Thorac Res Pract. DOI: 10.4274/ThoracResPract.2025.2025-8-2

Original Article

Household Tobacco Smoke Exposure in Asthmatic Children in Algeria: A Multicenter Study

Redouene Sid Ahmed Benazzouz[1], Massinissa Benyagoub[1], Azeddine Mekideche[2], Mohamed Safouane Benazzouz[3,4], Faiza Hadjersi[5]

[1]Department of Medicine, Faculty of Medicine, Laghouat University, Laghouat, Algeria
[2]Private Pulmonology Medical Office (Dr. Azzeddine Mekideche), Jijel, Algeria
[3]Department of Therapeutic Serum Production, Pasteur Institute of Algeria, Algiers, Algeria
[4]Department of Pharmacy, Faculty of Pharmacy, University of Algiers, Algiers, Algeria
[5]Department of Medicine, Laghouat Public Hospital, Laghouat, Algeria

Cite this article as: Benazzouz RSA, Benyagoub M, Mekideche A, Benazzouz MS, Hadjersi F. Household tobacco smoke exposure in asthmatic children in Algeria: a multicenter study. *Thorac Res Pract.* [Epub Ahead of Print]

Abstract

OBJECTIVE: Passive and active tobacco smoke exposure can worsen asthma outcomes in children, yet data on its prevalence in Algeria are limited. To assess the prevalence and characteristics of tobacco smoke exposure, including prenatal and adolescent active smoking, among asthmatic children in Algeria.

MATERIAL AND METHODS: A multicenter cross-sectional study was conducted from December 1, 2024, to January 31, 2025, in five pediatric consultation centers across Algeria. A total of 135 children with physician-diagnosed asthma, aged 2 months to 15 years, were enrolled. Data on demographic, clinical, socioeconomic, and environmental factors were collected.

RESULTS: Tobacco smoke exposure was documented in 37.8% of participants, most commonly attributable to paternal smoking. In utero exposure was reported in 40% of the study population. Low-income households showed a higher prevalence of exposure compared with higher-income groups (P = 0.009). The geographic distribution of exposure varied significantly (P = 0.001). No significant association was found between tobacco smoke exposure and asthma severity or asthma control. Three adolescent patients reported active smoking.

CONCLUSION: Over one-third of Algerian children with asthma are exposed to tobacco smoke, with a substantial proportion exposed prenatally. These findings highlight the need for family-focused cessation programs and region-specific preventive actions to reduce children's exposure to tobacco smoke in Algeria.

KEYWORDS: Asthma, passive smoking, prenatal tobacco exposure, health disparities, Algeria

Received: 11.08.2025 ***Revision Requested:*** 23.09.2025 ***Last Revision Received:*** 16.11.2025
Accepted: 01.12.2025 ***Epub:*** 28.01.2026

INTRODUCTION

Asthma is one of the most common chronic diseases in children worldwide, with prevalence estimates ranging from 5% to 20% depending on the region.[1] Environmental factors play a key role in its onset and progression, and tobacco smoke remains one of the most important and preventable contributors.[2,3] Exposure to passive smoke, whether during pregnancy, in early childhood, or through ongoing household smoking, has consistently been linked to increased respiratory symptoms, reduced treatment efficacy, and higher morbidity among children with asthma.[4-6]

The impact of early-life exposure is particularly well established. A systematic review and meta-analysis by Burke et al.[7] demonstrated that prenatal maternal smoking increased the risk of incident asthma in children ≤2 years of age by 85% [odds ratio (OR): 1.85, 95% confidence interval (CI): 1.35–2.53], whereas postnatal maternal smoking increased the risk of wheezing in the same age group by 70% (OR: 1.70, 95% CI: 1.24–2.35).

In Algeria, tobacco smoking remains a significant public health issue: adult smoking prevalence is estimated at 15.6%, reaching 30.2% among men and just 0.6% among women, with tobacco-related mortality contributing to

Corresponding author: Prof. Assoc. Redouene Sid Ahmed Benazzouz, e-mail: r.benazzouz@lagh-univ.dz

approximately 8.4% of all deaths.[8] Despite the high prevalence of tobacco use in Algeria, multicenter data describing the prevalence and patterns of household tobacco smoke exposure among asthmatic children are lacking. In particular, national evidence on prenatal exposure, parental smoking patterns, and socioeconomic and geographic disparities is limited.

