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Research Article

CORRELATION OF NUTRITIONAL STATUS OF MOTHER AND THE BIRTH WEIGHT OF THE BABY

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ABSTRACT

Objective: The objective of this study is to correlate mother's nutritional status during pregnancy and determine the birth weight of the baby.

Methods: A comparative, exploratory approach and prospective cohort study design was used to find out mothers' nutritional status during pregnancy influences the birth weight of babies. The data were collected using structured interview schedule and dietary history by 24 h recall method from a randomly selected sample of 380 eligible mothers delivered at Krishna Hospital, Karad.

Results: There was a significant correlation between birth weight and calorie intake (correlation coefficient [r]=0.595; p<0.001; Chi-square=201.3; p<0.001.) A higher proportion of low birth weight babies, i.e., 105 (32.2%) were delivered by the mothers consuming <70% of protein ([r]=0.245; p<0.001; χ2=24.033; p<0.001]). There was correlation between birth weight and calcium intake of mothers ([r]=0.525; p<0.001; χ2=10.12; p<0.001] "birth" weight and iron intake of mothers ([r]=0.250; p<0.001; χ2=13.798; p<0.001).

Conclusion: The intake of calorie, protein, calcium, and iron of mother can significantly influence the weight of the newborn baby. Among all anthropometric parameters of the mother, weight gain was the strongest predictor of adequacy of the birth weight.

Keywords: Low birth weight, Nutritional status, Protein, Calcium, Iron, Pregnancy.

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INTRODUCTION

India alone accounts for 40% of low birth weight (LBW) babies born in the developing world [1,2]. LBW is, in turn, an immediate major determinant of malnutrition during infancy and childhood [3,4]. LBW is a significant public health problem as it has serious health, social, and economic consequences for the individual, family, and society at large. Inadequate intrauterine nutrition is the major cause of LBW in the developing countries [5,6].

Nutritional status of mothers both before and during pregnancy is critical in determining the birth weight. There is also evidence that girls with LBW are likely to give birth to LBW babies as they grow into adults [7].

The studies conducted by Raman *et al*. [8], Kulkarni *et al.* [9], and Naidu and Rao [10] have found that there is a very strong connection between maternal nutrition, in particular, body mass index (BMI) and the birth weight of their children. Another study conducted by Dharmalingam *et al.* [11] provides a national focus and examines the relationship between a selected number of proximate factors and LBW among Indian children. They have investigated the role of mothers' nutritional status measured by their BMI in determining the birth weight of their most recent births. They have also explored the variation in the effect of maternal nutritional status on birth weight among the various states in India.

LBW infants (<2500 g) are at risk of morbidity and mortality at birth and during early days of life. Infant weight is directly linked to the status of maternal nutrition. Lower calorie and protein intake by a mother throughout the pregnancy can result in small size of the baby [12]. Assessment of the dietary intake of pregnant women is time-consuming and tedious process, hence there is scarcity of studies related to the actual food intake and birth weight of the baby. The dietary pattern of pregnant women varies from state to state and also in urban and rural population and subpockets within the states. There are very few studies undertaken on rural population of Western Maharashtra. Therefore, the present study was undertaken in Krishna hospital, Karad, to investigate mothers' selected parameters of nutritional status during pregnancy determining the birth weight of babies.

In this study, known things were the maternal factors affecting birth weight of the baby. They were studied by many researchers from India and other countries in different setting with different approaches. The important aspect we studied was correlation of calorie, protein, calcium, and iron intake of individual mother was calculated according to the Recommended Daily Allowance (RDA) and correlated with birth weight of the baby.

India and other countries, very few studies have focused on birth weight and their correlation with calorie, protein, calcium and iron intake of mothers during pregnancy. Therefore the investigator planned to conduct present on this aspect.

METHODS

A comparative, exploratory approach and a prospective cohort study design was used to identify maternal nutrition influencing the birth weight of the babies. The data were collected from a randomly selected apparently healthy 380 eligible pregnant women who were registered at antenatal clinic and planned to deliver at Krishna Hospital, Karad. The data were collected using structured interview schedule. Assessment of mothers was done by taking selected anthropometric maternal measurements such as height in cm, weight in "kg" at registration, weight gain of the pregnant woman from registration to delivery in kg, BMI, dietary history by 24-h recall method, and laboratory parameter of blood hemoglobin. The ethical clearance was obtained from institutional ethics committee. The data were collected after formal permission from hospital authorities and after taking informed consent from each respondent.

