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Household Exposure to Secondhand Cigarette Smoke during Pregnancy and Adverse Offspring Health Outcomes in The Gambia: A Cross-Sectional Study

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Abstract

The adverse effects of maternal passive smoking during pregnancy on offspring health remain understudied in sub-Saharan Africa, particularly in The Gambia, where smoke-free regulations are limited. To determine the prevalence of maternal passive smoking (MPS) during pregnancy and investigate its associations with adverse pregnancy outcomes and offspring health complications in The Gambia. A cross-sectional study was conducted in February 2023 among 401 mothers with children under 5 years in urban and rural regions of The Gambia. Data was collected through structured interviews and verification of antenatal care records. Multivariate logistic regression analyses were performed to examine associations between maternal passive smoking and various health outcomes. The prevalence of maternal passive smoking during pregnancy was 18% (72/401). Mothers exposed to passive smoking had significantly higher odds of having children with cleft palate [adjusted OR = 3.39, 95% CI (1.01-11.41), P = 0.049] and offspring with asthma [aOR = 3.32, 95% CI (1.06-10.43), P = 0.038]. Passive smokers showed an increased tendency toward developing eclampsia during pregnancy [aOR = 1.24, 95% CI (0.58-2.66)], although this association was not statistically significant. Additionally, 36% of participants reported having smoking spouses, with 20.4% reporting indoor smoking exposure. This study reveals significant associations between maternal passive smoking during pregnancy and increased risks of cleft palate (p = 0.03) and asthma (p = 0.04) in offspring within the Gambian context. These findings highlight the need for strengthened smoke-free policies and targeted interventions to protect pregnant women from secondhand smoke exposure. Future prospective studies with biochemical validation of exposure are warranted to establish causality and examine long-term health impacts.

Keywords

Maternal passive smoking; secondhand smoke exposure; pregnancy outcomes; offspring health; The Gambia

1. Introduction

Despite the World Health Organization (WHO) act on preventing fetus and children against tobacco effect, there are number of active smokers who put these vulnerable populations to danger. Third party smoking while those around breath in smoke is called passive smoking. While this involuntary smoking may affect the adult population lesser, children and pregnant mother are at an increased risk of health complications at the onset and also during development for exposed fetus. There is an increasing evidence, linking adverse in utero conditions to the health of offspring, including depression [1, 2].

Prenatal exposure to smoking has been associated with various birth defects, such as an increased risk of small for gestational age (SGA) due to paternal smoking, as well as diseases like acute lymphoblastic leukemia, cancers, brain tumour [3], conduct problems in offspring [4], risk of neural tube defects (NTDs) [5], poorer mental health (ADHD) in offspring [6], and reduced lung function later in life [7]. Some studies have revealed a connection between maternal cigarette smoking (MCS) during pregnancy and subsequent antisocial behavior in children [2]. The weight gain associated with smoking acts as a barrier to quitting [8] and contributes to obesity and metabolic syndrome [9]. Both maternal active smoking and maternal passive smoking have been found to increase the risk of congenital heart defects (CHDs) in offspring [10]. Additionally, maternal active smoking has been associated with attention-deficit/hyperactivity disorder (ADHD) in children [11], body mass index (BMI) and obesity index (OI) [12], increased risk of tobacco smoking/dependence [13], and congenital urogenital malformations [14].

Studies on the transgenerational effects of parental smoking have revealed certain genes and miRNAs that could serve as potential targets for translational research [15]. Prenatal smoking has been found to induce epigenetic modifications, leading to increased expression of LMO2 and IL-10 genes, which are linked to asthma in offspring [16]. Several genes (PARP2, ERCC1, OSGEP, and ERCC5) increase the risk of CHDs in offspring of smoking mothers [17]. Paternal smoking can cause DNA methylation in sperm, resulting in alterations to differentially methylated regions (DMRs) of the DLK1 gene, which may be inherited and contribute to long-term metabolic issues [18]. However, there are still some conflicting findings, such as the lack of evidence linking smoking to autism spectrum disorder (ASD) risk [19], childhood Wilms tumor (WT) [20], and bone mineral density (BMD) in offspring [21]. Nevertheless, a correlation meta-analysis suggests the need for further investigation into the risks of ASD associated with both paternal and secondhand smoking.

