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Original Research Article

Anthropometric measurements of a neonate vis-a-vis maternal nutritional status

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ABSTRACT

Background: The incidence of low birth weight i.e. <2500gm babies in India is 30-40% as compared to 7.5% in the developed world. The objective of this study was to find correlation between neonatal anthropometric indices and maternal nutritional status.
Methods: Out of one thousand twelve live births during the study period 529 newborns which were fulfilling the required criteria were enrolled in the study. All the enrolled newborns were assessed for weight, length, OFC, MAC, MAC/OFC and Ponderal index. Maternal nutritional status was assessed by maternal weight, maternal height and BMI. Maternal data also comprised of demographic and social factors viz. maternal age, socioeconomic status, dietary habits, maternal education, occupation, parity, residence, altitude and antenatal care. The correlation between neonatal anthropometric indices and maternal nutritional status was studied using appropriate statistical methods.
Results: The study population had mean maternal weight 50.0593±7.97, mean maternal height 154.148±9.0388 and mean body mass index 21.5871±10.458 which were significantly higher than national figure (NFHS 2 data). The mean birth weight was 2822.80±447.64, mean length 48.0319±2.1963, mean OFC 33.6866±1.3510, mean MAC 8.8866±0.8349,MAC/OFC 0.2636±2.039 E-02 .The study showed 29% LBW babies. The study showed highly significant positive relationship between maternal nutritional status assessed by maternal weight, height and BMI; and neonatal anthropometry i.e. birth weight length, OFC MAC, and MAC/OFC ratio.
Conclusions: Maternal nutritional status has strong linear correlation with neonatal anthropometry. Shorter and lighter mothers tend to give birth to small babies with lower anthropometric measurements. Improvement in the maternal nutritional status can lead to better neonatal anthropometric indices which can be helpful in decreasing the neonatal morbidity and mortality.

Keywords: LBW, Maternal nutritional status, Newborn, Neonatal anthropometry

INTRODUCTION

The incidence of low birth weight i.e. <2500gm babies in India is 30-40% as compared to 7.5% in the developed world.

The low birth weight babies are five times more likely to die in the perinatal period and three times more likely to die during infancy. Among 30-40% low birth weight babies, 2/3rd proportion is contributed by SGA and IUGR and 1/3rd by preterm babies. Factors influencing birth weight are maternal malnutrition, closely spaced pregnancies, severe anemia, adolescent pregnancies, antenatal infection, heavy workload and maternal hypertension.[1]

The relation between maternal malnutrition and fetal outcome became evident during the siege of Leningrad in world war-II and Dutch Famine in the winter of 1944 which demonstrated that severe protein calorie

malnutrition especially during the second half of pregnancy causes decreased fetal weight.

Out of numerous biosocial, physical and nutritional determinants of fetal growth, maternal nutritional influences are the most important and these include height, weight, BMI and anemia. Birth weight is one of the most sensitive and reliable predictors of the health of any community. Head circumference is an indirect way of measuring the growth of brain in utero as well as after birth.

Maternal malnutrition has been shown to influence the function of central nervous system in children at later date. Upper mid arm circumference reflects somatic growth, muscles and fat stores and mid arm circumference/head circumference (MAC/HC) is a good indicator of body proportion and correlate with fetal growth disorders.

Since severe maternal malnutrition is associated with fetal growth retardations which is a problem of paramount importance in developing countries, hence study is designed with the objective to correlate the newborn anthropometry with the maternal nutritional status and to generate anthropometric data of the newborn in the state.[2]

METHODS

Out of one thousand twelve consecutive live births at Kamla Nehru Hospital, Shimla, Himachal Pradesh an associated hospital of Indira Gandhi Medical college Shimla, 529 term healthy term newborns who were meeting the requisite criteria were enrolled.

Inclusion criteria

- Maternal age 20-30 years
- Parity <4
- Complete maternal data available
- Singleton term baby (POG≥37 weeks)
- Newborn with hospital stay > 24 hours
- Mother registered antenatally during first trimester
- Parents consenting to take part in the study.

Exclusion criteria

- Chronic maternal illness (diabetes mellitus, hypertension, pulmonary tuberculosis, renal, heart diseases etc.)
- Handicapped or mentally retarded mothers.
- Major neonatal congenital anomalies.
- Intrauterine infections.

After obtaining an informed consent from parents, anthropometric evaluation was carried out between 24-48 hours by single observer in a warm well lighted room.

Gestational age assessment was based on accurate recollection of date of the last menstrual period by the mother, when doubt existed, assessment of newborn using Expanded New Ballard score were used to assign gestational age in completed weeks. Weight was obtained one hour after feeding using a digital scale with a capacity of 10 kgs and sensitivity of ±5gm without any clothing on and 2500gm is taken as normal weight.[2]

Length was measured to the nearest of 0.1cm using an infantometer. The baby was placed on the infantometer with head towards the fixed end of the infantometer and feet towards the sliding end of infantometer. A slight pressure was applied at the newborn's knees to ensure full extension of lower extremities. A value below 3rd centile was taken as abnormal (CDC2000).[3]

HC was measured with a non stretchable measuring tape just above the supraorbital prominence and over the maximum occipital prominence excluding ears. Midarm circumference was taken on left arm midway between the tip of acromion and olecranon process with non stretchable measuring tape.