24-h dietary recall

Each woman was asked about her dietary intake by recall method. The mother recalled what and how much food was consumed and when it was consumed. The mothers were asked to express the consumption of all food items in terms of exact katori/wati/glass size, chapati or bhakari size and number, and spoon size (large, medium, and small). This information was used to compute the daily intake of cooked foods by converting the household measures into grams or kilograms. The daily intake of calories (Kcal); proteins (g); calcium (mg); and iron (mg) was calculated using conversion table and compared with Recommended Dietary Allowance (RDA) [13] of the caloric requirement during pregnancy add "of each pregnant woman was found out on individualized recommendations as per the Indian Council of Medical Research (ICMR) guidelines [13]. The recommendations take into consideration are body weight, type of work, and sex. The table of values for every 5 kg weight from 40 kg to 70 kg for women [13]. From this table, the individualized caloric requirements were found out. The individualized protein requirements were found out using the formula of 1.04 kg of weight [14,15] at the time of registration as a proxy for prepregnancy weight. Calcium and iron requirements were taken from the general recommendations [14,15] of the ICMR.

Sample size

The sample size was calculated for the present study using the following formula,

$$n = Z^2 \frac{(1-p)}{E^2 p}$$

where Z=the standard normal variate at 5% significance level (value of Z is 1.96=2)

p=4% preterm deliveries; E=Relative precision=50%

$$n = Z^2 \frac{(1-p)}{E^2 p}$$

$$n = \frac{(1.96)^2 (1-0.04)}{(0.50)^2 \times 4}$$

$$n = \frac{3.69}{0.01}$$

n=369 Rounded off to 380.

n=380=final sample for the study.

Data were analyzed by SPSS version 16 using descriptive and inferential statistics.

1. Descriptive statistics-frequency, percentage mean and standard deviation (SD) where ever applicable.
2. Inferential statistics-χ^2 test was used to see an association with respect to maternal risk factors for qualitative data and analysis of variance (ANOVA), Bonferroni multiple comparison test, and unpaired t-test for quantitative data.

RESULTS

The mean birth weight was 2708.5 g with SD of ±486.1 g. There were 105 (27.6%) out of 380 babies who were LBW. Among those, 22 (5.8%) were between 1000 g and <1500 g, 83, i.e., 21.8% of LBW babies were in the birth weight group of 2000–<2500 g and 275 (72.4%) babies were in normal birth weight (NBW) category (Table 1).

Out of 380 women, there were 259 (68.1%) women who delivered NBW (not preterm) babies and 73 (19.2%) women who delivered intrauterine growth retardation (IUGR) (LBW). There were 32 (8.5%) preterm babies who were also LBW and 16 (4.2%) preterm but had NBW (Table 2).

The recommended daily calorie intake calculated for individual mother by weight at registration and age of mother as compared to actual daily intake indicated that 33 (8.7%) mothers consumed <70% of kcal. The mean birth weight of the babies born to mothers who were taking <70% kcal was lowest, i.e., 2121.4±340.9 and the proportion of LBW was 93.9% as compared to those who were consuming higher proportion of calories. The birth weight increased and the proportion of LBW decreased with the increasing proportion of calorie intake. The higher proportion of LBW babies, i.e., 105 (32.2%) were delivered by the mothers consuming <70% of protein (χ^2=201.3; p<0.001). There was a highly significant correlation between birth weight and proportion of calorie intake of mothers as compared to their individualized RDA [13] (r)=0.595; p<0.001 with 95% confidence interval (CI) of 0.5263 to 0.6557 (Table 3).

Protein intake was calculated for individual mother by weight at registration

The 326 (85.8%) mothers consumed <70% of g protein. The mean birth weight of mothers who were taking <70% g of protein was lowest, i.e., 2647.6±474.7 as compared to those who were consuming higher proportion of protein intake. There was a statically significant association between proportion of protein intake (g) of individualized recommended daily allowance and proportion of LBWs (χ^2=24.033; p<0.001). There was significant correlation between birth weight and proportion of protein intake of mothers (r)=0.245; p<0.001 with 95% CI of 0.4475–0.5938. The mean protein intake of these subset of 380 mothers was 70.7 g with SD of 15.9 g (Table 3).

