Indian J.Sci.Res. 6(2) : 147-152, 2015

ISSN : 0976-2876 (Print)
ISSN : 2250-0138 (Online)

VEHICULAR POPULATION EXPLOSION: AIR POLLUTION EXPOSURE DURING PREGNANCY AND LOW BIRTH WEIGHT

R. RAJESWARI[1a], DEBBARMAN BINAYAK[b], S.O.SHARADHA[c], K.RAMYA[d] AND S. RAJESWARI[e]

[a]Department of Obstetrics and Gynaecology, Chief Medical Officer, ESIC Hospital, K.K. Nagar, Chennai, Tamil Nadu, India
[b]Department Obstetrics and Gynaecology, Specialist Grade 1, ESIC Hospital, K. K. Nagar, Chennai, Tamil Nadu, India
[cde]Department Obstetrics and Gynaecology, Senior Resident, ESIC Hospital, K. K. Nagar, Chennai, Tamil Nadu, India

ABSTRACT

Indian cities are highly polluted, there are very few Indian studies which try to correlate air pollution to low birth weight. The aim of this paper is to examine the relationship between Nitrogen oxides (NOx), Particulate matter (PM 10) and Low Birth weight in a polluted coastal city of India. Information about low birth weight (< 2.5 kg) for both the sexes and air pollution data mainly Nitrogen oxides and Particulate matter were collected. Increase in number of registered vehicles in Chennai was also investigated. We compared our study result with other studies conducted in rural and semi-urban parts of Tamilnadu on Low birth weight. PM 10 levels was much higher than WHO prescribed limit since the year 2000. Low birth weight rate is high in Chennai when compared to other parts of Tamilnadu. However there is a significant decrease in Low birth weight rate during the study period of 14 years. A marginal increase in average weight at birth was also noted. When we compare our low birth weight rate with the same in a rural and semi-urban population of Tamilnadu, we see that LBW rate in Chennai is almost two to three times higher. Though a cause and effect relationship cannot be established from this observation we may safely conclude that a well designed study is needed to confirm or refute this finding.

KEYWORDS : Low birth weight, Air pollution, Particulate matter, Nitrogen oxides

Air pollution has been drastically increasing due to rapid urbanization and motorization. Ambient particulate matter in polluted air is one of the major health threats and is found to be associated with cardiovascular diseases, lung cancer, asthma and adverse pregnancy outcomes such as preterm birth and low birth weight babies [Fleicher et al, 2014]. Chennai is the highly polluted city in eastern coast of India with rapid explosion of vehicular population. Chennai ranks fifth in carbon emission from the transport sector among the 54 South Asian cities according to a study done by the International Council for Local Environment Initiative (ICLEI) (Wikipedia, Transport in Chennai, 14.10.2014).

In recent past a number of studies have focused on relation of environmental pollution to birth outcome. Many of the studies have found that exposure to air pollution during antenatal period is related to low birth weight and preterm birth, though cause and effect relationship is yet to be established. Particulate matter in the air may cause inflammation and oxidative stress leading to preterm birth and low birth weight babies (Slama et al, 2008).

Many megacities in India like Delhi, Calcutta, Lucknow, Chennai are highly polluted. Unfortunately there are hardly any attempt made to find out the impact of air pollution on birth weight. Chennai is a rapidly growing megacity situated in the eastern coast of India. Because of rapid industrialization, quality of life and purchasing power of people has increased over the period of last 15 years. In comparison to other megacities, motorization rate is very high in Chennai. Vehicular population in Chennai has been steadily increasing from 600,000 in 1992 to 1.3 million in 2001 to 3,881,850 as on 1/4/2013 (Wikipedia, Transport in Chennai, 14.10.2014). With a vehicular density of 2093 vehicle per kilometer on road, Chennai ranks highest among Indian cities (Times of India Newspaper report, dated 6.05.2015). There are extensive studies in developed countries documenting the association between increasing air pollution and adverse pregnancy outcomes [Brauer et al , 2008], [Chang et al, 2012]. But in India there are very limited data available regarding this aspect. So we have collected the birth weight of the babies, air pollution indices and vehicular density data, to study the trend in the low birth weight and its association with air pollution indices over 14 years.

NOx and PM_{10} are the air pollutants most frequently used as markers for vehicular pollution. Outdoor NOx level can be easily measured and correlate well with pollutants generated by traffic. Previous studies have shown that particulate matter are more spatially homogenous and outdoor level may serve as an index of personal exposure.

[1]**Corresponding author**

The object of our study is to find out what is the impact of vehicular emission on Chennai environment and how it affects the birth weight of comparatively poorer section of the society in a developing country like India.

