



Research Article

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# The Role of Maternal Serum Triglycerides in Prediction of Large-For Gestational-Age in Pregestational and Gestational Diabetes Mellitus



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## Abstract

**Introduction:** Still there is increasing tendency to macrosomia in fetuses of diabetic women despite good diabetic control. Hyperglycemia is not only the responsible factor of undue fetal weight in pregnant women. The study intent was to find out whether maternal hyperlipidemia is responsible for prevalence of large for gestational age (LGA) in newborns of women with pregestational (PGDM) and gestational diabetes (GDM).

**Material and methods:** This prospective observational, single-center study was executed in women with PGDM and GDM. The study was held in Ain Shams University Maternity Hospital. Data were gathered in the (35th–38th weeks).

**Result:** Among 216 pregnant women recruited in the analysis, 45 cases (20.8%) delivered average-for-gestational-age (AGA) newborns, all of them delivered normally. The remaining 171 cases (79.2%) newborns were large for gestational age (LGA), 100 of them were delivered by C.S and other 71 were delivered normally. The preponderance of LGA newborns was significantly higher in women with hypertriglyceridemia. Maternal TG and cholesterol levels were significantly higher in the group of LGA than in the AGA group (374.73±103.16) vs (242.23±88.99),  $p = 0.00$ , and (249.93±38.85) vs (187.54±22.95),  $p < 0.0001$  respectively. While HDL was significantly lower in the LGA group than in the AGA group (53.95±11.78) vs (66.61±9.01),  $p < 0.0001$ . Maternal Cholesterol, HDL-C and triglycerides levels tended to be correlated with newborn birth weight with sensitivity 80%, 86.7%, 86.7%, specificity 87.7%, 87.7%, 70.1% and cut off value >213.5mg/dl, <61.3mg/dl, >345mg/dl respectively.

**Conclusion:** Decreased serum HDL-C and increased serum triglycerides and cholesterol levels in pregnant women with PGDM and GDM might chip in the evolution of fetal macrosomia or LGA

**Keywords:** Pregestational and gestational diabetes; Pregnancy; Lipids; Large-for-gestational-age; Hypertriglyceridemia; Fetal macrosomia; Serum lipid metabolism; Insulin; Fetuses; Maternal nutrients; Glucose, Amino acids; Lipoproteins

## Introduction

The magnitude of fetal macrosomia is significantly high in diabetic pregnant women. Distinction in neonatal weight that occur are not restricted only to the maternal glucose level, but also other metabolic factors such as lipids may have a remarkable role [1-4]. Serum lipid metabolism is somewhat altered during pregnancy in diabetic women with increased serum maternal lipoprotein concentrations because of increased insulin resistance and lipolysis of peripheral adipose tissue [5,6]. Obstetric complications such as preterm delivery and preeclampsia were more frequent with this abnormal metabolism of lipid. Furthermore, study of Freinkel et al. showed that "mixture" of maternal nutrients as (glucose, amino acids and lipoproteins) change the metabolic

state of the fetuses, the fetal development and growth, also future obesity and development of diabetes in the progeny (fuel mediated-teratogenesis), and cardiovascular disease due to fetal programming [7]. Treatment of hyperlipidemia is a very important therapeutic target in non-pregnant diabetic settings. But are not recommended among diabetic pregnant women [8]. The intent of the current study was to assess the upshot of maternal lipids in the third trimester in predicting (large-for-gestational-age) macrosomic newborns in pregnant women with pregestational and gestational diabetes and if there is preventive measures may be taken such as prepregnancy management of hyperlipidemia and proper diabetic control.

### The study intents are

- a) To ascertain the relevance between maternal lipids and newborns with large-for-gestational-age in diabetic pregnant women.
- b) To check the predictive level of maternal triglycerides in predicting neonatal weight in diabetic pregnant women.

