DOI: 10.14260/jemds/2015/1358

ORIGINAL ARTICLE

METERNAL ANTHROPOMETRY DETEMINES PREGNANCY OUTCOME

Rupa L. Balihalimath[1], Vijaykumar Shinde[2], Nareshkumar Tyagi[3], Amruta S. Patil[4]

HOW TO CITE THIS ARTICLE:
Rupa L. Balihalimath, Vijaykumar Shinde, Nareshkumar Tyagi, Amruta S. Patil. "Meternal Anthropometry Detemines Pregnancy Outcome". Journal of Evolution of Medical and Dental Sciences 2015; Vol. 4, Issue 54, July 06; Page: 9347-9357, DOI: 10.14260/jemds/2015/1358

ABSTRACT: Placenta is a transient vital organ of pregnancy and one of the most sensitive determinants of birth weight and pregnancy complications. Placental morphology and pregnancy outcome are influenced by maternal genetic, socio-economic and psychological make-up, and nutritional status in childhood and thereafter. Variation in these factors will lead to adverse pregnancy outcome. Hence, the study assessed the influence of maternal anthropometry: weight and, height on placental morphometry: weight, volume and surface area, and birth weight. **MATERIALS AND METHOD:** The study was conducted on 391 placentae of singleton newborn from a teaching hospital of North Karnataka, India. Data was collected from August 2012 to January 2013 by using standard operating procedures in a pre-designed and pre-tested proforma. Maternal anthropometry cumulative distribution is described with figures. Analysis of variance is used to study the differences in means of placental morphometry in different groups of maternal anthropometry. **RESULTS:** The Means and standard deviations of placental morphometry; weight, volume, surface area and thickness were 440±100gm, 386±101ml, 230±50cm sq, and 2.1±0.4cm respectively. Mean and standard deviations of birth weight and were 2700±500gm. Maternal pre-pregnancy weight followed moderately normal distribution with mean 48.4 and SD 8.9 kg. Mean birth weight ($p<0.001$) and placental morphometry [weight ($p<0.001$), volume ($p<0.001$) and surface area ($p<0.05$)] increased consistently with the increasing maternal pre-pregnancy weight. Gestational weight gain was significantly related with birth weight ($p<0.01$) however, placental morphometry did not exhibit any significant difference with weight gain. Maternal height followed moderately normal distribution with mean maternal height 153.9 cm with SD of 6.7. Means of birth weight ($p<0.05$) increased consistently with the increasing maternal height, however, placental morphometry did not show any significant difference. **CONCLUSIONS:** The study infers that maternal pre-pregnancy and during pregnancy health status along with placental morphology determines neonatal health status. Hence, variations in the maternal nutritional status lead to adverse pregnancy outcome.

KEYWORDS: Gestation, Maternal pre-pregnancy weight, Weight gain, Height, Placental weight, Placental surface area, Placental volume.

INTRODUCTION: Placenta nourishes the embryo from early embryonic period by facilitating the nutrition, from the secretion of the uterus by diffusion. As the embryo grows, it becomes structurally complex and it cannot meet its nutritional requirements by simple diffusion. Hence, to meet these nutritional requirements, fetal membranes were evolved namely amnion, chorion, yolk sac, allantois, placenta and umbilical cord. These membranes are of functional importance during the embryonic life, as they are concerned with the supply and storage of the nutrients, respiratory exchange, excretion, passive immunity, production of hormones and mechanical protection of the embryo.[1]

Maternal obesity prior to and during pregnancy is present in 20-34% of all pregnant women. Obesity and high weight gain in pregnancy were correlated with many complications: gestational diabetes, preeclampsia, multifoetal pregnancy, macrosomia, caesarean section, obstetric bleeding,

DOI: 10.14260/jemds/2015/1358

fetal asphyxia at birth.[2,3,4] Pre-pregnancy body size that is adiposity (Overall and central) , pre-pregnancy weight gain, and gestational weight gain influence the risk of preterm birth. Maternal obesity may lead to greater placental transfer of nutrients during embryonic and fetal development leading to permanent changes in appetite, metabolism and neuroendocrine function of offspring. Maternal obesity subsequently influences the body composition of offspring mediated through the intra-uterine environment accelerating the intergenerational obesity levels.[5,6,7]

