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Impact of Industrialization on Nutritional and Health Status of Pregnant Women and Their Obstetric Outcome

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ABSTRACT Sixty pregnant women 30 each in Group I(Industrial area) and Group II (Non industrial area in the age group of 20 to 28 years, belonging to low income group having monthly per capita income of Rs 969.83 and Rs 631.87 of Bathinda city were selected during 7th month of pregnancy . The mean daily intake of energy, proteins, carbohydrates, vitamins B12, niacin, iron, folic acid, sodium and zinc was inadequate when compared with ICMR standards. Common symptoms of iron deficiency were pale conjunctiva, paleness of skin, pallor of tongue and fatigue. The mean birth weight was 1923.3+359.0 and 2320+-426.3 gram in Group I and II respectively. It was further observed that 16.67 and30.0 percent of newborns had respiratory infections and fever at the time of birth. It could be due to poor hygienic status, higher maternal exposure to pollutants in Group I. It is concluded that inadequate nutrient intake, poor sanitation and exposure to environmental pollutants resulted in higher incidence of prematurity and low birth weight in subjects of Group I.

INTRODUCTION

Pregnancy is one of the most critical and unique period of a woman's life cycle. Though, it is the most exciting period of expectations and fulfillments, it is a condition of great stress because many anabolic activities take place and foetal growth is accomplished by extensive changes in maternal body composition and metabolism. Maternal nutrition is the most important determinant of the course and outcome of pregnancy. It is estimated that 75% of the foetal growth is related to maternal nutritional status and it not only determines the state of off-springs at birth but also the future course of its development and health in late adult years (Pallavi et al. 2002).

Anemia is a major and pressing problem among pregnant women in India, being as high as 60-70 per cent. Maternal anaemia is associated with an increased potential morbidity and mortality. In pregnant women, the prevalence of iron deficiency anemia exceeds 80 per cent. It is directly or indirectly responsible for about 20 per cent maternal deaths and is also significant contributor to foetal waste, premature births and low birth weight infants (Mehta and Dood 2004).

Foetal malnutrition is intimately related to the health and nutrition of the mother which depends on her biosocial environment. Maternal exposure to air pollution adversely impacts birth outcomes such as low birth weight, preterm delivery, IUGR (intra-uterine growth retardation) and post neonatal infant mortality etc. (Bell et al. 2007). Environmental pollution is a growing problem of mankind because it affects the health and nutritional status of an individual. Pollution is common especially in industrial cities where, despite the legal restrictions, factories and sewage works dump dangerous substances like fertilizers, chemicals, heavy metals and other industrial wastes in the river and air. Thus, water, food chain and air are adversely affected by pollution which result in many diseases like respiratory diseases (Bronchitis, asthma), infectious diseases like typhoid, diarrhoea, dysentery, cancer, immuno-toxicity, reproduction defects (poor weight gain during pregnancy and low birth weight babies) etc. (Eastwood 2002). Effect of environmental pollution on Punjabi women, especially pregnant women, particularly those in the "Cancer belt" of Bathinda, could be considered a "problem of high magnitude" (Gupta and Gupta 2006). Hence, the present study was undertaken to see the effect of nutritional and health status of pregnant women and their obstetric outcomes in industrial and non-industrial areas of Bathinda city.

MATERIALS AND METHODS

Selection of the Subjects: A statistically adequate sample of sixty pregnant women aged 20-28 yrs, belonging to low income group were selected and divided into two groups, *viz.* group I (Industrial) and group II (non-industrial area). Group I comprised of 15 subjects each from

National Fertilizer Limited and Guru Nanak Dev Thermal Plant, Bathinda city and the rest 30 subjects from village Bandi as Group II, being non-polluted area as it was 30 km away from industrial area.

Collection and Analysis of Data: Background information pertaining to age, education, total and per capita income, life style, economic status, living conditions and obstetric history etc. was elicited through the interview schedule. Nutrient intake was calculated by "MSU nutriguide" (Song et al. 1992). Clinical assessment was carried out to see the mani-festation of nutrient deficiency symptoms. History of serious diseases like asthma, bronchitis etc. was also recorded. Morbidity pattern of the subjects was also observed. Anthropometry of the newborns was recorded within 24 hr. of delivery (Jelliffee 1966). Roher's Ponderal Index was also calculated by using following formula:

Ponderal Index = Birth weight (g)/[Crown heel length]^3 x 100

Statistical Analysis: The data was analyzed with the help of various statistical tools such as mean, standard error and percentage. Student's t-test was applied to test the significance of mean difference of various parameters of newborns.

