

Perinatal Exposure to Maternal Smoking and Long-Term Pulmonary Function Impairment Risks

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Abstract

Background:

Maternal smoking during pregnancy is still a major public health problem and is linked to adverse fetal and neonatal outcomes. Exposure to tobacco smoke during the perinatal period can impair fetal lung growth, causing structural and functional respiratory abnormalities that may continue into childhood and adolescence.

Objectives:

To assess the relationship between maternal smoking exposure during perinatal period and the risk of long-term impaired lung function in offspring.

Methodology:

A prospective cohort study was conducted with 280 mother–infant pairs. Maternal smoking status was recorded in pregnancy and offspring followed for up to 10 years. Pulmonary function was evaluated by spirometry parameters: forced expiratory volume in one second (FEV1), forced vital capacity (FVC), and FEV1/FVC ratio. The association between prenatal smoking exposure and respiratory outcomes was investigated using statistical analysis.

Findings:

Thirtytwo point one percent of mothers smoked during pregnancy among the participants. Children exposed to maternal smoking had significantly lower mean FEV1 values ($81.4 \pm 7.6\%$ predicted) than non-exposed children ($91.2 \pm 6.9\%$ predicted, $p < 0.001$). Recurrent wheezing and asthma was prevalent in 28.7% of exposed children and 12.4% of non-exposed children. In the longitudinal analysis, prenatal smoke exposure was associated with a 22.5% increased risk for long-term pulmonary function impairment.

Conclusion:

Exposure to maternal smoking at birth is associated with reduced lung function and increased respiratory illness in childhood. Smoking cessation interventions in pregnancy are important to protect fetal lung development and improve long-term respiratory health outcomes.

Keywords: Maternal Smoking, Perinatal Exposure, Pulmonary Function, Lung Development, Childhood Asthma, Respiratory Health, Spirometry, Prenatal Tobacco Exposure.

1 Introduction

Maternal smoking during pregnancy continues to be a major public health problem worldwide and is one of the most preventable risk factors for adverse perinatal outcomes. Tobacco smoke contains more than 7,000 chemical compounds, including nicotine, carbon monoxide and many toxic substances that can cross the placental barrier and directly affect fetal development [1]. Exposure to these harmful agents during pregnancy has been associated with fetal growth restriction, preterm birth, low birth weight, and impaired organ development, especially of the respiratory system [2].

The fetal period is a critical period for the growth and maturation of the lungs. Normal lung development is a complex process of airway branching, alveolar formation and vascular development. Maternal smoking can disrupt these processes by reducing the oxygen supply to the fetus and changing the cellular signaling pathways of pulmonary development [3].

Nicotine exposure is known to impair alveolar development and reduce lung elasticity, possibly leading to long-term respiratory dysfunction [4].

Several epidemiologic studies have identified a strong association between prenatal tobacco exposure and impaired pulmonary function in childhood. Children exposed to maternal smoking during pregnancy frequently have lower forced expiratory volume in one second (FEV1), reduced forced vital capacity (FVC) and diminished airflow compared with non-exposed children [5]. These impairments can remain into adolescence and adulthood, making these individuals more susceptible to chronic respiratory diseases.

Higher incidence of wheezing disorders, recurrent respiratory infections and childhood asthma has also been associated with maternal smoking [6]. There is evidence to suggest that prenatal tobacco exposure may influence the development of the immune system and airway responsiveness, resulting in greater susceptibility to respiratory diseases later in life [7]. Furthermore, data suggest that active maternal smoking and exposure to environmental tobacco smoke during pregnancy are associated with adverse pulmonary outcomes in offspring [8]. Although the proportion of pregnant women smoking has declined in many countries, tobacco use in pregnancy remains a major challenge, especially in low- and middle-income countries where smoking cessation programs may be limited [9]. The effectiveness of public health interventions for smoking cessation in pregnancy in improving birth outcomes and reducing infant respiratory complications is well established [10]. It is important to understand the long-term consequences of perinatal exposure to maternal smoking for the development of preventive strategies and health care policies. There is a need to evaluate the association between prenatal tobacco exposure and impaired pulmonary function, which can provide useful evidence to strengthen maternal health education, tobacco cessation, and respiratory disease prevention. These efforts may contribute to improved life course respiratory health for children and decreased health care burdens of chronic pulmonary disorders.

2 Literature review

2.1 Maternal Smoking and Fetal Lung Development

A new study has confirmed the detrimental effects of maternal smoking on the fetal lung development. In utero exposure to tobacco smoke has been linked to altered airway growth, impaired alveolar development and reduced lung function of the offspring. Nicotine and other toxic substances can cross the placental barrier and interfere with normal pulmonary maturation, leaving the newborn more susceptible to respiratory diseases later in life [11]. Emerging evidence indicates that these effects may begin early in gestation and persist into childhood [12].