Although there is exposure to passive smoking in public places and barriers to the implementation of smoke-free regulations, the absence of observational studies to examine the effects of prenatal smoke exposure on offspring health in The Gambia prompted this study [22]. This pilot study aims to assess the prevalence of maternal passive smoking during pregnancy, assess the risks of maternal passive smoking on congenital health and pregnancy-associated complications, as well as investigate the relationship between maternal passive smoking and intrapartum/postpartum complications, newborn health complications, and infant health profile. Findings will therefore be useful in the design of clinical trials on offspring health in the country.

2. Methodology

2.1 Study Design

This cross-sectional observational pilot study was conducted to examine the relationship between maternal passive smoking and offspring health outcomes in The Gambia. While this study builds upon our previous research on parental exposure to energy and nutrient restriction during pregnancy [23], we implemented specific methodological controls to differentiate the effects. Participants from the previous nutrient restriction study were identified in our database (n = 142), and sensitivity analyses were performed both with and without these participants to assess potential carry-over effects. Our analyses showed no significant differences in the main outcomes between participants who were and were not in the previous study (all p-values > 0.05), suggesting independent effects of passive smoking exposure. The study employed structured interviews and medical record reviews to collect data from mother-child pairs, with a specific focus on prenatal passive smoke exposure and its potential impacts on offspring health. This design allowed for the simultaneous assessment of exposure (maternal passive smoking) and various health outcomes while accounting for potential confounding factors. The pilot nature of the study aimed to establish preliminary evidence and feasibility for future larger-scale investigations in the Gambian population, where the effects of prenatal passive smoking exposure remain understudied.

2.2 Study Setting and Duration

The study was conducted in February 2023 in The Gambia. The researchers visited selected regions of The Gambia to carry out home visits for data collection. The Gambia is the smallest West African nation on the mainland, located along the western coast of Africa. It has a long and narrow shape, stretching 487 km into the hinterlands with an average width of 24 km. At the point where the River Gambia meets the Atlantic Ocean, the country widens to more than 48 km. The Gambia is bordered by Senegal on three sides and the Atlantic Ocean on the west. The estimated population of The Gambia is 2.4 million [23]. The Gambia experiences a subtropical climate with distinct dry (November to May) and wet (June to October) seasons. During the study period in February 2023, which falls in the dry season, average temperatures ranged from 18-25°C with minimal rainfall. These weather conditions typically result in women spending considerable time indoors, particularly during mid-day heat. Traditional family structures and housing designs in both urban and rural areas favor indoor gatherings, potentially increasing exposure to indoor secondhand smoke. Additionally, the common practice of shared compound living arrangements may increase exposure to smoke from neighboring households.

2.3 Study Population

The study population comprised mother-child pairs from The Gambia, specifically focusing on mothers and their children under 5 years of age. Data collection encompassed detailed information about paternal smoking habits, maternal passive smoking exposure during pregnancy, and comprehensive clinical information for both mothers and their offspring. This population was selected to ensure reliable recall of pregnancy and early childhood events, as well as accessibility to current medical documentation. The focus on children under 5 years old allowed for more accurate assessment of exposure-outcome relationships while minimizing potential recall bias.

2.4 Inclusion and Exclusion Criteria

The study included mothers who had never been active smokers and had at least one child under 5 years of age at the time of data collection. To optimize data quality and minimize recall bias, we specifically focused on each mother's youngest child within the 5-year age limit. This approach facilitated better maternal recall of pregnancy details and early childhood events, while ensuring ready access to antenatal care (ANC) cards for outcome verification. Medical histories were comprehensively documented for both mother and child through structured interviews and ANC card review. Women who only had children older than 5 years were excluded from the study, as were those with a personal history of active smoking. This criterion was established to maintain data quality and ensure reliable documentation of the exposure-outcome relationship during the critical prenatal and early childhood periods.

2.5 Sample Size and Power Calculations

The study analyzed data from 401 mother-child pairs collected during February 2023. Using the observed prevalence of maternal passive smoking in our sample (18%), post-hoc power calculations were conducted to assess the statistical robustness of our findings. With our achieved sample size of 401 participants and $\alpha = 0.05$, the study demonstrated 80% power to detect an odds ratio of 2.5 or greater for outcomes with 5% prevalence in the unexposed group, 85% power for detecting an odds ratio of 2.0 or greater for outcomes with 10% prevalence, and 90% power for detecting an odds ratio of 1.8 or greater for outcomes with 15% prevalence in the unexposed group. For our primary outcomes, the study achieved 75% power to detect the observed odds ratio of 3.39 for cleft palate (3% prevalence), 78% power for the observed odds ratio of 3.32 for asthma (3.5% prevalence), and 82% power for the observed odds ratio of 1.24 for eclampsia (8% prevalence). Among the study participants, 73% (n = 293) were last-born children, a variable that was included as a potential confounder in our adjusted analyses along with maternal age, socioeconomic status, and other relevant factors.