### Material and Methods

This prospective study of pregnant diabetic women attended to antenatal clinic (ANC) and/or admitted to the maternity ward at Ain Shams University Maternity Hospitals (ASUH), Egypt, over the period from March 2016 till June 2018. Patients were recruited from Ain Shams Maternity clinic and ward admission in the hospital. Of the 251 diabetic women, 35 cases were excluded from the study due to missed abortion (10 cases), missed during follow up (9 cases), IUDF (4 cases), preterm labor (5 cases) and 7 cases refused participation. 216 diabetic pregnant women were included in the study and were eligible for the final analysis.

The study protocol was approved by ASUH Ethical Committee. Counseling of participating women, clear caption of the intervention, and an informed written consent was then taken from all of them. During the ANC visit enrolment, medical, past, surgical and obstetric histories were reviewed, general and abdominal examinations were carried out, FHR was checked, and findings were recorded. Estimation of gestational age (GA) was done from the date of LMP in women with prior regular periods or estimated from early ultrasound scan (USS) at 7 weeks' gestation. GA was verified by the 13th week USS. Fetal anomaly scan was arranged at around 20 weeks' gestation. Then women were followed up as per the standard pregnancy care for diabetes where they attended every 2 weeks until 28 weeks' gestation, every 1 weeks until 36 weeks' gestation then twice weekly thereafter until delivery. Targeting a fasting glucose level of 60-100mg/dl, 1-hour postprandial glucose below 120mg/dl, and glycated hemoglobin (HbA1c) below 6.1% (25). All women were on insulin therapy.

### Exclusion criteria

- a. Pregnancies with congenital anomalies.
- b. Women with hypertension, thyroid or connective tissue disorders
- c. Multifetal gestations.
- d. Cases delivered before 35 weeks' gestation.
- e. Postdate.
- f. Uncontrolled diabetics.
- g. Abnormal glycosylated hemoglobin (HbA1c) level, above 6.1%.
- h. IUGR.
- i. BMI <30 kg/m<sup>2</sup>.

- j. Past history of macrosomic baby.
- k. Bad obstetric history.

### Cases are divided into two main groups

Group A: Pregestational Diabetic women with type 1 or type 2 diabetes.

Group B: Pregnant women diagnosed with gestational diabetes mellitus (GDM). GDM was generally diagnosed by OGTT in the second half of pregnancy. The OGTT was performed in the morning after a nightlong fasting from 8 to 12h. The criteria for the diagnosing GDM were at least one abnormally high out of three plasma glucose value measurements during the 75gm OGTT (normal values: a fasting level <92mg/dl, 1-hour level < 180mg/dl, 2-hour level < 153mg/dl). The venous blood glucose levels were measured using the glucose oxidase method (AU 480 Analyzer; Beckman Coulter, California, USA). The glucose tolerance was classified by the latest criteria of the International Association of Diabetes in Pregnancy Study Group (IADPSG) (9) by using the 75gm 2-hour oral glucose tolerance test (OGTT) at 24-28week gestation.

In the third trimester, the fasting maternal total cholesterol, triglycerides, high-density lipoprotein Cholesterol (HDL-C), low-density lipoprotein Cholesterol (LDL-C) were measured in both groups. The samples for lipids assessment were collected after the overnight fasting. Analysis of the lipoproteins blood samples was executed using AU 480 analyzer according to the standard methods. Total cholesterol and triglycerides were checked with the full enzymatic methods (Cholesterol Oxidase and triglycerides-Glycerol Phosphate Oxidase). HDL-C was measured using the polyanion precipitation method, while LDL was calculated using the Friedewald formula.

Blood samples were assembled after nightlong fasting and transported immediately to the laboratory of the Obstetric Gynecological University Hospital for analysis. The total serum cholesterol, HDL-C, LDL, and triglyceride (TG) levels were assessed with participation of the clinical pathology department in Ain Shams University. The level of low-density lipoprotein (LDL) cholesterol was calculated using Friedewald formula:  $LDL\ cholesterol = Total\ cholesterol - (HDL\ cholesterol + (TG/5))$ .