This multicenter study primarily aimed to describe the prevalence and characteristics of household tobacco smoke exposure among asthmatic children in Algeria, including prenatal, early-life, and current passive exposure. Secondary objectives were to examine parental smoking behavior and to explore sociodemographic and geographic variations in exposure.

MATERIAL AND METHODS

Study Design and Setting

This was a prospective, multicenter, cross-sectional study conducted over two months, from 1 December 2024 to 31 January 2025. It took place in five pediatric outpatient respiratory consultation centers located in different regions of Algeria, specifically in the cities of Laghouat, Djelfa, Blida, Algiers, and Jijel. The five participating centers were selected to ensure geographic and socioeconomic diversity across Algeria, representing the capital coastal metropolis (Algiers), an inland urban center (Blida), a coastal province (Jijel), a high-plateau region (Djelfa), and a semi-arid southern region (Laghouat). All centers host specialized pulmonology consultation units staffed by qualified personnel and sufficient patient volume to support standardized, multicenter data collection. The pulmonologists responsible for each site shared a common postgraduate training in respiratory medicine, ensuring consistency in diagnostic and clinical assessment practices across centres.

Study Population

The study included all children under 18 years of age who had a confirmed diagnosis of asthma and attended routine outpatient consultations during the study period. Asthma was diagnosed by a pneumologist specializing in respiratory diseases, in accordance with the 2024 Global Initiative for Asthma (GINA) guidelines,[9] based on clinical symptoms such as recurrent wheezing, dyspnea, nocturnal cough, and bronchodilator responsiveness, and/or on spirometric evidence of reversible airway obstruction.

Main Points

- This is the first multicenter study assessing household tobacco smoke exposure in asthmatic children in Algeria.
- More than one-third of Algerian children with asthma are exposed to secondhand smoke.
- Prenatal exposure to tobacco smoke was reported in 40% of the study population.
- Tobacco smoke exposure was more prevalent in socioeconomically disadvantaged households.
- Exposure rates varied significantly across geographic regions in Algeria.

Asthma severity was determined retrospectively according to the GINA 2024 classification, based on the treatment level required to achieve and maintain control (steps 1–5). Mild asthma corresponded to steps 1–2, moderate asthma to step 3, and severe asthma to steps 4–5.

Children with comorbid chronic respiratory conditions, including cystic fibrosis and bronchopulmonary dysplasia, as well as those with incomplete medical records, were excluded. Cases of active smoking in children were identified and documented, but were excluded from the final analysis. The overall recruitment and selection process is summarized in Figure 1.

Data Collection

After obtaining informed consent from the parents or legal guardians, the attending physician collected data using a standardized, structured questionnaire administered in person. The questionnaire included variables related to demographic characteristics (age, sex, region of residence), asthma-related clinical history (age of onset, severity, current treatment, and previous exacerbations), tobacco smoke exposure, smoking behavior of both parents, and household socioeconomic status.

Assessment of Tobacco Smoke Exposure

Tobacco smoke exposure was assessed through parental report. Passive smoking exposure was defined as the presence of one or more household members actively smoking inside the home, regardless of frequency. In utero, or prenatal, exposure refers to maternal smoking during pregnancy, whether active or resulting from significant passive exposure to tobacco smoke. Early-life exposure was defined as household smoking during the child's early years. Active smoking was recorded when children, particularly adolescents, reported smoking more than 100 cigarettes. These individuals were excluded from the analysis.

The smoking habits of both parents were systematically documented, including current smoking status and typical patterns of consumption and exposure within the household.

