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ORIGINAL ARTICLE

The Impact of Body Mass Index on Maternal and Neonatal Outcomes

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Abstract

Background: **Many illnesses have been linked to obesity as a risk factor, including the metabolic syndrome, diabetes mellitus, hypertension, preeclampsia, operative vaginal deliveries, caesarean deliveries, placental pathological lesions, and comorbidities in neonates (macrosomia, low APGAR score, neonatal intensive care unit admission).**

Aim and objectives: **To evaluate the impact that body mass index (BMI) has on pregnant women's and neonates' outcomes.**

Subjects and methods: **This prospective randomized controlled research trial was conducted in outpatient antenatal care clinics of the maternity hospital at Al-Hussein and Bab El-Sheirya (Sayed Galal) Hospitals, Al-Azhar University. 150 women participated in this study.**

Each patient was assigned to one of three groups: Group A, the control group (BMI = 18.5−24.9 kg/m^2), Group B, the overweight group (BMI = 25−29.9 kg/m^2), and Group C, the obese group (BMI>30 kg/m).

Result: **There was a very substantial variation in LGA across the three study groups (*P*.001). There was a very substantial difference in SGA between the three research groups (*P*.001). Regarding ICU admission, Between the three groups that were analysed, there was a highly significant difference ($P = 0.001$).**

Conclusion: **Obesity causes serious maternal and foetal problems and has a considerable negative impact on the outcome of pregnancy when it is present. Maternal BMI was significantly correlated with mode of delivery, child sex, Gestational age, APGAR 5 min, Birth weight, child length, head circumference, LGA, SGA and admission to neonatal-ICU.**

Keywords: A high body mass index, A large or small foetus during the gestational period

1. Introduction

A condition known as obesity occurs when the body's excess body fat builds up to the point where it could be hazardous to one's health.[1]

Typically, a body mass index (BMI) of 30 kg/m or more is considered obese. Obesity is a rise in bodily adipose (fat tissue) mass, which is difficult to directly measure in a practical situation. As a result, the most widely used clinical techniques for estimating obesity are body mass index (BMI) and the waist-hip ratio.[2]

Obesity is considered as a complex, polygenic, multifactorial, chronic and resistant disease, predisposing to cardiovascular disorders, type two DM, hypertensive diseases and numerous other pathological issues.[3]

Adults who have a body mass index (BMI) of 30 or more are considered obese or overweight. Adults who have a BMI of 25−29.9 kg/m^2 or more are considered overweight.[4] Obesity has been identified as a risk factor for numerous diseases such as the metabolic syndrome, diabetes mellitus, and hypertension, pre-eclampsia, operative vaginal deliveries, caesarean deliveries, placental pathological lesions, and comorbidities in newborns (macrosomia, low APGAR score, neonatal intensive care unit admission).[5]

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Inhibition of global gene profile associated with mitochondrial dysfunction and reduced energy metabolism was caused by maternal obesity, insulin resistance, and hyperinsulinemia. For instance, The risk of post-term delivery is greatly increased by the maternal insulin secretory response in the early stages of pregnancy, which is directly associated to placental weight and neonatal adiposity after birth.[6]

Babies born to obese mothers are more likely to experience overgrowth. Several criteria have been used to categorise foetal overgrowth. Without taking gestational age into account, a birth weight of more than 4000 or 4500 g is considered macrosomia.[7]

Examined prenatal growth measurements that make use of hypotheses for estimates of lean body mass and fat mass. Despite making up only 12–14% of birth weight, fat mass is responsible for around 50% of the variation in term birth weight.[7]

The purpose of this study was to evaluate the impact of body mass index (BMI) on mother and baby outcomes.

2. Patients and methods

This was a prospective randomized controlled research trial in which 150 patients recruited from the outpatient antenatal care clinics of the maternity hospital at Al-Hussein and Bab El-Sheirya (Sayed Galal) Hospitals, Al-Azhar University.