Placental hypertrophy and decreased fetal growth were hypothesized as an adaptation to sustain placental function in underweight pregnant women due to malnutrition. Complications related to underweight mothers were reported as: low APGAR score, low birth weight (LBW), preterm delivery, increase of perinatal mortality. Common life stress during pregnancy is associated with moderately increased placental weight at birth, controlled for length of gestation[4,8]. The short maternal height is associated with increased mortality and anthropometric failure among children in India, suggesting intergenerational pathways between a mother's health and social wellbeing during her childhood and her offspring's health.[9]

Mothers with hypertension and anemia were associated with growth restriction of placental weight and chorionic plate area. Pre-pregnancy BMI and pregnancy weight gain were related with an increased possibility of hypertrophy for all three dimensions (Placental weight, thickness, and chorionic plate area) of placental growth.[10]

MATERIALS AND METHODS: The present study was conducted in the Department of Anatomy, Jawaharlal Nehru Medical College, Belgaum. Placentae were collected from Obstetrics and Gynecology Unit of Dr. Prabhakar Kore Charitable Hospital, Belgaum. Data was collected from August 2012 to January 2013. The study was conducted on 391 mothers and their singleton offspring. The study was approved by the KLE University Ethical Clearance Committee. Detailed information about the intended research work was given to the mothers and written consent was obtained from them. A pilot study was carried out before commencing the actual study. This was done to assess the feasibility and practicability of the whole research design. The subjects without antenatal check-up during first trimester and with history of pre-pregnancy systemic and chronic diseases were excluded. Placental morphometry, maternal, and newborn parameters were recorded on predesigned and pretested proforma.

2.1 Methods of specimen collection, preparation, and assessment of placental morphometry[11,12,13]:

- Placentae were collected soon after separating the baby from the umbilical cord. The collected placentae were examined thoroughly and washed under running tap water, thereafter, membranes were trimmed.
- The specimens were tagged with numbers for identification, and were transported to the skill lab by placing in a 10% formalin container.
- The weight of each placenta were determined by the digital baby weighing scale CS-8316 (CE certified) and recorded with accuracy of 1 gm.
- The maternal surface area of the placenta was calculated using the formula.
    - Surface area= **π x dl x ds/4**, (Where dl: largest diameter, ds: smallest diameter)
    - The Surface area was recorded with accuracy of 1 sq cm.

DOI: 10.14260/jemds/2015/1358

- The volume was recorded using water displacement method, with accuracy of 1 ml.
- The thickness was measured by inserting a calibrated Knitting needle at the center of placenta and measured in centimeter, with accuracy of 0.1cm.

2.2 Parameters of newborn baby assessed were:

- Gestational age, weight of the baby.
- The gestational age was recorded from last menstrual period (LMP) and further confirmed by Ultrasonography (USG); grouped as 28-34, 35-36, 37+ weeks (wk).
- Birth weight was measured by using Digital baby weighing scale CS-8316 (CE certified) with accuracy of 10 gm.

2.3 Maternal Parameters assessed were,[14]

- Maternal pre-pregnancy weight (kg) recorded from antenatal check-up card (i.e., weight recorded within the initial 12 weeks of pregnancy).
- Height (cm) - by using stadiometer.
- Weight before delivery (kg).

Statistical analysis was carried out using SPSS-16. The differences in means were tested using Analysis of Variances and comparisons of means were studied by t-test. Differences were considered statistically significant at p value less than 0.05, 0.01 and 0.001. The Box plots were prepared to study the relative distributions placental morphometry and newborn anthropometry.