METHODS

Study Design

Our hospital is located in one of the busiest intersection of Chennai with very high traffic density. It mainly caters to the factory workers and families whose income is less than Rs.15,000 per month. Almost the whole study population live in Chennai Metropolitan area presumed to be within a diameter of 20 kms from the hospital. Patients living farther do not come to this hospital for delivery. All the mothers in our study group had basic education. Many are Graduates also. Though we don't have any data about maternal smoking, but smoking by ladies in this part of country is very uncommon. In our study population 1.67% are less than 20 years and 1.95% are above 35 years. Rest are within 20-35 years.

Labour room register from 1/1/2000 to 31/12/2013 was perused meticulously and data collected about birth weight and sex of the baby. Twins were not included. Number of study population was 19,223 mothers.

Birth Weight Assessment

Outcome variable was birth weight in kilograms. Birth weight was measured by the midwife or nurse who has attended the delivery, immediately after birth. Sex of the baby was also noted. Babies with ambiguous genitalia were excluded. We defined low birth weight as less than 2.5 kg which include Preterm, IUGR/ SGA.

Assessment of Air Pollution

Chennai has 5 air quality monitoring stations. They are located within a distance of 2-16 kms from our hospital in different directions. They measure SO_2, NOx , RSPM (Respirable Suspended Particulate Matter) less than 10 micron size. RSPM is equivalent to PM_{10} . We mainly focused on NOx and PM_{10} (RSPM) which are the main pollutants of vehicular emission.

They monitor the air quality twice in a week, on weekdays only, for 24 hours. Status of air quality in Chennai city during 2000-2013 was collected from Tamilnadu State Pollution Control Board (Annual Mean). Internet search was made and number of registered vehicle in Chennai from 1992 to April 2013 was found out. Though we could not delineate an area with a radius of few kilometers from Air Monitoring Station (AMS) within which all our patient resides, we are reasonably certain that most of our study population lives within 8 10 kms of AMS. We presume that pollution exposure will be correctly represented by the proximity of the house to AMS. We used average of air monitoring data across various AMS as the proxy of population exposure level to air pollution.

Potential Confounders

Birth weight depends on many demographic and pregnancy related factors like race, age, maternal education, nutrition, prenatal care, sex of the infants, pregnancy complication etc. Many of them we were unable to control because of missing data. However we collected data on weight at birth and low birth weight from studies conducted on similar population at other rural and semi-urban areas of Tamilnadu .We compared high exposure area of Chennai with other low exposure area. In addition we made a time-series analysis to find out the effect of air pollution on birth weight.

Statistical Method

The information collected regarding all the selected cases were recorded in a Master Chart. Data analysis was done with the help of computer using Epidemiological Information Package (EPI 2010) developed by Centre for Disease Control, Atlanta. Using this software range, frequencies, percentages, means and standard deviations were calculated. Correlation coefficient was calculated using Excel Software. If the value of 'r' between two variables is than +/- 0.5 , then those two variables are taken to be correlated.

RESULTS

Among the 19,223 deliveries, the average birth weight of the babies was found to be 2.84 kilograms (kg). Year wise number of deliveries and parameters such as parity and mode of delivery is shown in Table-1.Average birth weight of male and female babies is 2.970 kg and 2.88 kg respectively. Percentage of low birth weight babies in the

Table 1 : Yearwise Delivery Details

Year	Total deliveries	Primi		Multi		
		No.	%	No.		%
2000	1594	685	43.0	909		57.0
2001	1464*	624	42.6	840		57.4
2002	1234	580	47.0	654		53.0
2003	1715	808	47.1	907		52.9
2004	1805	835	46.3	870		53.7
2005	1832	834	45.5	998		54.5
2006	1691	691	40.9	1000		59.1
2007	1468	618	42.1	850		57.9
2008	1329	594	44.7	735		55.3
2009	1259	532	42.3	727		57.7
2010	1116	497	44.5	619		55.5
2011	979	402	41.1	577		58.9
2012	833	347	41.7	486		58.3
2013	904*	438	48.4	466		51.6
Total	19223*	8486	44.1	10737		55.9