### Fetal investigations

- a) CTG.
- b) Trans-abdominal ultrasound examination for fetal viability, gestational age confirmation, measurement of the fetal abdominal circumference (AC), and estimation of expected fetal birth weight (EFBW) immediately before delivery. Hospital admission of the patients will be at the time of delivery or if developed any complication of diabetes.
- c) Neonatal birth weight is measured in grams upon delivery.

d) Large-for-gestational-age fetuses are defined as those with birth weight above the 90th centile for age, and whose birth weight falling below 10th centile is defined as small-for-gestational-age.

Mode of delivery will be according to hospital protocol.

**Statistical Analysis**

Data were collected from taken history, clinical examination, laboratory investigations, and outcome measured, entered and analyzed using Microsoft Excel software. Then data were submitted to Statistical Package for the Social Sciences software for analysis (SPSS version 20). According to the type of data, qualitative represented as number and percentage, quantitative represented by mean ± SD, the following tests were used to test the differences for significance; difference and association of qualitative variable by Chi-square test (X2), between quantitative parametric groups by t-test, non-parametric by Mann Whitney, correlation by Pearson's correlation and regression. P value was set at <0.05 for significant results & <0.001 for high significant result.

Results: 216 diabetic women were eligible for the final analysis. The demographic criteria for studied groups shown

in Table 1 with no significance among them. The mean, Serum triglycerides (TG) levels were found to be significantly higher in women with GDM (248.83±114.2mg/dl), type 2 DM women (286.91± 94.12mg/dl) and type 1 DM (258.14±135.5) compared to controls (180.7±10.8)mg/dl. Similarly, Serum Cholesterol was significantly higher in women with GDM (199.11±35.09) mg/dl and type 2 DM women (220.5±44.5)mg/dl and type1 DM (274.8±50.3)mg/dl as compared with controls (151.9±10.5) mg/dl. Such a significance was also seen in the case of LDL-C, with the mean LDL-C being (137.96±28.35)mg/dl in GDM, (110.7 ± 38.4) mg/dl in type 2 DM and (146±42.3) mg/dl in type1 DM. In contrast, HDL-C was significantly elevated in controls (47.1±3.7) mg/dl, compared to GDM (64.15±5.9)mg/dl and type 2 DM women (63.28±12.71)mg/dl and (61.33±7) in type 1 DM as in Table 2. Among 216 women included in the analysis 45 cases (20.8%) delivered AGA newborns and all of them delivered normally. The remaining 171 cases (79.2%) delivered newborns with large-for-gestational-age (LGA). 100 of them had delivered by C.S other 71 had delivered normally (Table 3). Women with GDM, 18 delivered AGA newborns, 63 delivered LGA newborns, in type 1 DM 6 cases delivered AGA newborns, 15 cases delivered LGA newborns, and in type 2 DM 21 cases delivered AGA newborns, 93 cases delivered LGA newborns.

**Table 1:** Socio-demographic data of the studied groups according to different types of DM (N=216).

		N	Mean±S.D	Minimum	Maximum	P
Age(years)	GDM	81	31.93±5.70	23	40	0.001**
	Type 2	114	29.42±4.27	20	35	
	Type 1	21	24.29±3.35	19	28	
BMI(kg/m <sup>2</sup> )	GDM	81	25.07±2.73	28	40	0.426
	Type 2	114	27.39±3.45	26	44	
	Type 1	21	31.71±2.36	29	36	
Gest age at delivery by LMP(week)	GDM	81	36.37±1.24	31	38	0.396
	Type 2	114	36.39±1.30	30	38	
	Type 1	21	35.71±0.48	35	36	
Gravidity	GDM	81	2.9±0.8	1	3	0.3
	Type 2	114	2.6±0.4	1	6	
	Type 1	21	2.5±0.48	1	14	
Parity	GDM	81	1.3±0.2	1	3	0.3
	Type 2	114	1.6±0.4	1	2	
	Type 1	21	1.5±0.48	1	2	
Abortion	GDM	81	0.3±0.05	0	4	0.2
	Type 2	114	0.4±0.1	1	10	
	Type 1	21	0.5±0.1	1	13	
Fetal Weight by US	GDM	81	3525.19±596.38	1900	4600	0.394
	Type 2	114	3443.50±525.07	2300	4240	
	Type 1	21	3172.29±989.62	1650	4400	
Neonatal birth weight	GDM	81	3711.11±514.66	2000	4500	0.365
	Type 2	114	3718.42±446.52	2500	4500	
	Type 1	21	3428.57±740.98	2500	4500	

