

An epidemiological study of anthropometry and physical activity of mothers as determinants of low birth weight in Wardha, India

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Abstract:

Introduction: Low Birth Weight(LBW) bring on an impaired growth to infant with its associated risk factors of higher mortality rate, increased morbidity, impaired mental development and risk of chronic diseases in adult hood. LBW babies are likely have developmental delays leading to start school late, dropout from school, complete fewer years of schooling, grow into stunted adult, and suffer from lower productivity and chronic diseases in future life. Prevalence of LBW in India is 22% as reported by NFHS III. **Objective:** To study the anthropometric and physical determinants of LBW babies in Wardha district,India. **Material and Methods:** A Case Control study conducted in Government Hospital Wardha, to explore the determinants of LBW. Cases were defined as single live born baby who had birth weight <2500 gms as per WHO. One control was selected for each case from consecutive live birth, who had birth weight \geq 2500 gms in the same hospital. Information was obtained by indepth maternal interview, and medical records. Anthropometric measurement of mother and newborn baby was taken within 48 hrs after birth. Data entered and analysis done in the computer using Epi-Info 6.04. **Results:** Among various anthropometric and physical determinants of LBW studied, the determinants which found significant were maternal weight less than 40 Kg, gestational weight gain of <6 Kg, maternal BMI <18.5 Kg/m² and MUAC < 23 cm, previous history of giving birth to LBW babies, maternal anemia, physical activity during pregnancy, less additional calories consumption during pregnancy. **Conclusions:** Maternal weight, gestational weight, maternal BMI. MUAC, previous history of LBW babies, maternal anemia, physical activity during pregnancy, less additional calories consumption during pregnancy were found significant determinants in present study.

Key Words: Low Birth Weight(LBW), anthropometry, physical activity

Introduction

Birth weight is an important criteria for predicting the neonatal and infant survival. Low birth weight(LBW) has been defined by the World Health Organization (WHO) as birth weight of less than 2500 grams.¹ This is adapted as practical cut-off for international comparison, based on epidemiological observations that infants weighing less than 2500 grams are approximately 20 times more likely to die than heavier babies.² Birth weight is a useful parameter in predicting the future growth and development of child. It can be used in identifying "at risk" families and help in decision making during the implementation of

intervention programs especially in countries and regions with limited resources.³

Mortality, morbidity and disability in neonates, infancy and childhood is more common in high income countries, it state that poor health range nothing but a birth weight below 2500 grams. Meanwhile, LBW has serious and long term effect on health of every type of age group specially relates to adult life. Low birth weight results in extensive expenditure on to the health profession and as well shows significant burden on human health to world health.⁴ Low birth weight nothing but an impaired growth of infant by means of its assistant hazards factor of advanced death rate,

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increased morbidity, impaired psychological improvement and possibility of persistent diseases in adult.⁵ Low birth weight babies are likely to begin school late, give up of school, entire fewer years of schooling, develop into undersized adult, and may be suffer from lower efficiency and chronic diseases in afterward life.⁶

As of now, it is well accepted that birth weight is not only a serious determinant of continued existence and development, but also a important display of maternal physical condition, nourishment and quality of life. Low birth weight (LBW) remains an unresolved important national concern in India. Its seen that Twenty-nine percent of infant mortality rate in India is associated with LBW. Low birth Weight babies who are 11-13 times at higher risk of mortality during the neonatal period witness three fourth of all neonatal deaths when compared to normal birth weight babies.⁸

An important component of Millennium Development Goals (MDGs) of reducing child mortality which can be achieved by reduction of LBW babies. Activities directed towards achievement of the MDGs needs to ensure a healthy start in life for children by ensuring that women commences healthy pregnancy, and undergoes pregnancy and childbirth safely. Low birth weight is therefore an important indicator in monitoring progress of internationally agreed goals.⁶ In India, one of the major child survival goals to be achieved by 2000 AD was to reduce the proportion of LBW babies to below 10%, which could not be achieved.⁹

