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Pollution from biomass burning and environmental tobacco smoke in the household and its impact on low birth weight of babies in India

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ABSTRACT*: The study intends to analyze the causal relationship amid pollution within the household due to biomass burning and environmental tobacco smoke (ETS), and the occurrence of low birth weight (LBW) in India. The analysis is based on 20,946 currently married women, included in India's National Family Health Survey, conducted in 2005-06. The birth weight of babies has been categorized into standard birth weight (2500 gms. and more), LBW (1500 to 2499 gms.) and very LBW (500 gms. to 1499 gms.). The result indicates that women living in households, exposed to biomass pollution are one and a half times (RRR = 1.43) and 1.32 times at the risk of delivering LBW and very LBW babies respectively than women not exposed to biomass pollution. Also, women who are exposed to ETS are 1.56 times and 1.82 times at the risk of delivering LBW and very LBW.*

KEYWORDS: *biomass pollution, environmental tobacco smoke, standard birth weight, low birth weight, and very low birth weight*

I. INTRODUCTION

Low birth weight (LBW) that results from suboptimal intrauterine growth is associated with three major risk factors: exposure to environmental tobacco smoke (ETS) during pregnancy, low maternal weight gain, and low pregnancy weight. These three risk factors account for nearly two-thirds of all growth-retarded infants[1]. Cigarette smoking is the single largest modifiable risk factor for LBW and infant mortality[2]. In general, LBW is considered to be an important predictor of infant mortality and childhood morbidity, and may continue to be a risk factor for morbidities into adulthood. In addition to that the phenomenon of LBW affects the later growth and development of babies, which is no less important. However, LBW itself does not cause adverse health outcomes, but rather serves as a biomarker for the primary causal factors responsible for prenatal developmental disturbances that predispose to childhood disability. It is widely accepted that it is important to reduce exposure to risk factors for LBW whenever possible in order to decrease the associated burden of disability and disease.LBW is defined as birth weight less than 2,500 gms. Well over 90% of all LBW babies are born in developing countries, where approximately 18% of newborns weigh less than 2,500 gms. LBW results from a wide range of factors that determine premature birth, intrauterine growth retardation, or combinations of both of these outcomes.

Any conditions that interfere with trans- placental delivery of nutrients, including oxygen, may cause varying degrees and types of intrauterine growth retardation (IUGR). Of the environmental factors linked with reduced birth weight, tobacco smoking both active and passive has probably been the most extensively studied[3]. Active smoking is associated with a mean reduction in birth weight of up to 200 gm, whereas passive smoking has a smaller effect variously estimated at 20-120 gms[4]. A recent meta-analysis reported a weighted estimate of 28gm, with a greater decrement of 40 gms when pooling was restricted to the more homogeneous studies[5]. Carbon monoxide (CO) in particular and possibly nicotine are regarded as the agents most likely to be responsible for detrimental effects on intrauterine growth[6]. CO results from the incomplete combustion of any biomass, which includes tobacco and bio-fuels (wood, dung, and fiber residues) as well as fossil fuels. Once inhaled, CO combines with hemoglobin to form CO-Hb, a much more stable compound that does not readily give up O_2 to peripheral tissues and organs, including the fetus. In terms of emissions of suspended particulates and pollutant gases, the combustion of wood and other biomass is qualitatively similar to the burning of tobacco, although without the nicotine. Studies have shown that exposure to bio-fuel is associated with CO-Hb levels of 2.5-13%[7], covering the range seen for passive through heavy active smoking. It is therefore not unreasonable to expect that the effect of passive smoking on birth weight would also apply to pregnant women habitually exposed to high levels of bio-fuel smoke, as is the case in developing countries[8].

Around two-thirds of households in developing countries still rely on bio-fuels as their primary fuel[9], and unless there is a major change in energy and development policy in developing countries, such use will continue for the foreseeable future. It is now recognized that indoor use of bio-fuel in rural communities is responsible not only for some of the highest levels of ambient air pollution ever recorded but also for about half the global burden of exposure to air-borne pollutants.