Table 2 : Ambiguous Cases Details

Year	Mean Birth weight			Low birth weight %
	Male	Female	Total	
2000	2.84	2.77	2.8	31.9
2001	2.86	2.8	2.83	28.6
2002	2.85	2.77	2.81	29.6
2003	2.85	2.77	2.81	28.3
2004	2.86	2.78	2.82	27.6
2005	2.89	2.77	2.83	26.1
2006	2.82	2.77	2.8	29.9
2007	2.87	2.79	2.83	27.7
2008	2.92	2.82	2.87	21.1
2009	2.93	2.79	2.86	23.4
2010	2.9	2.81	2.85	22.7
2011	2.94	2.89	2.92	18.0
2012	2.97	2.88	2.93	17.8
2013	2.97	2.88	2.93	16.3
Total	2.88	2.8	2.84	25.8

year 2000 is 31.9% and it is declined to 16.3% in the year 2013. Average low birth weight over the 14 years period is 25.8 %. Average Birth Weight and Low Birth Weight of the babies from the year 2000 is shown in Table-2. There is an exponential rise of vehicular population over a period of last 20 years. Steady increase in RSPM / PM 10 from 67mcg/m 3 to 113 mcg/m 3 from the year 2000 to 2013 was observed. Details of air pollution parameters and percentage of excess prescribed over the Tamilnadu Pollution Control Board (TNPCB) standards from the year 2000 to 2013 is shown in the Table -3. The correlation coefficient between PM 10 and low birth weight was -0.8. The correlation between the air pollution indices and birth weight is shown in Table -4. There is a small increase observed in birth weight of both male and female babies over the study period of 14 years.

DISCUSSION

Air pollution is a major but prevenatable health threat. RSPM and NO x are the main parameters measured

Table 3 : Pollution Data Details

YEAR	NO_x	RSPM (PM_{10})	% of Excess of over prescribed standard of TNPCB		Vehicle strength
			NO_x	RSPM (PM_{10})	
2000	17	67	Nil	**11**	
2001	18	69	Nil	15	1300000
2002	13	72	Nil	20	
2003	14	60	Nil	Nil	
2004	20	68	Nil	13	
2005	24	67	Nil	11	
2006	25	62	Nil	3	
2007	18	95	Nil	58	
2008	23	133	Nil	121	
2009	24	92	Nil	53	
2010	21	91	Nil	51	
2011	19	137	Nil	128	
2012	19	119	Nil	98	37,60,000
2013	25	113	Nil	88	3881850

TNPCB values (till 18/11/09)

PM_{10} 60 mcg/ m^3 NO_x - 60 mcg / m^3

After 18/11/09

PM_{10} 60 mcg/ m^3 NO_x - 40 mcg / m^3

Table 4 : Correlation Between Environmental Pollution Parameters & Birth Variables During 2002-2013

Correlation Between	Correlation Coefficient With		
	NOX	RSPM	% of Excess of RSPM Above Prescribed Standard
No. of birth	0.1184	-0.7652	0.0968
Male birth weight	0.3873	0.8299	-0.2319
Female birth	0.2174	0.8561	-0.3375
Total birth weight	0.3258	0.8679	-0.3046
% of low birth weight	-0.4163	-0.8679	0.3841

and are associated with various cardiovascular, pulmonary hazards and adverse pregnancy outcome. In our study, the observed annual mean levels of RSPM and NOx are 113 mcg/ m_3 and 25 mcg / m_3 respectively in the year 2013. Though NOx levels were within the standard set up by WHO and TNPCB , PM 10 levels were continuously higher than the threshold value set up by these authorities. (Refer Table 3). The WHO guideline value for PM_{10} and NO_2 are 20 mcg/ m_3 and 40 mcg/ m_3 respectively [WHO Air Quality Guidelines, 2013]. Ambient air contains a dynamic mixture of pollutants and are known to cause endocrine disturbances, altered placental growth, decreased placental exchange of nutrients and gases resulting in oxidative stress [Pederson et al., 2013]. Studies from USA and other developed countries shows the association of PM_{2-5} and preterm birth [Brauer et al 2008] [Chang et al., 2012], although few other studies did not find any relation [Wilhelm et al., 2012][Rudra et al., 2011]. But studies in South Korea and China shows the association between PM_{10} and preterm birth and low birth weight [Suh et al., 2009], [Jiang et al., 2007], [Zhao et al., 2011].

Our study is a crude attempt where we wanted to investigate the relationship of increase in vehicular population with Chennai environment and its effect on the

weight of newborn. Chennai is a coastal city and probably sea breeze has got a detoxifying effect on the Chennai environment. Hence in spite of threefold increase in vehicular population from 2001 2013, air quality did not deteriorate as expected.

We compared our study result with three other studies conducted in rural and semi- urban areas of Tamilnadu on birth weight of newborn. In one study conducted in a rural area of Vellore, LBW was found to be 11.81 % (between Jan 2005 and Oct 2008) [Balaji et al, 2010].During this period LBW was 26.2 % in our study at Chennai. In another Pan Indian study [Ramesh Chellan et al, 2007], incidence of low birth weight in Tamilnadu was quoted as 11.1%.(1995- 1997). In a third study conducted at a small District hospital (Perambalur) LBW was found to be 11.6% [Dandekar et al , 2014]. Rural areas of Tamilnadu are mostly pollution free. In our present study, LBW percent was found to be 31.9 % in 2000 which kept on falling and became 16.3 % in 2013, still higher than low birth weight rate in Tamilnadu. In another study conducted at CMC, Vellore average birth weight of new born babies was found to be 2945 grams [Mathai et al, 1996]. It was higher than the average birth weight 2800 grams in our study. From these observations we cannot come to the inference that air pollution was the causative factor of increased percentage of low birth weight. This issue requires further investigations. A direct approach of measurement of air pollution in the study area around the maternal residence would have been more helpful.