**Table 2:** Lipid profile distribution according to types of D.M (n=216).

		Mean S.D	Minimum	Maximum	P
TG in 3rd trimester	GDM	248.83±114.2	93.3	494	0.351
	Type 2	286.91± 94.12	100	539.6	
	Type 1	258.14±135.5	143.7	431	
HDL	GDM	64.15±9.33	49	84	0.85
	Type 2	63.28±12.71	32	84	
	Type 1	61.33±7.00	50	70	
LDL	GDM	137.96±28.35	95	195	0.898
	Type 2	110.7±38.4	100	188	
	Type 1	146.0±42.3	98	190	
Cholest	GDM	199.11±35.09	145	295	0.969
	Type 2	220.5±44.5	150	300	
	Type 1	274.8±50.3 220.5±44.5	165	310	

**Table 3:** Association between neonatal birth weight & types of DM and mode of delivery.

		Neonatal weight		Total	X <sup>2</sup>	P
		over No (%)	Normal No (%)			
GDM	No (%)	63(29.2)	18(8.3)	81(37.5)	0.42	0.81
Type 1 DM	No (%)	15 (6.9)	6(2.7)	21(9.6)		
Type 2 DM	No (%)	93(43.05)	21(9.7)	114 (52.8)		
Total		171(79.2)	45(20.8)	216(100)		
Delivery CS	No.(%)	100 (46.2)	0	100 (46.2)	6.31	0.012*
VD	No.(%)	71 (32.8)	45(20.8)	116(53.7)		
Total	No.(%)	171(79)	45(20.8)	216(100)		

**Table 4:** Comparison between demographic data and lipid profiles in the studied groups in relation to neonatal body weight.

	Weight	Mean ±S.D	t/ Mann Whitney	P
Age(years)	Over weight	31.13±4.63	1.065	0.291
	Within Normal	29.53±5.34		
BMI(kg/m2)	Over weight	32.40±2.47	-0.996-	0.322
	Within Normal	33.29±3.25		
Gest age at delivery by LMP(week)	Over weight	36.60±.83	0.992	0.325
	Within Normal	36.25±1.31		
TG(mg/dl)	Over weight	374.73±103.16	4.963	0.00**
	Within Normal	242.23±88.99		
	Within Normal	152.16±55.39		
HDL(mg/dl)	Over weight	53.95±11.78	-4.334	0.00**
	Within Normal	66.61±9.01		
Cholesterol(mg/dl)	Over weight	249.93±38.85	7.995	0.00**
	Within Normal	187.54±22.95		
LDL(mg/dl)	Over weight	156.90±32.30	2.147	0.051
	Within Normal	126.76±22.39		

