Journal of Population Therapeutics & Clinical Pharmacology

RESEARCH ARTICLE
DOI: 10.53555/jptcp.v31i3.4737

THE STUDY OF EFFECT OF MATERNAL BODY MASS COMPOSITION AND HB% AT TERM GESTATION ON BIRTH WEIGHT AND APGAR SCORE OF THE NEWBORN IN A TERTIARY HOSPITAL OF UTTAR PRADESH

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Abstract-

Introduction- Low birth weight is the major public health problem in todays world. The maternal weight gain and other nutritional indicators during pregnancy which are related to optimum foetal growth are the consequence of pre-pregnancy BMI (body mass index). Out of these indicators, maternal body mass composition and Hb% (haemoglobin percentage) are the two important parameters which determine maternal and fetal outcome. So our study focused on these two parameters to see their effect on birth weight and APGAR score of the newborn

Material and Methods- This study was an observational cross-sectional hospital based study done in pediatrics department in collaboration with obstetrics & gynaecology department of Government Medical college, Azamgarh, UP on a total of 150 pregnant females. The maternal variables assessed were gestational age, nutritional status and various anthropometric measurements and neonatal variables assessed in our study were gestational age, fetal birth weight, length, ponderal index, APGAR score etc. All the demographic and other parameters were noted and statistically analyzed using SPSS 20.

Result- The mean age of participants in our study was 28.01±8.67yrs with maximum subjects falling into the age group of 20-29yrs. Maximum subjects were anemic and had low BMI, less fat and fat free mass (FFM) leading into fetal low birth weight (LBW) with low ponderal index in babies. All the parameters were lowest in severely anemic group and improved along with the improvement in hemoglobin levels except the APGAR score. As far as GWG is concerned, it was seen that in normal BMI class, majority of subjects had adequate GWG, whereas underweight group had insufficient GWG and overweight and obese group had excessive GWG.

Conclusion- The current research revealed the importance of better maternal body composition, before and during pregnancy along with maternal anthropometrics for superior neonatal outcomes. Hence before and during pregnancy, maternal nutritional status should be taken care off.

Keywords- Maternal, pregnant females, fetal, LBW, GWG, Hb etc.

Introduction-

Worldwide estimation of children with low birth weight (LBW) is 14.6% and roughly 47% of them are South Asians.[1] LBW in children raises the chance of poor growth among them up to 3.5 times [2] and they are at greatest risk of infant mortality.[3] Birth weight is determined by gestation length and foetal growth rate.[4] The maternal weight gain and other nutritional indicators during pregnancy which are related to optimum foetal growth are the consequence of pre-pregnancy BMI (body mass index).[5] These maternal variables are believed to be the best predictors of birth weight of newborn[6] but they are just surrogate markers of nutritional status rather than maternal body composition. There are wide-ranging beliefs on how maternal body composition is associated with birth weight rather than other variable. So, in present study we have considered maternal body mass composition as one of the maternal variable. The maternal body composition relies on a lot of other factors like socioeconomic, constitutional, racial, genetic and nutritional factors etc. During pregnancy, in maternal metabolism, gestational alterations occur to meet fetal and maternal energy needs along with fetal growth. In early gestation, the fat stores of the mother increase significantly to provide energy from mid-gestation to late-gestation. Along with other factors, maternal and fetal outcome is determined and influenced by other two important parameters i.e. pre-pregnancy body weight and Hb% (haemoglobin percentage). Nutritional surveillance showed overweight and underweight to be 53.7% and 4.5% respectively among pre-pregnant females.[7] The prevalence of obesity related pregnancy complications ranges from 18-38%.[8-10] On the other hand, India being the developing country also faces the issue of low BMI and anemia due to malnutrition. Along with India, many other South East Asian countries are also facing pregnancy anaemia as a major public health problem. In India, pregnancy anaemia ranges from 65%-75% and accounts for nearly 16%-40% maternal deaths. So to detect maternal anemia in our study we have taken Hb% as one of the maternal variable and mothers with Hb% <11gm% were considered anaemic based on world health organization standards. Pregnant females with low BMI are also at greater risk of premature rupture of membrane, preterm deliveries along with fetal LBW and low APGAR score. The LBW is associated with risk of ischaemic heart disease and type 2 diabetes mellitus in later life of the fetus. Gestational weight gain (GWG) is also a significant predictor of long and short term health status of mother and the newborn. So, in our study we have also assessed GWG in all the pregnant females along with their BMI. APGAR score is a valuable tool for predicting long term neonatal outcomes and low APGAR scores signifies poor vitality.[11,12] Many previous studies have documented higher risk of APGAR score <7 at 1 or 5 minutes in fetus of obese & overweight women.[13,14] Therefore, this research was conducted to observe the effect of maternal body mass composition and Hb% at term gestation on birth weight and APGAR score of the newborn.