Socioeconomic Status Classification

Socioeconomic status was assessed subjectively by the attending physician based on an overall impression that integrated

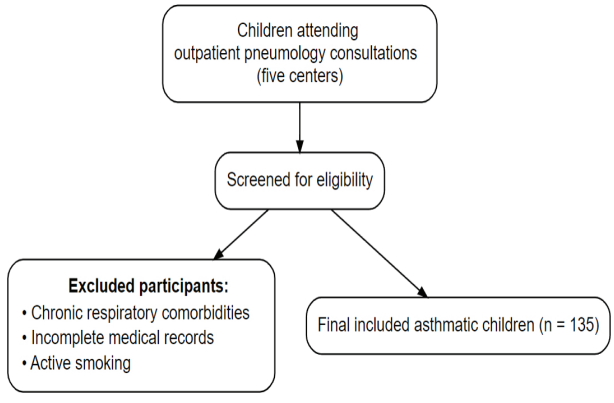

Figure 1. Flow diagram of patient recruitment and inclusion process

several observable and reported indicators, including estimated family income relative to the national average net income in Algeria (approximately 42,800 DZD per month according to the 2021 ONS report),[10] stability of parental occupation, education level, housing conditions, type of schooling (public or private), and social security coverage. Reported financial difficulties or limited access to healthcare were also considered. The evaluation followed a descending logic, in which the accumulation of indicators suggesting financial limitations led to classification into a lower socioeconomic category. No single factor was used as a determinant. Socioeconomic status was then categorized into three levels: low, middle, and high.

Ethical Considerations

The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ethics Committee of the Laghouat University Faculty of Medicine (protocol no. 13/2024; decision date: 20 November 2024). Written informed consent was obtained from the parents or legal guardians of all participants. All data were anonymized prior to analysis and stored in a secure, password-protected database.

Statistical Analysis

Data entry and analysis were performed using R Project for Statistical Computing, version 4.5.1 (R Foundation for Statistical Computing, Vienna, Austria). Categorical variables were presented as frequencies and percentages, and continuous variables as medians with interquartile ranges (IQR). The prevalence of passive smoking exposure was calculated with 95% CIs. Differences in the distribution of tobacco smoke exposure across sociodemographic and clinical variables were examined using the chi-square test or Fisher's exact test for categorical variables, and the Mann-Whitney U test for continuous variables. A *P* value less than 0.05 was considered statistically significant.

RESULTS

A total of 135 children with physician-diagnosed asthma were included in the analysis. The participants ranged in age from 2 months to 15 years, with a median age of 7.0 years (IQR: 4.0–9.0). Males accounted for 55.6% of the sample. The median age of fathers was 40.0 years (IQR: 37.0–44.0), and that of mothers was 37.0 years (IQR: 32.0–40.0) (Table 1).

Table 1. Baseline characteristics of the study population according to smoke exposure

	Study population	Smoke exposure	No smoke exposure	*P*
Total (%)	135 (100.0)	51 (37.8)	84 (62.2)	
Age[a]	7.0 [4.0, 9.0]	7.0 [4.0, 9.0]	7.0 [4.0, 9.0]	0.523
Paternal age[a]	40.0 [37.0, 44.0]	40.0 [38.0, 45.5]	40.0 [37.0, 44.0]	0.464
Maternal age[a]	37.0 [32.0, 40.0]	37.0 [31.5, 40.0]	36.0 [32.0, 40.0]	0.994
Male (%)	75 (55.56)	29 (56.86)	46 (54.76)	0.953
Asthma severity (%)				
Step 1	32 (24.43)	10 (19.61)	22 (27.50)	
Step 2	29 (22.14)	15 (29.41)	14 (17.50)	
Step 3	63 (48.09)	24 (47.06)	39 (48.75)	0.373
Step 4	7 (5.34)	2 (3.92)	5 (6.25)	
Step 5	0 (0.00)	0 (0.00)	0 (0.00)	
Asthma control (%)				
Well controlled	68 (50.37)	29 (56.86)	39 (46.43)	
Partly controlled	37 (27.41)	9 (17.65)	28 (33.33)	0.140
Uncontrolled	30 (22.22)	13 (25.49)	17 (20.24)	
Socioeconomic level (%)				
Low-income	27 (20.00)	16 (31.37)	11 (13.10)	
Middle-income	50 (37.04)	12 (23.53)	38 (45.24)	**0.009**
High-income	58 (42.96)	23 (45.10)	35 (41.67)	
Geographic location (%)				
Blida	8 (5.93)	3 (5.88)	5 (5.95)	
Jijel	72 (53.33)	22 (43.14)	50 (59.52)	
Djelfa	40 (29.63)	25 (49.02)	15 (17.86)	**0.001**
Laghouat	4 (2.96)	0 (0.00)	4 (4.76)	
Algiers	11 (8.15)	1 (1.96)	10 (11.90)	

