A Study of Body Mass Index in Pregnancy and Its Correlation with Maternal and Perinatal Outcome

Nagalakshmi Muddu[1], Shashi Jyothsna Parlapally[2], Shravika Gajjala[3]

[1, 2, 3] Department of Obstetrics and Gynaecology, CKM Maternity Hospital, Warangal, Telangana, India.

ABSTRACT

BACKGROUND

An increasing BMI is associated with an increased incidence of hypothyroidism, gestational diabetes mellitus, gestational hypertension, macrosomia, induction of labour, cesarean deliveries, PPH (Postpartum Haemorrhage), infections, lactation dysfunction, NICU (Neonatal Intensive Care Unit) admissions, neonatal & childhood morbidity. We wanted to compare BMI with mother and child outcomes during pregnancy.

METHODS

Women attending antenatal OPD for antenatal checkup, at CKM Government Maternity Hospital, Warangal, from January 2018 to June 2019 were included after informed and written consent. The above women were grouped into standard BMI groups and their obstetric outcomes and perinatal outcome variables were evaluated.

RESULTS

Increased rate of hypothyroidism, GDM, GHTN and anaemias was associated with high BMI group when compared to normal group (p = 0.001, significant). Increased rate of LSCS was noted in the high BMI group 41.67 % (n = 60) when compared to normal 16.5 % (n = 18) (p = 0.001, significant). Increased rate of instrumental deliveries was seen in the high BMI group 10 % (n = 15) when compared to normal BMI group 2.8 % (n = 3) (p = 0.001, significant). Increased rate of PPH was associated with both low and high BMI 2.1 % (n = 1) and 6.9 % (n = 10) respectively when compared to normal BMI 0 %, with p = 0.001 (significant). Increased rate of wound complications was associated with high BMI group 9.7 % (n = 14) when compared to normal BMI group 0.9 % (n = 1), p = 0.001 (significant). Increased rate of lactation dysfunction was associated with high BMI group 10 % (n = 15) when compared to normal BMI group, p = 0.001 (significant). Increased rate of NICU admissions was associated with underweight group 17 % (n = 8) & high BMI 43.3 % (n = 13) when compared to normal 2.8 % (n = 3) p = 0.001 (significant).

CONCLUSIONS

Body Mass Index has significant association with anaemia, low birth weight, small for gestational age, and neonatal intensive care unit admissions.

KEYWORDS

Body Mass Index, Underweight, Obesity, Maternal Outcome, Perinatal Outcome

Corresponding Author:
Dr. Shashi Jyothsna Parlapally,
H. No. 3-10-72, Reddy Colony,
Hanamkonda – 506001,
Telangana, India.
E-mail: drshashee@gmail.com

DOI: 10.18410/jebmh/2020/490

How to Cite This Article:
Muddu N, Parlapally SJ, Gajjala S. A study of body mass index in pregnancy and its correlation with maternal and perinatal outcome. J Evid Based Med Healthc 2020; 7(41), 2365-2370. DOI: 10.18410/jebmh/2020/490

Submission 07-07-2020,
Peer Review 15-07-2020,
Acceptance 11-09-2020,
Published 12-10-2020.

BACKGROUND

In all affluent societies, excessive weight is a big health issue. The prevalence of obesity continues to grow across the world. The global obesity epidemic continues to rise at an unprecedented pace, transcending age, race and gender boundaries. Indeed, it is now so popular that it is one of the most important contributors to ill health to replace the more conventional public health issues, including diet and infectious disease.[1] Maternal obesity was associated with the perinatal adverse effects. Obese pregnant women are at increased risk of hypothyroidism, gestational hypertension, operative vaginal delivery, cesarean delivery, gestational diabetes and PPH.[2,3,4,5] They are also at increased risk of wound infection and endomyometritis. Their offspring are at increased risk of birth defects, macrosomia, NICU admission, neonatal complications such as HMD (Hyaline Membrane Disease), metabolic abnormalities and morbidity associated with subsequent metabolic syndrome. In developing countries such as India, they also face problems of underweight-related malnutrition complications such as anaemia, premature membrane rupture, low birth weight babies, low APGAR scores, premature delivery and raised perinatal mortality. In rural areas undernutrition and urban obesity is more common. Both these women are at risk of anovulation and infertility. It is maybe the way nature suspends reproduction in nutritional extremes as nature deems this condition metabolically inadequate for procreation. These women get pregnant with advances in infertility treatment which poses a risk of maternal and perinatal outcomes. These highlight the study's need. The study aims to compare the BMI with mother and infant outcomes during pregnancy.