It is overall agreed that the etiology of LBW is multifactorial.² Determinants of LBW are likely to vary between different populations. In his meta-analysis on determinants of LBW, Sir Kramer reviewed 895 studies.² He identified 43 potential factors, which were mainly genetic and constitutional factors, obstetric factors, demographic and psychosocial factors, nutritional factors, maternal morbidity during pregnancy, and care during pregnancy etc. Various other studies also have been carried out globally to assess the magnitude and to identify the major determinants of LBW.^{2,8,10}

Newborn's birth weight depends on the stay in utero, his intrauterine environment and also effect of maternal factors. Low birth weight indicates that the baby did not remain in utero long enough or it did not develop enough.¹¹ The identification of factors contributing to low birth are of utmost importance. Different obstetric factors, Genetic factors, socio-demographic factors, maternal morbidity

during pregnancy, nutritional factors, toxic exposures and antenatal care are all reported to impact the occurrence of LBW. Its public health priority to prevent LBW, particularly in developing countries with high prevalence. Less studies are focused on the maternal factors as determinants of LBW. Debates continues on independent effect of each of these factors. Hence, the present study was undertaken to explore the determinants of LBW.

Material and methods

A Case control study conducted at the Obstetric ward of a District Hospital from January 2013 to December 2013. Singleton live born with term gestation had birth weight below 2500 grams were registered as cases.¹ The cases were selected serially till the required numbers of cases were completed. Cases excluded, where family not willing to participate in the study, Baby born with multiple pregnancies and Baby born to mothers with chronic illness. Singleton live born babies of birth weight equal to or more than 2500 grams delivered with term gestation in the same hospital, were taken as control for the study. For each case, the next available newborn baby born within 5 days of the birth was selected as control. One control was selected per case. While selecting the controls, matching was done by categories of gestational age was done. The gestational age were categorized as <39 weeks, ≥ 39 to <41 weeks and ≥ 41 weeks. Inclusion and Exclusion criteria for the controls were same as cases. Sample size was calculated keeping 95% confidence and 80% power to detect a minimum odds ratio of 2.0 assuming that the least prevalent factor will be present in minimum 10% of the controls as reported by Anand¹² in his study. Sample size was calculated using the STATCALC program of EPI6. Program calculated a sample size of 307 cases and 307 controls.

Data was collected on a pre-designed and pre-tested questionnaire by interviewing mother after taking informed consent. The questionnaire included information on basic demography, maternal anthropometry, Dietary history and physical activity of mother.

Maternal anthropometry (weight, height, BMI and MUAC as described in NFHS 3) were taken as a proxy of baseline maternal nutritional status. Efforts were made to verify information regarding the maternal and obstetric factors from the ante-natal/maternal health records wherever possible.

Weight of newborn was taken within 24 hours after birth to the nearest 10 gm before the postnatal weight loss commences. The naked baby was placed on electronic

Tables 1: Distribution of cases and controls by gestational age

Gestational age categories	Cases N=307 (%)	Controls N=307 (%)
<39 weeks	100 (32.6)	100 (32.6)
=39 to <41 weeks	171 (55.7)	171(55.7)
=41 weeks	36 (11.7)	36 (11.7)