**Table 5:** Area under the Curve for Cholesterol, HDL & TG.

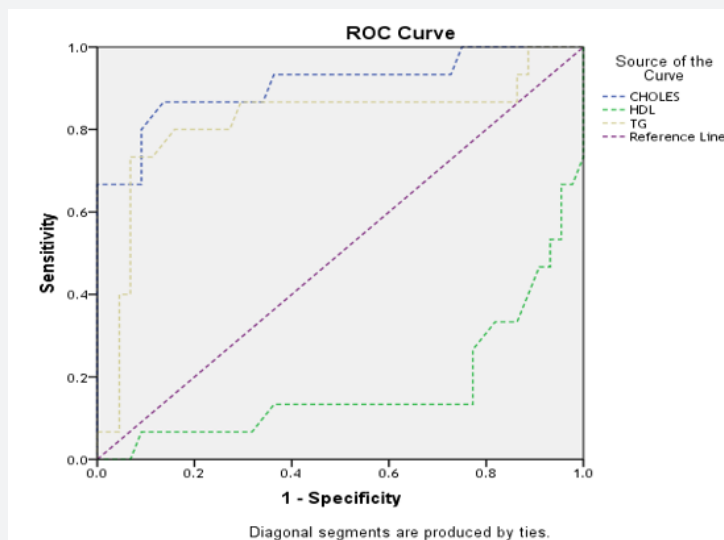
Test Result Variable(S)	Area	Cutoff	Sensitivity	Specificity	P	95% Confdeince Interval	
Cholesterol	0.908	>213.5	86.70%	87.70%	0	0.804	1
HDL	0.832	<61.3	86.70%	70.10%	0	0.035	0.316
TG	0.817	>345	80%	87.70%	0	0.665	0.97

**Table 6:** shows Significant association and agreement between overweight cutoff regarding TG, Cholesterol and HDL.

Normal Over weight		Neonatal weight		Total	X <sup>2</sup>	P	Kappa Agree-ment	
< 213.5	No. (%)	> 213.5	No. (%)					
Chol	< 213.5	No. (%)	150(87.7)	6(13.3)	156(72.2)	32.75	0.00**	0.66
	> 213.5	No. (%)	21 (12.3)	39(86.7)				
HDL	> 61.3	No. (%)	120 (70.1)	6(13.3)	126(58.3)	15.72	0.00007**	0.54
	< 61.3	No. (%)	51(29.9)	39(86.7)				
TG	< 345	No. (%)	150(87.7)	9 (20)	159(73.6)	28.03	0.00**	0.61
	> 345	No. (%)	21(12.3)	36 (80)				
Total		No. (%)	171(79.2)	45(20.8)	216(100)			

The prevalence of LGA newborns was significantly higher in women with hypertriglyceridemia independent on BMI or maternal age. Maternal TG and cholesterol levels were significantly higher in the LGA group than in the AGA group (374.73±103.16) vs (242.23±88.99), p=0.00, and (249.93±38.85) vs (187.54 ± 22.95) p <0.0001 respectively in contrast to HDL was significantly

lower in the LGA group than in the AGA group (53.95 ± 11.78) vs. (66.61 ± 9.01), p <0.0001 (Table 4). Maternal Cholesterol, HDL-C and TG levels tended to be correlated with newborn birth weight with sensitivity 86.7%, 86.7%, 80% and specificity 87.7%, 70.1%, 87.7%, respectively (Table 5&6).



**Figure 1:** OC Curve for overweight cutoff regarding TG, Cholesterol and HDL.

The area under the ROC curve was 0.817, 0.832 and 0.908 for maternal serum TG, HDL-C and cholesterol respectively in the prediction of LGA newborns. The optimally proposed cut-off values by the ROC analysis for maternal serum TG, HDL-C and cholesterol were  $>345\text{mg/dl}$ ,  $<61.3\text{mg/dl}$  and  $>213.5\text{mg/dl}$  respectively. Maternal TG is a significant predictor of LGA newborns (95% CI: 0.665-0.970, cut off value  $> 345\text{mg/dl}$ ,  $p < 0.00$ ) with sensitivity and specificity of 80% and 87.7% respectively (Figure 1).