METHODS

This is an observational prospective study conducted among 300 women attending antenatal OPD for antenatal checkup, at CKM Government Maternity Hospital, Warangal, from January 2018 to June 2019. Informed and written consent was obtained from all study aprticipants.

Women had been briefed in depth about the research and study intent. A comprehensive history has been taken with respect to gender, age, obstetric score and extensive medical and surgical records. Estimated gestational age estimated based on the last menstrual cycle and ultrasound results of the 1st trimester recalled. The base weight and height recorded in the first trimester during the initial visit and the basal BMI determined using the formula weight in kilograms divided by height in meters square [Kg / m2]. The women above placed in standard BMI groups and assessed the variables of obstetric outcomes.

The BMI is a simple weight-for-height measure, which is measured by dividing the weight of an individual into kilograms by square of their height into metres [Kg / m2]. The women were divided into the following four categories according to their BMI according to the WHO (World Health Organization) 2000 classification.

Obese (Group 4): BMI > 30 Kg / m^2
Overweight (Group 3): BMI 25 - 29.9 Kg / m^2
Normal (Group 2): BMI 18.5 - 24.9 Kg / m^2
Underweight (Group 1): BMI < 18.5 Kg / m^2

In first trimester all women were subjected to the routine antenatal investigations like complete blood picture, blood grouping and typing, HIV, VDRL, HBsAg, complete urine examination, thyroid function test and oral glucose challenge test. Dating scan was done below 10 weeks. Ultrasound scan between 11 weeks and 13 + 6 weeks was done to determine the gestational age and to note the nuchal translucency, nasal bone visualization and ductus venous flow. Folic acid supplements were given throughout the first 12 weeks.

In second trimester at each visit, thorough general and obstetric examination was conducted. Iron supplements were started after 12 weeks. 2 doses of injections Tetanus Toxoid were given with 1 month apart. At 18 - 22 weeks, patients were subjected to a detailed anomaly scan. At 24 – 28 weeks oral glucose tolerance test was again performed and documented. Haemoglobin and urine for sugar, microscopy and proteinuria was tested every 4 weeks.

Till 28 weeks, the patient was reviewed every 4 weeks and then every 2 weeks up to 36 weeks and weekly there after till delivery. At each visit, blood pressure was noted and thorough examination to look for the fundal height, fetal heart and position of the fetus. Iron supplements were continued. OGTT was repeated at 32 - 34 weeks if it was normal the previous two times. Pelvic assessment done at 38 weeks. Any adverse findings, or whether any symptoms acquired by the patient were reported at any point of the study. Complication management was introduced.

The outcome variables of the study included development of hypertensive disorders of pregnancy which included gestational hypertension, pre-eclampsia, eclampsia and HELLP syndrome. Women with chronic hypertension excluded from study.

Development of GDM (Gestational Diabetes Mellitus) was diagnosed based on the criteria of DIPSI guidelines. According to DIPSI guidelines, 75 gms of oral glucose was given irrespective of fasting state and meal status. Blood glucose was measured after 2 hrs. GDM is diagnosed when blood glucose levels are > or = 140 mg / dl.

Development of hypothyroidism diagnosed if the TSH was more than 2.5 microIU / ml in the first trimester and more than 3 microIU / ml in the second and third trimesters. Development of anaemia as Indian Council of Medical Research recommends the following categories of anaemia.

Anaemia Severity	Haemoglobin Level (g / dL)
Mild	10 – 10.9
Moderate	7 – 10
Severe	4 – 7
Very Severe	< 4

Table 1. Categories of Anaemia as per Indian Council of Medical Research

Postpartum complications, postpartum haemorrhage, lactation failure wound infections.