The study participants will be categorized into 3 main groups: Group A: control (BMI = 18.5–24.9 kg/m^2), Group B: overweight patients (BMI = 25–29.9 kg/m^2). Group C: obese patients (BMI>30 kg/m).

2.1. Inclusion criteria

An ultrasound performed during the first trimester or a gestational age of greater than 28 weeks, and a gestational age of the mother between 20 and 40 years old.

2.2. Exclusion criteria

Women who have had more than one pregnancy, those who have pre-gestational diabetes or hypertension, those who have additional medical conditions (such as endocrine, cardiac, renal, or other conditions), and those with grand multipara.

All patients in the three groups subjected to the following:

Antenatal: Informed consent will be sought from the pregnant study participants before they are enrolled in the study. complete history taking with: Name, age, place of employment, first day of last period (LMP), documentation of gestational age, medical or surgical history (particularly bariatric procedures), and drug allergy or obstetric or surgical issue.

Clinical Examination: General examination: Vital signs include breathing rate, temperature, and blood pressure. Measurements of the respondents' height (in centimetres) and weight (in kilogrammes) will be taken while they are dressed as lightly as possible. Examination of the head and neck for swollen lymph nodes, goitre, edoema, pigmentations, jaundice, pallor, and congested neck veins. Looking for pregnancy indicators in the breasts. Examining the limbs for abnormalities, varicose veins, and edoema. Examination of the abdomen: Inspection: to find striae gravidarum, the size of the abdomen, and pigmentations such the linea nigra.

Obstetric palpation (Maneuvers of Leopold): To identify the portion of the foetus occupying the fundus, use the fundal level and grasp. First pelvic grip to identify the area of the foetus that occupies the lower uterine segment and to identify engagement. Umbilical grip to identify the back and foetal limbs.

Laboratory Investigations: CBC, kidney and liver function Coagulation profile and FBS, PPBS, HBA1C and urine analysis.

Ultrasound: To Asses Biophysical Profile (BPP), which include: Amniotic Fluid Index (AFI), Fetal Movement, Fetal Tone, Fetal Breathing. Number of fetuses (Exclusion of multiple pregnancies). Position of the Placenta, biometry, Gestational age, Presentation (at term), estimated Fetal weight using Hadlock formula depending on BPD, AC, FL for assessment of normal growth, macrosomia, and IUGR and umbilical artery Doppler flowmetry for assessment of fetal condition.

Termination of Pregnancy: Either by vaginal delivery or cesarean section.

Neonatal assessment: Follow up the neonate for Apgar score at 1 & at 5 min by trained pediatrician, the neonatal weight and neonatal admission to ICU.

Primary outcomes (Most important outcomes to be assessed): The following outcomes for mothers and newborns were impacted by body mass index: birth weight, pregnancy-related high blood pressure, gestational diabetes mellitus, Delivery method (regular vaginal delivery, surgical vaginal delivery, or caesarean delivery), delivery time, and admission to the newborn intensive care unit.

Secondary outcome parameters (other outcomes to be assessed): Postpartum hemorrhage, puerperal sepsis and venous thromboembolism.

Table 1. Demographic characteristics among the study population.

	Control group ($n = 50$) n (%)	Overweight group ($n = 50$) n (%)	Obese group ($n = 50$) n (%)	Test of Sig.	P
Age (years)					
Mean ± SD.	29.9 ± 3.1	30.2 ± 3.4	30.6 ± 2.8	F = 1.586	0.208
Median (IQR)	30 (28–32)	30 (28–32)	31 (29–32)		
Range (Min-Max)	12 (24–36)	14 (23–37)	11 (25–36)		
	$P1 = 0.159$, $P2 = 0.124$, $P3 = 0.919$				

F, ANOVA test; **IQR**, interquartile range; **SD**, standard deviation.
P: *P* value for comparing between the studied groups.
P value > 0.05: Non significant; *P* value < 0.05: Significant; *P* value < 0.001: Highly significant.
P_1: Group 1 versus Group 2.
P_2: Group 2 versus Group 3.
P_3: Group 1 versus Group 3.