RESULTS:

Height in cm	Percent (n=391)	Cumulative Percent	
		Observed	Expected
<145	8.2	8.2	9.2
145-149	13.6	21.7	28.0
150-154	29.9	51.7	56.5
155-159	29.9	81.6	81.9
160+	18.4	100	100.00
Total	**100**		
Mean= 153.9, SD=6.7			

Table 1.1: Maternal height distribution

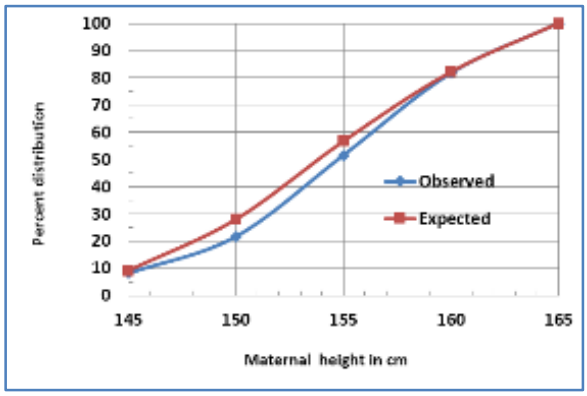

Fig. 1.1: Maternal height distribution

DOI: 10.14260/jemds/2015/1358

Maternal height distribution in Table 1.1 and Fig.1.1 reveals that 29.9 percent pregnant women were of height 155-159 cm and 8.2 percent were less than 145 cm. Maternal height followed moderately normal distribution with mean 153.9 and SD 6.7 cm.

Weight in Kg	Pre-pregnancy weight			Before delivery weight		
	Percent (n=391)	Cumulative Percent		Percent (n=391)	Cumulative Percent	
		Observed	Expected		Observed	Expected
30-34.9	3.1	3.1	6.6	-	-	
35-39.9	11.0	14.1	17.3	0.8	0.8	2.3
40-44.9	19.9	34.0	35.1	4.3	5.1	7.5
45-49.9	17.9	51.9	57.1	13.0	18.2	18.7
50-54.9	27.1	79.0	77.1	18.4	36.6	36.7
55-59.9	9.7	88.7	90.4	24.3	60.9	58.3
60-64.9	6.2	94.9	96.9	17.2	78.0	77.6
65+	5.1	100.0	100.0	22.0	100.0	100
Total	**100.0**		-	**100.0**		-
Mean=48.4, SD=8.9				**Mean=58.1, SD=9.1**		