Outcomes as mode of delivery, birth weight of baby, APGAR Scores at 5 minutes, need for NICU admission and neonatal complications were monitored. The statistical analysis was carried out using version 17 of SPSS. Number and percentages were used to identify categorical variables. Chi-squire test and Fisher's Exact test was done to find the association between the BMI categories and the outcome variables. Suggestive significance $0.05 < p < 0.10$

RESULTS

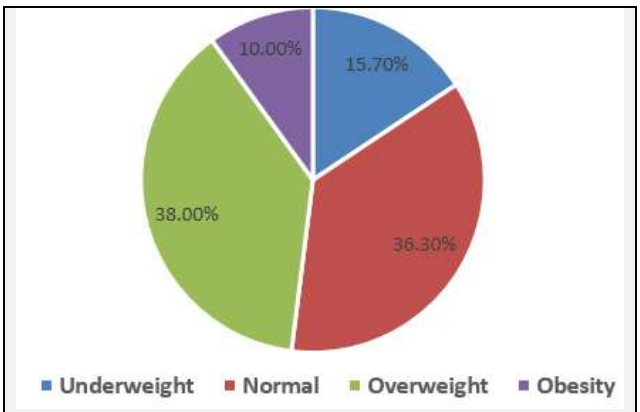

Figure 1. Distribution of Different BMI groups

Normal: 36.3 % (n = 109), Underweight: 15.70 % (n = 47), Overweight: 38 % (n = 114), Obese: 10 % (n = 30) High BMI 48 % (n = 144) [overweight and obese].

Distribution According to Age	Underweight		Normal		Overweight		Obesity	
	Number of Subjects	Percentages	Number of Subjects	Percentages	Number of Subjects	Percentages	Number of Subjects	Percentages
18 - 22 Years	8	17.00 %	21	19.30 %	27	23.70 %	6	20.00 %
23 - 29 Years	27	57.40 %	79	72.50 %	74	64.90 %	18	60.00 %
30 - 35 Years	12	25.50 %	9	8.30 %	13	11.40 %	6	20.00 %
Total	**47**	**100.00 %**	**109**	**100.00 %**	**114**	**100.00 %**	**30**	**100.00 %**
Parity								
	N	%	N	%	N	%	N	%
PRIMI	17	36.20 %	81	74.30 %	84	73.70 %	21	70.00 %
P1	24	51.10 %	19	17.40 %	21	18.40 %	6	20.00 %
P2	6	12.80 %	9	8.30 %	9	7.90 %	3	10.00 %
Total	**47**	**100.00 %**	**109**	**100.00 %**	**114**	**100.00 %**	**30**	**100.00 %**
Mode of Delivery								
Ftnd	40	85.10 %	88	80.70 %	66	57.90 %	3	10.00 %
Instrumental	0	0.00 %	3	2.80 %	6	5.30 %	9	30.00 %
Lscs	7	14.90 %	18	16.50 %	42	36.80 %	18	60.00 %
Total	**47**	**100.00 %**	**109**	**100.00 %**	**114**	**100.00 %**	**30**	**100.00 %**

Table 2. Demographic Distribution in the Study

20.7 % (n = 62) of women are between 18 - 22 yrs. age group. 66 % (n = 198) of women are in 23 - 29 yrs. age group. Mean age of women in the study was 25.84 years. 67.7 % (n = 203) women are primi. 23.3 % (n = 70) women are para 1, 9 % (n = 27) women are multiparous.

Most of women 67.7 % (n = 203) in study were primi. Increased significance in instrumental delivery & LSCS as BMI rises. Increased operative delivery & LSCS which is statistically relevant as BMI rises.