2.3. Ethical considerations

The AL-Azhar University Faculty of Medicine's Ethical Committee submitted a study protocol for approval.— Ethical committee of the Obstructs and Gynecology Department. After explaining the study's aim and procedures to each participant, they will give their informed verbal and written consent.

2.4. Statistical analysis

Using SPSS 26.0 for Windows, all data were gathered, tabulated, and statistically examined (SPSS Inc., Chicago, IL, USA). The qualitative data were expressed in terms of number and percentage. Quantitative data were described using the range (minimum and maximum), mean, standard deviation, and median. The two-tailed significance test was applied to each statistical comparison. *P* values under 0.05 indicate no change at all, *P* values above 0.05 suggest no difference, and *P* values under 0.001 indicate a very significant difference.

3. Results

Table 1 presented the research population's demographic features. Age ranged from 24 to 36 in the Control group with a mean and standard deviation of 29.9 to 3.1, from 23 to 37 in the Overweight group with a mean and standard deviation of 30.2 to 3.4, and from 25 to 36 in the Obese group with a mean and standard deviation of 30.6 to 2.8, with no statistically significant difference ($P = 0.208$) between the three groups.

Table 2 showed Maternal BMI among the study population. Maternal BMI in Control group ranged from 18.7 to 24.7 with mean ± SD = 21.7 ± 1.5, While the maternal BMI for the obese group ranged from 31.1 to 38.7 with mean SD = 34.9 1.9, the maternal BMI for the overweight group ranged from 25.2 to 29.7 with mean SD = 27.45 1.12, and there was a highly statistically significant difference ($P = 0.001$) between the three groups.

Table 3 showed Mode of delivery among the study population. Regarding Mode of delivery, There was a highly significant difference between the three studied groups (P=<0.001).

Table 4 demonstrated that among the study population, maternal problems were developing. Between the three groups under study, there was a highly significant difference in gestational diabetes mellitus ($P = 0.001$). Between the three groups under study, there was a highly significant difference in PPH ($P = 0.001$). Between the three groups under

Table 2. Maternal BMI among the study population.

	Control group ($n = 50$)	Overweight group ($n = 50$)	Obese group ($n = 50$)	Test of Sig.	P
Maternal BMI					
Mean ± SD.	21.7 ± 1.5	27.45 ± 1.12	34.9 ± 1.9		
Median (IQR)	21.9 (20.7–22.7)	27.7 (26.7–28.2)	35.2 (33.6–36.2)	F = 1052.972	<0.001
Range (Min-Max)	6.1 (18.7–24.7)	4.5 (25.2–29.7)	7.7 (31.1–38.7)		
	$P1$=<0.001, $P2$=<0.001, $P3$=<0.001				

F, ANOVA test; **IQR**, interquartile range; **SD**, standard deviation.
P: *P* value for comparing between the studied groups.
P value > 0.05: Non significant; *P* value < 0.05: Significant; *P* value < 0.001: Highly significant.
P_1: Group 1 versus Group 2.
P_2: Group 2 versus Group 3.
P_3: Group 1 versus Group 3.

Table 3. Mode of delivery among the study population.

	Control group ($n = 50$) n (%)	Overweight group ($n = 50$) n (%)	Obese group ($n = 50$) n (%)	Test of Sig.	P
Mode of delivery					
Vaginal					
n (%)	37 (74%)	32 (64%)	34 (68%)	X2 = 22.154	<0.001
CS					
n (%)	13 (26%)	18 (36%	16 (32%)		
	$P1$=<0.001, $P2$=<0.001, $P3$=<0.001				

χ2: Chi- Square test.
P: P value for comparing between the studied groups.
P value > 0.05: Non significant; P value < 0.05: Significant; P value < 0.001: Highly significant.
P_1: Group 1 versus Group 2.
P_2: Group 2 versus Group 3.
P_3: Group 1 versus Group 3.

study, there was a highly significant difference in episotomy wound sepsis ($P = 0.001$). Between the three groups under study, there was a highly significant difference in puerperal sepsis ($P = 0.001$).

