

Impact of Air Pollution on Stillbirth in India

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Abstract: -India has one of the world's most polluting cities. The rising concentration of air pollution and its associated health effects is rapidly increasing in India. PM_{2.5} can cause significant negative health impacts, as 349,681 pregnancy losses per year in India were associated with exposure to PM_{2.5} concentrations that exceeded India's air quality standard of 40 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) of small particulate matter (PM_{2.5}). The objective of this study is to estimate the impact of air pollution on stillbirth in India. We consider an econometric model using data obtained from the Central Pollution Control Board (CPCB), National Family Health Survey-5 (NFHS) and Health Management Information System (HMIS). The data spans over three-years with observations recorded on a daily basis from 2018 to 2020. We estimate a linear regression model (LRM) to explain the correlation of particulate matter (PM_{2.5}) and stillbirth in India. Estimated Predicted values are that almost all parameters are positively significant. The results indicate that pollution is significantly effect on stillbirth.

Key Words: Air pollution, Linear regression model (LRM), Particulate Matter (PM_{2.5}), Stillbirth.

INTRODUCTION

India has one of the world's most polluting cities. The rising concentration of air pollution and its associated health effects is rapidly increasing in India. India recorded the highest annual average PM_{2.5} concentration exposure in the world last year, according to the State of Global Air 2020. PM_{2.5} stands for Particulate Matter measuring 2.5 microns or less in diameter suspended in air. The major sources of particulate matter pollution are combustion (vehicular emissions industry emissions, residential and commercial biomass burning) and through reactions of other airborne pollutants. PM_{2.5} can cause significant negative health impacts, as 349,681 pregnancy losses per year in India were associated with exposure to PM_{2.5} concentrations that exceeded India's air quality standard of 40 micrograms per cubic meter ($\mu\text{g}/\text{m}^3$) of small particulate matter (PM_{2.5}).

Stillbirth is "complete expulsing or extraction of baby from its mother where the fetus does not breathe or show any evidence of life, such as beating of the heart or a cry or movement of the limbs" (HMIS). Finally A stillbirth is the death or loss of a baby before or during delivery. Air pollution in Delhi was linked to the loss of around 24,000 lives and 5.8 % of its GDP in the first half of 2020, despite a strict COVID-19 lockdown since March 25

report said. In 2019, the central government declared a "war on pollution" and announced the National Clean Air Programme (NCAP). The objective of this study is to estimate the impact of Particulate Matter 2.5 on stillbirth in India. We estimate a linear regression model (LRM) to explain the correlation of particulate matter (PM_{2.5}) and stillbirth in Indian.

Air pollution has significant effect on stillbirth in India. Delhi had the highest per-capita economic loss due to air pollution, followed by Haryana in 2019, with 5.4 times variation across all states [1]. One study on the effect of PM_{2.5} on the risk of stillbirth found a statistically nonsignificant increase in the risk of stillbirth per 10 $\mu\text{g}/\text{m}^3$ increases in PM_{2.5} [2]. The relationship between air pollution and low birth weight and preterm birth is a significant correlation [3]. The five leading risk factors for DALYs in 2016 were child and maternal malnutrition, air pollution, dietary risks, high systolic blood pressure, and high fasting plasma glucose [4]. Exposure to high levels of PM_{2.5} in the third trimester of pregnancy was associated with 42% increased stillbirth risk. Although the risk increase associated with high PM_{2.5} levels is modest, the potential impact on overall stillbirth rates could be robust as all pregnant women are potentially at risk [5]. A 10- $\mu\text{g}/\text{m}^3$ increase in pregnancy period PM_{2.5} exposures were associated with a 4 g (95% CI: 1.08 g, 6.76 g) decrease in birth weight and 2% increase in the prevalence of low birth weight [odds ratio (OR) = 1.02; 95% CI: 1.005, 1.041] after adjusting for gestational age, infant sex, maternal BMI, maternal age, history of a previous low birth weight child, birth order and season of conception. Study results also point to the need for considering maternal PM_{2.5} exposures alongside other risk factors for low birth weight in India [6]. Air pollution exposure during pregnancy in relation to spontaneous abortion and stillbirth. Evidence have shown adverse effects of air pollutants on pregnancy and birth outcomes. Pregnancy loss, including spontaneous abortion (miscarriage) and stillbirth, is the most severe adverse pregnancy outcome [7]. Following the literature, we

estimate the impact of Particulate Matter 2.5 on stillbirth in Indian specific states.