Calcium intake and birth weight

Those mothers consuming less RDA of calcium gave birth to the babies weighing significantly lesser and proportion of LBW being significantly higher than the babies born to mothers consuming calcium equal to or above 1200 mg/day (Unpaired t=4.914; p<0.001). There was a significant association between calcium intake and the proportion of LBW (χ^2=10.12; p<0.001). There was significant correlation between birth weight and proportion of calcium intake of mothers (r)=0.525; p<0.001 with 95% CI of 0.2611–0.4376. The mean calcium intake of these 380 mothers was 785.1 mg with SD of 278.6 mg (Table 3).

Iron intake and births weight

The mean iron intake of these subset of 380 mothers was 24.7 mg with SD of 6.5 mg. The mean iron intake of these subset of 380 mothers was 24.7 mg± SD 6.5 mg. There were 347 (91.3%) mothers whose iron intake was less than the RDA (As prescribed by the ICMR for Indian pregnant women). (Table 3). Gave birth to low birth weight babies and proportion of LBW babies were significantly higher than the babies born to mothers consuming iron 35 mg or more per day (unpaired t=2.034; p=0.043; χ2=13.798; p<0.001). There was significant correlation between birth weight and proportion of iron intake of mothers (r)=0.250; p<0.001 with 95% CI of 0.1532–0.3420 (Table 3).

The mean weight of the pregnant women at registration was 46.7 kg, with SD of 8.9 kg minimum being 31 kg and maximum of 74 kg (Table 4).

Mothers weight at registration and birth weight

There was no significant difference between weight at registration and birth weight (ANOVA F=1.077, p=0.359). There was apparently higher mean birth weight for the babies born to the mothers weighing in the weight range of 40–45 kg as compared to the babies born to mothers with weight range of 45 kg–<50 kg. Weight of mother at registration was not associated with the rate of LBW babies. (χ^2=3.442; p=0.328) (Table 4).

Height and birth weight

The mean height of the delivering women was 154.4 cm with an SD of 6.2 cm. Minimum height was 127.0 cm and maximum was 170.0 cm. There was no significant association between the height of mother and mean birth weight of babies. (ANOVA F=0.668, p=0.648). There was no significant difference in the rate of LBW among different height groups of mothers although an apparently higher rate of LBW of 36.4% was observed for height of mother of ≤145cm (χ^2=3.466; p=0.629) (Table 4).

The minimum weight before delivery was 40 kg and maximum was 87 kg. The mean weight before delivery was 58.2 kg with an SD of 9.0 kg. The mean weight gain from registration to delivery was 11.5 kg with an SD of 2.6 kg and minimum weight gain was 4 kg the maximum gain in weight was 15.1 kg.

There was a significant direct correlation between the weight gain of the mother and the birth weight of the baby. As the weight gain increased, the mean birth weight also increased. The proportion of LBW decreased with increase in weight gain for all groups except the weight gain group of 10 kg–<12.5 kg. There was a marginal and insignificant (χ^2=0.003484; p=0.9529) increase of LBW from 43.5% to 44% between 7.5 kg and <10 kg group and 10 kg–<12.5 kg group (χ^2=64.971; p<0.001; ANOVA F=31.214, p<0.001) (Table 4).

Table 1: Distribution of birth weight

Birth weight in (g)	Frequency (%)
1000–1499	9 (2.4)
1500–1999	13 (3.4)
2000–2499	83 (21.8)
Subtotal of LBW babies	105 (27.6)
2500–2999	171 (45.0)
3000+	104 (27.4)
Subtotal of NBW babies	275 (72.4)

n=380. LBW: Low birth weight, NBW: Normal birth weight

Table 2: Distribution of LBW, NBW, preterm births, and not preterm births

Not preterm	Not preterm	Preterm	Preterm	Total
(≥37 weeks) and NBW babies (≥2500 g)	([≥37 weeks] [IUGR]) but LBW babies (<2500 g)	(<37 weeks) and LBW babies (<2500 g)	(<37 weeks) and NBW (≥ 2500 g)	
259 (68.1%)	73 (19.2%)	32 (8.5%)	16 (4.2%)	380 (100%)

n=380, IUGR: Intrauterine growth retardation. LBW: Low birth weight, NBW: Normal birth weight