Materials and Methods-

This study was an observational cross-sectional hospital based study done in pediatrics department in collaboration with obstetrics & gynaecology department of Government Medical college, Azamgarh, UP, India for a period of one year from December 2022 to November 2023. A total of 150 pregnant females booked for regular antenatal care were taken into study after obtaining informed consent from them and ethical clearance from the institutional ethics committee. Patients with last menstrual period (LMP) or an ultrasonography (USG) scan prior to 20 weeks of gestation and singleton uncomplicated pregnancy were included in the study. Participants with fetal congenital anomalies and participants with pre-elcampsia, gestations diabetes or any other obstetric or medical condition complicating pregnancy were excluded from the study. The maternal variables assessed were nutritional status and various anthropometric measurements like mid arm

circumference (MAC), skin fold thickness, weight, height, BMI, body fat, fat free mass and Hb%. MAC was measured to the nearest 0.1cm at a middle spot of the left arm between tip of acromion and olecranon process. Skin fold thickness was measured at left biceps, triceps, subscapular and suprailiac region of the patient seated on a stool with Harpenden skin fold calipers. Before applying the calipers, the skin fold of these four sites was pulled a little away from the underlying tissues by firmly pinching up the skin fold between the fore finger and thumb. Maternal weight before and after delivery was assessed to the nearest 0.5 kg by using the standard hospital tool. Maternal height was measured to the nearest 1cm by using a standard height rod of the hospital. Maternal BMI was defined by 'Quetelet index' and evaluated by dividing post partum weight in kg by square of height in meters. Body density (BD) was measured by using a standard formula i.e. 'C-M x log of sum of skin folds where C = 1.1549 and M = 0.0678'. Further by using BD, maternal body fat can be assessed by using a standard formula i.e. 'body fat mass= BW/100 X [(522.5/DB)-480.5] BD, where BW is body weight'. Maternal Fat free mass was calculated by simply deducting 'body fat mass from total body weight'. Maternal Hb was measured by using spectrophotometry. Further neonatal variables assessed were gestational age, fetal BW, length, ponderal index (PI), APGAR score. Gestational age was assessed by USG or LMP. BW of the naked newborn was measured to the nearest 5gms by using pre-zeroed electronic weighing balance within 24hours of birth. Length of the newborn was recorded to the nearest of 0.1cm using an infantometer. Further PI was evaluated by the using a formula i.e. 'weight in gm x 100/ length in cm^3'. APGAR score was assessed at 5minutes. All the demographic and other parameters were noted and statistically analyzed using SPSS 20.

Result-

The study was conducted on 150 pregnant females with the mean age of 28.01±8.67yrs. As clearly visible from figure 1, participants were divided into three age groups i.e. <20yrs, 20-29yrs and ≥30yrs with 18(12.00%), 127 (84.66%) and 5(3.33%) cases respectively.

