RESEARCH PAPER

Metabolic and Lipid Profile Alterations in Gestational Diabetes Mellitus Compared with Normal Pregnancy and Healthy Controls

Shalu Singh[1*], Dr. Sanjiv Kumar Bansal[2]
[1]Ph.D. Scholar, Department of Biochemistry, Department of Biochemistry, SGT University, Budhera, Gurugram, Haryana, India. Email-singhshalu4296@gmail.com
[2]Professor and HOD, Department of Biochemistry, SGT University, Budhera, Gurugram, Haryana, India. Email-hod.biochemistry_fmhs@sgtuniversity.org
Corresponding author: Shalu Singh, Email singhshalu4296@gmail.com

ABSTRACT
Background: Gestational diabetes mellitus (GDM) is associated with disturbances in glucose and lipid metabolism, potentially increasing maternal and fetal complications.
Objective: To compare metabolic parameters and lipid profiles among women with GDM, normal pregnant women, and healthy non-pregnant controls.
Materials and Methods: This hospital-based case-control study included 90 women divided into three groups of 30 each: healthy controls, normal pregnancy, and GDM. Glycaemic parameters and serum lipid profiles were evaluated and compared statistically.
Results: Women with GDM demonstrated significantly higher fasting blood glucose (117.65 ± 7.43 mg/dL), postprandial glucose (163.20 ± 11.03 mg/dL), and HbA1c (6.88%) compared with normal pregnant women. Triglycerides (244.58 ± 17.95 mg/dL), LDL-C (159.94 ± 13.24 mg/dL), and VLDL-C (48.92 ± 3.59 mg/dL) were significantly elevated, whereas HDL-C (41.13 ± 4.80 mg/dL) was reduced ($p<0.001$). Total cholesterol was also highest in the GDM group (249.12 mg/dL).
Conclusion: GDM was associated with significant glycaemic disturbances and dyslipidaemia compared with normal pregnancy and healthy controls, highlighting the importance of metabolic and lipid profile assessment.
Keywords: Gestational diabetes mellitus, Lipid profile, Dyslipidaemia, Hyperglycaemia, Pregnancy.
How to cite this article: Shalu Singh1* Dr. Sanjiv Kumar Bansal2. Metabolic and Lipid Profile Alterations in Gestational Diabetes Mellitus Compared with Normal Pregnancy and Healthy Controls. Int J Drug Deliv Technol. 2026;16(90s):848-854. DOI: 10.25258/ijddt.16.90s.84.

INTRODUCTION

Gestational diabetes mellitus (GDM) is one of the most common metabolic complications of pregnancy and represents a significant public health concern worldwide. It is characterized by hyperglycaemia first detected during pregnancy that does not meet the criteria for overt diabetes mellitus [1]. Pregnancy involves substantial physiological adaptations in carbohydrate and lipid metabolism to meet maternal and fetal energy requirements. During the second and third trimesters, progressive insulin resistance develops, which is normally compensated by increased pancreatic β-cell insulin secretion. Failure of this compensatory mechanism results in maternal hyperglycaemia and GDM [2]. The increasing prevalence of GDM has been associated with advancing maternal age, obesity, and metabolic disorders. GDM is associated with adverse maternal and neonatal outcomes, including hypertensive disorders, operative delivery, fetal macrosomia, neonatal metabolic disturbances, and an increased long-term risk of type 2 diabetes mellitus. These complications highlight the importance of identifying metabolic abnormalities during pregnancy [3,4]. Normal pregnancy is characterized by dynamic changes in glucose utilization, insulin sensitivity, and lipid metabolism. Early pregnancy predominantly involves anabolic processes, including increased fat deposition and energy storage. Conversely, late pregnancy is associated with enhanced lipolysis, increased circulating free fatty acids, and physiological insulin resistance to support fetal development. These adaptations result in progressive increases in circulating triglycerides and cholesterol fractions [5]. In women with GDM, impaired glucose regulation is frequently accompanied by abnormalities in lipid metabolism. Increased insulin resistance promotes adipose tissue lipolysis and alters hepatic lipid metabolism, contributing to elevated triglyceride-rich lipoproteins. Differences in triglycerides and other lipid fractions have been reported between GDM and uncomplicated pregnancies, although these alterations may vary with gestational age, maternal adiposity, and metabolic characteristics [6,7]. Previous investigations have demonstrated significant associations between maternal lipid abnormalities and GDM. Ryckman et al. identified differences in maternal lipid concentrations associated with GDM in a systematic review and meta-analysis [8]. Layton et al. reported variations in lipid profiles according to GDM physiological subtypes, while O'Malley et al.