Table 2: Association of maternal anthropometry with Low Birth Weight

Maternal parameters		Cases N=307(%)	Controls N=306*(%)	Odds Ratio	95% CI	p-value
Anthropometric parameters						
Maternal weight (Kg)	<40	101 (32.9)	67 (21.9)	1.75	1.20-2.55	0.002*
	=40	206 (67.1)	239 (78.1)	1	-	
Maternal height (cm)	<145	29 (9.4)	22 (7.2)	1.35	0.73-2.50	0.31
	=145	278 (90.6)	284 (92.8)	1	-	
Gestational weight gain (Kg)	<6	183 (59.6)	123 (40.2)	2.20	1.57-3.07	0.001*
	=6	124 (40.4)	183 (59.8)	1	-	
Body mass index	<18.5	187 (60.9)	148 (48.2)	1.67	1.20-2.34	0.002*
	=18.5	120 (39.1)	159 (51.8)	1	-	
MUAC (cm)	<23	222 (72.3)	196 (63.8)	1.48	1.04-2.11	0.02*
	=23	85 (27.7)	111 (36.2)	1	-	
Obstetric parameters						
Birth order	1	155 (50.5)	144 (46.9)	1.15	0.83-1.60	0.38
	2 or more	152 (49.5)	163 (53.1)	1		
Birth spacing(Months)	<24	62 (20.2)	61 (19.9)	1.23	0.76-1.98	0.38
	=24	87 (28.3)	105 (38.2)	1		
Any Morbidity in pregnancy	Yes	112 (36.5)	104 (33.9)	1.12	0.79-1.58	0.5
	No	195 (63.5)	203 (66.1)	1		
Previous history of LBW	Yes	46(37.8)	28(19.9)	2.44	1.36-4.41	0.001*
	No	76(62.2)	113(80.1)	1		
Maternal Anemia any time during pregnancy	Moderate to severe anemia	140(45.6)	102(33.3)	1.68	1.19-2.36	0.002*
	No or mild anemia	167(54.4)	204(66.6)	1		
Unplanned Pregnancy	Yes	195 (63.5)	189(61.6)	1.09	0.77-1.53	0.61
	No	112 (36.5)	118(38.4)	1	-	
Utilization of antenatal services						
Early Registration months	=3	60 (19.5)	36(11.7)	1.83	1.14-2.93	0.008*
	<3	247 (80.5)	271(88.3)	1	-	
Number of antenatal visits	<3	14 (4.6)	4(1.3)	3.62	1.10-13.17	0.02*
	=3	293 (95.4)	303(98.7)	1	-	
IFA tablets Consumed	<75	169 (55.0)	129(42.0)	1.69	1.21-2.36	0.001*
	=75	138 (45.0)	178(58.0)	1		
Rest/ sleep during Pregnancy	<10	94 (30.6)	93(30.3)	1.02	0.71-1.46	0.93
	=10	213 (69.4)	214(69.7)	1	-	

weighing machine and same weighing scale was used for both cases and controls.

Information on dietary intake of the mothers of the study subjects was obtained. Inquiry was made about the amounts of all foods and liquids taken in the past 24 hour. Calorie intake was calculated using the 24-hours recall method.¹³

The physical activity score was measured by using the Physical Activity Scoring System which was given by Ramachandran et al.¹⁴ We used this system for measuring physical activity of mother's of study subjects during antenatal period by modifying the category of occupation/work. The data entry and analysis was done in the computer using EPI-INFO version 6.04. Odds ratio was calculated to find out the association of various factors under

study with low birth weight. Prior approval from the institutional ethical committee was taken.

Results

While enrolling the controls frequency matching for gestational age of the baby was done by dividing the babies in three categories of gestational age - a) less than 39 weeks, b) ≥ 39 to <41 weeks and c) ≥ 41 weeks. Table 1 above gives the distribution of cases and controls as per the gestational age categories.

As seen in table 2 a higher proportion of mothers of cases (32.9%) had weight less than 40 Kg than mothers of controls (21.9%), giving a statistically significant odds ratio of 1.75

(95% CI:1.20-2.55; p-value=0.002). Less than 10% of mothers in both the groups (among 9.4% cases and 7.2% controls) had height less than 145 cm. The relationship between maternal height and odds of delivering a low birth weight baby was not statistically significant. A higher proportion of mothers of cases (59.6%) had weight gain of less than 6 kg during the current pregnancy as compared to controls (40.2%) with odds ratio of 2.20 (95% CI: 1.57-3.07; p-value <0.001), was statistically significant. Similarly, a higher proportion (60.9%) of mothers of cases had body mass index (BMI) less than 18.5 as against 48.2% of controls. The odds ratio in this case was 1.67 (95% CI: 1.20-2.34; p-value=0.002). Among the mothers who had MUAC less than 23 cm had delivered 72.3% of LBW babies while 63.8% delivered normal weight babies. The odds was 1.48 (95% CI: 1.04-2.11; p=0.02).

Table 2 shows that higher proportion of mothers of cases (37.8%) had previous history of low birth weight as against 19.9% of controls. The odds ratio in this case was 2.44 (95% CI: 1.36-4.41; p-value=0.001). This was highly significant. Similarly higher proportion of mothers of cases (45.6%) had moderate to severe anemia as against 33.3% of controls. The odds of moderate to severe anemia was 1.68 (95% CI: 1.19-2.36; p-value=0.002) for the cases. This was found statistically significant. Birth order, birth spacing, any morbidity during pregnancy were not found to be associated with LBW.