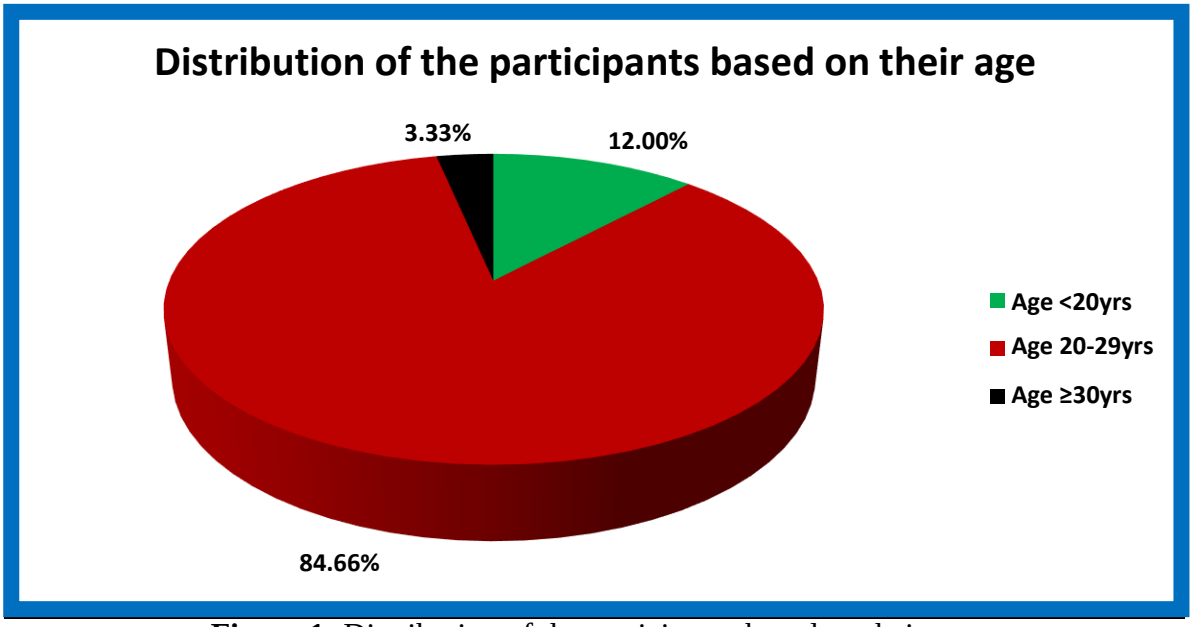

Figure 1- Distribution of the participants based on their age

As can be seen in Table 1, the maximum of the participants in current study were literate up to secondary education (58, 38.66%), followed by higher (53, 35.33%) and primary education (24, 16.00%) and only 15(10.00%) subjects were illiterate. In present study, 6(4.00%) patients were indulged into smoking and rest 144(96.00%) never smoked in their lives. Table 1 also depicts the maternal variable like MAC, weight, height, body fat, body FFM, BMI and Hb% with mean±SD value of 24.70±2.03cm, 62.21±11.01kg, 164.12±5.71cm, 13.62±4.14kg, 43.75±4.46kg, 22.63±2.53kg/m^2 and 10.72±1.51gm% respectively.

Table 1- Distribution of the participants based on the maternal variables

Maternal Variable		**Mean±SD or N (%)**
Maternal age (yrs)		28.01±8.67
Literacy rate	Illiterate	15(10.00%)
	Primary	24(16.00%
	Secondary	58(38.66%)
	Higher	53(35.33%)
Smoking	No	144(96.00%)
	Yes	6(4.00%)
MAC (cm)		24.70±2.03
Weight (kg)		62.21±11.01
Height (cm)		164.12±5.71
Body fat (kg)		13.62±4.14
Body fat free mass (kg)		43.75±4.46
BMI (kg/m^2)		22.63±2.53
Hb% (gm%)		10.72±1.51

Further participants were divided based on BMI and hemoglobin level. Figure 2 shows categorization of the participants into 4 classes based on the maternal BMI. As per Asian Classification, if BMI was <18.5kg/m^2, 18.5-22.99kg/m^2, 23-27.49kg/m^2, ≥27.5kg/m^2 then subjects were categorized into underweight, normal, overweight and obese [15] with 36(24.00%), 65 (43.33%), 32 (21.33%) and 17 (11.33%) cases respectively.