Table 3: Calorie and protein intake as proportion of the individualized RDA and mean birth weight and proportion of LBW

Individualized RDA	n (%)	Mean birth weight with±SD in (g)	Number of LBW and (%)	χ^2 and p	Correlation coefficient (r) with 95% CI
% of calorie intake (kcal) of individualized recommended daily allowance					
<70	33 (8.7)	2121.4±340.9	31 (93.9)	χ^2=201.3; p<0.001**	(r)=0.595 p<0.001** CI: 0.5263–0.6557
70–<80	31 (8.2)	2252.1±355.3	24 (77.4)		
80–<90	39 (10.3)	2355.4±477.7	26 (66.7)		
90–<100	59 (15.5)	2701.1±378.3	15 (25.4)		
100–<110	67 (17.6)	2854.5±301.8	3 (4.5)		
110–<120	67 (17.6)	2921.6±418.6	4 (6.0)		
≥120	84 (22.1)	2990.2±405.8	2 (2.4)		
% of protein intake (g) of individualized recommended daily allowance					
<70	326 (85.8)	2647.6±474.7	105 (32.2)	χ^2 =24.033; p<0.001**	(r)=0.245 p<0.001** CI: 0.4475–0.5938
70–<80	37 (9.7)	3027.0±329.6	0.0		
80–<90	13 (3.4)	3079.2±438.5	0.0		
90–<100	2 (0.5)	3747.5±710.6	0.0		
100–<110	2 (0.5)	3290.0±113.1	0.0		
110–<120	00 (0.0)	0.0	0.0		
≥120	00 (0.0)	0.0	0.0		
Calcium intake: (mg)					
<RDA	343 (90.3)	2669.4±474.8	103(30.0)	χ^2 =10.12; p<0.001**	(r)=0.525 p<0.001** CI: 0.2611–0.4376
≥RDA	37 (9.7)	3070.7±443.6	2 (5.4)		
(Unpaired t=4.914; p<0.001**)					
Iron intake: (mg)					
<RDA	347 (91.3)	2692.9±498.5	105 (29.8)	χ^2 =13.798; p<0.001**	(r)=0.250 p<0.001** CI: 0.1532–0.3420
≥RDA	33 (8.7)	2872.3±284.9	0.0		
(Unpaired t=2.034; p=0.043*)					

n=380, RDA for sedentary type of work during pregnancy ≥2250 kcals, RDA for moderate type of work during pregnancy ≥2580 kcals, RDA for heavy type of work during pregnancy ≥3200 kcals Ref: [14,15], significant p<0.01** significant p<0.05*. LBW: Low birth weight, CI: Confidence interval, SD: Standard deviation

Anemia at registration and birth weight

There was a significant difference between the basic hemoglobin level of the mothers at registration and the birth weight of the baby. (ANOVA F= 4.111; p=0.007**). The Bonferroni multiple tests revealed that among all comparisons mild vs. moderate anemia was significant (p=0.013). The mean birth weight increased with increasing hemoglobin values. Those mothers with <7 g% hemoglobin in the first trimester were 3.7% who delivered babies with mean birth weight below 2500 g and proportion of LBW of (35.7). Anemia of all grades, i.e., mild, moderate, and severe was not associated significantly with higher rates of LBW (χ^2=3.767; p=0.288). A very high proportion of pregnant women, i.e., 288 (75.8%) was anemic. The proportion of LBW was 28.1 as compared to 26.1% in babies born to nonanemic mothers. This difference was not statistically significant. Mean birth weight of babies of anemic mothers was 2632.3±488.6 g and mean birth weight of babies of nonanemic mothers was 2715.4±462.8 g. The babies born to nonanemic mothers weighed higher by 83.1 g (Table 5).