[a]Results expressed as median [interquartile range]. Asthma severity and control levels according to GINA criteria[9]
GINA: Global Initiative for Asthma

Overall, 51 children [37.8% (95% CI: 29.6–45.9)] were exposed to passive tobacco smoke at home. Exposure was strongly associated with socioeconomic status: approximately 60% of low-income households reported exposure, compared with 24% of middle-income households and 40% of high-income households ($P = 0.009$).

No statistically significant differences were observed with respect to the child's sex ($P = 0.953$), the child's age ($P = 0.523$), or the age of either parent ($P = 0.464$ and $P = 0.994$ for fathers and mothers, respectively). The distribution of asthma severity and control status did not differ significantly between children with and without current passive exposure.

Geographic Disparities

Marked differences were observed between cities. Djelfa exhibited the highest prevalence of exposure (62.5%), whereas all other locations reported prevalences below 50%. This difference was statistically significant ($P = 0.001$).

Sources and Timing of Exposure

Regarding parental smoking, 41.5% of fathers and 1.5% of mothers reported current smoking. Prenatal exposure was reported in 40% of participants, and early-life exposure (during the first year of life) was reported in a similar proportion.

The median number of cigarettes smoked per day by fathers was 20 (IQR: 20–30), consistent with that reported by the two smoking mothers. Among fathers, 4.6% reported quitting smoking, with a median duration of smoking cessation of 10 years (IQR: 4.75–13.75).

Three adolescents reported active smoking (≥100 cigarettes in their lifetime) and were excluded from the main analysis.

DISCUSSION

More than one in three asthmatic children in our multicenter Algerian cohort were exposed to tobacco smoke at home, and approximately 40% had been exposed prenatally or during early life. Exposure levels varied significantly across socioeconomic groups and geographic regions. These findings provide one of the first multicenter estimates of household tobacco smoke exposure among asthmatic children in Algeria.

Prevalence in the Context of Existing Literature

Our prevalence (37.8%) is lower than the 53.3% prevalence reported by Tamim et al.[11] in Beirut in 2006 among preschool children. Some countries have reported a gradual decline in children's exposure over recent decades.[12] Algerian data on this topic remain scarce.

A single-centre study from Annaba, Eastern Algeria, reported passive smoke exposure in about one-third of asthmatic children.[13] This figure is consistent with our multicentre findings, but its representativeness is limited by the study's localized scope and lack of socioeconomic stratification.

According to the most recent World Health Organization country profile, adult smoking prevalence in Algeria remains around 15–16% overall (about 30% in men and 1% in women), with no clear downward trend documented over the past two decades.[8] In our cohort, the proportion of smoking fathers (41.5%) was considerably higher than the national average for males, whereas maternal smoking (1.5%) slightly exceeded the national estimate.[8]

Our participants were recruited from outpatient pediatric respiratory clinics rather than from hospital wards, which makes this sample broadly representative of community-based asthma care in Algeria. The higher prevalence of parental smoking in our cohort, particularly among fathers, aligns with international evidence linking parental smoking to the onset and exacerbation of childhood asthma.[4,7] However, causality cannot be inferred from this cross-sectional observation, and further population-based studies are warranted to confirm whether elevated parental smoking rates are a contributing factor or simply reflect shared socio-environmental conditions.

Lack of Sex and Age Differences

Contrary to the findings of Murray and Morrison[14], who reported greater susceptibility to passive smoking among boys and older children, our study did not reveal significant differences by sex or age. This absence of differences may indicate that the overall exposure levels in our sample were sufficient to produce similar effects across demographic subgroups. It is also possible that our design, which did not include objective physiological measurements such as bronchial hyperresponsiveness or airway inflammatory markers, was not sensitive enough to detect subtle sex- or age-related variations in response to passive smoke exposure.