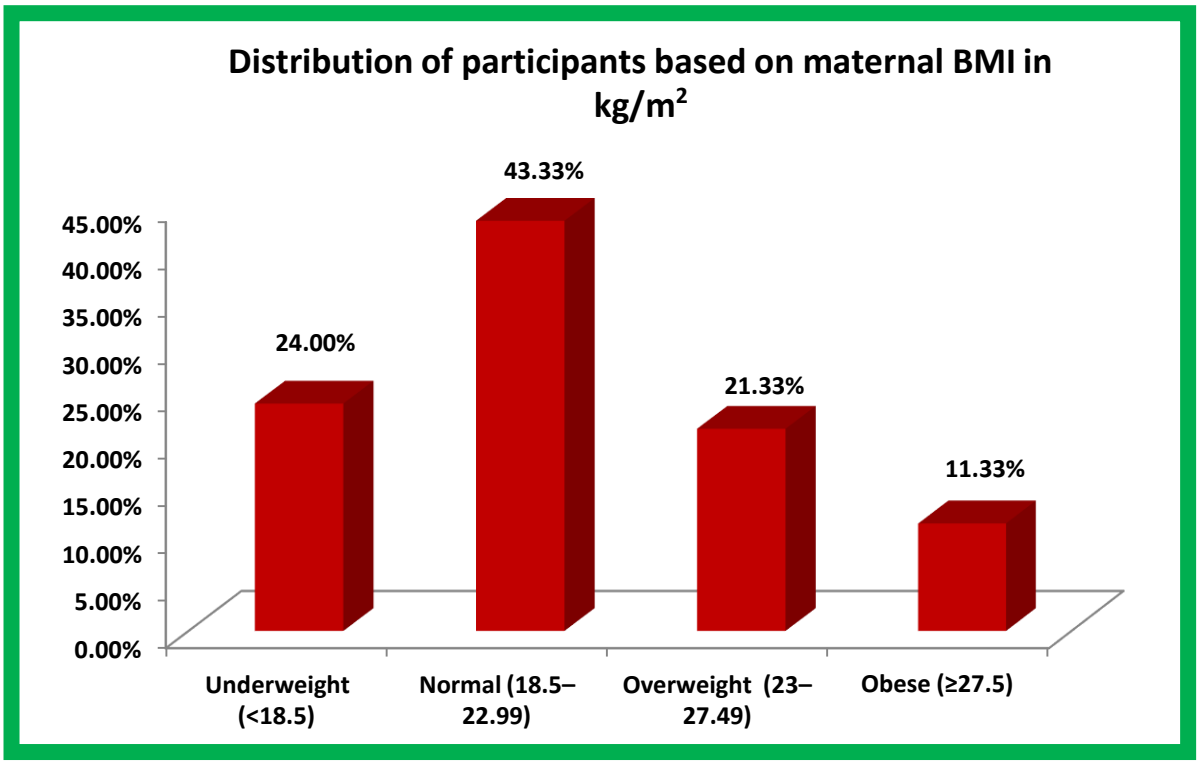

Figure 2- Distribution of the participants based on the maternal BMI (Asian Classification)

As far as maternal Hb level is concerned, figure 3 illustrates grouping of subjects again into 4 groups. Hb level of <7gm%, 7-9gm%, 9.1-11gm% and >11gm% were grouped as group A, B, C and group D with 19(12.66%), 33(22.00%), 75(50.00%) and 23(15.33%) cases respectively.