DATA AND METHODOLOGY

This study develops an econometric model using data obtained from the Central Pollution Control Board (CPCB), National Family Health Survey-5(NFHS) and Health Management Information System (HMIS). The data spans over three-years with observations recorded on a daily basis from 2018 to 2020. A total of 1572 observations were recorded in the dataset in India. This data set organized into data base in SAS. This data has been analyzed using SAS SQL routines.

Descriptive statistics of the PM2.5 and stillbirth are presented in Table 1. Approximately 17.87% were particulate matter 2.5 in Delhi. But 10.52% stillbirth is there. Karnataka has 5.20% pollution and childbirth alone is 13.12%. Stillbirth was not only caused by pollution, other variables also cause stillbirth. For example - Nutrition, mother care, income, body mass index, illiteracy, tobacco consumption and drinking alcohol, etc. A maximum value of 362.49 units PM2.5 was observed in Uttar Pradesh but the Maximum value of stillbirth 2515 in Rajasthan during 2018-2020 across the entire study area. Particulate matter 2.5 in Andhra Pradesh, West Bengal, Haryana and Madhya Pradesh are pollutant index is moderate. Gujarat, Karnataka, Maharashtra, Rajasthan, Tamil Nadu and Punjab are in poor stage. The highest air pollutant states are Uttar Pradesh, Bihar and Delhi are very poor or severe stage in India. And also Stillbirth in Haryana, Andhra Pradesh, Madhya Pradesh, and Punjab are the medium stage. Uttar Pradesh, Tamil Nadu, Bihar, Maharashtra, Rajasthan, and West Bengal are in high stage. Delhi, Gujarat, and Karnataka are very high or severe stages in India.

ESTIMATION

Equation 1 shows a linear regression model that can be used to estimate the PM2.5 and stillbirth.

$$y = f(x_1, x_2, \dots, x_k) + e \dots \dots \dots \text{Equation 1}$$

Where y is the dependent or explained variable and x_1, \dots, x_k are the independent or explanatory variables. In this setting, y is the regressand and $x_k, k=1, \dots, K,$ are the regressors or covariates.

$$SB = \beta_0 + \beta_1 SB + \beta_2 PM2.5 + \beta_3 BMI + \beta_4 ANC + \beta_5 NU + \beta_6 ED + \beta_7 TTT + \beta_8 GDP +$$

eEquation 2

Linear regression model is calculated using the Equation 2. SB (Stillbirth) is Dependent Variable. Independent variables or Particulate Matter (PM2.5), Body Mass Index (BMI), Antenatal Care (ANC), Nutrition (NU), Education (ED), Tetanus Toxoid (TT), Gross domestic product (GDP). In this estimated using the SAS system by combination of Base SAS. Regression was estimated for each variable of the data from 2018 to 2020.

RESULTS

The results indicate that the linear regression model (LRM). The result from the estimated models in indicate that Table 2. Shows that Particulate Matter 2.5, Gross Domestic Product, Pregnant Women given 180 Pregnant Women given Iron Folic Acid (IFA) tablets, Pregnant Women given 360 Calcium tablets, Pregnant Women given one Albendazole tablet after 1st trimester, Antenatal care, Institutional Delivery, Literate, Married before age 18 years, Body Mass Index, anemic and Blood sugar level. Particulate matter 2.5 negatively impacts stillbirth. Stillbirth is also on the rise as pollution increases and also People with anemia have more stillbirths. Stillbirth is less common among literacy women. These are all Parameters that show that positively significant Particulate matter Impact on stillbirth. Some parameters are positively significant related to stillbirth. Some more variables are negatively significant in these parameters. Results from our model are consistent with the results in previous literature.

CONCLUSION

This study developed model to estimate and predict impact of air pollution on stillbirth in India, using the air pollutant monitoring data provided by Central Pollution Control Board (CPCB), Health data National Family Health Survey-5 (NFHS) and Health Management Information System (HMIS). Regression model was estimated. Stillbirth was not only caused by pollution, other variables also cause stillbirth depend upon Nutrition, mother care, income, body mass index, illiteracy, tobacco consumption and drinking alcohol etc. Statistically significant differences exist in particulate matter 2.5 and stillbirth in India. Estimated Predicted values are that almost all parameters are significantly effect on stillbirth.

