

A study of Maternal BMI as Determinant of Pregnancy & Perinatal Outcomes in Hazaribagh Medical College and Hospital, Hazaribagh.

Snehlata.¹, Lal S.^{2*}


DOI: <https://doi.org/10.17511/joog.2021.i01.03>

¹ Snehlata, Specialist Medical Officer, Department of Obstetrics and Gynaecology, Hazaribagh Medical College and Hospital, Hazaribagh, Jharkhand, India.

^{2*} Sweta Lal, Assistant Professor, Department of Obstetrics and Gynaecology, Hazaribagh Medical College and Hospital, Hazaribagh, Jharkhand, India.

Introduction: Maternal nutrition plays an important role in maternal and fetal outcomes. The low maternal BMI or Obesity are both associated with adverse outcomes. **Objectives:** To evaluate the impact of the maternal body mass index on the pregnancy outcome and neonatal outcomes. **Materials and Methods:** This is a prospective cohort study in which a total of 200 patients meeting the inclusion criteria were enrolled in the study after informed consent of which 100 patients enrolled after 18 weeks of gestation had a low BMI and 100 patients with a higher BMI than normal. **Results:** Pregnant females having low BMI as baseline had more risk of IUGR, fetal distress and low birth weight in newborns while those having high maternal BMI had more incidence of PIH in mothers, oligohydramnios, increased birth weight, increased risk of LSCS and NICU admissions and delayed maternal wound healing. **Conclusion:** The health of women, throughout their childbearing ages, should be cared, to improve their obstetrical and perinatal outcomes. Also, the high-risk groups should be managed properly.

Keywords: Maternal BMI, Gestational weight gain (GWG), Pregnancy outcomes, Preterm delivery, Fetal distress.

Corresponding Author	How to Cite this Article	To Browse
Sweta Lal, Assistant Professor, Department of Obstetrics and Gynaecology, Hazaribagh Medical College and Hospital, Hazaribagh, Jharkhand, India. Email: drsweta2004@gmail.com	Snehlata, Lal S. A study of Maternal BMI as Determinant of Pregnancy & Perinatal Outcomes in Hazaribagh Medical College and Hospital, Hazaribagh.. Obs Gyne Review J Obstet Gynecol. 2021;7(1):13-19. Available From https://obstetrics.medresearch.in/index.php/joog/article/view/131	

Manuscript Received
2021-02-02

Review Round 1
2021-02-12

Review Round 2
2021-02-22

Review Round 3

Accepted
2021-02-27

Conflict of Interest
No

Funding
Nil

Ethical Approval
Yes

Plagiarism X-checker
7%

Note



© 2021 by Snehlata, Sweta Lal and Published by Siddharth Health Research and Social Welfare Society. This is an Open Access article licensed under a Creative Commons Attribution 4.0 International License <https://creativecommons.org/licenses/by/4.0/> unported [CC BY 4.0].



Introduction

According to the WHO, obesity is one of the most common and most neglected public health problems in both developing and developed countries [1]. Globally 1 out of 6 adults is obese, Due to obesity nearly 2.8 million individuals die each year [2]. India, is having the second highest population overload in the world and malnutrition due to poverty which dominated in the previous years, is being rapidly transmitted by obesity associated with affluence [3].

The risk for obesity related obstetric complications appear to start from a BMI of about. 21 kg/m². Obese and overweight females undergoing pregnancy and childbirth as calculated by maternal BMI will have higher risk for significant antenatal, postpartum, and neonatal complications. Diabetes, hypertensive disorders including preeclampsia, post-date pregnancies, caesarean sections, macrosomia, thromboembolism, fetal deaths have all been associated with maternal obesity [4-7].

There is increase in obesity in Indian women from 10.6% to 14.8% during last decade in urban areas at the same time in rural area, 48.2% of pre-pregnant women are underweight [8,9]. Maternal malnutrition is the most important underlying determinant factor in adverse maternal and fetal outcome A malnourished mother gives birth to undernourished infant who struggle to thrive. The low maternal BMI is associated with increased risk of abortion and intrauterine growth restriction anemia, which may further cause low Apgar scores and increased early neonatal deaths [10,11].

As maternal nutrition and weight gain during pregnancy are modifiable factors, so the knowledge of association between maternal weight gain during pregnancy, obstetric complications and fetal outcomes becomes essential. The objectives of the study were to evaluate the impact of the maternal body mass index on the pregnancy outcome and neonatal outcomes.