Maternal nutritional status was assessed by maternal weight, height, BMI. Maternal weight at first contact with the health functionaries was recorded from the maternal records and was stratified in to two categories i.e. ≤40kg and ≥40kg[2].

Maternal height was recorded by Stediometer without shoes on with sensitivity of 0.5cm and divided in to two categories i.e. ≤145cm and ≥145cm. BMI was calculated with the formula weight in kg/(height in meters)^2 and classified into malnourished (<18.5), well nourished (19-24), over weight (25-29) and obesity (>30).

Socioeconomic status was categorized by modified Prasad's Classification updated by P. Kumar and classified as low, middle and high socioeconomic group.

Pearson chi square, likelihood ratio, linear by linear association has been run at p 0.05 values at 95% confidence interval (CI), nutritional status of mother and anthropometry by applying ANOVA, Mean and SD for all the parameters has been calculated and Frequency wherever applicable is generated.

RESULTS

The data was collected from mothers between 20-30 years (25.03±3.35) and their newborns.

The demographic and social attributes of study population was recorded Table 1. Majority of population (72.4%) was from rural background with a place of residence at an altitude of 2000-2500meters.

Table 1: Demographic and social attributes of study population (n- 529).

Variable	Category	Frequency	%
Altitude	<1000mts	46	8.69
	1000-1500mts	100	18.90
	1500-2000mts	99	18.71
	2000-2500mts	284	57.70
Rural/Urban	Rural	383	72.40
	Urban	146	27.60
Parity	1st Para	335	63.3
	2nd Para	149	28.2
	3rd Para	45	8.5
Socioeconomic status	Low income group	165	31.2
	Middle Income	284	53.7
	High income	80	15.1
Maternal education	Illiterate	18	3.4
	Primary	12	2.3
	High School	122	23.1
	Higher Sec/+2	130	24.3
	Graduates	138	26.1
	Postgraduates	73	13.8
Personal history	Vegetarian	298	56.00
	Non vegetarian	231	44.00
Occupation	House wives	484	91.5
	Working	45	8.5
Wt gain during pregnancy	<3kg	1	0.2
	3-9kg	216	40.8
	≥9	312	59

53.7% belongs to middle income group, 96.6% of mothers were literate, 91.5% were house wives, and 87.5% received optimal care. 59% of mothers had gained equal to or more than 9 kg weight during pregnancy. 89.2% mothers had good weight and optimal height >145cm in 82.2%.

63.9% of mothers were in the 19-24 BMI group and indicator of good nutritional status.

Nutritional status of the mother was assessed by weight, height and body mass index (BMI) with mean maternal weight 50.05±7.97, height 154.14±9.03 and BMI 21.58±10.45 (Table 2).

Table 2: Maternal nutritional status.

Variable	Mean±SD	Category	Frequency	%
Maternal weight	50.05±7.97	≤40Kg	57	10.8
		>40Kg	472	89.2
Maternal Height	154.14±9.03	≤145cm	94	17.8
		145cm	432	82.2
BMI	21.58.14±10.45	≤18.5	131	24.8
		19-24	338	63.8
		25-29	53	10
		>30	7	1.3

BMI status of mother and incidence of low birth weight, Intergroup comparison between the number of LBW born to well nourished and malnourished mothers is highly significant (p<0.042). The mean BMI was 21.5871±10.4589.

Table 3: BMI status of mothers and incidence of low birth weight.

Variable	Category	Mean±SD	No.	<2500gm	>2500gm
Nutritional status based upon BMI	Malnourished <18.5	17.33±1.0475	131	48 (37%)	83 (63%)
	Well nourished 19-24	21.34±1.7208	338	96 (28%)	242 (72%)
	Overweight 25-29	26.58±1.4282	53	9 (17%)	44 (83%)
	Obese>30	32.10±1.3106	7	1 (14%)	6 (86%)

Table 4: Various anthropometric measurements of neonate in study population.

Variable	Mean	Standard deviation
Birth weight	2822.80	±447.64
Length	48.0319	±2.1963
Occipito Frontal circumference	33.6866	±1.3510
Mid arm circumference	8.8868	±0.8349
Mid arm circumference/Occipito frontal circumference	0.2636	±2.039

Newborns anthropometric measurements showed the mean birth weight 2822.80±447.64, length 48.0319±2.1963, mean occipitofrontal circumference 33.68±1.35, mean mid arm circumference 8.88±0.83, MAC/OFC was 0.2636±2.039 (Table 4).

Table 5: Prevalence of low birth weight (LBW).

Variable	Frequency	Percentage
<2500gm	154	29
>2500gm	375	71

The neonatal anthropometry i.e. birth weight (p<0.000), length (p<0.001), OFC (P<0.000), MAC (P<0.001) MAC/OFC (P<0.050) showed highly significant relationship with maternal nutritional status i.e. Weight, height and BMI (Table 6).

Analysis of variance showed highly significant relationship of the neonatal anthropometry with the nutritional status of the mother assessed by maternal weight and height and BMI.