Table 1.1.2: Maternal pre-pregnancy and before delivery weight distributions

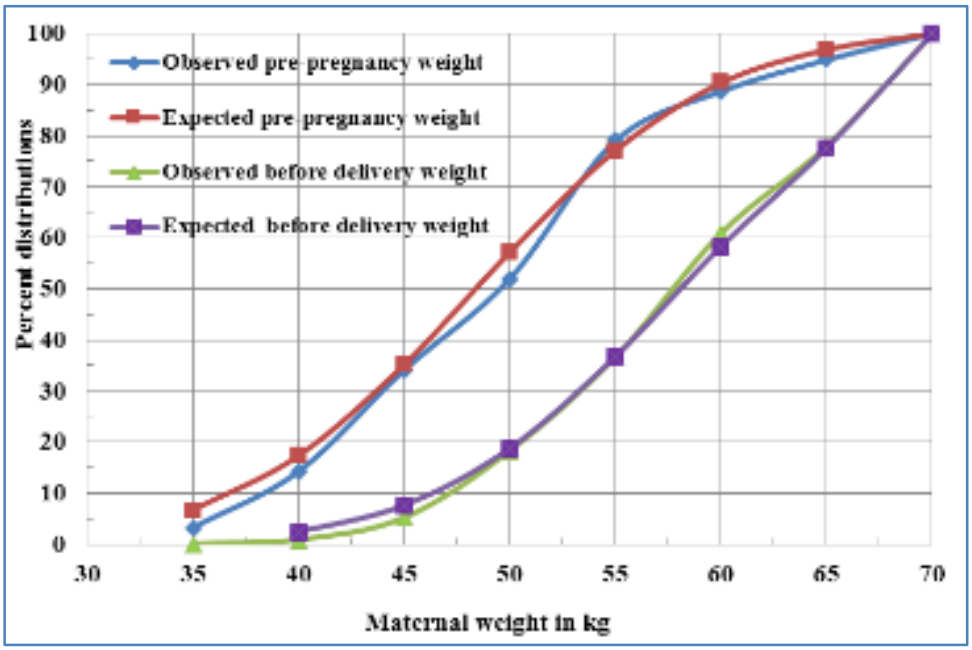

Fig.1.2: Maternal weight distribution

Maternal Pre-pregnancy and before delivery weight distributions in Table 1.2 and Fig.1.2 reveal that in maternal pre-pregnancy weight, a maximum of 27.1 percent were of 50-54.9 kg and 14.1 percent were less than 40 kg, whereas, in before delivery maternal weight a maximum 24.3 percent of women were of 55-59.9 kg and 5.1 percent were less than 45 kg. Cumulative distribution of pre-pregnancy and before delivery weight exhibited weight gain phenomena during pregnancy.

DOI: 10.14260/jemds/2015/1358

Pre-pregnancy and before delivery weight followed moderately normal distribution with respective means and SD of 48.4±8.9 and 58.1±9.1 kg.

Maternal height groups	n	Percent	Mean	SD	SE	95% Confidence Interval	
						Lower	Upper
Birth weight in gm;*; $F_{2,388}$=3.5; p<0.05							
< (Mean-1SD)	59	15.1	2566	474	62	2443	2690
(Mean±1SD)	275	70.3	2654	485	29	2596	2712
> (Mean+1SD)	57	14.6	2801	499	66	2668	2933
Total	391	100.0	2700	500	25	2613	2711
Placental weight in gm; NS							
< (Mean-1SD)	59	15.1	449.9	97.0	12.6	424.7	475.2
(Mean±1SD)	275	70.3	440.9	93.9	5.7	429.7	452.0
> (Mean+1SD)	57	14.6	453.7	119.0	15.8	422.1	485.3
Total	391	100.0	440.0	100.0	5.0	434.3	453.9
Placental volume in ml; NS							
< (Mean-1SD)	59	15.1	389.3	91.6	11.9	365.4	413.2
(Mean±1SD)	275	70.3	383.2	95.9	5.8	371.8	394.6
> (Mean+1SD)	57	14.6	400.4	120.0	15.9	368.5	432.2
Total	391	100.0	384.6	101.0	5.0	376.8	396.5
Placental surface area in cm sq; NS							
< (Mean-1SD)	59	15.1	229.8	49.6	6.5	216.9	242.8
(Mean±1SD)	275	70.3	228.9	48.3	2.9	223.2	234.6
> (Mean+1SD)	57	14.6	234.3	59.0	7.8	218.7	250.0
Total	391	100.0	229.8	50.1	2.5	224.9	234.8
Placental thickness in cm; NS							
< (Mean-1SD)	59	15.1	2.1	0.4	0.1	2.0	2.2
(Mean±1SD)	275	70.3	2.2	0.4	0.0	2.1	2.2
> (Mean+1SD)	57	14.6	2.3	0.8	0.1	2.1	2.5
Total	**391**	**100.0**	**2.1**	**0.5**	**0.0**	**2.1**	**2.2**

Table 2: Association of birth weight and placental morphometry with maternal height

Association of birth weight and placental morphometry with maternal height in Table 2 reveal that the birth weight increased consistently and significantly with increasing maternal height groups (p<0.05) . Placental weight, volume and surface area did not exhibit any significant difference with increasing maternal height. Though the placental morphometry was higher in third group > (Mean+1SD) as compared to lower two groups [<(Mean-1SD) and (Mean±1SD)], but their differences were not statistically significant.