Gestational age in the Control group ranged from 37 to 41 with a mean and standard deviation of 39 to 1.1, while the Overweight group's ranged from 36 to 42 with a mean and standard deviation of 38.8 1.5 and the Obese group's ranged from 36 to 42 with a mean and standard deviation of 39 to 1.6, with a statistically significant difference ($P = 0.037$) between the three groups. Fig. 1.

APGAR 5 min in Control group ranged from 8 to 11 with mean ± SD = 9.4 ± 0.7, while in Overweight group the APGAR 5 min ranged from 8 to 11 with mean ± SD = 9.3 ± 0.8, while in Obese group the APGAR 5 min ranged from 8 to 11 with mean ± SD = 9.3 ± 0.7, with statistical significant difference ($P = 0.019$) between the three groups. Fig. 2.

Birth weight in Control group ranged from 2572 to 4122 with mean ± SD = 3347.1 ± 407.8, while in Overweight group the Birth weight ranged from 2609 to 4296 with mean ± SD = 3452.5 ± 444.2, while in Obese group the Birth weight ranged from 2794 to 4381 with mean ± SD = 3587.4 ± 417.5, with highly statistical significant difference (P=<001) between the three groups (Fig. 3).

Table 5 showed Admission to neonatal-ICU among the study population. Regarding Admission

Table 4. Development of maternal complications among the study population.

	Control group ($n = 50$) n (%)	Overweight group ($n = 50$) n (%)	Obese group ($n = 50$) n (%)	Test of Sig.	P
	Preeclampsia				
n (%)	3 (6%)	7 (14%)	8 (16%)	X2 = 23.098	<0.001
		$P1$=<0.001, $P2$=<0.001, $P3$=<0.001			
	Gestational DM				
n (%)	4 (8%)	8 (16%)	15 (30%)	X2 = 26.792	<0.001
		$P1$=<0.001, $P2$=<0.001, $P3$=<0.001			
	Postpartum hemorrhage				
n (%)	7 (14%)	15 (30%)	12 (24%)	X2 = 23.787	<0.001
		$P1$=<0.001, $P2$=<0.001, $P3$=<0.001			
	Wound sepsis of episotomy				
n (%)	3 (6%)	6 (12%)	9 (18%)	X2 = 23.583	<0.001
		$P1$=<0.001, $P2$=<0.001, $P3$=<0.001			
	Wound sepsis of CS				
n (%)	2 (4%)	3 (6%)	14 (28%)	X2 = 31.72	<0.001
		$P1$=<0.001, $P2$=<0.001, $P3$=<0.001			
	Puerperal sepsis				
n (%)	3 (6%)	7 (14%)	9 (18%)	X2 = 23.561	<0.001
		$P1$=<0.001, $P2$=<0.001, $P3$=<0.001			

χ2: Chi- Square test.
P: P value for comparing between the studied groups.
P value > 0.05: Non significant; P value < 0.05: Significant; P value < 0.001: Highly significant.
P_1: Group 1 versus Group 2.
P_2: Group 2 versus Group 3.
P_3: Group 1 versus Group 3.