Hypothyroidism with Each BMI Category	Under Weight		Normal		Over Weight		Obesity	
	N	%	N	%	N	%	N	%
Yes	17	36.20 %	81	74.30 %	84	73.70 %	21	70.00 %
No	24	51.10 %	19	17.40 %	21	18.40 %	6	20.00 %
Total	**6**	**12.80 %**	**9**	**8.30 %**	**9**	**7.90 %**	**3**	**10.00 %**
GDM with Each BMI Category								
Yes	0	0.00 %	9	8.30 %	21	18.40 %	9	30.00 %
No	47	100.00 %	100	91.70 %	93	81.60 %	21	70.00 %
Total	**47**	**100.00 %**	**109**	**100.00 %**	**114**	**100.0 0%**	**30**	**100.00 %**
Gestational Hypertension with Each BMI Category								
Yes	0.00 %	9	8.30 %	21	18.40 %	9	30.00 %	30.00 %
No	100.00 %	100	91.70%	93	81.60 %	21	70.00%	70.00 %
Total	**100.00 %**	**109**	**100.00 %**	**114**	**100. 00%**	**30**	**100.00 %**	**100.00 %**
Anaemia with Each BMI Category								
Yes	26	55.30 %	31	28.40 %	18	15.70 %	3	10 %
No	21	44.70 %	78	71.60 %	96	84.30 %	27	90 %
Total	**47**	**100.00 %**	**109**	**100.00 %**	**114**	**100.0 0%**	**30**	**100.00 %**

Table 3. Hypothyroidism, Gestational Diabetes Mellitus and BMI Category

Statistically important rise in prevalence of hypothyroidism, GDM, GHTN and anaemia in obese and overweight groups.

	Underweight		Normal		Overweight		Obesity	
	N	%	N	%	N	%	N	%
PPH and BMI								
No	46	97.90 %	109	100.00 %	109	95.60 %	25	83.30 %
Yes	1	2.10 %	0	0.00 %	5	4.40 %	5	16.70 %
Total	**47**	**100.00 %**	**109**	**100.00 %**	**114**	**100.00 %**	**30**	**100.00 %**
Wound Complications								
No	47	100.00 %	108	99.10 %	106	93.00 %	24	80.00 %
Yes	0	0.00 %	1	0.90 %	8	7.00 %	6	20.00 %
Total	**47**	**100.00 %**	**109**	**100.00 %**	**114**	**100.00 %**	**30**	**100.00 %**
Lactation Dysfunction								
No	47	100.00 %	109	100.00 %	104	91.20 %	25	83.30 %
Yes	0	0.00 %	0	0.00 %	10	8.80 %	5	16.70 %
Total	**47**	**100.00 %**	**109**	**100.00 %**	**114**	**100.00 %**	**30**	**100.00 %**

Table 4. Maternal Complications in the Present Study

Significant increase of PPH (atonic & traumatic) in overweight and obese & underweight (atonic) when compared to normal BMI. Significant increase in wound complications and lactation dysfunction in high BMI when compared to normal BMI.

BMI and Birth Weight	Under Weight		Normal		Over Weight		Obesity	
	N	%	N	%	N	%	N	%
< 2.5 Kg	38	80.90 %	34	31.20 %	17	14.90 %	0	0.00 %
2.6 - 3.0 Kg	9	19.10 %	56	51.40 %	46	40.40 %	9	30.00 %
3.1 - 3.5 Kg	0	0.00 %	15	13.80 %	42	36.80 %	11	36.70 %
> 3.6 Kg	0	0.00 %	4	3.70 %	9	7.90 %	10	33.30 %
APGAR Score at 5 Minutes								
5.-7	16	34.00 %	4	3.70 %	20	17.50 %	12	40.00 %
> 8	31	66.00 %	105	96.30 %	94	82.50 %	18	60.00 %
Total	**47**	**100.00 %**	**109**	**100.00 %**	**114**	**100.00 %**	**30**	**100.00 %**
NICU Admissions								
No	39	83.00 %	106	97.20 %	106	93.00 %	17	56.70 %
Yes	8	17.00 %	3	2.80 %	8	7.00 %	13	43.30 %
Total	**47**	**100.00 %**	**109**	**100.00 %**	**114**	**100.00 %**	**30**	**100.00 %**

Table 5. Neonatal Outcome and BMI

Shows that majority of underweight women significantly associated with low birth weight, as BMI increases birth weight increases.

