Original Article

Secondhand Smoke Exposure during Pregnancy and its Effect on Birth Outcomes: Evidence from a Retrospective Cohort Study in a Tertiary Care Hospital in Bengaluru

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Abstract

Context: The effect of maternal smoking on birth outcomes is well-established, but the effect of maternal secondhand smoke (SHS) exposure is less clear, especially among Indian women. **Aim:** To evaluate the effect of SHS exposure during pregnancy on birth outcomes such as gestational age at birth, neonatal anthropometry, and Apgar score. **Setting and Design:** Retrospective cohort study at a tertiary hospital in Bengaluru. **Methods:** 208 postnatal mothers: 104 each in "exposed" and "nonexposed" group, based on the history of SHS exposure during pregnancy. Sociodemographic and obstetric details were obtained by interview schedule and birth outcomes were obtained from patient charts. **Statistical Analysis:** Association of SHS exposure with birth outcomes was analyzed using inferential statistics such as Chi-square, *t*-test, and Mann–Whitney U-test, whereas the strength of association was expressed as relative risk with 95% confidence intervals. $P < 0.05$ was considered statistically significant. **Results:** SHS exposed and nonexposed groups were comparable with regard to potentially confounding socioeconomic and obstetric covariates. Babies born to SHS-exposed mothers had significantly lower mean birth weight, mean birth length, and mean birth head circumference by 172.5 g ($P = 0.027$), 1.6 cm ($P = 0.001$), and 1.1 cm ($P = 0.001$), respectively. **Conclusion:** Mothers exposed to SHS during pregnancy were twice likely to deliver low birth weight babies (relative risk [RR] = 1.9 [1.0–3.6], $P = 0.02$) and babies of low birth length (RR = 2.64 [1.4–4.6], $P = 0.001$) than unexposed mothers. With a significant risk of adverse birth outcomes found among mothers exposed to SHS during pregnancy, it is important that a "no tobacco smoke" environment at home should be recommended for pregnant women and their families.

Keywords: Birth outcomes, low birth length, low birth weight, neonatal anthropometry, passive smoking, secondhand smoke

Introduction

India is the second largest consumer of tobacco in the world,[1] where one in every ten adults smokes tobacco.[2] Secondhand smoke (SHS) is smoke from burning tobacco products, such as cigarettes and beedis, as well as the smoke exhaled by the person smoking.[3] Tobacco smoke contains more than 7000 toxic chemicals, some carcinogenic.[4] Persons breathing in SHS are exposed to the same toxins as the person smoking tobacco products.[5]

Although since 2008, smoking in public places is prohibited throughout India,[6] nearly 40% of adults are still exposed to SHS at home.[1] In the absence of tests for biological markers and environmental monitoring, questionnaires can be a simple and cost-effective method for assessing SHS exposure.[7] While adverse birth outcomes as a result of maternal smoking during pregnancy have been proven conclusively in numerous studies,[8,9] results have also emerged from various research done on the effect of SHS exposure during pregnancy, in terms of low birth weight (LBW) and preterm birth.[10-12] However, there is a paucity of data, more so in India, on the effect of SHS exposure during pregnancy on other birth outcomes such as birth length, head circumference at birth, and APGAR score (an indicator of health status in the early neonatal period).[13] There is also a dearth of scientifically

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robust studies with study designs better suited to establishing the effect of SHS exposure in pregnancy on birth outcomes. This study was therefore conducted with the aim of determining the effect of SHS exposure during pregnancy, on birth outcomes including neonatal anthropometry (birth weight, length, and head circumference), gestational age at birth, and APGAR scores in a tertiary care teaching hospital in Bengaluru city.

Methods

Study design and setting

A retrospective cohort study was conducted in a large medical college teaching hospital in Bengaluru city in 2018. This study received ethics approval from the institutional ethics committee.

Study population

Women who delivered in the hospital and were admitted in the postnatal ward were included in the study.

Sampling

With reference to a study by Gupta *et al*.,[12] which found 20% LBW among mothers unexposed to SHS and an estimated odds ratio of 2.2, with power of 90% and alpha error of 5%, we estimated that the minimum sample size to test a two-sided hypothesis was 104 postnatal women exposed to SHS during pregnancy and 104 postnatal women not exposed to SHS during pregnancy. Women were consecutively enrolled until the sample size was achieved in each group.

Inclusion criteria

Women with live singleton birth.

Exclusion criteria

Women who had smoked during pregnancy, had diabetes in pregnancy, or were seriously ill.

Data collection

Women were approached on second or third postnatal day, and after obtaining written informed consent, they were assigned to either exposed or nonexposed group, based on the reported SHS exposure during pregnancy.