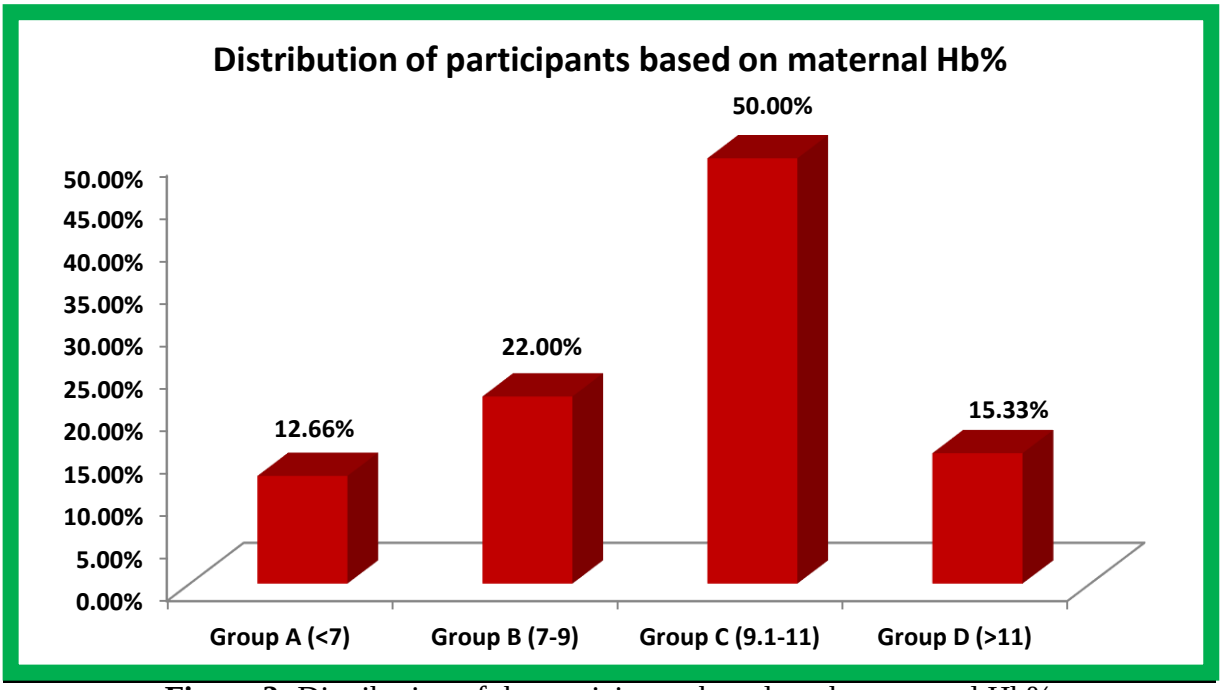

Figure 3- Distribution of the participants based on the maternal Hb%

Mean gestational of the newborn was 38.00±2.00weeks. Table 2 shows distribution of subjects based on different fetal parameters like fetal birth weight, fetal length, ponderal index and APGAR score with mean±SD of 2.81±0.52kg, 49.7±2.00cm, 2.33±0.17 and 9.15±1.75 respectively. In present study, maximum of the subjects had fetal birth weight ≥2.5kgs and fetal length ≥48cm i.e. 122(81.33%) and 133(88.66%) respectively. Rest 28(18.66%) were having LBW of ≤2.5kgs and 17(11.33%) born with fetal length <48cm respectively. As far as ponderal index is concerned, majority of the subjects i.e. 101(67.33%) had fetal ponderal index ≥2.3 followed by 49(32.66%) with ponderal index of <2.3. APGAR score of all the newborns were ≥7.

Table 2- Distribution of the participants based on the fetal variables

Fetal variable (Mean±SD)		**Mean±SD or n (%)**
Gestational age (weeks)		38.00±2.00
Birth weight in kg (2.81±0.52)	<2.5kg (LBW)	28(18.66%)
	≥2.5kg (NBW)	122(81.33%)
Length in cm (49.7±2.00)	<48	17(11.33%)
	≥48	133(88.66%)
Ponderal index (2.33±0.17)	<2.3	49(32.66%)
	≥2.3	101(67.33%)
APGAR score (9.15±1.75)	<7	0(0.00%)
	≥7	150(100%)

Table 3 depicts grouping of participants into four groups i.e. Group A, B, C and D based on their Hb level. In Group A, the mean ante-natal weight (ANW), maternal BMI, MAC, body fat, free fat mass, neonatal birth weight, LBW%, birth length, pondreal index and APGAR score were observed to be 51.54±5.36kg, 19.89±2.12kg/m^2, 22.88±1.93cm, 9.69±2.31kg, 41.20±3.54kg, 2.31±0.18kg 10%, 47.89±0.20cm, 2.08±0.16 and 8.64±1.36 respectively. In group B, the mean ANW, maternal BMI, MAC, body fat, free fat mass, neonatal birth weight, LBW%, birth length, pondreal index and APGAR score were assessed as 55.16±6.24kg, 22.07±2.45 kg/m^2, 24.45±2.12cm, 14.21±6.85kg, 41.90±3.79kg, 2.63±0.26kg, 5.34%, 47.57±0.90cm, 2.34±0.18 and 9.34±1.02 consecutively. As far as group C and D are concerned, the mean ANW, maternal BMI, MAC, body fat, free fat mass, neonatal birth weight, LBW%, birth length, pondreal index and APGAR score were seen to be