II. STUDIES IN THE RECENT PAST

There is extensive evidence that ambient air pollution affects human health[10, 11, 12]. Most studies have focused on the effects of air pollution on adult mortality and respiratory morbidity[13]. There is now emerging evidence that air pollution is also associated with elevated risk of adverse pregnancy outcomes[14, 15]. The study of birth outcomes is an important emerging field of environmental epidemiology. Birth outcomes are important in their own right because they are important indicators of the health of the newborns and infants. In addition, LBW, intrauterine growth retardation (IUGR), and impaired growth in the first years of life are known to influence the subsequent health status of individuals, including increased mortality and morbidity in childhood and an elevated risk of hypertension, coronary heart disease, and non-insulin-dependent diabetes in adulthood[16]. It is increasingly apparent that there is a critical period of development when the timing of exposure and the dose absorption rate can be even more important for the biologic effects than is the overall dose[17]. Fetuses, in particular, are considered to be highly susceptible to a variety of toxicants because of their exposure pattern and physiologic immaturity[18]. Their developing organ systems can be more vulnerable to environmental toxicants during critical windows (sensitive periods of development) because of higher rates of cell proliferation or changing metabolic capabilities[19]. Therefore, prenatal exposure to environmental pollutants can result in some adverse reproductive outcomes, similar to the association between maternal active and passive smoking and impaired reproductive outcomes[20].

Air pollution and birth weight: -

The potential effects of air pollutants on birth weight were first examined in a small case-control study by Alderman. The study did not find any relationship between neighborhood ambient levels of CO during the third trimester of pregnancy and LBW[21]. Over the last decade, this question has been investigated in a number of studies. Lin et al. compared the rates of adverse pregnancy outcomes in an area polluted by the petrochemical industry and in a control area in Taiwan[22]. The exposed and control areas differed substantially in the levels of air pollution; for example, the differences in the mean concentrations of PM10 was 26.7 ug/m3. The RR of term LBW, when the petrochemical municipality was compared with the control municipality, was 1.77 times more. Ha et al. examined full-term births from 1996 through 1997 in Seoul, South Korea, to determine the association between LBW and exposure to CO, S02, N02, TSP, and O3 in the first and third trimesters[23]. They found that ambient CO, S02, N02, and TSP concentrations during the first trimester of pregnancy were associated with LBW; the RRs were 1.08 for CO, 1.06 for $S0_2$, 1.07 for $N0_2$, and 1.04 for total suspended particles (TSP). Bobak et al. tested the hypothesis that air pollution is related to LBW on data from a British 1946 cohort. They found a strong association between birth weight and air pollution index based on coal consumption[24]. After controlling for a number of potential confounding variables, babies born in the most polluted areas (annual mean concentration of smoke > 281 pg/m3) were on average 82gm lighter than those born in the areas with the cleanest air (mean smoke concentration < 67 pg/m3). Chen and others examined the association between PM_{10}, CO, and 0_3 and birth weight in northern Nevada (USA) from 1991 through 1999[25]. The results suggested that a 10-pg/m3 increase in the mean PM_{10} concentrations during the third trimester of pregnancy was associated a reduction in birth weight of 11gm. A time-series study in Sao Paulo, Brazil, found that birth weight was inversely related to CO in the first trimester; after controlling for potential confounders, a 1-ppm increase in the mean CO concentration in the first trimester was associated with a 23gm reduction in birth weight[26].

Given the potential problem with multiple comparisons and the heterogeneity of results, further studies are needed to confirm that the effect is indeed causal, to clarify the most vulnerable periods of pregnancy and the role of pollutants. There is ample literature to suggest that exposure to air pollution, particularly pollution originating from biomass fuels and ETS is causal factor for LBW. The pollutants present in burning biomass and tobacco are accountable for IUGR which in fact causes the incidence of LBW of babies. In developing parts of the world, including India, majority of household work related to cooking and heating is performed by using the biomass fuels. Moreover, in India, the prevalence of different forms of tobacco use is also high[27]. These two factors, either in association or in isolation exposes the pregnant women to the harmful effects of biomass burning and subsequently causes LBW of babies. In addition to that women, particularly in rural areas, are most exposed to biomass fuels. In spite of the fact that LBW of babies causes mortality and several kinds of morbidities among children less than one years of age; and many other disorders in later ages. Interestingly, very

few literatures are available in India regarding LBW of babies and its association between household pollution and ETS. Therefore, this study endeavors to explain the relationship between household pollution and ETS and its association with LBW of babies.