highlighted associations between maternal obesity, dyslipidaemia, and GDM [9,10]. Furthermore, maternal lipid alterations may influence fetal growth and neonatal adiposity, emphasizing their potential clinical significance [11,12]. Assessment of glycaemic parameters, including fasting blood glucose, postprandial blood glucose, and glycated haemoglobin (HbA1c), provides information regarding maternal glucose regulation. Similarly, evaluation of total cholesterol, triglycerides, high-density lipoprotein cholesterol (HDL-C), low-density lipoprotein cholesterol (LDL-C), and very-low-density lipoprotein cholesterol (VLDL-C) helps characterize pregnancy-associated lipid alterations. Previous studies have demonstrated differences in lipid metabolism between normal and diabetic pregnancies [5,13]. Comparing women with GDM, normoglycaemic pregnant women, and healthy non-pregnant controls may help distinguish pathological metabolic disturbances from physiological pregnancy-related adaptations. Non-pregnant controls provide baseline biochemical values, while uncomplicated pregnancies reflect normal gestational metabolic changes [6]. Therefore, the present study was undertaken to evaluate and compare metabolic parameters and serum lipid profiles among women with GDM, women with normal pregnancies, and healthy non-pregnant controls.

MATERIALS AND METHODS

The present hospital-based case-control study was conducted in the Department of Biochemistry, Faculty of Medicine and Health Sciences, SGT University, Budhera, Gurugram, in collaboration with the Department of Obstetrics and Gynaecology, over a period of 24 months. The study was designed to compare metabolic parameters and serum lipid profiles among women with gestational diabetes mellitus (GDM), women with normal pregnancies, and healthy non-pregnant controls.

Study Population

A total of 90 women aged 20–40 years were included in the present analysis, with 30 participants in each of the three groups. Pregnant women were recruited from the Obstetrics and Gynaecology outpatient department, whereas apparently healthy, age-matched non-pregnant women were enrolled as controls. Participants were categorized into three groups: Group I comprised 30 healthy non-pregnant women, Group II included 30 normoglycaemic pregnant women with uncomplicated pregnancies, and Group III consisted of 30 pregnant women diagnosed with GDM according to the American Diabetes Association diagnostic criteria.

Eligibility Criteria

Inclusion Criteria

Women aged 20–40 years with normal pregnancy or GDM and apparently healthy, age-matched non-pregnant women were included in the study. Only participants who fulfilled the respective group-specific eligibility criteria and provided written informed consent were enrolled.

Exclusion Criteria

Women with pre-existing liver disease, kidney disease, acute or chronic inflammatory disorders, or a history of drug or alcohol intoxication were excluded. Participants receiving hypolipidaemic medications, steroid therapy, or hormone replacement therapy were also excluded.

Clinical Assessment and Blood Sample Collection

Demographic and clinical information, including age, pregnancy status, relevant medical history, and biochemical findings, was recorded for all participants. Following an overnight fasting period of 12–14 hours, approximately 5 mL of venous blood was collected from each participant under aseptic precautions. The collected samples were processed according to standard laboratory procedures. Serum was separated by centrifugation at 3500 rpm for 15 minutes, and the separated serum or plasma was used for subsequent biochemical investigations.

Biochemical Investigations

Assessment of Metabolic Profile

Fasting plasma glucose was estimated using an ERBA XL 360 automated biochemical analyser according to standard laboratory procedures. The obtained values were used to evaluate differences in glucose metabolism among healthy non-pregnant controls, women with normal pregnancies, and women with GDM.