RESULTS AND DISCUSSION

As per the demographic information, the mean age of the subjects was 23.5±2.1 and 24.1±2.0 yrs. in group I and group II, respectively. The majority (46.66 and 26.67 per cent) was educated upto middle school in both the groups and the remaining 36.67 and 33.33 per cent were literate in both the groups, respectively. The level of education was recorded to be higher in group I (83.33 per cent) as compared to group II (60 per cent). Statistical data reported that only 57 and 63.55 per cent females respectively,were literate in India and Punjab (Anonymous 2007). The information regarding the occupation and economic status of the subjects depicted that most of the subjects in both the groups were housewives (100 and 93.33 per cent) and remaining 6.67 per cent were maid servants in group II. Further, it was observed that majority of the husbands of the subjects were agricultural labourers and shopkeepers in group II, whereas all the husbands of the subjects in group I were workers in the fertilizer factory and thermal plant. The average monthly per capita income was Rs. 969.83 and 631.87 in group I and II, respectively. While the average per capita income at constant prices was Rs. 30701 (Anonymous 2007). Living conditions and hygiene status were poor in the group I. The data revealed that majority (56.67 and 66.67 per cent) of the subjects were in primipara, while the remaining 26.67 and 26.67 per cent in second, 16.67 per cent in terci in group I and 6.67 per cent in multipara in group II. It was observed that very few subjects visited Anganwadis and Primary Health Centre for health services and medical treatment. Very few subjects took iron supplements in both the groups. Lack of awareness was the main cause for not taking supplements.

Nutrient Intake

Tables 1 and 2 depicted that the mean daily intake of energy by the subjects was 1712.3±158.7 and 1635±201; 1920±124 and 1862±181 kcal during both the months of pregnancy. The intake was increased during 9th month and could be due to increased consumption of cereals, sugar and jaggery and fats and oils. The mean daily intake of protein in the two groups was 50.5±4.5 and 49.6±5.8 ; 56.2±4.3 and 55.5±5.2 g, respectively. The mean daily intake of carbohydrate was 241.6±24.6 and 231.9±31.7; 269.5±19.5 and 33.7 g in both the groups, respectively. The mean daily intake of fats and oils was 60.4±7.3 and 56.6±7.4 ; 68.6±6.0 and 61.2±6.7 g during both the months, respectively. The higher intake of fats and oils in both the groups during 9th month could be due to more consumption of *desi ghee* (butter oil) and hydrogenated fat by most of the subjects as they used to put extra *ghee* in milk, vegetables, *saag* and pulses. The average daily intake of β-carotene was adequate during 7th month but decreased in 9th month due to less availability of GLV's. The intake of retinol, and vitamin-C was more than adequate due to consumption of carrots, green leafy vegetables and citrus fruit whereas the intake of Vit.-B1, B2, niacin and folic acid was inadequate. Low intake of Vit-B12 among the subjects might be ascribed to lack of non-vegetarian foods in their diet. It was clearly related to poor purchasing power of the subjects. The mean daily intake of iron decreased during 9th month in both groups because of decreased intake of green leafy vegetables and *jaggery.* Pathak et al. (2004) reported that nearly 73.5, 2.7,