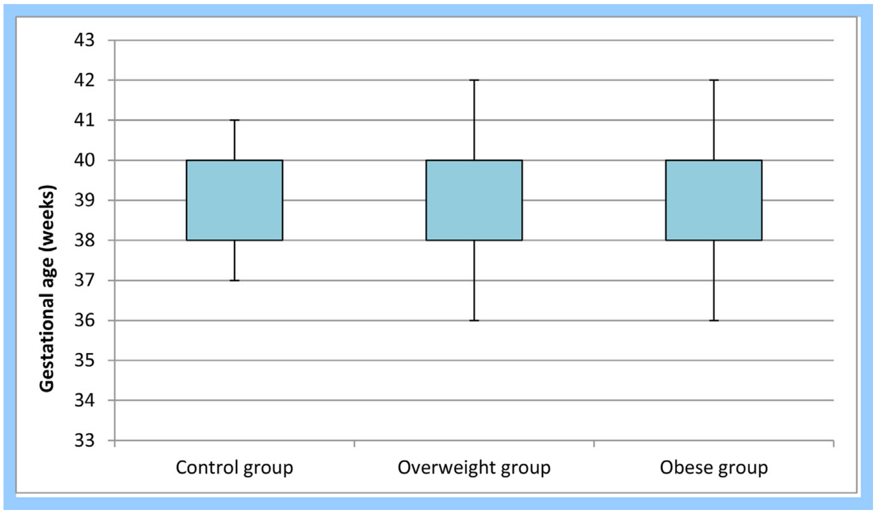

Fig. 1. Box-plot comparing the differences in gestational age between the research groups.

to ICU, There was a highly significant difference between the three studied groups (P=<0.001).

4. Discussion

Pregnancy-related maternal obesity and overweight might be seen as a risk factor for preterm birth, especially for severely preterm births (22–27 weeks). The risk of newborn morbidity has also been associated to a lower gestational age,[8] as have hypertensive and diabetic conditions that may be attributed to high maternal BMI.[9]

This prospective randomized controlled research trial was conducted in outpatient antenatal care clinics of the maternity hospital at Al-Hussein and Bab El-Sheirya (Sayed Galal) Hospitals, Al-Azhar University. 150 women participated in this study.

Each patient was placed in one of the following three groups: Group A, which included the obese patients (BMI>30 kg/m), the overweight patients (BMI 25–29.9 kg/m^2), and the control patients (BMI 18.5–24.9 kg/m^2). The demographic information we looked at showed no statistically significant age difference between the three groups, among the groups. Obese women have significantly higher parity in comparison to controls and Overweight. Maternal BMI in Control group ranged from 18.7 to 24.7 with mean ± SD = 21.7 ± 1.5, While the maternal BMI for the obese group ranged from 31.1 to 38.7 with mean SD = 34.9 ± 1.9, The mean SD of the maternal BMI for the overweight group was 27.45, and amongst the three groups, there was a very statistically significant difference (P = 0.001). The maternal BMI for the obese group varied from

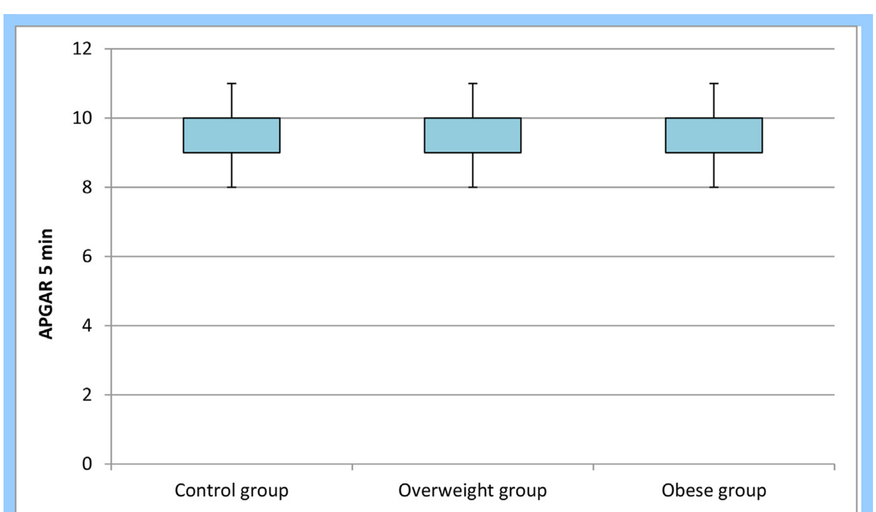

Fig. 2. Box-plot showing difference between the study groups regarding APGAR 5 min.