III. DATA SOURCE AND METHODOLOGY

For the present study data from the third round of National Family Health Survey (NFHS-III), 2005-06, has been used. The NFHS-3 collected information from a nationally representative sample of 124,389 women aged 15 to 49. The sample of the survey covers 99% of India's population living in all 29 states[28]. NFHS III survey is suitably designed to provide estimates of important indicators on family welfare, nuptility, fertility, mortality and child health care and nutrition at all India level and at state level too. The percent distribution of three categories of birth weight with respect to selected background characteristics have been calculated using the bivariate analysis. Also, the state wise differences with respect to all categories of birth weight have calculated using the bivariate analysis. Simultaneously, multivariate technique has been applied to find out determinants of LBW and very LBW. The dependent variables used in the analysis is the LBW of babies, which is in three categories namely, standard birth weight (more than 2500 gms.), LBW (1500 to 2500 gms.) and very LBW (less than 500 to 1500 gms.). Independent variables considered for the study are pollution in the household, smoking status of the any household member, age, place of the residence, educational status, religion, caste, household structure, wealth index, birth in the last five years, and iron tablets taken during pregnancy.

The response variable:

In the NFHS, currently married women in the age group of 15 to 49 had been asked, "When the child was born, was he/she very large, larger than average, average, smaller than average, or very small (Q# 435)?" Then responses were recorded accordingly. For more precise response, additional question were asked, "How much did the child weight (Q# 437)? The responses were recorded either from recall or form the birth card, if available. This study has used responses of the second question (Q# 437) as the dependent variable. The second response has been chosen because of the fact that mothers may not identify subjective options of the first question, that is, very large, larger than normal, average and smaller than average. Then, it has been categorized into three groups based on either from birth cards or recall namely, standard birth weight (SBW), LBW, and very LBW. The categorization of the response variable has been done considering the World Health Organization (WHO) definition for the SBW, LBW and very LBW.

The predictor variables:

The household pollution is the main explanatory variable in this study therefore; its computation has been done considering utmost care. To envisage the household pollution, three questions had been asked in the NFHS and the study has used all. The NFHS-3 used a thirteen-fold classification of cooking fuel namely electricity, LPG/ natural gas, biogas, kerosene, coal and lignite, charcoal, wood, straw/shrubs/grasses, agricultural crops, animal dung, no food cook in household and others. The question asked to the respondent was, "what type of fuel does your household mainly used for cooking?" (Q# 48) followed by the above list of fuels. Accordingly, the type of fuel used has been categorized into biomass fuel (coal and lignite, charcoal, wood, straw/shrubs/grasses, agricultural crops, animal dung and others) and cleaner fuel (electricity, LPG/ natural gas, biogas, kerosene). Secondly, for the type of cooking stove, the question was asked as, "In the household, is food cooked on a stove, chullah or open fire (Q# 49)? The responses for this question are modern stove, chullah and open fire. These responses have been made dichotomous by making stove as one and chullah and open fire as two. Finally, regarding the household pollution the question asked was, "Is the cooking done under a chimney (Q# 50)? Based on these responses, that is, household using biomass fuel, cooking is done using modern stove and under the chimney, the household have been computed as pollution free household or otherwise. Similarly, to know the smoking status, the NFHS-3 had asked, "Do you currently smoke cigarettes or bidi, locally made smoking tobacco, (Q# 566)? In addition to that to know the use of other tobacco, the question was asked, "In what other form do you currently smoke (Q# 568)? If responses were yes then the respondent has been categorized as smoker or else. Educational qualification has been categorized into three groups as "no education", "upto secondary education", and above secondary or "higher education". Similarly other variables have been categorized as found necessary.

IV. RESULTS

The bivariate result depict that 78.5% of all the births in India are standard births whereas, 19.5% and 2% of all births are low and very low births respectively (Table 1.). The table shows that households with no pollution have 70% standard birth weight. Out of the total LBW of babies, 57% are from the households where there is pollution in it.

Similarly, in the case of VLBW of babies, 62% of babies are from households where there is pollution. Therefore, the percent distribution indicates that large percentages of babies with LBW and VLBW belong to the households where there is pollution. But, this is not the case with use of tobacco by the household members. Out of the total LBW and VLBW of babies, only 6% and 8.5% have taken place in household where there are users of tobacco. The prime productive age group accounts for 46.7%, 87.9% and 86.8% of all SBW, LBW and VLBW respectively. Highest percentage of the standard birth weight babies have born to mothers in the age group 20 to 29 followed by 33% to mothers in the age group 30 to 49 years. Similarly, for LBW babies, 88% took place to mother's in the age group 20 to 29, followed by only 7.5% to mother's in the age group 15 to 19. In case of very LBW babies, 87% of the total is born to mothers in the age group 20 to 29 and 9% to mothers in the age group 15 to 19 followed by 4% to mothers in the age group 30 to 49. The concentration of all births in a particular age group is because of the fact that this group accounts for the largest number of birth in all socio economic and political settings.