Table 1: Average daily nutrient intake of the subjects

Food items	*7th Month*			*9th Month*			*RDA**
	Group-I (N=30) Average±SE	*Group-II (N=30) Average±SE*	*t-value*	*Group-I (N=30) Average±SE*	*Group-II (N=30) Average±SE*	*t-value*	
Energy (Kcal)	1712 ±158	1635 ±201	1.655^{NS}	1920 ±124	1826 ±181	1.402^{NS}	2175
Protein (gm)	50.5 ± 4.5	49.6 ± 5.8	0.648 ^{NS}	56.2 ± 4.3	55.5 ± 56.2	0.561^{NS}	65
Carbohydrates (gm)	241.6 ± 24.6	231.9 ± 31.7	1.322 ^{NS}	269.5 ± 19.5	272.3 ± 33.6	0.389^{NS}	353
Total fats (gm)	60.4 ± 7.3	56.6 ± 7.4	1.998 ^{NS}	68.6 ± 6.0	61.2 ± 6.7	4.427**	55
Carotene (µg)	2260.0 ±128.7	2688.2 ±109.0	4.170**	1776.6 ±174.6	1880.3 ±203.3	2.42**	2400
Retinol (µg)	947.5 ±430.8	982.5 ±452.5	0.306 ^{NS}	8558.5 ± 90.3	885.3 ±327.3	0.004^{NS}	600
Thiamine (mg)	1.15± 0.1	1.0 ± 0.1	2.990**	1.1 ± 0.1	1.0 ± 0.1	4.486**	1.1+0.2
Riboflavin (mg)	1.0 ± 0.3	0.5 ± 0.3	2.862**	1.2 ± 0.1	1.2 ± 0.1	2.543**	1.3+0.2
Niacin (mg)	11.7 ± 1.3	11.0 ± 1.5	1.726 ^{NS}	12.9 ± 1.0	12.6 ± 1.5	0.868^{NS}	14+2
B_{12} (mg)	0.5 ± 0.0	0.5 ± 0.1	0.130 ^{NS}	0.6 ± 0.0	0.6 ± 0.0	0.960^{NS}	1
Folic acid (µg)	258.8 ± 65.5	283.0 ± 91.9	1.865^{NS}	246.6 ± 74.5	274.6 ± 70.8	1.689^{NS}	400
Vitamin-C (mg)	43.6 ± 14.8	46.1 ± 27.8	1.545**	41.9 ± 12.9	43.0 ± 14.6	1.022^{NS}	40

* ICMR 1999
** Significant at 5% level
*** Non-significant at 5% level

Table 2: Average daily intake of minerals among the subjects

Food items	*7th Month*			*9th Month*			*RDA**
	Group-I (N=30) Average±SE	*Group-II (N=30) Average±SE*	*t-value*	*Group-I (N=30) Average±SE*	*Group-II (N=30) Average±SE*	*t-value*	
Iron (mg)	15.2 ± 1.8	15.7 ± 1.3	1.184^{NS}	13.7 ± 1.9	14.5 ± 1.8	1.608 ^{NS}	38
Calcium (mg)	897.1 ±139.0	867.5 ±139.0	0.892 ^{NS}	903.5 ±171.9	887.7 ±129.3	0.849 ^{NS}	1000
Phosphorus (mg)	1311.2 ±129.1	1257.2 ± 16..1	1.4231 ^{NS}	1463.2 ±116.2	1426.8 ±142.6	1.084 ^{NS}	1200
Sodium (mg)	153.3 ± 24.0	151.03± 16.2	0.428 ^{NS}	130.9 ± 19.9	126.2 ± 23.1	0.428 ^{NS}	500
Potassium (mg)	1593.6 ±148.9	1567.6 ±198.8	0.574 ^{NS}	1842.3 ±159.3	1813.1 ±193.4	0.638 ^{NS}	800-1300
Magnesium (mg)	306.6 ± 37.7	290.0 ± 51.8	1.421 ^{NS}	357.3 ± 28.0	356.9 ± 50.2	0.041 ^{NS}	300
Zinc (mg)	5.2 ± 0.6	4.8 ± 0.84	2.338**	6.03± 0.6	5.8 ± 0.7	2.891**	14

* ICMR (1999)
** Significant at 5% level
*** Non-significant at 5% level

43.6, 73.4, 26.3 and 6.4 per cent pregnant women were deficient in zinc, copper, magnesium, iron, folic acid and iodine, respectively and over 90 per cent of pregnant women were consuming the nutrients even less than 50 per cent of the recommended intake. Similar results have also been reported by Shobeiri et al. (2006). The intake of calcium, phosphorus, potassium and magnesium was more than adequate due to higher intake of milk and milk products and bananas. Intake of iron, sodium and zinc met less than 50 per cent of the total requirements as suggested by ICMR (1999).

Health Status of the Subjects

Clinical symptoms of nutritional deficiencies have been presented in table 3. Among vitamin deficiencies, mottled enamel teeth (66.67 vs 33.33 per cent) and bleeding gums (66.67 vs 33.33 per cent) were most common. The morbidity status of pregnant women showed that 83.33 and 96.67 per cent of the subjects were normal in group I and II, respectively. Common symptoms of iron deficiency were pale conjunctiva (93.3 vs 83.3 and 73.3 vs 46.6 per cent), paleness of skin (90.0 vs 70.0 and 76.6 vs 53.3 per cent), pallor of tongue (90 vs 63.3 and 76.6 vs 53.3 per cent), pigmentation of skin (66.67 vs 60.0 and 80.0 vs 736.3 per cent) and fatigue (90.0 vs 76.6 and 80.0 vs 63.3 per cent). The data revealed extensive prevalence of anaemia among the subjects which was as high 93.3 per cent in group I as compared to group II (83.3 per cent). Prevalence of anaemia was as high as 89.5 per cent in female population of rural Punjab (Gupta and Gupta 2006).