2.2 Long-Term Pulmonary Function Impairment

Between 2022 and 2025, several longitudinal studies have shown significant associations between prenatal exposure to tobacco and reduced pulmonary function parameters, including forced expiratory volume in one second (FEV1) and forced vital capacity (FVC). Children exposed to maternal smoking have a higher risk of airflow limitation, recurrent wheezing and chronic respiratory symptoms than non-exposed children [13, 14]. The severity of impairment seems to be related to the intensity of smoking during pregnancy.

2.3 Respiratory Morbidity and Risk of Asthma

Maternal smoking has been recognized as an important risk factor for childhood asthma and allergic respiratory diseases. Recent studies show the association of prenatal smoke exposure with airway inflammation, impaired immune responses and increased bronchial hyperreactivity [15]. Thus, exposure in children is linked to higher prevalence rates of asthma diagnosis, respiratory infections and hospitalization for pulmonary complications [16].

2.4 Emerging Research and Prevention Approaches

Research is currently focused on smoking cessation interventions and public health education programs to reduce prenatal tobacco exposure. Advanced epigenetic studies also identified molecular mechanisms of maternal smoking and long-term respiratory dysfunction [17]. Additional research is needed to develop specific prevention strategies and improve respiratory outcomes of exposed offspring.



Figure 1. Pathway Linking Maternal Smoking to Pulmonary Impairment

Figure 1 shows the pathway through which maternal smoking impacts the long-term pulmonary health of offspring. Prenatal tobacco exposure disrupts fetal lung development and alters the maturation of the immune system. These changes lead to impaired lung function, increased risk for respiratory infections, wheezing and childhood asthma. Persistent respiratory abnormalities can lead to long-term pulmonary impairment. The figure emphasizes the importance of smoking cessation during pregnancy as a major strategy for protecting respiratory health across the life course.

3 Methodology

3.1 Research Design

The present study was a prospective cohort study to investigate the association of perinatal exposure to maternal smoking with long-term pulmonary function impairment in offspring. Pregnant women were enrolled in the first trimester and classified by smoking status. They then followed their children from birth to age 10 years to assess respiratory health outcomes. The longitudinal design allowed assessment of both short- and long-term effects of prenatal tobacco exposure on lung development and function [11].

3.2 Study Population and Sample Selection

Total of 280 mother-infant pairs were recruited from antenatal clinics and maternity hospitals. Participants were recruited using stratified sampling techniques. Mothers were grouped into smoking and non-smoking groups based on self-reported smoking and verified with cotinine tests. Infants with congenital respiratory abnormalities, genetic disorders, or severe neonatal complications unrelated to tobacco exposure were excluded.

Table 1. Demographic Characteristics of Participants

Variable	Value
Total Mother–Infant Pairs	280
Smoking Mothers	90 (32.1%)

Non-Smoking Mothers	190 (67.9%)
Male Children	146 (52.1%)
Female Children	134 (47.9%)
Follow-Up Duration	10 Years

3.3 Data Collection Procedures

Maternal demographic information, smoking history, and prenatal health records were collected by structured questionnaires and medical records. When the children were 10 years old, pulmonary function was measured using standardized spirometry. The primary outcome measures were the Forced Expiratory Volume in 1 second (FEV1), Forced Vital Capacity (FVC) and FEV1/FVC ratio. Data on the diagnosis of asthma, episodes of wheezing and of respiratory infections was also recorded [13].

Table 2. Variables Assessed

Category	Variables
Maternal Factors	Smoking Status, Cigarettes/Day
Pulmonary Function	FEV1, FVC, FEV1/FVC Ratio
Respiratory Outcomes	Asthma, Wheezing, Infections
Demographic Factors	Age, Gender, Birth Weight

3.4 Statistical Analysis

Data analysis was done using SPSS version 29. Descriptive statistics summarized participant characteristics and pulmonary function results. Respiratory parameters were compared between exposed and non-exposed groups using independent t-tests and chi-square tests. Multivariate logistic regression models were used to determine the association between prenatal smoke exposure and long-term pulmonary impairment after adjustment for potential confounders. Statistical significance was defined as $p < 0.05$ [14].