Assessment of Lipid Profile

Serum lipid profile was evaluated by estimating total cholesterol (TC), triglycerides (TG), high-density lipoprotein cholesterol (HDL-C), and low-density lipoprotein cholesterol (LDL-C). All lipid parameters were measured using an ERBA XL 360 automated biochemical analyser according to the standard operating procedures of the laboratory. The obtained values were compared among the three study groups to assess physiological pregnancy-related lipid alterations and additional dyslipidaemia associated with GDM.

Statistical Analysis

The collected data were entered and analysed using the Statistical Package for the Social Sciences (SPSS), version 26.0. Continuous variables were expressed as mean ± standard deviation (SD) for normally distributed data and as median with interquartile range (IQR) for non-normally distributed data. The normality of data distribution was assessed using the Shapiro–Wilk test. Comparisons of continuous variables among the three study groups were

performed using one-way analysis of variance (ANOVA), followed by Tukey's post-hoc test for pairwise comparisons of normally distributed variables. For non-normally distributed variables, the Kruskal–Wallis test was applied, followed by adjusted pairwise comparisons. A p-value of less than 0.05 was considered statistically significant.

RESULTS

A total of 90 women were included in the study, comprising 30 healthy non-pregnant controls (Group I), 30 women with normal pregnancies (Group II), and 30 women with gestational diabetes mellitus (GDM; Group III). Anthropometric characteristics, glycaemic parameters, and lipid profiles were compared among the groups. Mean height was comparable among healthy controls (154.80 ± 4.46 cm), normal pregnancy (155.08 ± 5.07 cm), and GDM (155.12 ± 4.67 cm; p=0.960). However, mean body weight was significantly higher in the GDM group (69.14 ± 6.49 kg) compared with normal pregnancy (59.21 ± 6.21 kg) and healthy controls (52.01 ± 5.40 kg; p<0.001) (Table 1). Pairwise comparisons showed significant differences in body weight between all groups (p<0.001) (Table 1). Fasting blood glucose (117.65 ± 7.43 mg/dL) and postprandial blood glucose (163.20 ± 11.03 mg/dL) were significantly higher in the GDM group compared with normal pregnancy (81.12 ± 8.15 and 108.72 ± 10.63 mg/dL) and healthy controls (83.87 ± 7.50 and 113.91 ± 9.61 mg/dL; both p<0.001). Median HbA1c was also significantly elevated in GDM [6.88% (6.71–6.99)] compared with normal pregnancy [4.81% (4.61–4.99)] and healthy controls [5.06% (4.85–5.26); p<0.001] (Table 2). Pairwise comparisons confirmed significant differences between GDM and both comparison groups for all glycaemic parameters (p<0.001) (Table 2). Median total cholesterol was significantly higher in the GDM group [249.12 (234.84–258.40) mg/dL] compared with normal pregnancy [213.01 (210.51–218.35) mg/dL] and healthy controls [168.43 (157.43–177.36) mg/dL; p<0.001]. Similarly, triglyceride concentrations were highest in GDM (244.58 ± 17.95 mg/dL), followed by normal pregnancy (176.65 ± 13.21 mg/dL) and healthy controls (120.81 ± 16.95 mg/dL; p<0.001) (Table 3). Mean HDL-C was significantly lower in GDM (41.13 ± 4.80 mg/dL) compared with normal pregnancy (55.18 ± 5.77 mg/dL) and healthy controls (49.41 ± 5.95 mg/dL). However, LDL-C (159.94 ± 13.24 mg/dL) and VLDL-C (48.92 ± 3.59 mg/dL) were significantly higher in GDM compared with both groups (all p<0.001) (Table 4, Figure 2). Pairwise comparisons demonstrated significant differences in all lipid parameters among the three groups (p<0.001) (Table 6). The mean HDL-C/LDL-C ratio was significantly lower in GDM (0.26 ± 0.04) compared with normal pregnancy (0.47 ± 0.07) and healthy controls (0.50 ± 0.07; p<0.001) (Table 5, Figure 2). Pairwise comparisons showed significant differences between GDM and both comparison groups (p<0.001), whereas the difference between healthy controls and normal pregnancy was not significant (p=0.27) (Table 6).