Table 2 shows four fifth of the mothers were registered within less than 3 months of gestational age. A higher proportion of cases (19.5%) had registered after 3 months of gestational age than the controls (11.7%). The odds of being registered after 3 months of gestational age was 1.83 (95% CI: 1.14-2.93; p-value=0.008) for the cases. This was statistically significant. More than 95% of cases and controls had adequate antenatal visits. Among the cases, 4.6% of mothers had less than 3 antenatal visits as compared to 1.3% of controls. The odds ratio for this was 3.62 (95% CI: 1.10-13.17; p-value=0.02).

A higher proportion of mothers of cases (55.0%) admitted to have consumed less than 75 IFA tablets than controls (42.0%). The odds ratio for this was 1.69 (95% CI: 1.21-2.36, p-value=0.0012). This was statistically significant.

Unplanned pregnancy and rest/sleep during pregnancy were not having significant odds ratio for occurrence of low birth weight.

A higher proportion of cases (20.5%, 17.6% and 12.7%) had higher total physical activity index separately for first, second and third trimester than the control (12.1%, 10.4% and 6.2%). The odds of giving birth to LBW baby was 1.88 for mothers who were involved in moderate or strenuous work. Similarly odds of delivering low birth weight baby during second trimester was 1.83 (95% CI: 1.12-3.01; p-value=0.01) and during third trimester was 2.21 (95% CI: 1.20-4.07; p-value=0.005) for mothers who were involved in moderate or strenuous physical activity (Table 3).

Table 3: Association of physical activity during pregnancy with Low Birth Weight

		Cases N=307(%)	Controls N=307(%)	Odds Ratio	95% CI	p- value
Physical activity score Quartiles						
1 st trimester	Moderate/ Strenuous	63(20.5)	37(12.1)	1.88	1.19-3.00	0.004*
	Sedentary/ Light	244(79.5)	270(87.9)	1	-	
2 nd trimester	Moderate/ Strenuous	54(17.6)	32(10.4)	1.83	1.12-3.01	0.01*
	Sedentary/ Light	253(82.4)	275(89.6)	1	-	
3 rd trimester	Moderate/ Strenuous	39(12.7)	19(6.2)	2.21	1.20-4.07	0.005*
	Sedentary/ Light	268(87.3)	288(93.8)	1	-	
Energy Consumption (Kcal)						
Energy consumpti on during first trimester	<1500	27(8.8)	13(4.2)	5.65	2.36-13.74	0.001*
	1500-2000	167(54.4)	119(38.8)	3.82	2.22-6.61	0.001*
	2001-2500	88(28.7)	107(34.9)	2.24	1.26-3.98	0.003*
	>2500	25(8.1)	68(22.1)	1	-	-
Additional Energy consumpti on in 2 nd trimester	<200	240(78.2)	206(67.1)	2.62	1.05-6.72	0.02*
	200-399	59(19.2)	83(27.0)	1.60	0.61-4.33	0.3
	>400	8(2.6)	18(5.9)	1	-	-
Additional Energy consumpti on in 3 rd trimester	<200	253(82.4)	212(69.1)	4.77	1.47-17.16	0.002*
	200-399	50(16.3)	79(25.7)	2.53	0.74-9.55	0.10
	>400	4(1.3)	16 (5.2)	1	-	-

Table 3 suggest that higher proportion of cases had low calorie intake during the first trimester than the controls. The odds ratio of giving birth to a low birth weight baby was 5.65 (95% CI: 2.36-13.74; p-value=0.001) for mothers with baseline calorie consumption of <1500 Kcal/ day; 3.82 (95% CI: 2.22-6.61; p-value: 0.001) for mothers with baseline calorie consumption of 1500-2000 Kcal/ day; and 2.24 (95% CI: 1.26-3.98; p-value=0.003) for mothers with baseline consumption of 2001-2500 Kcal/ day.

A higher proportion of controls had high additional calorie intake during the second and third trimester as compared to the cases. The respective odds ratios were statistically significant for additional calorie intake of less than 200 Kcal per day as compared to those with ≥ 400 Kcal per day (Table 3).