Assessment of exposure

Global Adult Tobacco Survey questions[14] were used in research studies to determine SHS exposure among adults.[15-17] SHS exposure at home was taken to be present if the response to the question, "How often does anyone smoke inside your home?," was "at least once in a month" or if the subject answered "Yes" to the question, "During the past 30 days, did anyone smoke in indoor areas where you work?"

Study tool

A pretested, face-validated, structured interview schedule was used to capture sociodemographic and obstetric details. Socioeconomic status was determined using the Modified BG Prasad classification.[18] Patient's antenatal records and hospital charts were the source of data for maternal complications in pregnancy, maternal hemoglobin levels (earliest hemoglobin reading during pregnancy), mode of delivery, gestational age at birth, and neonatal anthropometry (birth weight, birth length, head circumference at birth, and APGAR score at 1 and 5 min).

Measuring outcome variables

Low birth weight

Low birth weight: Birth weight <2500 g irrespective of gestational age. Low birth length: Birth length <3rd percentile for newborn (<46.1 cm for boys and <45.4 cm for girls) based on the WHO Child Growth Standards.[19] Low head circumference: Head circumference <3rd percentile for newborn (<31.9 cm for boys and <31.5 cm for girls). Preterm: Gestational age at birth of 37 completed weeks. Low APGAR score: <7 at 1 min and at 5 min after birth.[13]

Statistical analysis

The IBM SPSS Statistics for Windows, version 17 (IBM Corp., Armonk, N.Y., USA). The data were checked for normality using Shapiro–Wilk test and normality probability plot. The study variables were described using frequencies, proportion, mean, standard deviation, median, and interquartile range. The exposed and nonexposed groups were compared with regard to confounding covariates, using Chi-square test, independent sample *t*-test, and Mann–Whitney U test as applicable. The strength of association between exposure to SHS and birth outcomes was expressed as relative risk with 95% confidence intervals. $P < 0.05$ was considered statistically significant for all analyses.

Results

A total of 208 subjects were included in this study, 104 exposed to SHS during pregnancy and 104 not exposed. The mean age of participants was 24.7 ± 4.1 years, and the mean years of education attained was 12.8 ± 2.8 years. Majority of subjects (80%) belonged to middle class. Most were homemakers (79.8%), residing in urban areas (68.8%), and had median per capita monthly income of Rs. 3333 (2000, 5000). At least one complication in pregnancy was experienced by 122 (58%) of the subjects, the most common being anemia, hypothyroidism, hypertension, and genitourinary infection. All the participants had tested negative for hepatitis B, HIV, and syphilis. None had consumed alcohol or drugs and smoked or chewed tobacco during pregnancy. There was no difference between the SHS-exposed and SHS nonexposed groups with regard to possibly confounding covariates such as age, education, occupation, income, gravida, and maternal complications in pregnancy [Table 1]. Of the 104 women exposed to SHS, 91 (87.5%) were exposed to SHS at home.

Regarding birth outcomes, nearly equal number of girls (49.5%) and boys (50.5%) were born to mothers in both exposed and unexposed groups. None of the babies had any congenital defects, 26.4% were LBW, 19.7% were preterm births, and 37% were born by cesarean section.

SHS exposure was significantly associated with LBW ($P = 0.041$) and low birth length ($P = 0.001$) [Table 2]. Among babies born to mothers exposed to SHS, the mean birth weight, mean birth length, and mean birth head circumference were significantly lower by 172.5 g ($P = 0.027$), 1.6 cm ($P = 0.001$), and 1.1 cm ($P = 0.001$), respectively. SHS exposure was not associated with mode of delivery, preterm birth, or low APGAR scores at 1 min and 5 min. Mothers exposed to SHS had double the risk of giving birth to an LBW baby (RR = 1.9 [1.0–3.6], $P = 0.02$) and two and a half times higher risk of giving birth to a low length baby (RR = 2.64 [1.4–4.6], $P = 0.001$) as compared to mothers without SHS exposure [Table 3].