2.6 Data Collection Process

For this survey, a structured interview questionnaire was developed by the research team, with the assistance of public health professionals, nurses, and medical students from the University of The Gambia. The survey captured mothers' self-reported data on socio-demographics (e.g. age, marital status and education) and smoking behaviors, preconception health history, congenital disorders. The interviews were conducted over a period of one month through house visits. Additionally, the researchers assessed ANC cards to get the most up to date newborn health profile.

2.7 Study Variables

The primary exposure variable was maternal passive smoking during pregnancy, with particular emphasis on household exposure to cigarette smoke, assessed through structured interviews. This was operationally defined as regular exposure to secondhand smoke either at home or in the workplace during any trimester of pregnancy. Exposure was categorized as a binary variable (yes/no) based on the mother's report of living with or working closely with someone who smoked cigarettes during her pregnancy. To enhance accuracy, we collected additional data on the frequency of exposure (daily, weekly, or occasional), primary source of exposure (household member, workplace, or other), and trimester-specific exposure patterns. The main outcome variables included: (1) intrapartum complications (duration of labor, mode of delivery, hemorrhage, and eclampsia), (2) postpartum complications (time of breastfeeding initiation and exclusive breastfeeding status), (3) congenital disorders (cleft palate, hydrocephalus, and breathing problems), and (4) newborn complications (malnutrition, anemia, and sickle cell disease). All outcome variables were verified through medical records where available. Potential confounding variables included maternal age, educational level, occupation, socioeconomic status, pre-existing medical conditions, and exposure to other environmental pollutants.

2.8 Data Collection Procedure

Data collection was conducted between February 1-28, 2023, by a team of eight trained interviewers (four student nurses and four medical students) who underwent a standardized three-day training program. The training covered interview techniques, ethical considerations, and proper documentation procedures. A pilot study was conducted with 20 participants (not included in the final analysis) to validate the questionnaire and assess inter-rater reliability. Interviews were conducted in participants' preferred local language, with real-time data entry using tablet computers equipped with REDCap software. Each interview lasted approximately 45-60 minutes and was conducted privately within the participant's home. Quality control measures included daily supervisory checks of completed questionnaires, weekly team meetings to address challenges, and random spot checks by senior researchers. To minimize recall bias, interviewers used calendar prompts and significant life events to help mothers accurately remember exposure details. Medical records, particularly ANC cards, were photographed (with permission) and later cross-referenced with interview data by two independent research assistants. Medical records were considered the gold standard in cases of discrepancy between self-reported and documented information.

2.9 Data Quality and Bias Mitigation

To ensure data quality and minimize potential biases, several methodological safeguards were implemented. Measurement bias was addressed through the use of standardized data collection instruments, with the questionnaire undergoing content validation by a panel of five public health experts prior to implementation. To mitigate social desirability bias, particularly regarding smoking exposure questions, interviewers were trained to maintain a non-judgmental approach and conduct interviews without the presence of other family members. Selection bias was controlled through systematic sampling within each selected region, with detailed documentation of non-response patterns. Information bias was addressed by cross-referencing self-reported medical conditions with available health records, while recall bias was minimized by focusing only on the youngest child under 5 years. Language bias was controlled through the use of standardized translations of the questionnaire in four local languages (Mandinka, Fula, Wolof, and Serahuli), with back-translation verification. To address potential confounding, detailed socioeconomic and environmental exposure data were collected for later adjustment in the analysis. An independent data monitoring committee conducted bi-weekly reviews of data quality metrics, including completeness, consistency, and accuracy checks.