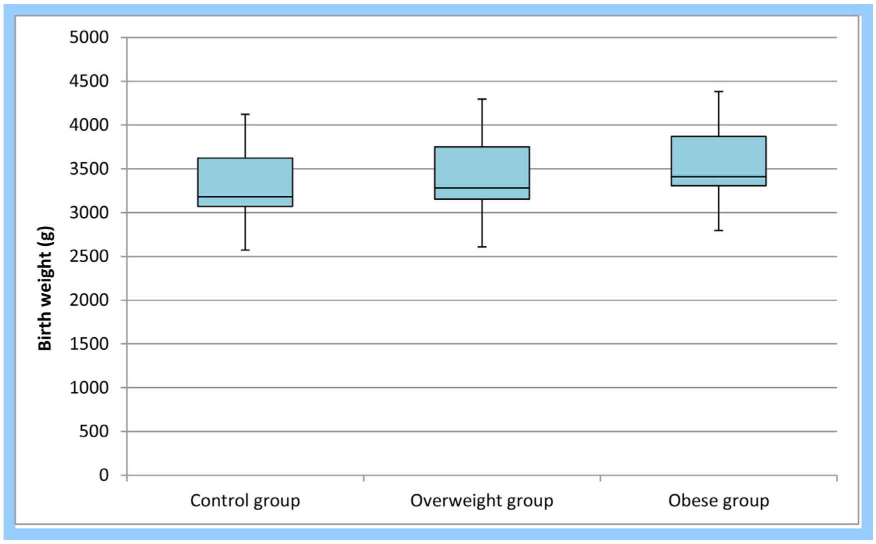

Fig. 3. Box-plot showing difference between the study groups regarding Birth weight.

25.2 to 29.7. In agreement with the current study **El-Sayed *et al.*,**[10] aimed to evaluate the impact of BMI of nulliparous females on progress of labour, incidence of peri-partum complications and neonatal outcome of these women. The study enrolled 330 nulliparous patients categorized into 4 groups according to BMI. The study found a substantial BMI difference between the three groups under observation, Despite the fact that their ages did not differ statistically significantly. The effects of maternal BMI and gestational weight gain (GWG) on the outcomes of newborns were examined. Additionally, Papazian et al.,[10] examined these components. The 1000 full-term newborns in the study showed no association between maternal age and BMI. The current study found that there was a highly significant difference in the administration method between the three groups that were analysed ($P = 0.0002$). In agreement with our findings, Yossef et al.[11] discovered that the mode of delivery varied significantly amongst the studied groups ($P = 0.0002$).

This was supported by **Chung,**[12] who noted that women with underweight have more caesarean sections than those with normal weight (0.17 versus 0.05, $P = 0.048$).

In the current study regarding the development of maternal complications among the study population we found that, In terms of gestational DM (GDM), Between the three study groups, there was a highly significant difference ($P = 0.001$).

PPH varied in a significantly significant way among the three study groups ($P = 0.001$).

Between the three research groups, there was a considerable variation in episotomy wound sepsis (P.001). There was a significantly significant difference ($P = 0.001$) between the three research groups in terms of puerperal sepsis. ($P = 0.001$). In line with our findings **Yossef *et al.***[11] reported that concerning the correlation between BMI groups and

Table 5. Admission to neonatal-ICU among the study population.

	Control group ($n = 50$) n (%)	Overweight group ($n = 50$) n (%)	Obese group ($n = 50$) n (%)	Test of Sig.	P
Admission to neonatal-ICU					
Yes				X2 = 23.352	<0.001
n (%)	11 (22%)	15 (30%)	19 (38%)		
No					
n (%)	39 (78%)	35 (70%)	31 (62%)		
	$P1$=<0.001, $P2$=<0.001, $P3$=<0.001				

$\chi 2$: Chi- Square test.
P: P value for comparing between the studied groups.
P value > 0.05: Non significant; P value < 0.05: Significant; P value < 0.001: Highly significant.
P_1: Group 1 versus Group 2.
P_2: Group 2 versus Group 3.
P_3: Group 1 versus Group 3.

development of gestational DM, gestational HTN and neonatal outcome, there were statistical differences as P value = 0.044, 0.014 and 0.023 respectively.