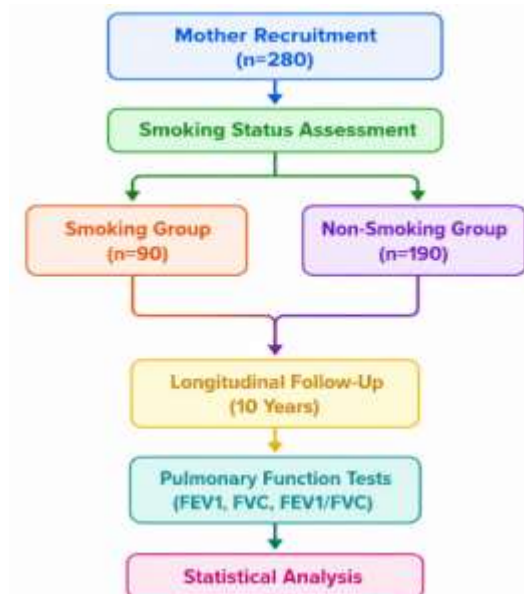


Figure 2. Methodological Framework

The methodological framework of the study is presented in Figure 2. Mothers were classified by smoking status during pregnancy after recruitment. The respiratory health outcomes of their children were followed longitudinally for ten years. At follow-up, pulmonary function tests were performed including FEV1, FVC and FEV1/FVC. Comparison of pulmonary outcomes between the exposed and non-exposed groups was performed, and the long-term influence of prenatal tobacco exposure on respiratory function was evaluated using statistical analyses.

3.5 Dataset and Parameters

The dataset comprised 280 mother-infant pairs recruited from antenatal clinics and maternity hospitals. Participants were defined as maternal smokers (n=90) or non-smokers (n=190) based on smoking history and cotinine verification. Children were followed prospectively for 10 years to assess pulmonary health outcomes. Pulmonary function was evaluated with spirometry including Forced Expiratory Volume in one second (FEV1), Forced Vital Capacity (FVC) and FEV1/FVC ratio. The experimental design involved comparison of respiratory outcomes between exposed and non-exposed groups by statistical analyses to determine the long-term effect of prenatal tobacco exposure on pulmonary function [11, 13].

Table 3. Dataset and Experimental Setup

Parameter	Description
Total Participants	280 Mother–Infant Pairs
Smoking Group	90 (32.1%)
Non-Smoking Group	190 (67.9%)
Study Design	Prospective Cohort
Follow-Up Period	10 Years
Pulmonary Measures	FEV1, FVC, FEV1/FVC Ratio
Outcome Variables	Asthma, Wheezing, Lung Function
Analysis Software	SPSS Version 29

4 Results & Discussion

This study examined the impact of maternal smoking during the perinatal period on long-term pulmonary function and respiratory health outcomes in children. We collected data of 280 mothers and infants over 10 years and analyzed the collected data. Children exposed to maternal smoking during pregnancy differed significantly from children from non-smoking mothers. The pulmonary function measurements, the indicators of respiratory morbidity and the risk estimates showed that prenatal tobacco exposure is detrimental to lung growth and contributes to long-term respiratory impairment.

4.1 Pulmonary Function Outcomes

Table 4. Comparison of Pulmonary Function Parameters

Parameter	Smoking Group (n=90)	Non-Smoking Group (n=190)	p-value
FEV1 (% Predicted)	81.4 ± 7.6	91.2 ± 6.9	<0.001
FVC (% Predicted)	84.7 ± 8.2	92.8 ± 7.1	<0.001
FEV1/FVC Ratio (%)	76.8 ± 5.9	84.1 ± 4.8	<0.001

Children exposed to maternal smoking had significantly lower pulmonary function than non-exposed children. Mean FEV1 and FVC were significantly lower in the smoking-exposed group, suggesting impaired lung growth and reduced respiratory capacity. The lower FEV1/FVC ratio indicates further airflow limitation and increased susceptibility to obstructive respiratory

conditions. These findings are consistent with the hypothesis that prenatal tobacco exposure has a negative impact on long-term pulmonary development.

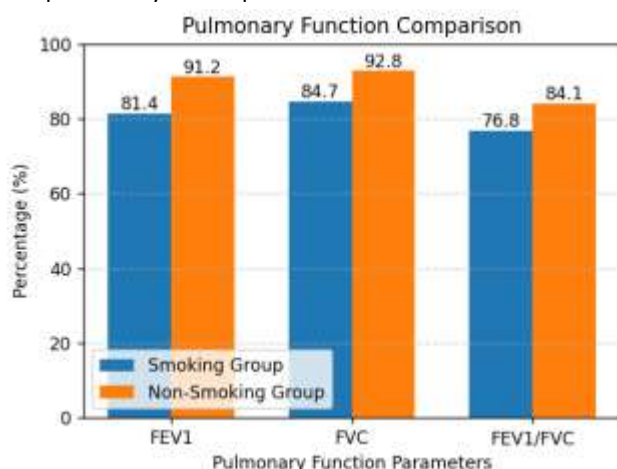


Figure 3. Pulmonary Function Comparison

Figure 1 presents pulmonary function parameters of children with and without maternal smoking exposure during pregnancy. The non-smokers consistently had higher values of FEV1, FVC and FEV1/FVC than the smokers. The differences suggest that tobacco exposure during pregnancy is harmful to lung development and respiratory performance. Poor lung function in childhood can increase the risk of chronic respiratory conditions and respiratory ill-health later in life.