Table 1. Percent distribution of birth weights (SBW, LBW and VLBW) with respect to different background characteristics in India, 2005-06

Background	SBW	LBW	VLBW
Total	**78.5**	**19.5**	**2.00**
Air pollution in the HH			
No	69.84	42.95	38.18
Yes	30.15	57.04	61.81
Environmental tobacco smoke			
No	88.9	93.86	91.48
Yes	11.09	6.13	8.51
Age of the mother			
15 to 19	20.66	7.39	9.06
20 to 29	46.66	87.92	86.81
30 to 49	32.66	4.68	4.12
Educational qualification			
No Education	41.6	62.74	53.44
Up to Primary	14.7	14.55	16.25
Secondary and higher	43.68	22.69	30.3
Place of residence			
Urban	46	40.4	37.7
Rural	53.9	59.5	62.2
Household structure			
Nuclear	52.95	40.22	40.24
Non-nuclear	47.04	59.77	59.75
Religion			
Others	5.41	6.24	5.78
Hindu	80.86	80.78	83.74
Muslim	13.72	12.96	10.46
Cast group			
Others	31.63	36.65	35.81
Other Backward Classes	40.66	38.19	38.29
Scheduled cast	19.17	18.87	22.58
Scheduled tribe	8.5	6.3	3.3
Wealth index			
Poor	42.7	55.1	51
Middle	20.2	20.5	19.8
Rich	37.1	24.4	29.5
Fe tab taken during pregnancy			
Yes	87.2	81.4	78.2
No	12.7	18.5	21
Nature of Work			
No physical work	21.6	12.1	10.3
Physical work	78.3	87.8	89.6

Note: SBW= Standard birth weight; LBW= Low birth weight; VLBW= Very low birth weight

Percentage of standard birth weight is highest for mothers with secondary and higher education which is 44% closely followed by mothers with no education which is 42%. In case of total LBW babies, 63% took place to mothers with no education followed by 23% to mothers with secondary and higher education. Similarly, out of the total very low birth babies, 54% took place to mothers with no education and 30% to mothers with

` secondary and higher education followed by 16% very LBW babies to mothers with up to primary education. Of the total SBW babies, 54% took place in rural areas and remaining 46 % in urban areas. But, in case of LBW babies, of the total 60% babies born in rural areas had low birth. This percentage is little high in case of very LBW of babies, that is, 63% in rural areas of India. This may be explained by the fact that in the rural areas about 94% of household relies on biomass fuel for cooking and heating[40]. Household structure is very important in case of Indian society; because unlike nuclear households, non-nuclear households have many household members to take care of the pregnant mothers. There are 53% babies born in the nuclear households have SBW in comparison to non-nuclear household where 47% babies have SBW. Of the total LBW babies, 60% took place in non-nuclear households and the remaining 40% took place in nuclear households. Similarly, in case of the very LBW babies, 60% took place in non-nuclear households and 40% took place in nuclear households. Hindus have 81 of the total SBW of babies followed by Muslims which is 14%. Of the total LBW of babies, Hindus again have the highest percentage amounting to81%. Out of the total very LBW of babies, Hindus have about 84% share compared to Muslims who have only 10% share. This may be because of the fact that Hindus constitute largest share of the total population, which is, among others, in the denominator. Out of the total LBW, 38% took place to women belonging to other backward class households, closely followed by mothers belonging to other households. In case of the very LBW of babies, other backward classes accounted for 38% of the total very LBW, closely followed by other which is 36%. Scheduled cast accounts for 23% o the total very LBW. Mothers belonging to poor households have 42% standard birth weight of the total birth weight closely followed by rich which is 37%. In case of LBW, 55% of the births have taken place to mothers belonging to poor households and 24% births have taken place to mothers belonging to rich households. Fifty one percent of the total very low births weight babies have taken place to mothers belonging to poor households followed by 30% births to mothers belonging to rich households.