Discussion

During last three decades the effect of various factors responsible for LBW has been subject of great interest. India encounters one of the highest LBW rates around the globe, still well documented studies to assess the determinants of LBW are few in India.^{11,15,16,17,18,19} So it becomes important to study factors which can help in identifying high risk mothers and thus enables future intervention.

The present study was conducted in obstetric ward of district hospital. A total of 307 singleton cases (birth weight <2500 gm) and equal number (307) of controls (birth weight ≥ 2500 gm) with term gestation born in same hospital after fulfillment of inclusion and exclusion criteria were enrolled for the present study.

Most of the studies uncover that maternal anthropometry bestow significantly to low birth weight.^{6,12,15,16} Review of the available literature, states that mother's nutritional status is main factor in the determination of LBW among infants. Malnourished mothers gave birth to higher proportion of LBW. In the present study we found association between maternal anthropometry and LBW.

Maternal weight, maternal BMI, and maternal MUAC were found to have significant association with LBW statistically. Maternal weight <40 Kg was significantly associated with LBW. This finding was similar to various studies.^{10,12,15} The present study did not find any significant association between maternal height and LBW. Several other researchers reported no association of maternal height and LBW.¹⁷ However, as regards maternal height, several studies reported significant association between maternal height and LBW.¹⁸ Gestational weight gain was also found to have statistically significant association with LBW in present study. The odds of delivering low birth weight was twice, when maternal weight gain less than 6 kg. Similar statistical significant association between weight gain during pregnancy and LBW was found consistent with other studies.¹⁹ On contrary to this the study by Anand et al from rural Wardha found no statistical difference between weight

gain during pregnancy and low birth weight.¹² Kramer in his Meta-analysis found maternal height and pre-pregnancy weight and gestational weight gain as important risk factors and its causal effect was established.²

As regards to Body Mass Index, a higher proportion (60.9%) of mothers of cases had body mass index (BMI) less than 18.5 as against 48.2% of controls. The odds ratio in case was 1.67 and was statistically significant. Similar significant association were reported by several other studies.^{6,18}

In present study, higher proportion of mothers of cases (45.6%) had moderate to severe anemia as against 33.3% controls. The odds ratio of moderate to severe anemia was 1.68 and was found statistically significant. This finding is uniform with other researchers.^{10,12,15,20,21} Ghosh et al found that the incidence of LBW babies among non-anemic and mild to moderately anemic mothers was about 20% compared to 29% among the severely anemic mothers.¹⁵ Deshmukhin urban area of Nagpur, identified maternal anemia had significant, four times risk of LBW than non anemic (OR:4.81).²⁰ Anand et al from rural Wardha and Mavalankar from Ahmedabad found having anemia during pregnancy was significantly associated with LBW and SGA respectively.^{10,12}

Present study reveals, birth order/parity was not associated significantly with low birth weight. Other researchers found association between primi parity and LBW.^{15,16,20} Opposite to this Joshi HS found, LBW increase was after fourth parity.¹⁸ Kramer in his study on determinants of LBW had identified parity as an important determining factor and its causal effect was established.² In present study, birth spacing, any morbidity during pregnancy was not found to be important in relationship with LBW. However, researchers from various studies shown important relationship between birth spacing,^{15,18,20,22} and morbidity during pregnancy.^{18,33} Kramer in his meta-analysis on determinants of low birth weight had observed birth spacing as an important risk factor but its causal effect was unpredictable.²

In the present study, four-fifth of mothers were registered within less than 3 months. A higher proportion of cases (19.5%) were registered after 3 months of gestational age than controls (11.7%). The odds ratio was 1.83 in case and found that statistically important in this study. Similar finding were reported by other studies.^{12,23,24} Anand et al found that unbooked mothers had higher risk of having LBW baby when compared to those had 5 or more visits.¹² Idris et al found, the lowest incidence (18.56%) was observed among those availing adequate antenatal care. The difference between them and those availing irregular or no care was found to have statistically significant association (p<0.001).²³