DOI: 10.14260/jemds/2015/1358

Pre-pregnancy weight groups	n	Percent	Mean	SD	SE	95% Confidence Interval	
						Lower	Upper
Birth weight in gm;*;$F_{2,388}$=7.15;p<0.001**							
< (Mean-1SD)	55	14.1	2512	506	68	2375	2649
(Mean±1SD)	275	70.3	2652	478	29	2595	2708
> (Mean+1SD)	61	15.6	2845	471	60	2724	2966
Total	391	100.0	2700	500	25	2613	2711
Placental weight in gm;*; $F_{2,388}$=5.70;p<0.001**							
< (Mean-1SD)	55	14.1	415.0	97.6	13.2	388.6	441.4
(Mean±1SD)	275	70.3	442.9	89.8	5.4	432.3	453.6
> (Mean+1SD)	61	15.6	475.6	124.7	16.0	443.7	507.6
Total	391	100.0	440.0	100.0	5.0	434.3	453.9
Placental volume in ml;*;$F_{2,388}$=5.76;p<0.001**							
< (Mean-1SD)	55	14.1	362.5	102.2	13.8	334.8	390.1
(Mean±1SD)	275	70.3	383.6	89.1	5.4	373.1	394.2
> (Mean+1SD)	61	15.6	421.9	127.7	16.3	389.2	454.6
Total	391	100.0	384.6	101.0	5.0	376.8	396.5
Placental surface area in cm sq;*;$F_{2,388}$=4.27;p<0.05							
< (Mean-1SD)	55	14.1	222.2	49.8	6.7	208.7	235.7
(Mean±1SD)	275	70.3	227.7	46.4	2.8	222.2	233.2
> (Mean+1SD)	61	15.6	246.4	62.3	8.0	230.4	262.3
Total	391	100.0	229.8	50.1	2.5	224.9	234.8
Placental thickness in cm; NS							
< (Mean-1SD)	55	14.1	2.1	0.5	0.1	1.9	2.2
(Mean±1SD)	275	70.3	2.2	0.5	0.0	2.1	2.3
> (Mean+1SD)	61	15.6	2.1	0.4	0.1	2.0	2.2
Total	391	100.0	2.1	0.5	0.0	2.1	2.2

Table 3: Association of birth weight and placental morphometry with maternal pre-pregnancy weight

Table 3 reveals that birth weight exhibited significant difference with maternal pre-pregnancy weight at p<0.001. Placental weight and volume increased consistently and significantly with increasing maternal pre-pregnancy weight (p<0.001) while placental surface area was significantly different at p<0.05. Placental thickness did not exhibit any significant difference with maternal pre-pregnancy weight.

DOI: 10.14260/jemds/2015/1358

Maternal weight gain groups	n	Percent	Mean	SD	SE	95% Confidence Interval	
						Lower	Upper
Birth weight in gm;;$F_{2,388}$=4.37;p<0.01**							
< (Mean-1SD)	57	14.6	2593	527	70	2453	2733
(Mean±1SD)	281	71.8	2643	476	28	2587	2699
> (Mean+1SD)	53	13.6	2840	481	66	2707	2972
Total	391	100.0	2700	500	25	2613	2711
Placental weight in gm; NS							
< (Mean-1SD)	57	14.6	430.8	100.3	13.3	404.2	457.4
(Mean±1SD)	281	71.8	442.0	94.0	5.6	431.0	453.1
> (Mean+1SD)	53	13.6	469.6	114.2	15.7	438.1	501.1
Total	391	100.0	440.0	100.0	5.0	434.3	453.9
Placental volume in ml; NS							
< (Mean-1SD)	57	14.6	374.0	103.0	13.6	346.7	401.4
(Mean±1SD)	281	71.8	383.7	93.0	5.5	372.8	394.6
> (Mean+1SD)	53	13.6	415.8	120.6	16.6	382.5	449.0
Total	391	100.0	384.6	101.0	5.0	376.8	396.5
Placental surface area in sq cm; NS							
< (Mean-1SD)	57	14.6	228.5	57.8	7.7	213.1	243.8
(Mean±1SD)	281	71.8	228.5	47.9	2.9	222.9	234.2
> (Mean+1SD)	53	13.6	238.1	52.6	7.2	223.7	252.6
Total	391	100.0	229.8	50.1	2.5	224.9	234.8
Placental thickness in cm; NS							
< (Mean-1SD)	57	14.6	2.2	0.4	0.1	2.1	2.3
(Mean±1SD)	281	71.8	2.1	0.5	0.0	2.1	2.2
> (Mean+1SD)	53	13.6	2.3	0.8	0.1	2.1	2.5
Total	391	100.0	2.1	0.5	0.0	2.1	2.2

Table 4: Association of birth weight and placental morphometry with maternal weight gain

Table 4 reveal that birth weight increased consistently and significantly (p<0.05) with three increasing groups of maternal weight gain (< (Mean -1SD), (Mean+1SD) and > (Mean+1SD)). The placental weight and volume increased consistently with maternal weight gain but their differences were not statistically significant, whereas, placental surface area and thickness did not exhibit any consistent and significant differences by maternal weight gain.