Methodology

This is a prospective cohort study conducted in the Department of Obstetrics and Gynecology, Hazaribagh Medical College and Hospital, Hazaribagh, after clearance from ethical committee between November 2019 to December 2020 with and aim to:

01. To calculate the body mass index of 200 pregnant
02. To classify pregnant females into 4 groups based on their body mass
 - Underweight if BMI <19.8 kg/m²
 - Normal if BMI between 18.6-24.9 kg/m²
 - Overweight if BMI between 25-29.9 kg/m²
 - Obese if BMI >30 kg/m²
03. To correlate the maternal morbidity and mortality with the body mass index of the pregnant
04. To correlate the maternal body mass index with fetal morbidity and

Inclusion Criteria

- Single fetus gestation
- Registered patient
- Pregnancy above 18 weeks
- Primigravida
- ANC patients with well-maintained records

Exclusion Criteria

- Multiple fetal gestation
- Nonregistered patients
- Patients reluctant for follow
- Lesser than 18 weeks gestation
- Patients with history of any co morbid conditions like DM, HTN, asthma, TB, epilepsy, thyroid
- Multipara patients
- Patients not willing to give consent

Sample Size: Total of 200 OPD and IPD registered ANC patients were enrolled for the study and were on regular follow up.

Results

A total of 200 patients meeting the inclusion criteria were enrolled in the study after informed consent of which 100 patients enrolled after 18 weeks of gestation had a low BMI and 100 patients with a higher BMI than normal. The weight taken at 18 weeks or after was considered as the initial or baseline weight. Body mass index was calculated by the formula weight in kg/ height in meter square. According to the institute of medicine (IOM) guidelines these 200 patients were divided into

3 groups.

01. Group A- group with low BMI i.e., <19.8 kg/m²

02. Group B- group with BMI 25-29.9 kg/m²

03. Group C- group with obesity BMI >30kg/m²

Further these groups were divided into 3 subgroups namely A1, A2, A3; and so, on depending on gestational weight gain according to IOM guidelines as:-

01. Gestational weight gain less than – A1, B1 and C1

02. Gestational weight gains equal to expected weight gain – A2, B2, C2

03. Gestational weight gains greater than expected- A3, B3, C3

We studied 200 patients out of which 50% i.e., 100 patients belonged to the low BMI (group A) category and 50% were of high BMI category. Out of 100 patients with a high BMI, 85 patients were overweight (group B), and 15 patients were obese (group C).

Age wise distribution with BMI The patients were further divided according to the age groups in different BMI category. The maximum number of cases were between the age of 21-29 which is the reproductive age group as depicted in table 1. However, it was observed that in the obese BMI category, maximum number of patients were >30 years of age, suggesting that obesity was more prevalent in females who conceived late and were hence in high-risk pregnancy strata.

Table 1: Age wise distribution with BMI

Age (years)	BMI		
	Group A (Low)	Group B (Overweight)	Group C (Obese)
<20	79 (79%)	2 (2.4%)	1 (6.7%)
21-29	21 (21%)	63 (74.1%)	8 (53.3%)
>30	0 (0%)	20 (23.5%)	6 (40.0)
Total	100 (100%)	85 (100%)	15 (100%)

BMI distribution with Gestational Weight Gain

It was found that in group A i.e., low BMI, the weight gain for 97% of the subjects was less than what was recommended by the institute of medicine guidelines as given in table 2. On the contrary, the group C patients, 13 out of 15 patients had a weight gain which was much more than what has been recommended according to the maternal BMI. This suggested that the pre pregnancy BMI was associated with the gestational weight gain and that the weight gain was "dose dependent" since it was an effect of the nutritional status of these patients.

Table 2: BMI distribution with Gestational Weight Gain

BMI	Group	Sub-Group	GWG (Gestational Weight Gain) (kg)	No. with Patients
Low	A	A1	<12.5	97 (48.5%)
		A2	12.5-18	3 (1.5%)
		A3	>18	0 (0%)
Overweight	B	B1	<7	9 (4.5%)
		B2	7-11.5	46 (23%)
		B3	>11.5	30 (15%)
Obese	C	C1	<7	0 (0%)
		C2	7	3 (1.5%)
		C3	>7	12 (6%)
Total				200 (100%)

Age wise distribution with Gestational Weight Gain

The gestational weight gain was seen in different age groups in different BMI groups, and we observed that, almost 95% of the patients in the age group of less than 20 in the Low BMI had a weight gain less than recommended, which suggested that these patients were at a higher risk due to adolescent pregnancies, whereas on the other extreme, group C had 5 out of 8 patients who were >30 years of age, gained weight much more than the recommended guidelines. These factors suggested that not only was gestational weight gain associated with maternal BMI, but also, that the maternal age played an important role.