Table 2 shows the state wise distribution of standard birth weight, LBW and very LBW. The percentage of standard birth weight is highest in Mizoram which is 93.5%. Arunachal Pradesh and Nagaland closely follow Mizoram in standard birth weight which is 86% in both the cases. The all India percentage of standard birth weight is 78.5%. There are 18 states where the standard birth weight is more than the national average. The major states where the standard birth weight is less than the national average are Himachal Pradesh, Punjab, Uttaranchal, Haryana, Delhi, Rajasthan, Uttar Pradesh, Bihar, and, Tripura. In case of LBW, the national average is 19.5%. The highest percentage of LBW takes place in the state of Haryana, which is little more than 32%. Majority of the north Indian states have LBW above national average. These states include Punjab, Uttaranchal, Himachal Pradesh, Delhi, Rajasthan, Uttar Pradesh, Bihar, and Tripura. Similarly, in the case of very LBW the north Indian states have higher birth weight than the national average. Though the national average is only 2% there are many states that have low birth babies of more than 4%, namely the state of Rajasthan.

Table 2. Percent of birth weights with respect to states/UTs, India. 2005-06

States/UTs	SBW	LBW	VLBW
India	**78.5**	**19.5**	**2.0**
Jammu & Kashmir	81.5	14.8	3.7
Himachal Pradesh	74.1	24.1	1.2
Punjab	71.9	23.9	4.2
Uttaranchal	75.0	22.4	2.6
Haryana	65.4	31.7	2.9
Delhi	75.1	23.0	1.8
Rajasthan	71.9	23.9	4.1
Uttar Pradesh	75.0	20.5	4.5
Bihar	73.8	22.8	3.4
Sikkim	90.9	9.90	0.0
Arunachal Pradesh	85.7	14.3	0.0
Nagaland	85.7	14.3	0.0
Manipur	88.1	11.9	0.0
Mizoram	93.5	6.50	0.0
Tripura	74.1	22.6	3.2

Table 2 Continued….

Meghalaya	82.2	17.8	0.0
Assam	82.3	15.7	1.2
West Bengal	79.3	19.0	1.6
Jharkhand	83.0	16.6	0.4
Odisha	80.5	17.9	1.6
Chhattisgarh	83.3	15.2	1.4
Madhya Pradesh	77.7	19.8	2.5
Gujarat	79.2	19.2	1.6
Maharashtra	78.0	20.2	1.8
Andhra Pradesh	80.8	18.5	0.7
Karnataka	81.9	16.8	1.1
Goa	78.9	21.0	0.0
Kerala	84.4	15.3	0.2
Tamil Nadu	83.5	14.4	2.1

Note: UTs = Union Territories

Table 3, shows the results of the multinomial logistic regression for the determinants of the LBW and very LBW. The analysis suggest that significant predictors of LBW are pollution in the household, use of tobacco, age of the mother, educational qualification of the mother, and iron tablets or syrups taken during pregnancy. Mothers living in the households where pollution from the biomass fuels is taking place are almost one and a half times more likely to give birth to LBW of babies compared to mothers living in households where there is no pollution. Whereas, women living in the households where pollution from the biomass fuels is taking place are 1.32 times more likely to give birth to very LBW of babies. In case of mothers or any other household member using any tobacco, the chances of LBW of babies are 1.44 times more compared to mothers or any other household member not using any tobacco. Similarly, mothers or any other household members using tobacco product in any form are 1.57 times more likely to give birth to very LBW of babies compared to mothers or any other household member who do not use any tobacco. Age of the women has an impact on the LBW and very LBW of babies. Mothers in the age group 15 to 19 are 1.66 times more likely to give birth to LBW of babies as compared to women in the age group 30 to 49. Furthermore, in case of very LBW, women in the age group 20 to 29 are 2.14 times more likely to give birth to very LBW of babies as compared to women in the age group 30 to 49. Educational qualification has also impact on the LBW of babies. Similarly, iron tablets taken during pregnancy have also effect on the LBW of babies.

Table 3. Relative risk ratio (RRR) from the multinomial logistic regression analysis for the determinants of low birth weight of babies in India, 2005-06.

Background variables	Low birth weight	Very low birth weight
Air pollution in the HH		
No pollution from biomass in HH [R]		
Pollution from biomass in HH	1.43***	1.32***
Environmental tobacco smoke		
No [R]		
Yes	1.56***	1.82***
Age of the mother		
30 to 49 [R]		
20 to 29	1.33***	2.14**
15 to 19	1.66***	1.2*
Educational qualification		
Secondary and higher [R]		
Up to Primary	1.24***	1.76***
No Education	1.3***	1.99***

Table 3 Continued….