DOI: 10.14260/jemds/2015/1358

DISCUSSION: An Australian study [15] from Brisbane opined the range of pre-pregnancy weight from 50.7-73.2kg with the mean and SD of 61.2 and SD 9.4kg, but in Croatian study[16] the range of pre-pregnancy weight was 44-116 kg with the mean and SD of 64.01 and 9.50 kg. Another Australian study from Perth inferred that the mean pre-pregnancy weight was 59.8 and SD 12.3kg.[17] As per the Mysore Parthenon study the mean maternal weight was 56 kg with SD 8.8 kg.[18] The range and mean pre-pregnancy maternal weight of present study was lower than all above mentioned studies, as the mothers were young and from lower socio economic class.

Shivarao et al., (2002) reported that maternal pre-pregnancy weight of Indian mothers was lower (Mean 60.7 with SD 0.1kg) than Chinese (Mean 65.7 with SD 0.1kg) and Malays (Mean 64.3 with SD 0.1kg) at $p<0.05$. Hence, the authors conclude that pre-pregnancy weight varies with ethnicity and affects the pregnancy outcomes significantly.[19] The variation in anthropometric measures might be due to population migration and gene mixing. Belonging to a particular population group imposes a strong effect on newborn birth weight and birth length, as it is one of the major intrinsic factor in the constitution of anthropologic frame of human beings.[20]

In the present study, birth weight and placental morphometry (Weight, volume and surface area) increased consistently and significantly ($p<0.001$) with the increasing maternal pre-pregnancy weight. Many other studies support this result to describe the pre-pregnancy weight as surrogate of the nutritional status of mother.[10,16,17,21,19]

In the present study, maternal pre-pregnancy underweight group was associated with lower birth weight and lesser placental morphometry whereas, higher pre-pregnancy weight group was associated with higher birth weight and placental morphometry. These findings were in accordance with earlier studies.[22,23] Therefore, one of the authors has put forth pre-pregnancy weight as one of the most sensitive predictor of birth weight.[24]

Weight gain: Studies from Norway[25], Croatia [16], America[10] and Indonesia [24] specified the mean and SD of maternal pregnancy weight gain as 10.6 and 3.5kg, 15.4 and 4.33kg, 9.7 and 5.0kg, and 8.8 and 2.6kg respectively. The mean pre-pregnancy maternal weight gain was lower in present study as compared to the above studies. As many women in the current study were from lower socio-economic class. Lower socio-economic class, household work, childcare responsibilities and also work outside the home with suboptimal nutrition might result in lower gestational weight gain. The influence of physical activity on birth weight was mediated through gestational weight gain.[26]In the present study, gestational weight gain was significantly ($p<0.01$) related with birth weight. Hence, current results were in congruence with previous studies.[27,28]

Maternal height: The range of height in Croatian study was 150-185 cm, with mean height 169.7 and SD 5.81cm[16]. In the Mysore Parthenon[18] and Australian[17] studies the mean maternal height were 154.6cm with SD 5.4 and 164cm with SD 7.0 respectively. The findings of above studies were higher than current study.

In the present study height exhibited consistent and significant relation with birth weight ($p<0.05$) , similar findings were reported by other studies.[16,18,24] Winder et al., (2011) has concluded that height did not show any significant relation with placental morphometry, our study results regarding the association of maternal height and placental morphometry was in congruence with this study.[18] Maternal height indicates the nutritional status of mother in her childhood and pubertal

growth i.e., early life. The women with height <145 cm had higher risk of delivering a low birth weight baby[16] and also have lower rate of protein synthesis during pregnancy than tall mothers.[29,30]