During the first trimester, there were 288 (75.8%) women who were anemic and 43.2% could be classified as mild, 28.9%, moderate, and 3.7% with severe anemia. The mothers showing mild or moderate anemia were given a higher dose of iron and folic acid tablets containing 60 mg of elemental iron and 1 mg of folic acid and 7.5 µg cyanocobalamine, i.e., 2 tablets daily and those in normal range of hemoglobin were given prophylactic iron and folic acid supplementation, i.e., 1 tablet daily. Those with <7 g % of hemoglobin were given packed cell transfusion or parenteral iron preparations. Status of anemia was found out in the second and third trimester.

DISCUSSION

In the present study, there were 105 (27.6%) LBW babies out of 380 babies. Among them, 13 (3.4%) were between 1000 g and <1500 g and 83 (21.8%) were between 2000 and 2499 g. The similar findings were noted in the study conducted by Noor *et al.* at Indore, Madhya Pradesh [16]. The WHO reported that 36.8% delivered LBW babies, that is, baby weight <2500 g. This was very high in comparison with NFHS-3 data where they reported LBW was 23% in rural areas in India [17]. Other studies from Indian subcontinent also have documented almost similar percentage of LBW, 30.3% in study by Deshmukh *et al.* at Wardha, Nagpur [18]. Velankar at Mumbai [19] reported the incidence as high as 45.2% and by Negi *et al*. at Dehradun [20] observed the incidence to be around 23.8%; whereas, other studies done by Trivedi and in Ahmedabad [21] and Kamaladoss *et al.* in rural Tamil Nadu [22] reported 20.37% and 24.6% LBW, respectively. Despite various efforts done to improve maternal and child health in our country, the prevalence of LBW is still on the higher side.

In the present study, out of 380 women, 259 (68.1%) women were having gestational age >37 weeks and delivered NBW babies (>2500 g). 73 (19.2%) women were having gestational age >37 weeks and delivered IUGR but LBW (<2500 g) babies. 32 (8.5%) were preterm (<37 weeks) and delivered LBW (<2500 g) and 16 (4.2%) women delivered preterm babies (<37 weeks) but had NBW (Table 2). Similar results were seen in a study done by Bisai, in Kolkata, India [23]. The researchers found that among all births, 9.97% were preterm (<37 weeks) and 90.03% were term (37–41 weeks) neonates. Similarly, among all LBW babies, 80.16% were term and 19.84% were preterm. Other study done by Temu *et al.* in Northern-eastern Tanzania [24] noted a high prevalence of preterm deliveries, i.e., 14.2%. Mahande *et al*. in Northern Tanzania [25] estimated the prevalence of preterm delivery in the study which was higher 19.9% than that reported in Tanzania of 12% and 11%, respectively, by Watson *et al*. [26] and Kinney *et al*. at London, UK [27].

In the present study, 33 (8.7%) mothers consumed <70% of kcal and the mean birth weight of the babies born to this mothers was lowest, i.e., 2121.4±340 and a very high proportion of LBW (93.9%) [9]. The higher proportion of LBW babies, i.e., 105 (32.2%) were delivered by the mothers consuming <70% of protein (p<0.001). There was significant correlation between birth weight and proportion of calorie intake of mothers (p<0.001) (Table 3). Similar findings were noted by

Table 4: Anthropometric indices and birth weight

Anthropometric indices	n (%)	Mean birth weight in (g)±SD in (g)	Number of LBW (%)
Weight at registration in (kg)			
<4	86 (22.6)	2734.0±482.7	21 (24.4)
40–45	106 (27.9)	2764.5±487.5	25 (23.6)
45–50	69 (18.2)	2679.9±490.9	19 (27.5)
50–55	119 (31.3)	2656.8±484.0	40 (33.6)
Height of mother in (cm)			
≤145	22 (5.8)	2721.1±448.4	8 (36.4)
146–150	87 (22.9)	2642.4±531.9	26 (29.9)
151–155	116 (30.5)	2698.4±509.4	34 (29.3)
156–160	104 (27.4)	2769.2±447.7	23 (22.1)
161–165	37 (9.7)	2705.1±444.2	9 (24.3)
>165	14 (3.7)	2740.4±448.9	5 (35.7)
Weight gain in (kg)			
<7.5	37 (9.7)	2281.2±614.7	21 (56.8)
7.5–<10	46 (12.1)	2511.3±444.8	20 (43.5)
10–<12.5	100 (26.3)	2573.3±429.4	44 (44.0)
≥12.5	197 (51.8)	2903.4±397.3	20 (10.2)