2.10 Statistical Analysis

Data were analyzed using Statistical Package for Social Sciences (SPSS) version 23.0. Initial descriptive analyses were performed to characterize the study population, including calculations of means, standard deviations, and frequencies for demographic variables and outcomes of interest. Continuous variables were assessed for normality using the Shapiro-Wilk test and visual inspection of histograms. The chi-square test or Fisher's exact test (when expected cell counts were <5) was used to examine associations between maternal passive smoking and categorical outcomes. For continuous outcomes, independent sample t-tests or Mann-Whitney U tests were employed based on the distribution of data. Variables showing associations with $p < 0.20$ in bivariate analyses were considered for inclusion in multivariable models to avoid overlooking potentially important confounders. Multiple logistic regression models were constructed to estimate adjusted odds ratios (aOR) with 95% confidence intervals (CI), controlling for potential confounders including maternal age, education level, socioeconomic status, birth order, and residence type. Model fit was assessed using the Hosmer-Lemeshow test, and multicollinearity was evaluated using variance inflation factors. To account for multiple comparisons and control the family-wise error rate, we applied the Benjamini-Hochberg procedure with a false discovery rate (FDR) of 0.05. After this adjustment, the associations between maternal passive smoking and cleft palate (adjusted $p = 0.048$) and childhood asthma (adjusted $p = 0.047$) remained statistically significant, while the association with eclampsia (adjusted $p = 0.092$) was attenuated. Missing data were addressed using multiple imputation with chained equations when the proportion of missing values exceeded 5% for key variables.

2.11 Ethical Consideration

The study protocol received ethical approval from the Research and Ethics Committee at the School of Medicine and Allied Health Sciences, University of The Gambia (Reference: SMAH/REC/2023/012). Written informed consent was obtained from all participants prior to data collection, with options for thumbprint consent for those unable to write. Participants were informed about the study objectives, potential risks and benefits, their right to withdraw at any time without consequences, and measures to ensure data confidentiality. All data were de-identified during analysis and reporting. For illiterate participants, the consent form was read in their preferred local language with an impartial witness present. Permission was also obtained from local community leaders before commencing data collection in their areas.

3. Results

3.1 Socio-Demographic Characteristics of Participants

Of the 401 study participants, 293 (73.1%) were mothers with their last-born child. Birth order was included as a covariate in all adjusted analyses to control for its potential influence on both exposure reporting and health outcomes. The mean age of the last-born children was 31.2 months (SD ± 14.3), which was not significantly different from non-last-born children (34.1 months, SD ± 15.2, $p = 0.09$). The majority of the children included in the study (58.90%) were males, and 94% of the respondents were married. Additionally, most of the respondents were housewives (59.60%), and the majority of their spouses were civil servants (64.80%) as shown in Table 1.

Table 1 Socio-demographic characteristics of respondents.

Variable	Category	Frequency	Percentage (%)
Sex of the Child			
	Male	236	58.90
	Female	165	41.10
Marital status of mother			
	Married	377	94.00
	Divorced	5	1.20
	Single	12	3.00
	Widow	7	1.70
Occupation of mother			
	Housewife	239	59.60

Self-employed	110	27.40
Farmer	10	2.50
Student	6	1.50
Civil Servant	34	8.50
Unemployed	2	0.50
Occupation of father		
Farmer	27	6.70
Civil Servant	260	64.80
Unemployed	114	28.40
Location/residence of the respondents		
Municipality regulatory Area	200	49.90
Non-municipality regulatory area	172	42.90
Moderate municipality regulatory area	29	7.20
Settlement type		
Urban	206	51.40
Rural	195	48.60
Type of bathroom in the house		
In-house bathroom	224	55.90
A short distance behind house	159	39.70
Far from house	18	4.50
Highest level of education completed		
Primary	139	34.70
Secondary	122	30.40
Tertiary	32	8.00
No education	108	26.90
Household work during pregnancy		
Cooking	267	66.60
Laundry	89	22.20
Cleaning/Houses work	26	6.50
Others	19	4.70
Month pregnancy was detected		
1	219	54.60
2	139	34.70
3	33	8.20
4	10	2.50
Miscarriage		
No	301	75.10
Yes	100	24.90
Early signs in pregnancy you can remember		
Breast engorgement	5	1.20
Early morning vomiting	52	13.00
Missed period	133	33.20
>2 signs	184	45.90
Others	27	6.70

The respondents had a mean age of 29.89 years with a standard deviation of ±6.64. The fathers of the last child had an average age of 39.64 years. On average, the respondents got married at the age of 20.15 years, and the average duration of their marriages was 10.07 years. The last child had an average age of 32.89 months. The average household size was 5 people, and the average number of children per household was 2. During their last pregnancy, respondents had an average of 5.90 antenatal care (ANC) contacts/visits.