CONCLUSION: Maternal pre-pregnancy weight followed moderately normal distribution (mean 48.4 and SD 8.9 kg) with 14.1 percent of women weighing less than 40 kg. Percentiles of birth weight and placental morphometry: weight, volume, and surface area exhibited increasing trend with maternal pre-pregnancy weight. Mean birth weight ($p<0.001$) and placental morphometry [weight ($p<0.001$), volume ($p<0.001$) and surface area ($p<0.05$)] increased consistently with the increasing maternal pre-pregnancy weight. Gestational weight gain was significantly related with birth weight ($p<0.01$) however, placental morphometry did not exhibit any significant difference with weight gain. Maternal height followed moderately normal distribution where 8.2 percent of pregnant women had height less than 145cm and 59.8 percent were from height group 150-159cm. The mean maternal height was 153.9 cm with SD of 6.7. Percentiles of birth weight exhibited almost increasing trend with maternal height but placental morphometry did not exhibit any consistent relation. Means of birth weight ($p<0.05$) increased consistently with the increasing maternal height, however, placental morphometry did not show any significant difference.

REFERENCES:

1. Boyd JD, Hamilton WJ. The Human Placenta, Cambridge, England, W Heffer and sons, 1970, 890, 221p.
2. Farley D, Tejero ME, Comuzzie AG. Feto-placental adaptations to maternal obesity in the baboon. Placenta. 2009; 30 (9): 752-60.
3. Abrams B, Altman SL, Pickett KE. Pregnancy weight gain: still controversial. Am J Clin Nutr 2000; 71: 1233-41.
4. Spinillo A, Capuzzo E, Piazzi G, Ferrati A, Morales V, Matio M. Risk for spontaneous preterm delivery by combined body mass index and gestational weight gain patterns. Acta Obstet Gynecol Scand 1998; 77: 32-6.
5. Wise LA, Palmer JR, Heffner LJ, Rosenberg L. Pre-pregnancy body size, gestational weight gain, and risk of preterm birth in African-American women. Epidemiology 2010; 21 (2): 243-52.
6. Whitkar RC, Dietz WH. Role of the prenatal environment in the development of obesity. Journal pediatrics 1998; 21:132768-76.
7. Levin BE, Govek E. Gestational obesity accentuates obesity in obesity prone progeny. Am J Physiology 1998; 275: 1374-9.
8. Marion T, Naomi G, Jorn O, Andrea H, Gunther M. Maternal psychosocial stress during pregnancy and placenta weight: evidence from a national cohort study. PLos One. 2010; 5 (12) e14478.
9. Subrmanian SV, Ackerson LK, Davy Smith G, John NA. Association of maternal height with child mortality, anthropometric failure and anemia in India. JAMA 2009; 301 (16): 1691-701.
10. Baptiste KR, Salafia CM, Nicholson WK, Anne D, Wang NY, Brancati FL. Maternal risk factor for abnormal placental growth: The National Collaborative Perinatal Project. Pregnancy and Child Birth. 2008; 8: 44.