## Discussion

In this prospective observational study on pregnant women with PGDM and GDM, we found maternal triglyceride, HDL-C, and cholesterol values in the third trimester of gestation were important predictors for macrosomia, independent of the maternal pregnancy BMI or maternal age. The current study showed that increase fetal weight, behind maternal glucose concentration is directly related to hyperlipidemia. Other studies demonstrated that maternal serum lipids are directly related to LGA, independent of maternal weight gain and glucose [10,11]. The increments of lipids during pregnancy mainly due to increments of estrogen [12]. The rising levels of estrogen with the advance of pregnancy reflects the changes in lipoproteins [8]. Lipids also increase with the increasing insulin resistance that presents in obesity, GDM and PGDM, as it was found in the studies of Gobi et al. [13], Kitajima et al. [14] and Knopp et al. [15]. Hyperlipidemia in diabetic pregnant women might also influence the fetal growth. In this study, we measured lipids in the third trimester in pregnant women with PGDM and GDM, there were higher levels of total cholesterol ( $274.8\pm 50.3\text{mg/dl}$ ) in the type 1 DM patients in comparison to that in the type 2 DM ( $220.5\pm 44.5\text{mg/dl}$ ) and in GDM patients ( $199.11\pm 35.09\text{mg/dl}$ ). Further, the multivariate analysis showed the positive relationship between the maternal cholesterol levels and the neonatal birth weight. Actually, the maternal cholesterol levels were an independent predictor for macrosomia. This agrees with Schaefer et al. [16], who found a positive correlation between the maternal cholesterol levels in the third trimester and the neonatal birth weight. Some studies have reported that serum lipids play an influential role in neonatal weight as compared to glucose level [10,11].

Triglycerides level which showed continuous increase throughout pregnancy is the most frequently changed lipids in all studies [15]. The increase in the lipids metabolism is an adaptation of the increased fuel delivery to the fetus. When they are too high, macrosomic babies are more likely to be born. Mothers with type 2 DM had higher triglycerides levels ( $286.83\pm 58.85\text{mg/dl}$ ) in comparison to the triglyceride levels in the type 1 DM patients ( $258.14\pm 135.5\text{mg/dl}$ ) and ( $248.83 \pm 114.2$ ) in GDM. Thus the triglycerides in late pregnancy were the strongest predictor of macrosomia. The increased triglycerides during the late pregnancy are due to the increased liver synthesis of VLDL under the effect of estrogens and increased adipose tissue lipolysis. HDL-C levels is reduced in type 1 DM more than in type 2 DM and GDM

( $61.33\pm 7\text{mg/dl}$ ) vs ( $63.28\pm 12.71\text{mg/dl}$ ) and ( $64.15\pm 9.33\text{mg/dl}$ ) respectively. In the study that was conducted by Yang et al. [17], a negative relationship was found between the HDL-C levels and the neonatal birth weight. In the present study, we stated that the negative relationship was found between HDL-C and LGA newborns ( $r = -0.293$ ,  $p = 0.019$ ), but without independent influence on LGA. LDL-C levels were within the normal range in all studied groups.

Pusukuru et al. [18] found a significant increase in the cholesterol, triglyceride levels in the third trimester than in the second trimester. The mean cholesterol levels in third and second trimester were ( $242.65\pm 20.44\text{mg/dl}$ ) and ( $214.6\pm 18.16\text{mg/dl}$ ) respectively. The mean triglyceride levels in third and second trimester were ( $216.78\pm 20.09\text{mg/dl}$ ) and ( $188.68\pm 20.88\text{mg/dl}$ ) respectively. The mean HDL and Cholesterol levels in third and second trimester were ( $43.07\pm 4.34\text{mg/dl}$ ) and ( $49.13\pm 6.15\text{mg/dl}$ ) respectively.

The present study showed that overweight significantly higher regard TG and cholesterol in the third trimester but significantly lower regard TG and HDL-C in the second trimester. This agreed with findings of Wang et al. [19]. Hypertriglyceridemia was defined as more than the 75<sup>th</sup> percentile value ( $259\text{mg/dl}$ ) of all subjects. The frequency of LGA infants was significantly higher in mothers with hypertriglyceridemia (4 of 34, 12%) than in mothers who had normal triglyceride levels (1 of 112, 0.9%). Also agreed with an earlier study made by Kitajima M et al. [20] founded that the frequency of LGA infants was significantly higher in mothers with hypertriglyceridemia than in mothers who had normal triglyceride levels.