Increase in babies with Low APGAR score in underweight, overweight and obese when compared to normal BMI women which is not significant statistically.

NICU admissions were 17 % (n = 8) in underweight, 2.8 % (n = 3), 50.3 % (n = 22) in high BMI women.

Statistical increase in NICU admissions in underweight and high BMI than normal BMI.

	LBW	HMD	Metabolic Complication	NICU Admission
Underweight	7	1	6	8
Normal	1	1	1	3
Overweight	0	6	6	8
Obesity	0	8	10	13
Total	**8**	**16**	**23**	**32**

Table 6. Neonatal Complications

Out of 8 NICU admissions in babies of underweight women, LBW and metabolic complications were more when compared to HMD. Out of 21 NICU admissions in neonates of high BMI women, HMD & metabolic complications were noted more.

DISCUSSION

In this study, 300 pregnant singletons visiting the antenatal OPD who fulfilled the criteria of inclusion and exclusion were studied. They were classified into four BMI groups, 15.7 % (n = 47) of 100 women in the present study were in the underweight category with BMI < 18.5 Kg / m2, 36.7 % (n = 109) were in normal group with BMI 18.5 - 24.9 Kg / m^2. The overweight category with BMI 25 - 29.9 Kg / m2 was 38 per cent (n = 114) and the obese with BMI > 30 Kg / m2 was 10 per cent (n = 30). Anjana Sharma[6] et al study 14.79 percent are underweight, and 51.78 percent belonged to the average weight group, while 21.04 percent were overweight, obese categories respectively, 10.71 percent were females. The study Yazdani [7] et al was 12.8 percent underweight, 41.2 percent average, 35.6 percent overweight and 9.8 percent obese. Hypothyroidism is observed in 7 % (n = 21) of the present sample, which corresponds to 6.5 % of Sahu[8] et al, 7.4 % of Taghavi[9] et al, 9 % of Sapana C Shah[10] et al. Present study shows statistically significant hypothyroid incidence increase (p = 0.001) as BMI rises. Boas Forman [11] et al have also reported a greater incidence of high BMI hypothyroidism. In the present analysis, GDM corresponds to 16.5 percent of Seshiah V [12] et al Gestational Diabetes in India in 13 cases (n = 39). Study conducted with 17.8 percent urban GDM, semi-urban 13.8 percent, rural 9.9 percent. Comparing obese and non-obese, Kumari et al [13] found GDM 24.5 per cent in obese Rajesh Rajput et al [14] found 22 per cent in obese. 30 per cent of obese patients had GDM in the present study. The incidence of GDM in high BMI is statistically increased in this study. GHTN is observed in 13 % (n = 39), 30 % (n = 9) in obese, 18.42 % (n = 21) in overweight, and 8.34 % (n = 9) in normal BMI. Statistically significant increase in GHTN incidence with BMI rise with P value 0.001. Kumari [13] et al study 28.8 % of GHTN in obese with 2.9 % in nonobese. Significant association of high BMI with GHTN, (26 percent) of anaemia is found in this study. In developing countries, the incidence of anaemia is 33 – 75 per cent as per WHO. Present study correlates with 21.7 per cent of Emmanuel et al [15] studying BMI associated anaemia. In present study 55.30 % (n = 26) in underweight, 28.4 % (n = 31), 15.70 % (n = 18) in overweight and 10 % (n = 3) in obese women had anaemia, shows statistically increase in incidence of anaemia as BMI decreases with p value 0.001. Qin Yu[16] et al in study says in Chinese women inverse association was found between overweight, obese and anaemia.

In 300 women, 65.7 % (n = 197) of women had normal vaginal delivery, 28.3 % (n = 85) of women had LSCS, with 6 % (n = 18) women had instrumental delivery. In this study, 36.84 % (n = 42) of overweight, 60 % (n = 18) of obese women, and 16.5 % (n = 18) of average BMI underwent LSCS. Increase in LSCS statistically important as BMI increases with p value 0.001. Poobalan [17] et al meta-analysis found that in overweight or obese women, the risk of LSCS was greater than in normal BMI. In his analysis Jang DG [18] et al found that the frequency of LSCS increased with women who were overweight before pregnancy.