Complications During Pregnancy

Complications during pregnancy have been summarized in table 4. Most of the pregnant women 86.6 and 80.0 per cent experienced nausea, 63.3 and 70.0 per cent vomiting and 40.0 and 23.3 per cent suffered from constipation in group I and II respectively. Whereas the percentage of the subjects suffered from abdominal cramps was 46.6 and 26.6, 40.0 and 20.0 during 7th and 9th month of pregnancy. The percentage of subjects suffered from backache was 66.6 and 73.3 ; 70.0 and 76.6 in group I and II during both the months of pregnancy. Jayasree and Kavitha (2004) reported that majority of the pregnant women in low income group suffered from discomforts such as nausea, vomiting, weakness, constipation and backache.

Morbidity Status of the Pregnant Women

Table 5 presents the morbidity status of the pregnant women. Asthma was very common among the subjects of group I. The percentage of subjects, suffered from hypertension was 36.67 and 33.33 ; 10.0 and 3.33 during 7th and 9th month in both the groups, respectively. A higher percentage of fever (63.33 and 40.0 per cent) was seen in group I as compared to group II. Incidence

Table 3: Clinical assessment and nutritional deficiency symptoms among the subjects

Symptoms	*7th month*		*9th month*	
	Group-I (n=30)	*Group-II (n=30)*	*Group-I (n=30)*	*Group-II (n=30)*
(a) Anaemia				
1. Paleness of skin	27(90.0)	21(70.0)	23(76.6)	16(53.3)
2. Pallor of tongue	27(90.0)	19(63.3)	23(76.6)	16(53.3)
3. Pale conjunctiva	28(93.3)	25(83.3)	22(73.3)	14(46.6)
4. Flat nails of				
i) Fingers	6(20.0)	1(3.33)	3(10.0)	1(3.33)
ii) Toes	6(20.0)	1(3.33)	3(10.0)	1(3.33)
5. Incidence of headache	28(93.3)	24(80.0)	16(53.3)	14(46.6)
6. Feeling of lethargy	17(56.6)	8(26.6)	11(36.67)	4(13.33)
7. Feeling of fatigue	27(90.0)	23(76.6)	24(80.0)	19(63.3)
i) Morning	1(3.33)	-	2(6.67)	-
ii) Noon	19(63.3)	22(73.3)	19(63.3)	14(46.67)
iii) Evening	5(16.67)	1(3.33)	1(3.33)	3(10.0)
iv) Whole day	1(3.33)	-	2(6.67)	2(6.67)
8. Bleeding gums	20(66.67)	10(33.3)	20(66.67)	10(33.3)
9. Teeth mottled enamel	20(66.67)	10(33.3)	20(66.67)	10(33.3)
10. Pigmentation of skin	20(66.67)	18(60.0)	24(80.0)	22(73.33)

*Multiresponse

of cold was also high as the percentage was 40.0 and 26.67 ; 23.3 and 6.67 in group I and II during both the months of pregnancy. Incidence of cough and typhoid was also higher in group I as compared to group II. The other problems like GI infections and hepatitis were also observed in group I. Ramakrishnan (2004) too reported that air pollution was the contributory factor of infections, hypertension to the pregnant women and also resulted in low birth weight infants.

Anthropometric Measurements of Newborns

Anthropometric measurements of newborns in group I as compared to the newborns in group II is presented in table 6. The mean birth weight was 1923.3±359.0 and 2320.0±426.3 g in group I and II, respectively. A significantly ($p \leq 0.05$) lower birth weight was observed in group I as compared to group II, because of high exposure of environmental pollutants and higher rate of prematurity as the mean gestational age of the newborns in group I and II was 34.2±3.71 and 38.4±0.94 weeks. Bell et al. (2007) reported that an interquartile increase in gestational exposure to NO2, CO, PM10 and PM2.5 (particulate matter with aerodynamic diameter <10, <2.5 µm) lowered the birth weight by 8.9g, 8.2 g and 14.7 g, respectively. Gouveia et al. (2004) also reported that exposure of 1 ppm of CO increase was inversely related to 23 g reduction in birth weight. Other anthropometric measurements *viz.*, crown heel length (45.9±3.7 Vs 47.9±2.6 cm), head circumference (28.7±2.9 Vs 30.1±2.4 cm), chest circumference (30.3±2.8 vs 31.6±2.5 cm) and mid-upper arm circumference (9.8±1.4 vs 10.1±1.3 cm)

