.** While factors like clinical guidelines promoting reduced antibiotic use may have influenced this trend, PCV7 likely played a key role in lowering AOM incidence**,** leading to significant reductions in medical costs.

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CONCLUSION

Our research provides compelling evidence of the harmful effects of household smoking on children's ear health and overall well-being. Addressing secondhand smoke exposure as a preventable risk factor can significantly reduce the incidence of AOM, improve hearing outcomes, and enhance the quality of life for children and their families in rural South India. Future efforts should focus on implementing targeted interventions and providing evidence-based resources to support parents in managing and preventing AOM in their children.

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