Discussion

This study has elicited findings that point out to increased risk of adverse birth outcomes among women exposed to SHS during pregnancy. Both the exposed and nonexposed groups were found to be similar with respect to age, education, income, parity, and hemoglobin levels. Each of these variables is known to have an independent relationship with the birth outcomes we studied, either directly, for example, low hemoglobin is linked to low neonatal anthropometry,[20] or indirectly, for example, low per capita income leads to poor maternal nutrition levels, which in turn leads to LBW.[21] A study by Goel *et al*. in North India found that women exposed to SHS tend to be

Table 1: Comparison of secondhand smoke exposed and secondhand smoke nonexposed groups with regard to possibly confounding covariates (*n*=208)

Variable	Category	Total	SHS exposed (%)	SHS nonexposed (%)	*P*
Per capita income (Rs.)	Median (IQR)	3333 (000-5000)	3000 (2000-5000)	3333.3 (2055-5000)	0.311[a]
Gravida	Primi	132 (63.5)	67 (50.8)	65 (49.2)	0.581[b]
	Multi	76 (36.5)	37 (48.7)	39 (51.3)	
Maternal pregnancy complication	Yes	122 (58.7)	62 (50.8)	60 (49.2)	0.778[b]
	No	86 (41.3)	42 (48.8)	44 (51.2)	
Hemoglobin (%)	Mean±SD	11.1±1.5	11.0±1.6	11.1±1.5	0.632[c]

[a]Mann-Whitney U-test, [b]Chi-square test, [c]Independent sample *t*-test. SHS: Secondhand smoke, IQR: Interquartile range, SD: Standard deviation

Table 2: Comparison of various birth outcomes among the exposed and nonexposed groups (*n*=208)

Variable	Category	Total	SHS exposed (%)	SHS nonexposed (%)	*P*[a]
Gestational age at birth	Preterm	41 (19.7)	23 (22.1)	18 (77.9)	0.385
	Term	167 (80.3)	81 (77.9)	86 (22.1)	
Birth weight (g)	<2500	55 (26.4)	34 (61.8)	21 (38.2)	0.041*
	≥2500	153 (73.6)	70 (45.8)	83 (54.2)	
Birth length	<3rd percentile	86 (41.3)	55 (64.0)	31 (36.0)	0.001*
	≥3rd percentile	122 (58.7)	49 (40.2)	73 (49.8)	
Head circumference at birth	<3rd percentile	19 (9.1)	10 (52.6)	9 (47.4)	0.809
	≥3rd percentile	189 (90.9)	94 (49.7)	95 (50.3)	
Apgar at 5 min	<7	3 (1.4)	2 (66.7)	1 (33.3)	0.561
	≥7	205 (98.6)	102 (49.7)	103 (50.3)	

[a]Chi-square test, *Statistically significant with $P<0.05$. SHS: Secondhand smoke

Table 3: Relative Risk for various birth outcomes among mothers exposed to SHS (*n*=208)

Outcome	Category	Exposed to SHS *N*=104	Not Exposed to SHS *N*=104	Relative Risk (95% CI)	*P value*
Birth Weight	< 2500gm	34(32.7)	21(20.2)	1.9 (1.02-3.60)	0.041*
	≥2500gm	70(67.3)	83(79.8)		
Birth Length	<3rd percentile	55(52.9)	31(29.8)	2.6 (1.49-4.67)	0.001*
	≥3rd percentile	49(47.1)	73(70.2)		
Head Circumference	<3rd percentile	10(9.6)	9(8.7)	1.1 (0.43-2.88)	0.809
	≥3rd percentile	94(90.4)	95(91.3)		
Gestational age at birth	Preterm	23(22.1)	18(17.3)	1.3 (0.68-2.69)	0.385
	Term	81(77.9)	86(82.7)		
Apgar Score at 1 min	< 7	14(13.5)	9(8.7)	1.6(0.67-3.98)	0.269
	≥7	90(86.5)	95(91.3)		
Apgar Score at 5 min	< 7	2(1.9)	1(1)	2.0 (0.18-22.62)	0.561
	≥7	102(98)	103(99)		

*statistically significant at $P<0.05$. SHS= Second hand smoke, CI= Confidence Interval

less educated and of lower socioeconomic class than women not exposed to SHS. However, in our study, the two exposure groups were comparable with respect to these confounding covariates. This was probably because the mothers in our study came from a uniform socioeconomic background, with majority belonging to middle class. The overall rates of LBW, preterm deliveries, and cesarean sections were comparable to tertiary hospitals elsewhere in India.[22]

In our study, SHS exposure was significantly associated with LBW ($P = 0.041$) and low birth length ($P = 0.001$). This was also found in a study conducted in Malaysia with a similar study design to ours,[23] as well as a cross-sectional study in Saudi Arabia, where exposure to SHS was associated with lower anthropometric measurements at birth.[11] In our study, mothers exposed to SHS had twice the risk of delivering an LBW baby. Goel *et al*. similarly found double the risk of LBW among SHS-exposed mothers.[10] There are several potential pathways by which maternal SHS exposure affects birth weight and birth length: one is that SHS triggers maternal inflammation with rising cytokine levels causing placental damage and the other is that carbon monoxide and nicotine inhaled through SHS reduce placental blood flow. These biologically plausible theories were expounded in a study by Niu *et al*. in China, which found that not only birth weight but also placental weight was significantly lower among those exposed to SHS in pregnancy.[24]