In present study with 30 % (n = 9) of obese women , 5.3 % (n = 6) of overweight women compared to 2.8 % (n = 3) of normal BMI women had instrumental delivery with P value 0.001 which is significant, shows significant increase in instrumental delivery as BMI increases. Johnson[19] et al stated obesity causes increased incidence of operative vaginal deliveries.

In this study, 29.7 % of babies weighed < 2.5 Kg, 40 % of babies weighing 2.6 - 3 Kg, 22.7 % of babies weighing 3.1 - 3.5 Kg, and 7.7 % of babies weighing > 3.6 Kg. 40 percent of babies born with a 2.8 Kg mean weight. In the present study, lower BMI was correlated significantly with low birth weight as BMI rises in baby birth weight were correlated with Frederick [20] et al. studies. The mean 5 min APGAR SCORE is 8.43. Present study significant correlation between BMI and APGAR SCORE. This correlates to Katie L Dickinson BS et al which found similar findings that BMI was not predictive of bad APGAR pregnancy. 17 % (n = 8) of underweight, P value 0.001, shows significant increase in NICU Admissions with low BMI corresponding with Gennete. Overweight 2.8 % (n = 3) and obese 50.3 % (n = 22) shows significant increase

in NICU admissions with high BMI corresponding with Anne – Frederique Misart.[21]

In present study risk of significant increase in postpartum hemorrhage with low BMI 2.1 % (n = 1) which was corresponding with Anjana verma et al. Significant increase in postpartum hemorrhage with high BMI 6.9 % (n = 10) when compared to normal BMI 0 %, with p = 0.001 which corresponded with Suvarna Satish Khadilkar.[22] Significant increase in lactation dysfunction with p = 0.001 with High BMI group 10 % (n = 15) was significant corresponding with Suvarna Satish Khadilkar.

Present study shows normal BMI 0.9 % (n = 1), overweight 7 % (n = 8) and obese 20 % (n = 8). Significant increase in wound complications with increasing BMI corresponding with Shayna N. Conner[23]

Recent studies on obesity and pregnancy have highlighted many research and management policy; Krishnamoorthy [24] et al recommend that all obese women's pregnancies be regarded as high risk and controlled according to strict guidelines. Obesity is a significant field of concern which does not include guidelines. In the field of obstetrics, research and clinical trials are required towards evidence-based treatment of obese women, which necessitates present analysis.

CONCLUSIONS

Body Mass Index plays a significant role in adverse pregnancy outcome. In this study we correlated the association of BMI on various pregnancy outcomes. Maternal BMI in this study shows significant association with complications and results of birth. High BMI is correlated with increased incidence of complications such as hypothyroidism, gestational hypertension, gestational diabetes mellitus, cesarean delivery and instrumental delivery. There is significant association of underweight BMI with anaemia, lBW and complications as gestational diabetes mellitus and gestational hypertension. Results of the present study, together with existing literature, suggests an independent role of abnormal BMI (High BMI + Underweight BMI) as a determinant of adverse pregnancy outcomes.

Data sharing statement provided by the authors is available with the full text of this article at jebmh.com.
Financial or other competing interests: None.
Disclosure forms provided by the authors are available with the full text of this article at jebmh.com.