This was supported by **Chen *et al.*,**[13] reported that women with prepregnancy overweight and obesity status had considerably higher risks of GDM, gestational hypertension (GHTN), preeclampsia, caesarean delivery, preterm birth, and macrosomia than did women with normal weight. These risks were always greater than those for all negative prenatal outcomes, from obesity to underweight status. In the current study, we discovered that the gestational age in the control group ranged from 37 to 41 with a mean and standard deviation of 39 1.1, while the gestational age in the overweight group ranged from 36 to 42 with a mean and standard deviation of 38.8 1.5, with a statistically significant difference ($P = 0.037$), the gestational age in the obese group varied from 36 to 42 weeks, with a mean and standard deviation of 39 1.6. In between Sun et al.,[14] who also discovered significant changes in gestational age across the four groups under investigation (each with a different BMI category; $P = 0.001$), reported similar results to our own. Also, this was supported by **Santos *et al.*, 2019** They shown that weight growth and BMI both increased the chance of preterm delivery.

As well, **Anchala & Ruchi,**[15] revealed that gestational age was significantly associated with maternal BMI.

Regarding APGAR score after 5 & 10 min among the study population, we found that APGAR 5 min in control group ranged from 8 to 11 with mean ± SD = 9.4 ± 0.7, while in overweight group the APGAR 5 min ranged from 8 to 11 with mean ± SD = 9.3 ± 0.8, while in obese group the APGAR 5 min ranged from 8 to 11 with mean ± SD = 9.3 ± 0.7, between the three groups, having a different that is statistically significant ($P = 0.019$). APGAR 10 min did not differ statistically significantly between groups, though ($P = 0.584$).

Also, **El-Sayed *et al.*,**[16] reported that both APGAR score after 1 & 5 min were significantly differed between groups with different maternal BMI (P=<05).

Similarly, **Ahmed *et al.*,**[17] reported that both APGAR score after 1 & 5 min were significantly inversely associated with maternal BMI (P=<0.001).

Also, this was supported by **Anchala & Ruchi,**[15] who reported that low APGAR at 5 min was significantly more prevalent in obese group.

In the current study, we discovered that the birth weight of the control group ranged from 2572 to 4122, with a mean and standard deviation of 3347.1 to 407.8, while the birth weight of the overweight group ranged from 2609 to 4296, with a mean and standard deviation of 3452.5 to 444.2, and the birth weight of the obese group ranged from 2794 to 4381, with a mean and standard deviation of 3587.4 to 417.5. This difference between the three groups In line with the latest research **Aji *et al.*,**[18] reported that Birth weight was significantly associated with pre-pregnancy BMI category. Furthermore, **Xi *et al.*,**[19] revealed that obese female have significantly higher fetal birth weight than non-obese females.

Also, **Wang *et al.*,**[20] reported that obese female have statistically significant higher fetal birth weight than non-obese females.

In addition, **Sun *et al.*,**[14] reported that obese female were significantly higher fetal birth weight than non-obese females.

In the current study regarding admission to NICU, Between the three groups that were being studied, there was a very significant difference ($P = 0.001$). Between the three study groups, there was a significant difference ($P = 0.05$), according to Yossef et al., which is consistent with our findings. Additionally, Saini et al.[21] discovered a connection between maternal BMI and neonates needing NICU hospitalisation and discovered that obese and overweight women have a higher risk of a variety of pregnancy and perinatal issues in addition to increased neonatal admissions. Furthermore, **Anchala & Ruchi,**[15] reported that NICU admission and newborn mortality were significantly higher in Underweight group.

However, **El-Sayed *et al.*,**[16] reported that the three groups under study did not differ significantly from one another ($P > 0.05$), this disagreement may be due to differences in inclusion criteria and sample size.

4.1. Conclusion

Obesity causes serious maternal and foetal problems and has a considerable negative impact on the outcome of pregnancy when it is present. Maternal BMI was significantly correlated with mode of delivery, child sex, Gestational age, APGAR 5 min, Birth weight, child length, head circumference.

Conflicts of interest

Authors declare that there is no conflict of interest, no financial issues to be declared.

Consent for Publication

I verify that all authors have agreed to submit manuscript.

Availability of data & material

Available.

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