Prenatal and Early-life Exposure

The persistence of high prenatal (40%) and early-life (40%) exposures is of concern, given the robust evidence linking these exposures to respiratory morbidity. The meta-analysis by Burke et al.[7] showed that prenatal maternal smoking increases asthma risk by up to 85% in children aged ≤2 years (OR: 1.85, 95% CI: 1.35–2.53), while postnatal maternal smoking increases the risk of wheezing by up to 70%. Mechanistically, prenatal exposure may impair fetal lung development via nicotine-induced alterations in airway structure and immune function.[15]

Socioeconomic and Geographic Disparities

The higher prevalence of passive smoking exposure among low-income families in our study mirrors the social gradient reported in other countries.[16,17]

The higher prevalence of passive smoking exposure among low-income families in our study reflects the patterns observed in the United Kingdom and Bangladesh, where children from lower socioeconomic backgrounds are disproportionately affected.[16,17] Similar mechanisms are likely at play in Algeria, where socioeconomic disparities may influence household crowding, parental awareness, and adherence to smoke-free home recommendations.

The markedly higher exposure in Djelfa may reflect regional variation, but the reasons for this difference remain to be clarified. No prior data from Algeria have examined regional patterns of household exposure to tobacco.

Study Limitations

This cross-sectional design precludes causal inference, and exposure assessment relied on parental self-report, which may have led to underestimation of prevalence. No biomarker validation was performed. The study included all eligible cases during the two-month multicenter collection period, which limited sample size and may have reduced statistical power, particularly given the unequal distribution of participants across centers. Finally, contextual factors, such as the time children spent at home or outdoors, were not recorded, which could have led to misestimation of exposure.

Policy and Research Implications

Our findings highlight the need for targeted health promotion campaigns, especially in high-prevalence regions and low-income households. Interventions should prioritize smoking cessation among fathers, who are the main household source of exposure, and integrate counselling on tobacco risks during prenatal and early-life visits. Region-specific awareness programs, particularly in areas such as Djelfa, could further strengthen prevention.

Future studies could integrate biomarkers such as cotinine to quantify exposure and assess its longitudinal impact on asthma control.

CONCLUSION

In this multicenter study of 135 asthmatic children in Algeria, more than one-third (37.8%) were currently exposed to household tobacco smoke, with prenatal and early-life exposures were each reported in 40% of cases. Paternal smoking was the predominant household source, and exposure was significantly more frequent in low-income families and in certain geographic regions.

Although asthma severity did not differ significantly between children with and without current passive exposure, the high rates of prenatal and early-life exposure underscore a substantial, preventable risk to pediatric respiratory health. These findings emphasize the urgent need for targeted public health actions—particularly smoking cessation programs for fathers, prenatal smoking counseling, and implementation of smoke-free home environments.

Reducing household tobacco exposure must now become a national priority within Algeria's child and maternal health agenda, combining clinical counselling, media-based awareness, and community-level prevention programs. Future research should include objective biomarkers of exposure and longitudinal tracking to better evaluate effects of exposure on asthma progression.

Ethics

Ethics Committee Approval: The study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Ethics Committee of the Laghouat University Faculty of Medicine (protocol no. 13/2024; decision date: 20 November 2024).

Informed Consent: Written informed consent was obtained from the parents or legal guardians of all participants.

Acknowledgements

The authors would like to express their gratitude to A. Cheddad, M. Hamidate, S. Akroun, and Y. Amazit for their valuable assistance in data collection and field coordination. Their contribution was essential to the successful completion of this study. They did not receive any financial compensation for their involvement.

Footnotes

Authorship Contributions

Surgical and Medical Practices: R.S.A.B., M.B., A.M., Concept: R.S.A.B., M.B., A.M., F.H., Design: R.S.A.B., A.M., F.H., Data Collection or Processing: R.S.A.B., A.M., F.H., Analysis or Interpretation: R.S.A.B., M.B., A.M., M.S.B., Literature Search: R.S.A.B., M.B., A.M., M.S.B.,F.H., Writing: R.S.A.B., M.B., A.M., M.S.B., F.H.