In our time series analysis, we found that PM 10 level almost doubled over a period of 14 years. However in contrary to the expectation percentage of low birth weight decreased significantly and there was a small increase in the average birth weight over a period of 14 years. This may be attributable to a number of factors like improved antenatal care, maternal nutrition and literacy, reduced indoor air pollution due to increased penetration of smoke free LPG gas stove etc. Probably in a developing country like India, the above mentioned factors have got more impact on the birth weight and nullifies or reverse the effect of air pollution.

CONCLUSION

With more than 3 million eight hunderd thousand vehicle on the road , Chennai air is one of the most polluted in India. Probably in a coastal city like Chennai, sea breeze has got a detoxifying effect on environment.

Comparison of our study results with other studies conducted in Tamilnadu suggests that increased percentage of low birth weight in Chennai may be due to Air pollution.

This may also be suggested that negative effect of air pollution on birth weight may be reversed or nullified by improving other factors like maternal nutrition, education etc. which are more powerful determinant of birth weight in a developing country.

REFERENCES

Brauer M., Lencar C., Tamburic L., 2008. A Cohort Study of Traffic Related Air Pollution impacts on Birth outcomes. Environ health perspect 116:680-686:doi10.1289/ehp.10952.

Chang H. H., Reich B. J., Miranda M. L., 2012.Time to-event analysis of fine particle Air Pollution and preterm birth: Results from North Carolina, 2001-2005 AmJ Epidemiol 175.91-98.

Jiang L. L., Zhang Y. H. and Song G. X., 2007. A time series analysis of outdoor air pollution and preterm birth in Shangai, China. Biomed Environ Sci20 :426-431.

Kavitha Balaji, Satish Sankar, Balaji Nandagopal, 2010.Low Birth Weight of Newborns .Indian Journal of Community Medicine 2010 April; **35**(2):362-364.

Marie Pederson, Lise Giorgis- Allemand, Claire Bernard, 2013. Ambient air pollution and low birth weight:- European Cohort study (ESCAPE)- Published online October 15. http://dx.doi.org/10.1016 /S2213-2600(13) 070192.9.

Matthews Mathai, Saramma Jacob, NG karthikeyan 1996.Birth weight Standards for South Indian Babies. Indian Paediatrics Volume 33- March.

Michael Wilhelm, Jo Kay Gosh, Jason SU, 2012. Traffic Related Air Toxics and Term low birth weight in Los Angels County, California. Environ Health Perspect, 120:132-138 doi.org/10.1289/ehp.1103408.

Nancy L. Fleicher, Mario Merialdi, Aaron van Donkelaar, 2014 .Outdoor Air pollution, Preterm Birth , and Low birth weight; Analysis of the World Health Organization Global survey on maternal and perinatal health. Environmental Health perspective / volume 122.

Rahul Hanumant Dandekar, Mohd.Shafee, Sati Prasad Sinha 2014. Prevalence and risk factors affecting low birth weight in a district hospital at Perambalur, Tamilnadu. GJMEDPH, Volume 3, issue 2.

Ramesh Chellan, Lopamudra Paul, PM kulkarni January July 2007. Incidence of Low birth weight in India .Journal of Health and Development, **3** : 182 .

Rudra C. B., Williams M. A. and Sheppard L., 2011. Ambient Carbon Monoxide and fine particulate matter in relation to Preeclampsia and Preterm delivery in Western Washington State. Environ Health Perspect 119:886-892; doi10.1289 /ehp1002947.

Slama R., Darrow L. and Parker J., 2008. Meeting Report: Atmospheric pollution and Human Reproduction.Report of the Munich International Workshop.Environ HealthPerspect 116:791-798.doi10.1289/ehp.11074.

Suh YJ, Kim H, Seo JH, 2009. Different effects of PM10 exposure on Preterm Birth by gestational period estimated from time-dependant survivalAnalysis.Int Arch Occup Environ Health **82**:613-621.

WHO Air quality and health, 28/11/2013.

Zhao Q. G., Liang Z. J. and Tao S. J., 2011. Effects of Air pollution on Neonatal prematurity in Guangzhou of China: a time-series study. Environ Health 10:2;doi:10.1186/1476-069X-10-2.