BMI & age correlation with Maternal Anemia

Maternal anaemia was assessed and it was found that it was present in all the groups, However, patients with low BMI had 84% of the total number of anemic patients in our study. Out of 100 patients with low BMI, 37 were anemic as compared to 7 out of 100 of high BMI. However, it was noteworthy that 3 out of 15 patients i.e., 20% of obese patients were anemic.

The presence of anemia was not only maximum in low BMI patients, but it was specifically highest in patients with a low BMI and a gestational weight gain which was lower than the recommended guidelines. In the obese BMI category, patients who had a gestational weight gain more than recommended were more prone to develop anemia.

BMI and its correlation with PIH and Gestational Weight Gain (GWG)

Of the study population, 46 had developed PIH. The point to be noted was that 25 out of 41 patients were overweight and 8 were obese.

These 8 obese were more significant since it accounted to 53.33% of the total number of obese patients (15). Patients with a low BMI were less prone to develop Preeclampsia (PIH) and maternal BMI was correlated with gestational weight gain, it was found that maximum patients were obese and had a gestational weight gain much more than recommended. Also, the maximum cases of PIH occurred in patients ≥ 30 yrs accounting for 33 out of 46 cases which is around 71.7% of total cases of PIH.

BMI and correlation with mode of delivery

The mode of delivery was seen to be vaginal in most of the patients with a low BMI, whereas obese patients had the highest chances of undergoing caesarean section (LSCS). Overweight mothers did have a fair chance of vaginal delivery. PROM (Premature rupture of membranes) was observed to be the reason for LSCS equally in all 3 groups. However, maximum caesarean sections were done for failure of induction in case of high BMI patients and oligohydramnios with IUGR (Intra Uterine Growth Retardation) in case of low BMI. CPD (Cephalon Pelvic Disproportion) was observed to be the second most common cause especially in obese women. Maximum IUGR rates were seen in B3 & C3 groups both of which had more than expected gestational weight gain and lying in the overweight and obese category respectively which reflects that birth weight of the neonate depends on maternal BMI.

Correlation of BMI with Maternal Wound Healing

Of the 15 patients who were obese, 13 patients were reported to have poor wound healing which implied that higher BMI was associated with poor wound healing.

Correlation of Maternal BMI with Perineal Injury During delivery

Of the 200 patients, only 9 had perineal injury which had no correlation with the study groups.

Correlation of Maternal BMI and Preterm Delivery

It was found that 38 of the 200 patients went into preterm delivery, of which Low BMI group had highest occurrence of 18% followed by overweight patients as in table 3. Group A1 which had less than expected gestational weight gain had maximum incidence of preterm delivery.

Table 3: Correlation of Maternal BMI and Preterm Delivery

GROUP	PRETERM DELIVERY	
	No. of Patients	%
A	18	18.00%
B	13	15.29%
C	7	46.67%
Total	38	19.00%

Correlation of maternal BMI and GWG with birth weight

It was found that of the 78 cases of low birth weight in newborns of the study groups patients, 61.54% i.e., 48 cases were in the A1 group implying that low BMI was directly proportional to low birth weight in neonates. However, higher birth weight in newborns was noted in the obese group C with 4 out of 15 cases.

APGAR Score of babies of maternal group @ 10 min (APGAR score less than 8 after 10 mins)

The incidence of newborns with APGAR <8 after 10 minutes was highest in Group A with low BMI followed by overweight group B as given in table. 4 This shows that low BMI associated with low GWG leads to increased rates of neonatal distress.

Table 4: APGAR Score of babies of maternal group @ 10 min

GROUP ACCORDING TO MATERNAL BMI	APGAR @ 10 MIN	
	No. of babies having APGAR <8 after 10 minutes. born to study group	%
A	33	33.00%
B	21	24.71%
C	3	20.00%
Total	57	28.50%

Correlation of Maternal BMI and Oligohydramnios

Group C who was obese with high BMI had 46.67% incidence of oligohydramnios suggesting.