Place of residence		
Urban [R]		
Rural	0.87	0.84
Household structure		
Non-nuclear [R]		
Nuclear	0.91*	0.83
Religion		
Others [R]		
Hindu	1.21*	1.16
Muslim	1.56**	1.84
Caste of the mother		
Others [R]		
Other Backward Classes	1.26	0.96
Scheduled cast	1.26***	0.47
Scheduled tribe	1.07***	1.33
Wealth index		
Rich [R]		
Middle	1.2	1.04
Poor	1.12	1.19
Fe tab taken during pregnancy		
Yes [R]		
No	1.5***	1.72***

[R] = Reference Category; *P<0.1, **P<0.05, ***P<0.01.

V. DISCUSSIONS AND CONCLUSIONS

In India, there are little more than 21% cases of LBW of babies in 2005-06. However, the distribution of LBW and very LBW is heterogeneous among different states of India. Bi-variate analysis depicts that the prevalence of LBW and very LBW is high in households where air pollution is high. In India, less than 30% of all households use safe fuel for daily use of cooking and heating which is free from pollution. The condition in the rural areas is particularly poorer, where merely about 10% of the households use safe fuel. Therefore, 90% of the populations in rural areas and about 45% of the population in the urban areas are exposed to the harmful effects of the biomass burning[29]. It is well established that the burning of the biomass fuel liberates CO_2, CO, particulate matter and other toxic gases. Although exposure was not measured directly in the current study, nevertheless, there is fairly substantial evidence to conclude that ambient air pollution due to biomass burning has an impact on the birth weight of babies[30, 6]. In addition, it is quite obvious that exposure to biomass fuel for more number of hours causes increase in CO-Hb level. Studies have shown that CO-Hb levels in people exposed to biomass fuels is 1.5-2.5%[12], 3.4%[31], and upto 13%[13]. Therefore, number of hours to the exposure is also important which has not been taken into account in this study because of data limitation. Although, it is a fact in the Indian social system and being predominantly a patriarchal society, women have to carry out all household activities which include cooking and cleaning. In addition, studies from many parts of the world have shown that women are exposed to very high levels of indoor air pollution from biomass fuel[5, 32] .Our result of the multinomial analysis has shown that household pollution due to burning of biomass fuel is responsible for the LBW and very LBW of babies which is in tune with several other studies[6, 32, 33]. Besides, the magnitude of likelihood of LBW due to biomass burning is high as compared to very LBW.

The impact of smoking on the birth weight of babies has been well documented. The present study finds that there is a strong relationship between ETS and the incidence of LBW and very LBW. Moreover, the scale of this relationship is higher as compared to the exposure due to biomass burning. The exposure to ETS

has two facet namely, prolonged exposure and partial exposure during pregnancy. Studies have shown that when mothers continue to smoke even during the second trimester, mean birth weight was strongly reduced by 150 gms. and 260 gm. for heavy smoker mothers[34]. Also, the impact of active smoking on birth weight is related to dose-response[35, 36]. Even, when mother do not smoke but, are exposed to second hand smoke, also called ETS, there is a significant positive relationship between ETS exposure and LBW[9,45,48,49]. In the light of this discussion, it is imperative to mention here that the prevalence of tobacco use is very high in India. According to the Global Adult Tobacco Survey India (GATS India), 2009-10, there are little more than 35% of tobacco users[38]. Moreover, 9% male and 2% female use smoking tobacco which is a huge number considering the base of the population of India.

This means that large number of women is exposed to the repercussions of different types of tobacco use and consequent LBW of babies in India. Apart from biomass fuel and ETS, there are certain socio-economic and demographic variables which is also contributing factor for the occurrence of LBW of babies, which must not be ignored. For example, age of the women is important indicator for LBW and VLBW. Similarly, relatively less educated or not educated women and women belonging to socially backward class (scheduled caste and scheduled tribe) are more likely to give LBW babies. There is growing evidence that kitchen smoke has a negative impact on the birth outcome of the birth weights of babies. In addition, there are known relationship like maternal nutrition, socioeconomic factors, demographic factors and regular prenatal examination. It is interesting here to mention that after controlling for all other factors, we found that exposure to biomass smoke is a risk factor for LBW of babies. We suggest that modern chullah (stove) for cooking, which is designed to liberate the smoke above the house through chimney could be an important intervention in minimizing the repercussions of biomass burning. Moreover, it is cost effective and could considerably reduce the amount of LBW.

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ABBREVIATIONS

ETS: Environmental tobacco smoke
LBW: Low Birth Weight
SBW: Standard Birth Weight
VLBW: Very Low Birth Weight