Also agreed with the results of Son et al. [21] from 104 women 25 delivered LGA newborns, 73 delivered appropriate-for-gestational-age (AGA) newborns, and 6 delivered SGA newborns; SGA and AGA newborns were incorporated into the non-LGA group. Maternal TG levels were significantly higher in the LGA group than in the non-LGA group with median [283 ( $213-319$ ) vs.  $204(159-275)$ ,  $p = 0.001$ ]. Hypertriglyceridemia was defined as a TG level  $>$  the 75<sup>th</sup> percentile value ( $> 292\text{mg/dl}$ ). The frequency of LGA newborns was significantly higher in women with hypertriglyceridemia than in those with normal TG levels [2 of 26, (46%) and 13 of 78, (4%), respectively;  $p = 0.02$ ].

This also agreed with Cianni et al. [22] in 83 pregnant women with normal glucose tolerance (NGT) who delivered at term, the influence of lipid parameters on newborn weight was evaluated. The prevalence of LGA infants was significantly higher in women with hypertriglyceridemia ( $P < 0.05$ ) (TG levels  $>$  75<sup>th</sup> percentile value;  $204\text{mg/dl}$ ) than in those with normal TG levels 4 of 19 (21%) and 2 of 44 (4.5%), respectively.

As shown in Area under Curve (AUC) for cholesterol=0.908, with (95% CI: 0.804-1.000). AUC for HDL-C = 0.832, with (95% CI:

0.035-0.316). AUC for TG=0.817, with (95% CI: 0.665-0.970). This agreed with Son et al. The area under the ROC curve was 0.702 for maternal serum TG in the prediction of LGA newborns. The optimally proposed cut-off value by the ROC analysis for serum TG was  $\geq 295$ mg/dl. Using that cut-off value, TG was a significant predictor of LGA newborns (95% CI: 0.59-0.81;  $p=0.002$ ) with sensitivity and specificity of 48.0 and 83.5%, respectively [21].

Also agreed with Wang et al., the ROC curve was drawn to determine sensitivity and specificity for detecting the risk of delivering LGA newborns. The area under ROC curves of TG/HDL-C to detect LGA was 0.668 (95% CI: 0.514-0.823). The optimal cut-off value proposed by the ROC analysis for TG/HDL-C was 1.85. Furthermore, the area under ROC curve to detect LGA was 0.806 (95% CI, 0.719-0.893) [19]. The current study found a significant association and agreement between overweight cutoff regarding TG, Cholesterol, and HDL-C.

This study showed that TG is a considerable foreteller of neonatal weight. Forward stepwise logistic regression analysis showed that increased TG/HDL-C independently and highly associated with LGA infants which is compatible with the findings of Wang et al. [19] who applied a logistic regression model with confounding variables, including fasting levels of plasma glucose, pre-pregnant BMI, and gained weight during pregnancy, to test whether maternal hypertriglyceridemia foretells the risk of developing LGA infant at term, independent of fasting plasma glucose and maternal obesity. In the model, hypertriglyceridemia was an important foreteller of having an LGA infant at term (Odds ratio 11.6; 95% CI: 1.1-1.22), independent of maternal glucose levels and obesity.

## Conclusion

Measurement of maternal triglyceride level in the third trimester is an estimable foreteller of neonatal weight in women with diabetic pregnancy. However, large-scale studies are required to support this data.

High maternal TG concentrations in the third trimester were significantly related to an increased risk of fetal macrosomia in women with diabetic pregnancy. Additionally, the findings of our results focused the value of maternal lipid metabolism in impeding adverse maternal and neonatal outcomes.

## Recommendations

Proper antenatal care for diabetic pregnant mothers is advised to achieve euglycemia and avoid abnormal increase in fetal weight during pregnancy. Follow up of serum triglyceride level is recommended to all women with diabetic pregnancy from 28<sup>th</sup> weeks' gestation onwards. Pre-pregnancy care, early screening, appropriate management, planned delivery should be given to all women with diabetic pregnancy to minimize the risk of fetal macrosomia.

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