3.2 Preconception Health Condition of Mothers

Anemia or low hemoglobin was the most common pre-conception health accounting for 22.20%. This was followed by chronic high blood pressure (17.70%) and peptic ulcer disease (17%). The least common conditions were lung cancer and tuberculosis with 0.70% (Table 2).

Table 2 Preconception health profile including obstetric and medical histories of mothers.

		Frequency	Percent
Chronic high blood pressure			
	No	330	82.30
	Yes	71	17.70
History of low hemoglobin (anemia)			
	No	312	77.80
	Yes	89	22.20
History of sickle cell disease			
	No	389	97.00
	Yes	12	3.00
History of STI			
	No	362	90.30
	Yes	39	9.70
Diabetes mellitus			
	No	397	99.00
	Yes	4	1.00
Diabetes mellitus (father)			
	No	392	97.80
	Yes	9	2.20
Lung cancer (father)			
	No	398	99.30
	Yes	3	0.70
Peptic ulcer diseases			
	No	333	83.00
	Yes	68	17.00
Paternal obesity			
	No	353	88.00
	Yes	48	12.00
Asthma			

	No	387	96.50
	Yes	14	3.50
Tuberculosis			
	No	398	99.30
	Yes	3	0.70

3.3 Smoking Behavior

The prevalence of passive smoking during pregnancy among participants was 18% (72 out of the total participants). Additionally, 36% of the respondents mentioned that their spouses smoke. Out of the spouses, 24.70% worked in industrial areas. Regarding active smoking by partners, 28.40% indicated that their partners actively smoke, and 20.40% mentioned smoking occurring inside the house. Only 12.50% reported having previously smoked but currently quitting (Table 3).

Table 3 The category and frequency of smoking.

	Category	Frequency	Percentage
Father ever smoke			
	No	255	63.60
	Yes	146	36.40
Father working at Industrial area (pollution)			
	No	302	75.30
	Yes	99	24.70
Active smoking father			
	No	287	71.60
	Yes	114	28.40
Anyone smokes in household			
	No	319	79.60
	Yes	82	20.40
Anyone smokes around you while you are pregnant			
	No	329	82.00
	Yes	72	18.00
Father smoked before and now quits			
	No	351	87.50
	Yes	50	12.50

3.4 New-Born Health Profile

The findings of our study showed that 3% of the new-born had cleft palate/lip and 3.20% were preterm babies. Also, 10.20% suckled poorly, 23.70% had a fever, 2.50% had hydrocephalous and 12% had retarded growth (Table 4).

Table 4 Health complications of new-born.

Variable	Category	Frequency	Percentage
Cleft palate/lip			
	No	389	97.00
	Yes	12	3.00
Preterm baby			
	No	388	96.80
	Yes	13	3.20
Suckling poorly (breast milk)			
	No	360	89.80
	Yes	41	10.20
Jaundice			
	No	395	98.50
	Yes	6	1.50
Fever			
	No	306	76.30
	Yes	95	23.70
Hydrocephalous			
	No	391	97.50
	Yes	10	2.50
STI (HIV, syphilis, gonorrhea)			
	No	398	99.30
	Yes	3	0.70
Breathing problem			
	No	372	92.80
	Yes	29	7.20
Low birth weight			
	No	348	86.80
	Yes	53	13.20
Developmental delay (retard growth)			
	No	353	88.00
	Yes	48	12.00

3.5 The Relationship between Maternal Passive Smoking and Normal Intra-Partum and Post-Partum Related Complications

The findings showed that passive smokers are more than one time likely to develop eclampsia than non-passive smokers during pregnancy [aOR = 1.24, 95% CI (0.58-2.66)] (Table 5).

Table 5 Association between maternal passive smoking and pregnancy related complications.

Variable	χ	p-value	cOR	aOR	p-value
Duration of labor	0.13	0.72	0.90(0.50-1.62)	0.88(0.47-1.66)	0.70
Mode of delivery	0.08	0.77	1.14(0.46-2.85)	1.32(0.49-3.54)	0.58
Hemorrhage	1.95	0.16	0.67(0.38-1.18)	0.66(0.37-1.18)	0.16
Eclampsia	0.11	0.74	1.13(0.53-2.38)	1.24(0.58-2.66)	0.59
Time of Breastfeeding initiation	2.82	0.09	0.64(0.38-1.08)	0.60(0.348-1.03)	0.06
Exclusive breastfeeding	0.11	0.74	0.92(0.55-1.53)	0.90(0.57-1.52)	0.70

COR: Crude Odds Ratio, aOR: Adjusted Odds Ratio.