REFERENCES

[1] Obesity: preventing and managing the global epidemic. Report of a WHO consultation. World Health Organ Tech Rep Ser 2000;894:i-xii, 1-253.
[2] Chen C, Xu X, Yan Y. Estimated Global overweight and obesity burden in pregnant women based on panel data model. PLoS One 2018;13(8):e0202183.
[3] American College of Obstetricians and Gynecologists. ACOG Committee Opinion number 549: obesity in pregnancy. Obstet Gynecol 2013;121(1):213-217.
[4] Worlds Health organization. ESOSOC High Level Segment (2009) Discussion paper: Non communicable diseases, poverty and the development agenda. http://www.who.Int/nmh/publications/discussion_paper_ncd_en.pdf.
[5] Wall PD, Deucy EE, Glantz JC, et al. Vertical skin incisions and wound complications in the obese parturient. Obstet Gynecol 2003;102(5 Pt 1):952-956.
[6] Verma A, Shrimali L. Maternal body mass index and pregnancy outcome. Journal of Clinical and Diagnostics Research 2012;6(9):1531-1533.
[7] Yazdani S, Yosofniyapasha Y, Nasab BH, et al. Effect of maternal body mass index on pregnancy outcome and newborn weight. BMC Res Notes 2012;5:34.
[8] Sahu MT, Das V, Mittal S, et al. Overt and subclinical thyroid dysfunction among Indian pregnant women and its effect on maternal and fetal outcome. Archives of Gynecology and Obstetrics 2010;281(2):215-220.
[9] Taghavi M, Saghafi N, Shirin S. Outcome of thyroid dysfunction in pregnancy in Mashhad, Iran. Int J Endocrinol Metab 2009;7(2):82-85.
[10] Shah SC, Shah CR. Thyroid disorders in pregnancy - a comparative study. International Journal of Fundamental and Applied Life Sciences 2015;5(1):7-14.
[11] Boas M, Forman JL, Juul A, et al. Narrow intra-individual variation of thyroid function in pregnancy based on longitudinal study on 132 women. Eur J Endocrinol 2009;161(6):903-910.
[12] Seshiah V, Balaji V, Balaji MS, et al. Prevalence of gestational diabetes mellitus in South India (Tamil Nadu) – a community based study. J Assoc Physicians India 2008;56:329-333.
[13] Kumari AS. Pregnancy outcome in women with morbid obesity. Int J Gynecol Obstet 2001;73(2):101-107.
[14] Rajput R, Goel V, Nanda S, et al. Prevalence of thyroid dysfunction among women during the first trimester of pregnancy at a tertiary care hospital in Haryana. Ind J Endocrinol Metab 2015;19(3):416-419.
[15] Ugwuja EI, Ogbonnaya LU, Obuna AJ, et al. Anaemia in relation to body mass index and socio-demographic characteristics. Journal of Clinical and Diagnostic Research 2015;9(1):LC04-LC07.
[16] Qin Y, Melse-Boonstra A, Pan X, et al. Anaemia in relation to body mass index and waist circumference among Chinese women. Nutrition Journal 2013;12:10.
[17] Poobalan AS, Aucott LS, Gurung T, et al. Obesity as an independent risk factor for elective and emergency caesarean delivery in nulliparous women — systematic review and meta-analysis of cohort studies. Obes Rev 2009;10(1):28-35.
[18] Jang DG, Jo YS, Lee GSR. Effect of pre-pregnancy body mass index and weight gain during pregnancy on the risk of emergency caesarean section in nullipara. Arch Gynecol Obstet 2011;284(6):1389-1397.
[19] Johnson JW, Longmate JA, Frentzen B. Excessive maternal weight and pregnancy outcome. Am J Obstet Gynecol 1992;167(2):353-372.

[20] Ihunnaya O, Williams MA, Sales AE, et al. Pre-pregnancy body mass index, gestational weight gain and other maternal characteristics in relation to infant birth weight. Acta Obstet Gynaecol Scand 2007;82:813-819.
[21] Anne-Frederique M, Buekens P, Englert Y. Neonatal outcomes in obese mothers: a population based analysis. BMC Pregnancy Childbirth 2013;13:36.
[22] Khadilkar SS. Obesity in pregnancy: Obstetrician's obstacle. The Journal of Obstetrics and Gynecology of India 2019;69:197-202.
[23] Sheiner E, Levy A, Menes TS, et al. Maternal obesity as an independent risk factor for casarean delivery. Paediatr Perinat Epidoemiol 2004;18(3):196-201.
[24] Krishnamoorthy U, Schram CMH, Hill SR. Maternal obesity in pregnancy: is time for meaningful research to inform preventive and management strategies? BJOG 2006;113(10):1134-1140.