Conflict of Interest: No conflict of interest was declared by the authors.

Financial Disclosure: The authors declared that this study received no financial support.

REFERENCES

1. Asher MI, Montefort S, Björkstén B, et al. Worldwide time trends in the prevalence of symptoms of asthma, allergic rhinoconjunctivitis, and eczema in childhood: ISAAC phases one and three repeat multicountry cross-sectional surveys. *Lancet*. 2006;368(9537):733-743. Erratum in: *Lancet*. 2007;370(9593):1128. **[Crossref]**
2. Office on Smoking and Health (US). The health consequences of involuntary exposure to tobacco smoke: a report of the surgeon general. Atlanta (GA): Centers for Disease Control and Prevention (US); 2006. **[Crossref]**
3. Oberg M, Jaakkola MS, Woodward A, Peruga A, Prüss-Ustün A. Worldwide burden of disease from exposure to second-hand smoke: a retrospective analysis of data from 192 countries. *Lancet*. 2011;377(9760):139-146. **[Crossref]**
4. Irvine L, Crombie IK, Clark RA, et al. What determines levels of passive smoking in children with asthma? *Thorax*. 1997;52(9):766-769. **[Crossref]**
5. Chilmonczyk BA, Salmun LM, Megathlin KN, et al. Association between exposure to environmental tobacco smoke and exacerbations of asthma in children. *N Engl J Med*. 1993;328(23):1665-1669. **[Crossref]**
6. Samet JM. Passive smoking and health. *Tob Public Health Sci Policy*. 2004;287-313. **[Crossref]**
7. Burke H, Leonardi-Bee J, Hashim A, et al. Prenatal and passive smoke exposure and incidence of asthma and wheeze: systematic review and meta-analysis. *Pediatrics*. 2012;129(4):735-744. **[Crossref]**
8. World Health Organization. WHO Global Report on Trends in Prevalence of Tobacco Use 2000–2025, 3rd ed. Geneva: WHO; 2019. Accessed January 22, 2025. **[Crossref]**
9. Global Initiative for Asthma (GINA). Global Strategy for Asthma Management and Prevention. 2024 update. Accessed January 15, 2026. **[Crossref]**

10. Office National des Statistiques (ONS). Salaire – Mai 2021 Internet. 2021. Accessed January 15, 2026. **[Crossref]**
11. Tamim H, Akkary G, El-Zein A, El-Roueiheb Z, El-Chemaly S. Exposure of pre-school children to passive cigarette and narghile smoke in Beirut. *Eur J Public Health*. 2006;16(5):509-512. **[Crossref]**
12. Lu H, Qi S, Chen W, Gu D. Trends of secondhand smoke exposure among children: a scientometric analysis. *Tob Induc Dis*. 2025;23. **[Crossref]**
13. Boumendjel A, Tridon A, Ughetto S, Messarah M, Boulakoud MS. Environnement allergénique d'une population d'enfants asthmatiques à Annaba (Algérie) [Allergenic environment in asthmatic children in Annaba (Algeria)]. *Ann Biol Clin (Paris)*. 2010;68(3):317-324. French.
14. Murray AB, Morrison BJ. Passive smoking by asthmatics: its greater effect on boys than on girls and on older than on younger children. *Pediatrics*. 1989;84(3):451-459. **[Crossref]**
15. Moshammer H, Hoek G, Luttmann-Gibson H, et al. Parental smoking and lung function in children: an international study. *Am J Respir Crit Care Med*. 2006;173(11):1255-1263. **[Crossref]**
16. Sims M, Tomkins S, Judge K, Taylor G, Jarvis MJ, Gilmore A. Trends in and predictors of second-hand smoke exposure indexed by cotinine in children in England from 1996 to 2006. *Addiction*. 2010;105:543-553. **[Crossref]**
17. Rahman M, Haque MN, Rahman MM, et al. Socio-economic inequalities in secondhand smoke exposure at home in the context of mother-child pairs in Bangladesh. *Public Health*. 2018;161:106-116. **[Crossref]**