Table-1 Descriptive statistics of air pollution and stillbirth in India 2018-20

Particulate Matter (PM2.5)				
state	Max	Mean	StdDev	CV
Andhra Pradesh	86.529355	8.78514	23.08762	262.803073
Bihar	311.49211	81.5724	77.06402	94.4731517

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Delhi	242.47427	93.09926	67.68933	72.7066223
Gujarat	123.11964	26.36658	43.32706	164.325685
Haryana	183.91862	25.6351	40.58903	158.333775
Karnataka	78.893597	27.09327	18.18442	67.117842
Madhya Pradesh	103.21931	25.85604	28.67245	110.892661
Maharashtra	108.41	30.32782	27.1319	89.4620823
Punjab	142.467	41.00262	35.8404	87.4100287
Rajasthan	250.9131	36.96884	44.86716	121.364791
Tamil Nadu	76.875269	39.74974	22.6101	56.8811141
Uttar Pradesh	362.49258	72.43501	77.8195	107.433543
West Bengal	109.52231	11.93337	26.91078	225.508581
Stillbirth				
state	Max	Mean	StdDev	CV
Andhra Pradesh	418	42.51282	87.50816	205.839452
Bihar	1087	115.7607	210.5252	181.862429
Delhi	1247	144.9744	262.7798	181.259518
Gujarat	1733	155.641	311.2152	199.957068
Haryana	876	53.62393	119.6787	223.181541
Karnataka	1487	180.718	318.8691	176.4457
Madhya Pradesh	614	57.82906	106.3748	183.946909
Maharashtra	1989	117.3691	234.4236	199.731931
Punjab	649	64.76923	135.6158	209.383125
Rajasthan	2515	129.7786	301.4865	232.308363
Tamil Nadu	1219	105.1795	217.6485	206.930599
Uttar Pradesh	2005	83.77289	197.3455	235.57201
West Bengal	2231	125.3918	300.4233	239.587792

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Table-2 Brief descriptive of variables and Regression estimates from 2018 to 2020 in the observed data sample

Variable	Label	Parameter Estimate	Pr > t
Intercept		14.05291	0.0009
PM25	Particulate Matter 2.5	0.04615	0.3795
GDP	Gross Domestic Product	-0.00002544	0.0133
TT1	Number of PW given Tetanus Toxoid 1 (TT1)	0.01281	<.0001
TT2	Number of PW given Tetanus Toxoid 2 (TT2)	-0.00031098	0.8644
ttb	Number of PW given TT Booster	0.00129	0.2454
ifat	Number of PW given 180 Iron Folic Acid (IFA) tablets	-0.00184	<.0001
calt	Number of PW given 360 Calcium tablets	0.00156	0.0009
oat	Number of PW given one Albendazole tablet after 1st trimester	-0.00578	<.0001
anc	Number of PW received 4 or more ANC check ups	-0.00463	<.0001
ance	Number of PW given ANC Corticosteroids in Pre TermLabour	0.0651	<.0001
hb	Number of PW tested for Haemoglobin (Hb) 4 or more than 4 times for respective ANCs	-0.00291	<.0001
id	Number of Institutional Deliveries conducted (Including C-Sections)	0.01009	<.0001
tid	Out of total institutional deliveries number of women discharged within 48 hours of delivery	-0.00209	0.0207
hbnc	Number of newborns received 6 HBNC visits after Institutional Delivery	-0.00287	0.0046
lit	Women who are literate	10.87163	0.336
sch	Women with 10 or more years of schooling	-6.20379	0.5674
18ym	Women age 20-24 years married before age 18 years	-3.54527	0.4381
19yp	Women age 15-19 years who were already mothers or pregnant at the time of the survey	5.27051	0.6456
ib	Institutional births	-8.70589	0.3474
ibp	Institutional births in public facility	4.18774	0.4753
b/wnlBMI	Women whose Body Mass Index (BMI) is below normal (BMI <18.5 kg/m2)	14.27672	0.1184
owBMI	Women who are overweight or obese (BMI ≥25.0 kg/m2)	-14.1477	0.5916
49yanc	All women age 15-49 years who are anaemic	-17.0112	0.4105
19yanc	All women age 15-19 years who are anaemic	14.01442	0.289
hbs	Blood sugar level - high (141-160 mg/dl)	-67.08817	0.0502
vhbs	Blood sugar level - very high (>160 mg/dl)	113.79311	0.2819

Total Observation in all of the above variables 1572

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