Its direct correlation when compared to low BMI groups as given in table 5:

Table 5: Correlation of Maternal BMI and Oligohydramnios

GROUP	OLIGOHYDROAMNIOS	
	No. of Patients	%
A	11	11.00%
B	14	16.47%
C	7	46.67%
Total	32	16.00%

Correlation of NICU Admission in Different Maternal BMI Group

The rates of newborns with NICU admissions were highest in Group C i.e., 46.67%, followed by 24% in Group A and 20% in Group B. Some of the reasons causing NICU admissions were respiratory distress syndrome, meconium aspiration, hypoglycemia, and birth

NICU Admission.

Reason for NICU	GROUP						Total
	A		B		C		
	No. of patients	Percentage	No. of patients	Percentage	No. of patients	Percentage	
RDS	14	50.00%	14	82.35%	5	71.43%	33 (63.46%)
Meconium Aspiration	11	39.29%	0	0.00%	1	14.29%	12 (23.08%)
Hypoglycemia	0	0.00%	1	5.88%	0	0.00%	1 (1.92%)
Birth asphyxia	3	10.71%	2	11.76%	1	14.29%	6 (11.54%)
Total	28	100.00%	17	100.00%	7	100.00%	52 (100.0%)

Correlation between fetal Distress and Maternal BMI

Increased rates of fetal distress were noted in Group C with 46.67% followed by 26.00% in Group A and 15.29% in Group B as depicted in table 7.

Table 7: Correlation between fetal Distress and Maternal BMI

GROUP	INTRANATAL FETAL DISTRESS	
	No. of Patients	Percentage
A	26	26.00%
B	13	15.29%
C	7	46.67%
Total	46	23.00%

Discussion

During the last two decades, there has been an alarming rise in the incidence of obesity all over the world and in India. There exists a double burden of this disease with under nutrition & underweight and a rapid upsurge in obesity and overweight on either extreme. The National Family Health Surveys (NFHS) in India indicated an increase in the obesity from 10.6% in 1998–1999 to 14.8% in 2005–2006, while there was only a marginal decrease in the incidence of underweight from 36.2% (1998–1999) to 33.0% (2005–2006) [12].

Both lean and obese women carry a risk for adverse pregnancy outcomes [13]. An increasing BMI is associated with an increased incidence of pre-eclampsia, gestational hypertension, macrosomia, induction of labour and caesarean deliveries [14].

Asphyxia.

Group B who are overweight reported 82.35% of RDS (Respiratory Distress Syndrome) and 5.88% of hypoglycaemia, 14.29% birth asphyxia was seen in Group C (obese) and 39.29% meconium aspiration were reported in Group A (low BMI).

Table 6: Correlation of various factors leading to

The BMI is a simple index of the weight-for-height and it is calculated by dividing a person's weight in kilograms by the square of their height in meters (kg/m²).

Underweight (a BMI of < 19.9 kg/m²) has been shown to be associated with an increased risk of preterm deliveries, low birth weight and anaemia and a decreased risk of pre-eclampsia, gestational diabetes, obstetric intervention, and post-partum haemorrhage [15].

The available data showed that in India, prevalence of overweight was low while that of under nutrition remained high. Overweight was more prevalent among female [16]. Overweight and obesity in Indian women have increased from 10.6 to 14.5 %. The obesity epidemic affects all including women on reproductive age [17].

In India more than high pre pregnancy weight and as a result high BMI is less encountered by obstetricians due to poor socioeconomic conditions and hence, low maternal BMI poses a bigger issue. A study conducted by N.J. Sebire et al in 2001 wherein the main objective of the study was to assess whether underweight mothers really posed a risk to adverse pregnancy outcome, revealed that it certainly was responsible for adverse fetal and perinatal outcomes [18].

The study demonstrated that the main adverse outcome associated with maternal underweight was the delivery of a low-birth-weight baby and preterm delivery. It confirmed that a low maternal weight resulted in a low birth weight of the fetus [19,20].

Of 200 patients in our study, 100 patients were with low BMI i.e., less than 19.9 kg/m² (Category A), 85 patients were overweight with BMI falling between 25-29.9 kg/m² (Category B) and rest of 15 patients were obese with BMI more than 30 kg/m² (Category C). They were further classified into categories 1, 2 and 3 based on low weight gain, adequate weight gain and high weight gain, respectively.

The maximum number of cases was between the age ranges of 21-29, that is the reproductive age group. However, it was observed that in the obese BMI category, maximum number of patients were >30 years of age, suggesting that obesity was more prevalent in females who conceived late and were hence in high-risk pregnancy strata. Maternal obesity (high BMI) is an important risk factor that can lead to obesity in offspring as per Strauss RS et al [21].