59.07±7.70kg, 23.32±2.60kg/m^2, 25.08±2.11cm, 14.30±3.72kg, 44.23±5.07kg, 2.82±0.25kg, 2.67%, 48.12±1.22cm, 2.42±0.16 and 9.36±0.95 respectively in group C, whereas 64.89±8.31kg, 25.10±2.93kg/m^2, 26.42±2.03cm, 16.30±3.68kg, 47.65±5.36kg, 3.24±0.41kg, 0.67%, 49.13±2.01cm, 2.52±0.19 and 9.32±0.98 consecutively in group D. Our study observed that as the Hb level of the subjects increased from group A to group D, the maternal and fetal variables showed a significant improvement except the APGAR score.

Table 3- Maternal and fetal variables based on the Hb% distribution of the mothers.

Variable	Group A	Group B	Group C	Group D
Ante natal weight (kg)	51.54±5.36	55.16±6.24	59.07±7.70	64.89±8.31
Maternal BMI (kg/m^2)	19.89±2.12	22.07±2.45	23.32±2.60	25.10±2.93
Maternal MAC (cm)	22.88±1.93	24.45±2.12	25.08±2.11	26.42±2.03
Maternal body fat (kg)	9.69±2.31	14.21±6.85	14.30±3.72	16.30±3.68
Maternal free fat mass (kg)	41.20±3.54	41.90±3.79	44.23±5.07	47.65±5.36
Neonatal birth weight (kg)	2.31±0.18	2.63±0.26	2.82±0.25	3.24±0.41
LBW% (%)	10%	5.34%	2.67%	0.67%
Neonatal birth length (cm)	47.89±0.20	47.57±0.90	48.12±1.22	49.13±2.01
Pondreal Index	2.08±0.16	2.34±0.18	2.42±0.16	2.52±0.19
APGAR score	8.64±1.36	9.34±1.02	9.36±0.95	9.32±0.98

Further table 4 depicts gestational weight gain (GWG) of mothers based on their BMI. Maternal BMI was categorized into underweight, normal, overweight and obese groups and the GWG in these BMI categories was observed as adequate, insufficient and excessive GWG. The maximum subjects of underweight group i.e. 18(50.00%) had insufficient GWG followed by adequate and excessive GWG with 12(33.33%) and 6(16.66%) respectively. In normal weight group, nearly half of the subjects i.e. 31(47.69%) had adequate GWG followed by insufficient and excessive GWG with 24(36.92%) and 10(15.38%) cases consecutively. In overweight group, more than half cases i.e. 17(53.12%) had excessive GWG followed by adequate and insufficient GWG with 12(37.50%) and 3(9.37%) cases respectively. As far as obese group is concerned, more than half had excessive GWG i.e. 9(52.94%) followed by both adequate and insufficient GWG seen in 4(23.52%) cases.

Table 4- Gestational weight gain (GWG) of mothers based on their BMI.

BMI category	Adequate GWG n (%)	Insufficient GWG n (%)	Excessive GWG n (%)
Underweight	12(33.33%)	18(50.00%)	6(16.66%)
Normal	31(47.69%)	24(36.92%)	10(15.38%)
Overweight	12(37.50%)	3(9.37%)	17(53.12%)
Obese	4(23.52%)	4(23.52%)	9(52.94%)

Discussion-

The present study was conducted on 150 pregnant females to observe the effect of maternal body mass composition and Hb% at term gestation on birth weight and APGAR score of the newborn. In both developed and developing countries, LBW is considered as the significant public health issue. Many factors can predict fetal outcome but neonatal birth weight (BW) is possibly the only significant factor affecting fetal mortality, infant mortality and postnatal morbidity. Thus, different maternal variables affecting BW were studied. The mean age in our study was 28.01±8.67yrs with maximum subjects falling into the age group of 20-29yrs. Majority of the patients never smoked in their lives and had literacy only up to secondary education. This finding is strongly supported by Mamidi, R.S. et al.[15] and Papazian T et al.[16] The reason behind our findings could be the cultural values and less awareness regarding female education in developing countries.