Table 4: Incidence of complication during pregnancy among the subjects

Symptoms	*7th month*		*9th month*	
	Group-I (n=30)	*Group-II (n=30)*	*Group-I (n=30)*	*Group-II (n=30)*
Nausea	26(86.6)	24(80.0)	4(13.3)	3(10.0)
Daily	3(10.0)	2(6.6)	-	-
Weekly	5(16.6)	10(33.3)	2(6.67)	1(3.3)
Alternate day	1(3.3)	6(20.0)	-	-
Occasionally	11(36.6)	6(20.30)	2(6.6)	2(6.6)
Vomiting	19(63.3)	21(70.0)	2(6.6)	4(13.3)
Daily	-	1(3.3)	-	-
Weekly	9(30.0)	6(20.0)	1(3.3)	3(10.0)
Alternate day	6(20.0)	9930.0)	1(3.3)	1(3.3)
Occasionally	4(13.3)	5(16.6)	-	-
Constipation	12(40.0)	7(23.3)	8(26.6)	6(20.0)
Cramps	14(46.6)	8(26.6)	12(40.0)	6(20.0)
Morning	4(13.3)	2(6.6)	8(26.6)	2(6.6)
Evening	10(33.3)	4(13.3)	4(13.3)	4(13.3)
Night time	-	2(6.6)	-	-
Backache	20(66.6)	22(73.3)	21(70.0)	23(76.6)
Whole day	6(20.0)	1(3.3)	7(23.3)	9(30.0)
Evening	8(26.6)	14(46.6)	8(26.6)	8(26.6)
Night time	6(20.0)	7(23.3)	6(20.0)	5(16.6)

*Multiresponse

Table 5: Incidence of morbidity status among the subjects

Symptoms	*7th month*		*9th month*	
	Group-I (n=30)	*Group-II (n=30)*	*Group-I (n=30)*	*Group-II (n=30)*
Hypertension	11(36.67)	3(10.0)	10(33.33)	1(3.33)
Asthma	6(20.0)	-	6(20.0)	-
Fever	19(63.33)	12(40.0)	2(6.67)	1(3.33)
Cold	12(40.0)	8(26.67)	7(23.3)	2(6.67)
GI infections	2(6.67)	-	2(6.67)	-
Cough	12(40.0)	8(26.67)	7(23.3)	2(6.67)
Hepatitis	3(10.00)	-	-	-
Typhoid	7(23.3)	-	1(3.33)	-
Normal	-	18(60.0)	25(83.3)	29(96.67)

*Multiresponse

Table 6: Anthropometric measurements of the newborns

Anthrompometric measurements	*Group-I (n=30) Average +SE*	*Group-II (n=30) Average +SE*	*t-value*	*ICMR* standards*
Birth weight (gm)	1923.3 ± 3.59	2320.0 ±426.3	2682**	2700 - 2800
Crown-heel length (cm)	45.9 ± 3.7	47.9 ± 2.6	2.581**	47.7 -48.50
Head circumference (cm)	28.7 ± 2.9	30.1 ± 2.4	2.247**	32.6 -33.50
Chest circumference (cm)	30.3 ± 2.8	31.6 ± 2.5	2.218**	30.2 -33.50
Mid-upper-arm circumference (cm)	9.8 ± 1.4	10.1 ± 1.3	0.827^{NS}	12.0 -12.22
Ponderial index	1.88 ± 0.2	2.15± 1.21	2.112**	2.25- 2.85
Gestational age (weeks)	34.2 ± 3.71	38.4 ± 0.94	3.310**	38-42

* Gupta (1978)
** Significant at 5% level
*** Non-significant at 5% level

were also lower in the newborns in group I as compared to the newborns in group II. Ponderal index can be used to detect aberrant intra-uterine growth independent to gestational age. The average value of Ponderal index was also lower in group I (1.8±0.2) as compared to group II (2.1±1.2) but lower than the reference standard (ICMR 1999) in both the groups due to low birth weight and crown heel length. Pharaoh (2003) reported that low birth weight would be either due to preterm delivery due to exposure of pregnant women to environmental toxins like DDT and other pesticides which led to intra-uterine growth retardation and less gestational age of the newborns. Wilhelm and Ritz (2003) also reported that 10-20 per cent risk of premature birth and low birth weight for infants born to the women living near high traffic areas or industrial areas.