Our study found a significant difference in anthropometric measurements at birth between the exposed and nonexposed groups. Mothers exposed to SHS delivered babies who were on an average 172.5 g lighter than those born of nonexposed mothers. Similarly, in studies in North India, by Goel *et al*. and Gupta *et al*., the mean birth weight among babies born to mothers exposed to SHS was 138 g and 282 g lower, respectively, than babies in the unexposed group.[10,12] These findings have implications for public health policy and practice, as this crucial additional birth weight gained by prevention of SHS exposure could help babies cross the 2500g cutoff, from LBW category to normal weight category.

While the difference in mean length (1.6 cm) and mean head circumference (1.1 cm) among the two groups was small, it was, nevertheless, significant. A similar small, but statistically significant mean difference of 0.26 cm in birth length and 1.1 mm in head circumference was noted in studies in Saudi Arabia[11] and Indonesia.[25] In our study, we also found that mothers exposed to SHS had 2.6 times higher risk of a low length baby. This has far-reaching public health implications, as short length at birth is a known risk factor for stunting among young children.[26] Avoiding SHS in pregnancy therefore becomes one way of addressing childhood stunting in the long run.

We did not find any association between SHS and low APGAR scores, unlike Gupta *et al*.,[12] who found that SHS exposure increased the risk of low APGAR scores at 5 min. However, the total number of babies with low APGAR scores at 5 min was only 3 (1.4%) in our study, a number too low to draw necessary statistical conclusion, as compared to 26 (9%) in theirs.

Considering that we found a significant risk of LBW and low birth length among women exposed to SHS during pregnancy, and the fact that an overwhelming majority of women who were exposed to SHS in our study reported SHS exposure at home, rather than the workplace, it is important that a "no tobacco smoke" environment at home be recommended for pregnant women. Doctors may utilize the opportunity afforded by regular antenatal visits (or home visits as in the case of grassroot-level health workers), to enquire about SHS exposure and advise pregnant women, their spouses and families regarding consequences of SHS exposure in terms of adverse birth outcomes, and the need to create a "no tobacco smoke" environment at home.

Conclusion

In the present study, we found that babies born to mothers exposed to SHS during pregnancy had significantly lower mean birth weight, lower mean birth length, and lower mean birth head circumference, as compared to babies born to mothers not exposed to SHS. Mothers exposed to SHS during pregnancy were twice likely to deliver LBW babies and babies of low birth length than unexposed mothers. Considering that we found a significant risk of adverse birth outcomes among women exposed to SHS during pregnancy, and the fact that SHS exposure occurred at home, rather than the workplace, it is important that a "no tobacco smoke" environment at home be recommended for pregnant women and their families.

Limitations of the study

Like most other research studies on SHS, we used self-reporting to assess exposure to SHS in our study, with a possible recall bias. Furthermore, as SHS exposure was not quantified in our study, a dose–response relationship could not be estimated. This, however, opens up further avenue for research in this area.

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Conflicts of interest

There are no conflicts of interest.

References

1. Mishra GA, Pimple SA, Shastri SS. An overview of the tobacco problem in India. Indian J Med Paediatr Oncol 2012;33:139-45.
2. Global Adult Tobacco Survey. Fact Sheet 2016-17. Ministry of Health and Family Welfare, Government of India, World Health Organisation and Centers for Disease Control, USA. Available from: https://www.who.int/tobacco/surveillance/survey/gats/GATS_India_2016-17_FactSheet.pdf?ua=1. [Last accessed on 2020 Apr 28].
3. National Center for Chronic Disease Prevention and Health Promotion (US) Office on Smoking and Health. The Health Consequences of Smoking – 50 Years of Progress: A Report of the Surgeon General. Atlanta (GA): Centers for Disease Control and Prevention (US); 2014. Available from: https://www.ncbi.nlm.nih.gov/books/NBK179276/. [Last accessed on 2020 Apr 28].