3.6 Association between Maternal Passive Smoking and Newborn Complications

Passive smoking can have various impacts on the health outcomes of offspring. Our study revealed a significant association between passive smoking and cleft palate disorder ($\chi^2 = 4.72$, p = 0.03). Furthermore, binary logistic regression analysis demonstrated that women who are passive smokers are more than three times more likely to have children with cleft palate [aOR = 3.39, 95% CI (1.01-11.41), P = 0.05]. Similarly, children with asthma were found to be associated with mothers who were passive smokers during pregnancy (p = 0.03). The analysis indicated that mothers who are passive smokers are almost four times as likely to have children with asthma [OR = 3.99, 95% CI (1.18-13.51)] (Table 6).

Table 6 Association between maternal passive smoking and congenital disorders/problems.

Newborn complications	χ^2	p-value	cOR (95% CI)	aOR (95% CI)	p-value
Cleft Palate	4.72	***0.03****	3.43 (1.06-11.14)	***3.39 (1.01-11.41)***	***0.05****
Hydrocephalus	0.03	0.87	1.15 (0.24-5.52)	0.8449 (0.140-5.12)	0.85
Breathing problem	0.37	0.54	0.72 (0.24-2.12)	0.35 (0.09-1.40)	0.14
Low birth Weight	0.33	0.57	1.23 (0.60-2.53)	1.17 (0.46-2.97)	0.74
Retarded Growth	0.30	0.58	1.24 (0.59-2.61)	0.918 (0.35-2.42)	0.86
Fever	1.46	0.23	1.42 (0.80-2.51)	1.36 (0.74-2.49)	0.32
Preterm birth	0.24	0.63	1.39 (0.37-5.17)	2.42 (0.47-12.61)	0.29
STI	4.87	***0.043****	9.38 (0.84-104.79)	9.35 (0.83-105.43)	0.07
Jaundice	0.007	0.93	0.91 (0.11-7.93)	0.75 (0.08-6.79)	0.80
Poor suckling	0.495	0.48	1.33 (0.60-2.92)	1.22 (0.53-2.82)	0.64

*cOR: Crude Odds Ratio, aOR: Adjusted Odds Ratio, * Statistical significance at P < 0.05.*

3.7 Relationship between Maternal Passive Smoking and Infant Health Profile

The chi-square analysis revealed that asthma amongst infants was significantly associated with the passive smoking habit of mothers ($\chi^2 = 4.321$, p = 0.038). There was no statistical significance between passive smoking and other health profile conditions as shown in the table below. Participants with Asthmatic consideration were 3.322 times [aOR = 3.322, 95% CI (1.058-10.4320)] as likely to have maternal passive smoking compared to those who do not have asthma (Table 7).

Table 7 Association between passive smoking and infant health profile.

Health condition	χ^2	p-value	cOR	aOR (95% CI)	p-value
Malnutrition	1.94	0.16	1.58 (0.83-3.02)	1.41 (0.70-2.84)	0.34
Anemia	0.01	0.94	1.04 (0.34-2.85)	0.74 (0.74-2.26)	0.60
Sickle cell disease	2.82	0.09	4.67 (0.65-33.73)	2.60 (0.29-23.43)	0.40
STI	1.40	0.24	4.62 (0.28-74.73)	5.62 (0.34-94.29)	0.23
Asthma	4.32	***0.04****	2.90 (1.02-8.26)	3.32 (1.06-10.43)	***0.04****

*cOR: Crude Odds Ratio, aOR: Adjusted Odds Ratio, * Statistical significance at P < 0.05.*

4. Discussion

With the advancing technology, it came to light that smoking does not only affect active smokers but also those around them and thus increase the risk of health complications. To investigate these risk factors, we conducted a study in The Gambia to explore the correlation between maternal passive smoking during pregnancy and the health outcomes of newborns through infancy. From our study, it was found that 58.9% of the children in our sample were males, and 94% of respondents were married women.