The study showed that obesity was more common in elderly primigravida > 30 years of age. Maternal obesity (high BMI) is an important risk factor that can lead to obesity in offspring as per Strauss RS et al [22] and this coupled with excessive gain of weight in pregnancy, also results in long-term obesity for such pregnant women as suggested by Mamun AA et al [23].

It was noted that there is a higher instance of low BMI i.e. A1 in patients lesser than 20 years of age. Maternal anemia is significantly higher in patients with low BMI and this association was noted in 84.09% of the patients. The prevalence of anemia was low in obese patients was low at 6.82%.

The presence of PIH was having higher prevalence in patients with categories A1, B2, B3 and C3 at 26.09%, 23.91%, 28.26% and 15.22%. It is to be noted that in patients with low gestational weight gain with low BMI, overweight patients with moderate to adequate weight gain and obese patients with weight gain more than 7 kgs.

Presented with higher incidence of pregnancy induced hypertension. Pregnancy induced hypertension was relatively high in patients in obese group with total of 8 cases. Considering overall 15 patients of these obese patients present in our study, there is a prevalence of 53.33% of PIH in obese patients which is quite high when compared to patients in other categories.

It was noted that all obese patients (n=15) underwent LSCS whereas the incidence of LSCS was

25.88% in overweight patients and 6% in underweight patients. Oligohydramnios with IUGR in 36.57%, failed induction in 36.57%, cephalo-pelvic disproportion in 19.51% and premature rupture of membranes in 7.32% of the patients were noted in patients who underwent LSCS. IUGR was noted in fetus of mothers whose BMI was low as in Group A1. Obesity had higher incidences of poor wound healing. 8 patients in over weight category had perineal injuries due to normal delivery out of 9 patients (88.89%). The incidence of preterm delivery in was highest in obese group with higher preponderance to high birth weight in newborns while low BMI group A had increased rates of low birth weight who had low Apgar score suggestive of increased fetal distress with meconium aspiration. There is a growing evidence from both animal and human studies suggesting that maternal obesity has an impact on offspring health, which has profound implications for public health policy. Of particular concern is the increased risk of obesity and metabolic sequelae in the offspring of obese mothers reported in both animal and human studies, which has the potential to result in an 'intergenerational cycle' affecting obesity and cardiovascular disease risk across several generations [24].

Study Limitations

The present study had few limitations. The sample was not homogeneous about age, education, and socio-economic status. All these factors may impact quality of life and BMI and, hence the study results. We suggest to future researchers to consider other effective factors besides BMI such as age, education, economic status, quality of life on pregnancy outcomes, progression to metabolic syndrome post pregnancy and in the offspring. The sample size was of 200 patients and hence certain areas of interest did not show significance statistically.

Conclusion

The study concludes that underweight as well as obese mothers have higher incidences of adverse maternal and neonatal outcomes.

What does the study add to the existing knowledge?

There is an association of higher instances of preterm deliveries, low birth weight, post-operative.

Author's contribution

Dr. Snehlata: Concept, study design

Dr. Sweta Lal: Manuscript preparation

Infection rates, excessive NICU admissions, respiratory distress along with altered Apgar scores in neonates born to such mothers. It is necessary that women planning to conceive should have an adequate BMI and gestational weight gain. Iron deficiency anemia seen commonly in undernourished mothers should be adequately treated. The role of regular antenatal check-ups is significant & necessary to diagnose any adverse maternal and fetal parameters at point of time and these parameters such as maternal anemia, amniotic fluid index, maternal blood pressure, fetal growth, along with other essential parameters should be screened adequately.