4. 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. Available from: https://www.ncbi.nlm.nih.gov/books/NBK44324/. [Last accessed on 2020 Apr 28].
5. Centers for Disease Control and Prevention. Smoking & Tobacco Use. Secondhand Smoke (SHS) Facts. 2020. Available from: https://www.cdc.gov/tobacco/data_statistics/factsheets/secondhand_smoke/general_facts/index.html. [Last accessed on 2019 Jun 18].
6. The Gazette of India. Controller of Publications. New Delhi: Govt of India Press; 30 May 2008;304:1-4. Available from: https://www.tobaccocontrollaws.org/files/live/India/India%20-%20G.S.R.%20417%28E%29.pdf. [Last accessed on 2019 Nov 07].
7. Avila-Tang E, Elf JL, Cummings KM, Fong GT, Hovell MF, Klein JD, *et al*. Assessing secondhand smoke exposure with reported measures. Tob Control 2013;22:156-63.
8. Miyake Y, Tanaka K, Arakawa M. Active and passive maternal smoking during pregnancy and birth outcomes: The Kyushu Okinawa maternal and child health study. BMC Pregnancy Childbirth 2013;13:157.
9. Knopik VS. Maternal smoking during pregnancy and child outcomes: Real or spurious effect? Dev Neuropsychol 2009;34:1-36.
10. Goel P, Radotra A, Singh I, Aggarwal A, Dua D. Effects of passive smoking on outcome in pregnancy. J Postgrad Med 2004;50:12-6.
11. Wahabi HA, Alzeidan RA, Fayed AA, Mandil A, Al-Shaikh G, Esmaeil SA. Effects of secondhand smoke on the birth weight of term infants and the demographic profile of Saudi exposed women. BMC Public Health 2013;13:341.
12. Gupta S, Malhotra A, Verma S, Deka M, Yadav R, Singh S. Effects of passive smoking (environmental tobacco smoke) on pregnancy outcome at district hospital, Jhansi, Uttar Pradesh. Int J Med Sci Public Heal 2015;4:1090.
13. Apgar V. A proposal for a new method of evaluation of the newborn infant. Curr Res Anesth Analg 1953;32:260-7.
14. Global Adult Tobacco Survey Collaborative Group. Tobacco Questions for Surveys: A Subset of Key Questions from the Global Adult Tobacco Survey (GATS). 2nd ed.. Atlanta, GA: Centers for Disease Control and Prevention; 2011.
15. Agrawal D, Aggarwal AK, Goel S. Women exposed to second-hand smoke more at home than at workplace: An analysis of GATS Report, India, 2009-10. J Family Med Prim Care 2015;4:293-7.
16. Lim KH, Lim HL, Teh CH, Kee CC, Heng PP, Cheah YK, *et al*. Second-hand smoke (SHS) exposure at home and at the workplace among non-smokers in Malaysia: Findings from the Global Adult Tobacco Survey 2011. Tob Induc Dis 2018;16:49.
17. Tong VT, Morello P, Alemán A, Johnson C, Dietz PM, Farr SL, *et al*. Pregnant women's secondhand smoke exposure and receipt of screening and brief advice by prenatal care providers in Argentina and Uruguay. Matern Child Health J 2015;19:1376-83.
18. Pandey VK, Aggarwal P, Kakkar R. Modified BG Prasad's Socio-economic Classification-2018: The need of an update in the present scenario. Indian J Comm Health 2018;30:82-4.
19. World Health Organization. Child Growth Standards. Geneva: WHO; 2006. Available from: https://www.who.int/childgrowth/standards/en/. [Last accessed on 2018 Sep 08].
20. Telatar B, Comert S, Vitrinel A, Erginoz E, Akin Y. The effect of maternal anemia on anthropometric measurements of newborns. Saudi Med J 2009;30:409-12.
21. Larson CP. Poverty during pregnancy: Its effects on child health outcomes. Paediatr Child Health 2007;12:673-7.
22. Das RK, Subudhi KT, Mohanty RK. The rate and indication of caesarean section in a tertiary care teaching hospital eastern India. Int J Contemp Pediatr 2018;5:1733.
23. Norsa'adah B, Salinah O. The effect of second-hand smoke exposure during pregnancy on the newborn weight in Malaysia. Malays J Med Sci 2014;21:44-53.
24. Niu Z, Xie C, Wen X, Tian F, Yuan S, Jia D, *et al*. Potential pathways by which maternal second-hand smoke exposure during pregnancy causes full-term low birth weight. Sci Rep 2016;6:24987.
25. Soesanti F, Uiterwaal CS, Grobbee DE, Hendarto A, Dalmeijer GW, Idris NS. Antenatal exposure to second hand smoke of non-smoking mothers and growth rate of their infants. PLoS One 2019;14:e0218577.
26. Utami N, Rachmalina R, Irawati A, Sari K. Rosha BC, Amaliah N, *et al*. Short birth length, low birth weight and maternal short stature are dominant risks of stunting among children aged 0-23 months: Evidence from Bogor longitudinal study on child growth and development, Indonesia. Mal J Nutr 2018;24:11-23.