Health Profile of the Newborns

Out of 60 live births (30 in each group), 40.0 per cent newborns suffered from Jaundice in group I, whereas in group II, the corresponding percentage was 16.67. It was further observed that 16.67 and 30.0 per cent had respiratory infections and fever at the time of birth and only 13.33 and 53.33 per cent of newborns were with normal health conditions in group I and II, respectively (Table 7). It could be due to poor hygiene status and higher maternal exposure to pollutants in group I.

Table 7: Health profile of newborns

Neonatal health	*Group-I (n=30)*	*Group-II (n=30)*
Jaundice	12(40.0)	5(16.67)
Respiratory infections	5(16.67)	2(6.67)
Fever	9(30.00)	7(23.33)
Normal	4(13.33)	16(53.33)

Multi response

CONCLUSION

In the light of above discussion, the scrutiny of data indicated that inadequate nutrient intake, poor sanitation, high morbidity status, poor iron status and exposure to environmental pollutants resulted into higher incidence of prematurity and low birth weight in the subjects of group I.

RECOMMENDATIONS

Besides the remedial techniques, new schemes and laws should be proposed and employed strictly to minimize the environmental pollution and maintain sanitary conditions as it resulted to poor birth outcomes. Environmental education and awareness programme should be implemented for the masses because *"unless the environment is healthy, the individual cannot be healthy"*.

REFERENCES

Anonymous India 2007. *A Reference Manual.* Ministry of Communication and Broadcasting, Govt. of India.

Bell ML, Ebiser K, Belanger P 2007. Ambient air pollution and low birth weight in Connecticut and Massachusetts. *Environ Health Perspect,* 115: 1118-1124.

Eastwood M 2002. *Principles of Human Nutrition.* New Delhi: Atlantic Publishers and Distributors.

Gouveia N, Bremer SA, Novaes HM 2004. Association between ambient air pollution and birth weight in Sao Paulo, Brazil. *J Epideml Comm Health,* 58(1): 11-17.

Gupta V, Gupta S 2006. Prevalence of anaemia in youth males and females in rural Punjab. *Abstract of the*

paper presented at 61st Annual Conference of the Association of Physicians of India from 30th Jan. to 2nd Feb. 2006 at Patna.

ICMR Dietary guidelines for Indians 2004. *A Manual*. Hyderabad: National Institute of Nutrition (ICMR).

Jayasree S, Kavitha T 2004. Pregnancy induced hypertension and its effect on the foetus. *Ind J Nutr Dietet*, 41: 256-264.

Jelliffe DB 1966. *The Assessment of Nutritional Status of Community* World Health Organization. Monograph Series No. 53, Geneva: WHO.

Mehta MB, Dood NS 2004. Effect of different levels of iron supplementation on maternal iron status and pregnancy outcome. *Ind J Nutr Dietet*, 41: 467-76.

Pallavi, Kharade P, Anthony U 2002. Nutritional status and outcome of pregnancy in youth and older mothers in Mumbai. *Ind J Nutr Dietet*, 39: 26-30.

Pathak P, Kapil U, Kapoor SK, Sexena R, Kumar A, Gupta N, Dwivedi SN, Singh R, Singh P 2004. Prevalence of multiple micronutrient deficiencies among pregnant women in a rural area of Haryana. *Ind Pediatrics*, 71: 1007-14.

Pharaoh CA 2003. Relation between ambient air pollution and low birth weight in northeastern United States. *Environ Health Perspective*, 109 351-356.

Ramakrishnan U 2004. Nutrition and low birth weight. *Amer J Clinical Nutr*, 79**:** 17-21.

Shobeiri F, Begum K, Nazari 2006. A prospective study of maternal haemoglobin status of Indian women during pre-pregnancy and pregnancy. Abstract Reviews, cited from doi:10.1016/j.nutres.2006.05 .008.2006.

Song WO, Roere S, Bond J, Kalarala M, Mann S, Sehgal S, Pande U, Singh I, Mehta U, Rohindeva PA 1992. Nutritional Analysis Computer Programme, Michigan State University, America .

Wilhelm M Ritz 2003. Residential proximity to traffic and adverse birth outcomes in Los Angeles, California. *Environ Health Perspect*, 111: 207-16.