11. Balihallimath RL, Shirol VS, Gan AM, Tyagi NK,.Clinical determinants of placental morphometry and birth weight. IOSR Journal of Dental and Medical Sciences 2013; 10(1): 22-27.
12. Scherle WF. A simple method for volumetry of organ in quantitative stereology Mickroskopie 1970; 26: 57-60.
13. Barker DJP, Gluckman PD, Godfrey KM, Hardling JE, Ownes JA, Beishre NA, et al. Placental hypertrophy in severe pregnancy anemia. J Obstet Gynecol Br Common W 1970; 77: 398-409
14. National Health and Nutrition Examination Survey (NHANES), Anthropometry Procedures Manual Jan-2007.
15. Fengxiu O, Parker M, Cerda S, Perason C, Fu L, Gillman MW, et al. Placental weight mediates the effects of prenatal factors on fetal growth: the extent differs by preterm status. Obesity 2013; 21 (13): 609-20.
16. Miletic T, Sntoini E, Mikulandra F, Tadin I, Roje D. Effect of parental anthropometric parameters on neonatal birth weight and birth length. Coll Antropol 2007; 31 (4); 993-7.
17. Williams LA, Evans SF, Newnham, JP. Prospective cohort study of factors influencing the relative weights of the placenta and newborn infant. BMJ 1997; 314: 1864-8.
18. Winder NR, Krishnaveni GV, Veena SR, Hill JC, Karat CL, Thornburg KL, et al. Mother's lifetime nutrition and the size, shape and efficiency of the placenta. Placenta 2011; 32 (11): 806-10.
19. Sivarao S, Vidyadaran MK, Jammal ABE, Zainab S, Goh YM, Ramesh KN. Weight, volume and surface area of placenta of normal pregnant women and their relation to maternal and neonatal parameters in Malaya, Chinese, and Indian ethnic groups. Placenta 2002; 23 (8-9): 691-6.
20. Miklundra F, Tadin I, Grguric J, Zakanj Z, Perisa M, Mikulandra F. Influence of father's weight and height on weight of male and female newborns. Collegium antropolgicum 2001; 25(1): 59-63.
21. Ihunnaya OF, Michelle AW, Anne ES, Diane P. Pre-pregnancy body mass index, gestational weight gain and other maternal characteristics in relation to infant birth weight. Callaway LK, Prins JB, Chang AM, Mcintyre HD. The prevalence and impact of overweight and obesity in an Australian obsetetric population. Med J Aust 2006; 184 (2): 56-9.
22. Callaway LK, Prins JB, Chang AM, Mcintyre HD. The prevalence and impact of overweight and obesity in an Australian obsetetric population. Med J Aust 2006; 184 (2): 56-9.
23. Chu SY, Bacham DJ, Callahan WM, Whitlock EP, Dietz PM, Berg C, et al. Association between obesity during pregnancy and increased use of health care. N Engl J Med 2008; 358 (14): 1444-53.
24. Husaini AM, Husaini YK, Kartono AB, Barizi, Karyadi D. Maternal anthropometry and pregnancy outcomes in Indonesia. WHO Bulletin OMS 1995; 73: 77-9.
25. Roland MCP, Fris CM, Voldner N, Godang K, Bollerslev J, Haugen G, et al. Fetal growth versus birth weight: The role of placenta versus other determinants. PLoS ONE 2012; 7 (6): e39324.
26. Launer LJ, Villar J, Kestler E, O nis M. The effect of maternal work on fetal growth and duration of pregnancy: a prospective study. Br J Obstet Gynaecol 1990; 97: 62-70.
27. Schaefer-Graf UM, Heuer R, Kilavuz O, Pandura A, Henrich W, Vetter K. Maternal obesity not maternal glucose values correlates best with high rates of fetal macrosomia in pregnancies complicated by gestational diabetes. J Perinat Med 2002; 30: 313-21.
28. Dietz PM, Callaghan WM, Sharma AJ. High pregnancy weight gain and risk of excessive fetal growth. Am J Obstet Gynecol 2009; 201: 51, e1-6.

DOI: 10.14260/jemds/2015/1358

29. Tanner JM. Growth and development record for head circumference from birth to 16 years. Castlemead publications; Ware: 1983.
30. Duggleby SL, Jackson AA. Relationships of maternal protein turn over and lean body mass during pregnancy and birth length. Clin Sci 2001; 101: 65-72.

AUTHORS:

1. Rupa L. Balihalimath
2. Vijaykumar Shinde
3. Nareshkumar Tyagi
4. Amruta S. Patil

PARTICULARS OF CONTRIBUTORS:

1. Tutor, Department of Anatomy, GIMS, Gadag.
2. Professor, Department of Anatomy, GIMS, Gadag.
3. Professor, Department of Biostatistics, KEL University.
4. Senior Resident, Department of Obstetrics & Gynaecology, GIMS, Gadag.

NAME ADDRESS EMAIL ID OF THE CORRESPONDING AUTHOR:
Dr. Rupa L. Balihalimath,
KC Rain Road, Gadag.
E-mail: rupalb485@gmail.com

FINANCIAL OR OTHER COMPETING INTERESTS: None

Date of Submission: 26/06/2015.
Date of Peer Review: 27/06/2015.
Date of Acceptance: 29/06/2015.
Date of Publishing: 03/07/2015.