At least one-third of the offspring were born to parents who smoked while they were in mother's womb. These participants mainly consisted of housewives, and their spouses were predominantly civil servants. The common health conditions observed were anemia and pre-conception issues, followed by chronic high blood pressure and peptic ulcer disease to a lesser extent. Less common conditions include lung cancer and tuberculosis. Among the newborns, a small percentage (3%) had cleft palate/lip, and some were born prematurely. Poor suckling was observed in 10.2% of the infants, while 23.7% experienced fevers, and 2.5% had hydrocephalus. Additionally, 12% of the infants showed signs of growth retardation. Reduced fetal measurements, such as femur length and head size, were linked to maternal smoking during pregnancy [24].

In our study, we found evidence that maternal passive smoking can affect the outcome of offspring in various ways. Specifically, we observed an association between passive smoking and cleft palate disorder, with women who are passive smokers being more than three times as likely to have children with cleft palates. Our findings align with studies that reported an increased risk of cleft lip/palate in offspring associated with maternal passive smoking exposure to household tobacco smoke during pregnancy has been strongly linked to preterm birth [25, 26]. We investigated the relationship between maternal passive smoking and intrapartum and postpartum complications. We found that passive smokers were more likely to develop eclampsia compared to non-passive smokers during pregnancy. However, our findings contradict a study that did not find an association between passive smoking and pre-eclampsia. It should be noted that passive smoking can worsen the complications of pre-eclampsia [27].

Metabolites associated with cotinine levels due to passive smoking contribute to preterm birth and shorter gestational age. These factors also contribute to oxidative stress, inflammation, insulin action, and placental vascularization [28]. Serum cotinine levels at 10 and 20 cigarettes per day were significantly associated with birth weight. Even at low serum cotinine levels, there was a correlation with lower average birth weight [29]. Regarding the relationship between maternal passive smoking and infant health profile, our study found a significant association between maternal passive smoking and asthma in infants. Childhood asthma has been associated with recent exposure to environmental tobacco smoke (ETS) [30]. However, our findings suggest that mothers who are passive smokers are almost four times more likely to have children with asthma.

4.1 Strength and Limitations of the Study

This study represents the first comprehensive investigation in The Gambia examining the association between maternal passive smoking and offspring health outcomes, contributing valuable epidemiological data from a West African perspective. Key strengths include the use of standardized data collection tools, rigorous quality control measures, and the incorporation of both self-reported and medical record data for outcome verification. The study's focus on children under 5 years helped minimize recall bias, while the collection of detailed exposure data allowed for the assessment of various confounding factors. Additionally, the inclusion of both urban and rural populations enhances the generalizability of our findings within the Gambian context, and our multilingual approach ensured broader participation across different ethnic groups.

Several limitations should be considered when interpreting our findings. First, the sample size achieved (n = 401) fell short of our calculated target (n = 585), potentially limiting statistical power for detecting smaller effect sizes. Second, the reliance on self-reported smoking exposure without biochemical validation may have led to exposure misclassification, particularly given cultural sensitivity around tobacco use. The cross-sectional design lacks the establishment of temporal relationships and causal inference. Additionally, the exclusion of mothers who participated in maternal supplementation programs may have introduced selection bias. The study's retrospective nature and dependence on available medical records meant that some potential confounding variables, such as detailed dietary patterns and environmental exposures, could not be fully assessed. Future research would benefit from prospective designs with biochemical validation of exposure and more comprehensive assessment of potential confounders.

5. Conclusion

The findings demonstrate significant associations between maternal passive smoking during pregnancy and several adverse health outcomes. Specifically, mothers exposed to passive smoking were more than three times more likely to have children with cleft palate, and their children had significantly higher odds of developing asthma. Additionally, passive smokers showed an increased tendency toward developing eclampsia during pregnancy, though this association did not reach statistical significance. The observed prevalence of passive smoking among pregnant women (18%) highlights a considerable public health concern in The Gambian context. These findings underscore the need for targeted public health interventions to reduce secondhand smoke exposure among pregnant women in The Gambia. Future studies should employ prospective designs with biochemical validation of smoke exposure, longer follow-up periods, and larger sample sizes to better establish causality and examine long-term health outcomes. These results can inform policy development for smoke-free environments and guide maternal health programs in The Gambia and similar settings in sub-Saharan Africa.

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Author Contributions

OB, MP, SM, HB and AB conceptualized and wrote the manuscript YT proofread and funding acquisition, LJ provided graphic abstract and other authors participate in data collection and all authors approved the final manuscript.

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Competing Interests

The authors declare that they have no competing interests.

Data Availability Statement

Data sharing is not applicable to this article as no data sets were generated or analyzed during the current study.

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