In present study, more than 95% of cases and controls had adequate antenatal visits. Among the cases, 4.6% mothers had less than 3 times for antenatal checkup as compared to 1.3% of controls. The odds ratio for case was 3.62. Similarly, the case control study from Natal, North-East Brazil, observed that the crude risk of both outcome i.e. preterm and IUGR, increased among mothers with insufficient (<5 visit)

antenatal care (AR;11.6%). Similar significant findings were reported by other studies.^{6,12,18,23,24}

Dharmalingam showed that those who were not ready to use antenatal care had increased chances of low birth weight baby (23%) compared to those who used antenatal care services frequently (3 or more visits).⁶ Raatikainen K found that the differences between the study groups and the reference groups in the incidence of birth outside hospital were statistically significant ($p < 0.025$ for under-attenders and $p < 0.001$ for non attenders)²⁴ The meta-analysis of Kramer, observed that antenatal care was potentially significant risk factor but casual outcome was unpredictable.² Approximately half of the mothers of study subjects had consumed more than 75 IFA tablets during the current pregnancy. A higher proportion of mothers of cases (55.0%) admitted to consume less than 75% IFA tablets than controls (42.0%). The odds ratio for this was 1.69. This was statistically significant. Rizvi has been found the similar significant, that mothers who did not take iron supplement during whole time pregnancy had increased chances of having an LBW baby (OR:2.88; 95% CI:1.83-4.54; $p < 0.001$).²⁵

In present study, physical activity during pregnancy was found to have statistically important probability of delivering low birth weight. The effect of excessive physical activity or work during pregnancy as a significant factor for causing low birth weight have been documented in various other studies.^{23,25,26,27} The meta-analysis of Kramer on determinants of low birth weight had observed that strenuous maternal work, was potentially significant danger factor but casual effect was not predictable.²

Unplanned pregnancy and rest/sleep during pregnancy were not found to have statistically considerable probability ratio for incidence of low birth weight. Other studies suggested that unplanned or unintended pregnancies were at higher possibility of low birth weight offspring as compared to infants from planned pregnancy.²⁸

Diet of pregnant women in the current study was found to be much below the recommended standards. It has been shown in other studies that as the energy consumption (caloric intake) increases, the frequency of low birth weight decreases. In present study, a higher proportion of cases had low caloric intake during the first trimester than controls. The odds of giving birth to a low birth weight baby was 5.65 (95% CI: 2.36-13.74; $p = 0.001$) for mothers with baseline caloric consumption of < 1500 Kcal/day; 3.82 (95% CI: 1.26; $p = 0.003$) for mothers with baseline consumption of 2001-2500 Kcal/day. Similarly Rao BT found the high incidence of LBW babies was observed in pregnant women with mean caloric eating of less than 1500 Kcal ($p < 0.001$).²⁹

Higher proportion of controls had high additional caloric intake during the second and third trimester as compared to the cases. The representative odds ratios were statistically important for additional caloric intake of more than 400 Kcal as compare to those with less than 200 Kcal per day. In this current study, the finding is consistent with the finding of

Idris et al. Meanwhile, the incidence of low birth weight was maximum (37.4%) along with those taking no supplementary diet, followed by 34.2% along with those taking enough diet, while it was lowest (17.6%) along with those taking sufficient extra diet during pregnancy. Moreover, the difference between mothers taking adequate additional diet and those taking either inadequate or no additional diet was statistically significant ($p < 0.001$).²³ Kramer in his meta-analysis observed that caloric intake, was important risk factor which and its casual effect was established.²

The study has several limitations. Most important it was hospital based. Although this was District hospital, chances of getting referred cases was more. The majority of women included in the study lived in town and surrounding area. The result of this study therefore should not be extrapolated to apply to women living and delivering their babies in more remote area of the district.

Similarly, selection bias may be an important problem in the current study. Again chances of differential recall bias among mothers who had low birth weight compared to those with normal birth weight are likely. The prevalence of anemia before conception could not be measured in this study. However, hemoglobin was recorded from ANC and medical records. Pre-pregnancy weight was not feasible in this study. In spite of its limitations, the present study provides interesting finding and important information which benefit in planning and implementing maternal and child health services.

Conclusion

Maternal weight, gestational weight, maternal body mass index. Mid upper arm circumference, previous history of low birth weight babies, maternal anemia, physical activity during pregnancy, less additional calories consumption during pregnancy were found significant determinants in present study

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