The mean of maternal variables like MAC, weight, height, body fat, body FFM, BMI and Hb% found in our study is in agreement with the study by Bushra Fatima et al.[17] and B. Sarada et al.[18] In present study the post-natal weight assessed within 48hours of delivery was used for calculation of BMI and was considered to signify pre-pregnancy BMI. The significant number i.e. 24% subjects were underweight and 84.67% were anemic with Hb level<11gm%. This finding is strongly in accordance with the Bushra Fatima et al.[17] and is in near agreement with study by B. Sarada et al.[18] and Mamidi, R.S. et al.[15] This probably could be due to females embracing motherhood in their early twenties in our country and their dietary intake is not sufficient to meet the pregnancy demands for fetal and maternal growth which may have harmful influence on the mother and fetal health leading to adverse outcomes. Our study clearly depicts that in spite of many programmes run by Indian government, a huge number of pregnant females still suffer from anaemia. In current study, the mean fetal variables and their categorized distribution like fetal birth weight, fetal length, ponderal index and APGAR score are in concordance with the study by Bushra Fatima et al.[17] The mean gestational of the newborn in our study was 38.00±2.00weeks which is similar to the study by Mamidi, R.S. et al.[15]

Further, parameters were compared in different groups categorized on the basis of Hb%. As 84.67% of primi-gravida mothers were anemic, this could be the reason for their low BMI, less fat and FFM in present study forming the grounds for fetal LBW with low ponderal index in babies delivered by them. When parameters were compared in all the four Hb% groups, it was observed that moderate and severe anemic groups had low BMI, body fat, FFM along with LBW and ponderal index in their delivered babies compared to mild or non-anaemic groups. All the parameters including mean birth weight was lowest in severely anemic group and was improved along with the improvement in Hb levels and anemia in moderate, mild and no anemia groups except the APGAR score. In severely anemic group, APGAR scores were the lowest but had no correlation with anemia as it did not improve in other groups. BW in current study was seen to be influenced by body FFM followed by maternal fat mass which is in harmony with many western studies[19] and the study by Franscisco mardones et al.[20] The fact that the Indian females genetically and constitutionally have small built along with poor nutrition is aptly accountable for LBW babies in our study. Another study supporting our outcome also documented high LBW rate in primi-gravida mothers.[21] Present study showed that females with low BMI delivered LBW babies, which clearly signifies effect of maternal weight and height on fetal BW. Normal BMI females have less risk of delivering a LBW or high birth weight babies. The underweight females are more likely to deliver LBW babies but the risk decreases if they put on right sum of weight during pregnancy.[22] So the Institute of medicine (IOM) has laid down the recommendations for GWG specified by pre pregnancy BMI. In our study, as far as GWG is concerned, it was seen that in normal BMI class, majority of subjects had adequate GWG, whereas underweight group had insufficient GWG and overweight and obese group had excessive GWG. Excessive GWG is not good for fetal growth as it is related to more maternal fat stores. In United States (US), currently maximum of pregnant females surpass IOM recommendations for GWG.[23,24] Similar findings were documented by Crane et al.[25] and Johnson et al.[26]

Conclusion-

The current research revealed the importance of better maternal body composition before and during pregnancy along with maternal anthropometrics for superior neonatal outcomes. Females with inadequate BMI showed negative significant birth outcomes like LBW, APGAR score and PI. Hence before and during pregnancy, maternal nutritional status plays a decisive role on pregnancy outcome. So, in pregnant females of developing countries like India, the only possible means to raise the BW of newborn is improving the maternal nutritional status. So the pregnant women should be motivated by heath care team to adopt a healthy lifestyle and should be given nutritional counseling before and after conception. Along with this national programmes should implemented

to monitor GWG throughout pregnancy to avoid any negative neonatal outcome of insufficient or excessive GWG.

Conflict of Interest: None

Source of funding: NIL

Authors' contribution: All the authors have made considerable contribution in designing, data collection, analysis and interpretation.

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