Table 6: Relationship between maternal nutritional status with neonatal anthropometry.

Variable	Category	Number	Birth weight	length	OFC	MAC	MAC/OFC
Weight	≤40kg	57(10.8%)	2620±393.72	47.11±2.06	33.06±1.36	8.55±0.90	0.2587±2.460
	≥40kg	472(89.2%)	2847.29±447.91	48.14±2.18	33.76±1.33	8.92±0.81	0.26±1.977
		Sig.	P<0.000	P<0.001	p<0.000	p<0.001	p<0.050
Height	≤145cm	94(17.8%)	2684.94±384.25	47.46±2.16	32.28±1.21	8.71±0.68	0.2619±1.877
	≥145cm	432(82.2%)	2852.59±455.13	48.15±2.18	33.77±1.36	8.92±0.86	0.2640±2.037
		Sig.	p<0.001	p<0.006	p<0.001	p<0.029	p>0.05
BMI	≤18.5	131(24.8%)	2669.00±416.53	47.43±2.20	33.18±1.34	8.65±0.84	0.2606±2.160
	19-24	338(63.6%)	2850.00±440.91	48.17±2.18	33.81±1.25	8.92±0.81	0.2638±1.986
	25-29	53(10%)	3011.79±473.74	48.54±1.96	34.09±1.25	9.16±0.79	0.2688±2.014
	>30	7(1.3%)	2957±340.86	48.45±2.48	33.82±1.44	9.21±0.87	0.2720±1.736
		Sig.	p<0.000	p<0.002	p<0.000	p<0.000	p<0.050

DISCUSSION

The causes of LBW have been the focus of a vast number of investigations of the last few decades. The multiple factors as the causality of LBW include the ethnicity/race, socioeconomic status, maternal nutritional status; anemia, smoking, alcoholism, drug abuse etc. have been evaluated by various investigators. Most of the studies have focused on one or two parameters. Little literature could be found which has made simultaneous evaluation of multiple parameters. We have tried to fill this gap in our study. Demographic and social attributes of the study population revealed that majority of women reported for delivery were from rural background (72.4%) and belonged to middle and low income group (84.9%). Ninety five percent (95.5%) were housewives, nearly half were vegetarian, and majority of cases resided at an altitude of 2000-2500 meters (57.7%). Weight gain during pregnancy was ≥9kg in 59% of cases and adequate antenatal care was received by 87.5% and hospital delivery services were maximally received by primipara (63.3%). The mean maternal weight was 50.0539±7.975, height 154.1488±9.0388cm, BMI 21.587±10.4589. Literacy rate among the study population was 96.6% and the number of illiterate mothers was 3.4% in comparison to all India figures of 31% (NFHS-2 1998-99).[4] The maternal weight frequency showed 82.9% of the mothers weighing >40kg. Maternal height is higher to the national figure (151.2%) and many other states viz. Bihar, Orissa, West Bengal, Assam etc.[4] Only 24.8% of mothers had BMI equal or below 18.5kg/m2 in comparison to national figure of 35.8%. The BMI below 18.5kg/m^2 was seen in higher percentage of married women in the state of Haryana (25.9%), J and K (26.4%) and Rajasthan (36.1%). BMI is better in Punjab and Delhi as the percentage of married women with BMI below 18.5kg/m^2 is 16.9% and 12% respectively (NFHS2).[4] The percentage of LBW in different groups was directly related to degree of severity of maternal malnutrition Table 3. As nutritional status of the mother increases, the number of LBW decreased which is similar to study done by Amin N et al, Thame M et al and Bhatia BD et al.[5-7] The mean birth weight was significantly more (p value<0.000) more in well nourished mothers (2850.00±440.91) in comparison to malnourished mothers (2669.00±416.53). The prevalence of low birth weight in the present study group was 29% which is similar to the incidence reported by Hirve S et al and lower to as reported to by Tyagi et al.[8,9]

The studied population showed highly significant positive relationship between the maternal weight, maternal height, BMI and neonatal anthropometry i.e. birth weight, length, OFC, MAC and MAC/OFC ratio. The results of the relationship between maternal nutritional status and neonatal anthropometry were similar to as reported by various authors though reported on one or two parameters at a time in contrast to our study involving multiple parameters simultaneously. Thilothamal N et al stated in their study that maternal nutritional status and neonatal head circumference and birth weight are positively correlated. The difference observed by them was statistically significant and same as reported in our study.[10] In another study conducted by Das JC et al showed significant correlation between weight of mother and weight of baby and height of mother with length of newborn (p≤0.05) which was same as found in present study.[11]

CONCLUSION

The study amply highlights the correlation of maternal nutritional status with neonatal anthropometry i.e. birth weight, length, occipitofrontal circumference, mid arm circumference and on multivariate analysis maternal

weight as the variable showed the strongest linear relationship with birth weight.

Utilization of health services including antenatal care, the nutritional supplements offered under the various maternal and child health (MCH), hospital delivery etc. was more among the literate women.

Percentage of the LBW was low in the studied population is due to higher literacy and consequent increased number of health care services.

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