n=380. SD: Standard deviation, LBW: Low birth weight

Table 5: Laboratory parameter, mean birth weight, and proportion of LBW

Anemia (hemoglobin level) at registration in (g %)	n (%)	Mean birth weight in (g)±SD (g)	Number of LBW (%)
Severe anemia	14 (3.7)	2499.3±478.6	5 (35.7)
Moderate anemia	110 (28.9)	2607.2±543.9	37 (33.6)
Mild anemia	164 (43.2)	2790.4±443.1	39 (23.8)
No anemia	92 (24.2)	2715.4±462.8	24 (26.1)

n=380. SD: Standard deviation, LBW: Low birth weight

Metgud *et al.* [28] at Belgaum in rural Karnataka, found a statistically significant relationship between the calorie intake (crude odds ratios [OR] 4.9, 95% CI 1.7–14.1, p=0.003) and birth weight of the newborn as well as protein intake (crude OR 2.1, 95% CI 1.2–3.7, p=0.007). A study done by Raman [29] reported that inadequate calorie intake can result in LBW babies and even supplementation given for anemia correction would not be able to increase the birth weight. Whereas, a study done by Kennedy *et al.* [30] found that birth weight of baby can be improved with the help of supplementations.

In the present study, 326 (85.8%) mothers consumed <70% of g protein. The mean birth weight of mother was lowest, i.e., 2647.6±474.7 and delivered higher proportion of LBW babies, i.e., 31 (93.9). There was significant correlation between birth weight and proportion of protein intake of mothers (p<0.001) (Table 3). In a study conducted by Raman [29] reported that protein consumption in the range of 30–50% of total diet reduced chances of LBW babies. The study conducted by Durrani and Rani [31] in Aligarh city, India, have reported that protein intake in all trimesters was also found to be positively correlated with birth weight (r=0.237, 0.279, and 0.348 in the first, second, and third trimesters, respectively). Similarly, Rao et al. [32] at Haryana have reported that the mean protein intake during three dietary assessments was 50.8±9.27 g. A higher prevalence of LBW babies was observed in pregnant women with mean protein intake of <40 g (*p*<0.001) by Al-Shosan at Pakistan [33].

Individualized RDA was specific for the concerned pregnant woman and has shown excellent correlation. The proportion of LBW was <5% if calories were taken as per individualized RDA, on the other hand, <70% of individualized RDA for proteins was sufficient to prevent LBW completely indicating that whatever food is consumed by the mother if calories were taken care of proteins also taken care of. There was no woman in this study who had primary protein deficiency.

If RDA as given by the ICMR taking into consideration, Indian reference woman and the type of work are considered for the mean birth weight, the work groups also showed a significant association, but without individualized RDA values, the correlation could not be worked out which was possible with the individualized RDA values.

In the present study, those mothers consuming less calcium than RDA gave birth to the babies weighing significantly lesser and proportion of LBW being significantly higher than the babies born to mothers consuming calcium equal to or above 1200 mg/day (p<0.001). There was a significant association and correlation between proportion of calcium intake and birth weight (p<0.001) (Table 3). The similar findings were noted by Durrani and Rani [31] in Aligarh city, India, has reported that calcium consumption was found to be positively correlated with birth weight in the first (r=0.276), second (r=0.355), and third (r=0.421) trimester. Similarly, significant correlations were found between adequate maternal calcium and Vitamin D intake with birth weight. Another researcher Gopalan *et al*. [14] at Hyderabad also found that the highest mean birth weight was observed among mothers consuming ≥1000 mg/d of calcium.

In the present study, those mothers with less iron intake than RDA gave birth to babies weighing significantly lesser and proportion of LBW babies being significantly higher than the babies born to mothers consuming iron 35 mg or more every day (p<0.001). There was a significant correlation between birth weight and proportion of iron intake of mothers (p<0.001).