Reference

01. Park K. Park's Textbook of Preventive and Social Medicine. 24th ed, Aniridias Bhanot. 2015;397. [Crossref]
02. Kim SY, Dietz PM, England L, Morrow B, Callaghan WM. Trends in pre-pregnancy obesity in nine states 1993–2003. *Obesity*. 2007;15;986-93. [Crossref]
03. Frederick IO, Williams MA, Sales AE, Martin DP, Killeen M. Prepreg Nancy body mass index, gestational weight gain, and other maternal characteristics in relation to infant birth weight. *Maternal Child Health J*. 2008;12;557-67. [Crossref]
04. Riz AM, Laraia B. The implications of maternal overweight and obesity on the course of pregnancy and birth outcomes. *Matern Child Health J*. 2006;10(5)153-6. [Crossref]
05. Andreasen KR, Andersen ML, Schantz AL. Obesity, and pregnancy. *Acta Obstet Gynecol Scand*. 2004;83(11)1022-9. [Crossref]
06. Guelinckx I, Devlieger R, Beckers K, Vansant G. Maternal obesity- pregnancy complications, gestational weight gain and nutrition. *Obes Rev*. 2008;9(2)140-50. [Crossref]
07. Heslehurst N, Simpson H, Ells LJ, Rankin J, Wilkinson J, Lang R, et al. The impact of maternal BMI status on pregnancy outcomes with immediate short-term obstetric resource implications- a meta- analysis. *Obes Rev*. 2008;9(6)635-83. [Crossref]
08. Mendez MA, Monteiro CA, Popkin BM. Overweight exceeds underweight among women in most developing countries. *Am J Clin Nutr*. 2005;81;714-21. [Crossref]
09. Balarajan Y, Villamor E. Nationally representative surveys show recent increases in the prevalence of overweight and obesity among women of reproductive age in Bangladesh, Nepal, and India. *J Nutr*. 2009;139;2139-44. [Crossref]
10. Sahu MT, Agarwal A, Das V, Pandey A. Impact of maternal body mass index on obstetric outcome. *J Obstet Gynaecol Res*. 2007;33(5) 655-9. [Crossref]
11. Abenhaim HA, Kinch RA, Morin L, Benjamin A, Usher R. Effect of pre- pregnancy body mass index categories on obstetrical and neonatal outcomes. *Arch Gynecol Obstet*. 2007;275(1) 39-43. [Crossref]
12. International Institute for population sciences. Key Indicators for India from NFHS-3. 2006. [Crossref]
13. Sahu MT, et al. The impact of the maternal body mass index on the obstetric outcome. *J Obstet Gynaecol Res*. 2007 Oct;33(5)655–59. [Crossref]
14. Bhattacharya S, et al. The effect of the body mass index on the pregnancy outcomes in nulliparous women who delivered singleton babies. *BMC Public Health*. 2007;7;168. doi; 10. 1186/1471-2458-7-168 [Crossref]
15. Ehrenberg HM, Dierker LRN, Milluzzi C, Mercer BM. Low maternal weight failure to thrive in pregnancy and adverse prenatal outcomes. *Am J Obstet Gynecol*. 2003;189;1726–30. [Crossref]
16. Van der Steeg JW, Steures P, Eijkemans MJ. Obesity affects spontaneous pregnancy chances in subfertile, ovulatory women. *Hum Reprod*. 2008;23;324–328. [Crossref]

17. Kim SS, Zhu Y, Grantz KL, et al. Obstetric and neonatal risks among obese women without chronic disease. *Obstet Gynecol.* 2016;128;104–112. [Crossref]
18. Sebire NJ, Jollya M, Harrisb J, Regana L S. Is maternal underweight really a risk factor for adverse pregnancy outcome?- A population-based study in London. *Robinsonc British journal of Obstetrics and Gynaecology.* 2001 jan;108;61-66. [Crossref]
19. O Frederick, Michelle A Williams, Anne E Sales, Diane P Martin, Marcia Killien. Pre pregnancy body mass index, gestational weight gain and other maternal characteristics in relation to infant birth weight Ihunnaya. *Maternal abd child health journal.* 2008;12(5)557- 567. [Crossref]
20. Ali S Khashan , Louise C Kenny. The effects of maternal body mass index on pregnancy outcome, *European journal of epidemiology.* 2009;24(11)697. [Crossref]
21. Harding KL, Aguayo VM, Namirembe G, Webb P. Determinants of anaemia among women and children in Nepal and Pakistan- An analysis of recent national survey data. *Matern Child Nutr.* 2018 Nov;14 Suppl 4;e12478. [Crossref]
22. Strauss RS, Knight J. Influence of the home environment on the development of obesity in children. *Pediatrics.* 1999;103;85. [Crossref]
23. Mamun AA, Callaway LK, O'Callaghan MJ, Williams GM, Najman JM. Associations of maternal pre-pregnancy obesity and excess pregnancy weight gains with adverse pregnancy outcomes and length of hospital stay. *BMC Pregnancy Childbirth.* 2011;11;62. [Crossref]
24. Amanda Drake J, Rebecca Reynolds M. Impact of maternal obesity on offspring obesity and cardiometabolic disease risk. *Society for Reproduction and Fertility.* 2010;140;387–398. [Crossref]