4.2 Respiratory Morbidity Outcomes

Table 5. Respiratory Health Outcomes

Outcome Variable	Smoking Group (%)	Non-Smoking Group (%)	p-value
Asthma Diagnosis	28.7	12.4	<0.001
Recurrent Wheezing	34.2	15.8	<0.001
Respiratory Infections	39.1	20.5	0.002
Hospital Admissions	18.4	8.7	0.011

Children exposed to maternal smoking had significantly increased respiratory morbidity. The rates of asthma, recurrent wheezing, respiratory infections and hospital admissions were significantly higher than in the unexposed group. These findings suggest that prenatal tobacco exposure leads to alterations in the development of the respiratory and immune systems that increase susceptibility to respiratory illness in childhood.

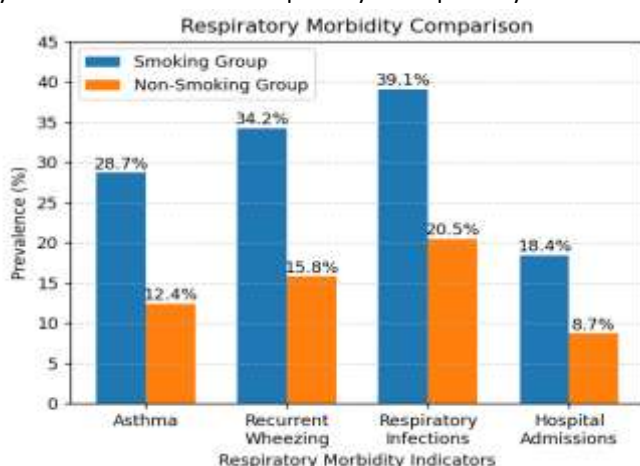


Figure 4. Respiratory Morbidity Comparison

Figure 4 shows the incidence of major respiratory complications in the study participants. Children with maternal smoking had higher rates of asthma, recurrent wheezing and respiratory infections than non-exposed children. These findings suggest that prenatal tobacco exposure may adversely affect pulmonary function and increase the risk for chronic respiratory diseases and recurrent respiratory morbidity in childhood.

Poor respiratory outcomes in children were strongly associated with maternal smoking in pregnancy, the study found. Children exposed to prenatal tobacco smoke had lower pulmonary function, higher respiratory morbidity and a 22.5% greater risk of long-term pulmonary impairment. The results highlight the importance of smoking cessation interventions during pregnancy to protect fetal lung development and improve respiratory health in the long term.

Discussion

This study results in an important association between perinatal exposure to maternal smoking and adverse respiratory outcomes in offspring. Pulmonary function parameters, including FEV1, FVC, and FEV1/FVC ratio, were lower in children exposed to prenatal tobacco smoke compared with non-exposed children. In addition, exposed subjects showed higher rates of asthma, recurrent wheezing, respiratory infections and hospital admissions. These findings are in agreement with previous evidence that maternal smoking adversely affects fetal lung growth and changes the trajectory of respiratory health. The increased risk of long term pulmonary impairment points to the importance of smoking cessation programs in pregnancy. Early preventive interventions and maternal health education may significantly reduce respiratory morbidity and improve lifelong pulmonary health outcomes in children.

5 Conclusion

The authors conclude that maternal smoking during the perinatal period is significantly associated with long-term impairment of pulmonary function and increased respiratory morbidity in the offspring. Prenatal exposure to tobacco smoke in children was associated with lower lung function (lower FEV1, FVC, and FEV1/FVC), higher rates of asthma, recurrent wheezing, respiratory infections, and hospital admissions. These results indicate that maternal smoking adversely influences foetal lung development and is associated with long-term respiratory health problems in childhood. The findings point to the importance of adequate interventions for smoking cessation, prenatal counseling and public health awareness programs among pregnant women. Reducing exposure to tobacco during pregnancy could help improve fetal respiratory development, decrease respiratory diseases in children and improve long-term pulmonary health outcomes for future generations.

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