In the study conducted by Khanal *et al*. [34] in Nepal noted that intake of iron supplements during pregnancy was found to have a protective effect with respect to LBW. In another study by Rizvi *et al*. [44] at Karachi noted that iron supplementation was found to be significantly associated a reduction in LBW. In another study by Khoushaabi and Saraswathi in Mysore city, India [35], also showed that the high intake of calcium and iron significantly influenced the birth weight of babies. Pregnant women with higher intake of minerals gave birth to neonates with normal weight, while pregnant women with lower intake gave birth to LBW neonates noted by Mridula *et al.* [36].

In the present study, weight of mother at registration and height was not associated with the rate of LBW babies. Similar findings were noted by Gebregzabiherher *et al*. [37].

In the present study, the mean weight gain from registration to delivery was 11.5 kg with an SD of 2.6 kg and minimum weight gain was 4 kg the maximum gain in weight was 15.1 kg. There was a significant direct correlation between the weight gain of the mother and the birth weight of the baby. As the weight gain increased, the mean birth weight also increased. Similar findings were reported by Sengupta et al. [38] in Ludhiana, Punjab; Mumbare et al*.* [39] at Nashik, India; Singh et al*.* [40] at Nepal; Sutan et al. [41] at Kuala Lumpur, Malaysia; and Ghani et al. [42] at West of Algeria. The study conducted by Metgud *et al*. at Belgaum in rural Karnataka [28] revealed that low weight gain during pregnancy was a risk factor significantly associated with the LBW of the newborn. Moller *et al*. [43] have shown in African women that total pregnancy weight gain to be of 6kg. The mean weight gain during pregnancy in India was only about 6kg in a study by Anderson [45] in rural India.

In the present study, there was a significant difference between the basic hemoglobin level of the mothers at registration and the birth weight of the baby (p=0.007). The mean birth weight increased with increasing hemoglobin values. Similar findings were noted by Kumar *et al.* [46] at Tumkur, Karnataka, India. That low maternal hemoglobin concentration was associated with LBW babies. The hemoglobin level (<8 g/dl–≥11 g/dl) during pregnancy was significantly associated with LBW as reported by many studies [40,47,48]. In another study by Metgud *et al*. [28] at Belgaum in rural Karnataka, noted that maximum (80.0%) number of LBW babies were born to mothers with hemoglobin level, 7 g/L (severe anemia) in the third trimester. The leaves of Colocasia esculenta (Alluu) and Alternanthera sessilis (436.7±14.9 mg/100g) [49] are rich source of calcium and iron [49]; hence it is advised to include this rich source of iron and calcium in the pregnant mother's diet.

Heat treatment improves food safety. Proteins are oxidized during heat treatment. However, heat treatment decreases the nutritional value of food. So it is very important to monitor protein changes caused by heat treatment to ensure benefits and to minimize all negative effects. [50] So it is advised to the pregnant mothers, to avoid heating the protein food again and again because it destroys the nutritive value of protein.

CONCLUSION AND RECOMMENDATIONS

Thus, intake of calories, proteins, calcium, and iron correlate with the birth weight of the baby and the proportion of LBW. Among anthropometric parameters, weight gain during pregnancy showed correlation. Anemia at first trimester also was identified as an important risk factor.

1. Adequacy of calories and proteins should be ensured during antenatal visits by advising more frequent and sufficient quantities of food available at home.
2. Enrollment of the eligible mothers at Anganwadi centers of ICDS scheme for dietary supplementation should be ensured.
3. Health education of the pregnant woman, the mother, mother-in-law, and husband should be undertaken to bridge the food gap of the women during pregnancy to prevent the LBW.
4. Inadequate weight gain should be identified early and timely dietary interventions undertaken.
5. Anemia prophylaxis during adolescence and supplementation during pregnancy will go a long way for prevention of anemia in pregnancy.

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AUTHORS' CONTRIBUTIONS

Concept, data collection, and writing of article - Mr. Avinash H. Salunkhe - Corresponding author; Guidance and critical review, editing content matter up to satisfactory level and final approval of article. Dr. Asha Pratinidhi; Valuable guidance in using relevant statistical test for analyzing data with significance of test results - Dr. S. V. Kakade; Rewriting and drafting with valuable corrections and guidance - Dr. Jyoti A. Salunkhe; Permitting official and sparing me for completion of this paperwork - Dr. Vaishali. R. Mohite; Formatting, typing, and statistical work- Trupti Bhosale.

CONFLICTS OF INTEREST

Nil.

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