Table 1. Comparison of Anthropometric Characteristics Among the Study Groups (N=90)

Parameter	Healthy controls (n=30)	Normal pregnancy (n=30)	GDM (n=30)	p-value	Statistical test
Height (cm)	154.80 ± 4.46	155.08 ± 5.07	155.12 ± 4.67	0.960	One-way ANOVA
Weight (kg)	52.01 ± 5.40	59.21 ± 6.21	69.14 ± 6.49	<0.001	One-way ANOVA

Table 2. Comparison of Glycaemic Parameters Among the Study Groups (N=90)

Parameter	Healthy controls (n=30)	Normal pregnancy (n=30)	GDM (n=30)	p-value	Statistical test
Fasting blood glucose (mg/dL)	83.87 ± 7.50	81.12 ± 8.15	117.65 ± 7.43	<0.001	One-way ANOVA

Postprandial blood glucose (mg/dL)	113.91 ± 9.61	108.72 ± 10.63	163.20 ± 11.03	<0.001	One-way ANOVA
HbA1c (%)	5.06 (4.85–5.26)	4.81 (4.61–4.99)	6.88 (6.71–6.99)	<0.001	Kruskal–Wallis test

Table 3. Comparison of Serum Total Cholesterol and Triglyceride Levels Among the Study Groups (N=90)

Parameter	**Healthy controls (n=30)**	**Normal pregnancy (n=30)**	**GDM (n=30)**	**p-value**	**Statistical test**
Total cholesterol (mg/dL)	168.43 (157.43–177.36)	213.01 (210.51–218.35)	249.12 (234.84–258.40)	<0.001	Kruskal–Wallis test
Triglycerides (mg/dL)	120.81 ± 16.95	176.65 ± 13.21	244.58 ± 17.95	<0.001	One-way ANOVA

Table 4. Comparison of Serum Lipoprotein Cholesterol Fractions Among the Study Groups (N=90)

Parameter	**Healthy controls (n=30)**	**Normal pregnancy (n=30)**	**GDM (n=30)**	**p-value**	**Statistical test**
HDL-C (mg/dL)	49.41 ± 5.95	55.18 ± 5.77	41.13 ± 4.80	<0.001	One-way ANOVA
LDL-C (mg/dL)	98.63 ± 9.09	119.07 ± 11.23	159.94 ± 13.24	<0.001	One-way ANOVA
VLDL-C (mg/dL)	24.17 ± 3.40	35.32 ± 2.64	48.92 ± 3.59	<0.001	One-way ANOVA

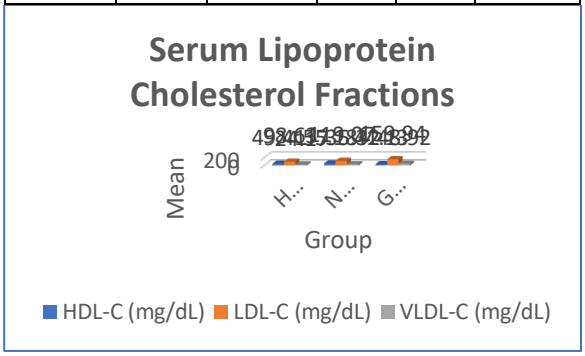

Figure 1. Comparison of Serum Lipoprotein Cholesterol Fractions Among the Study Groups (N=90)

Table 5. Comparison of HDL-C/LDL-C Ratio Among the Study Groups (N=90)

Parameter	**Healthy controls (n=30)**	**Normal pregnancy (n=30)**	**GDM (n=30)**	**p-value**	**Statistical test**

HDL-C/LDL-C ratio	0.50 ± 0.07	0.47 ± 0.07	0.26 ± 0.04	<0.001	One-way ANOVA

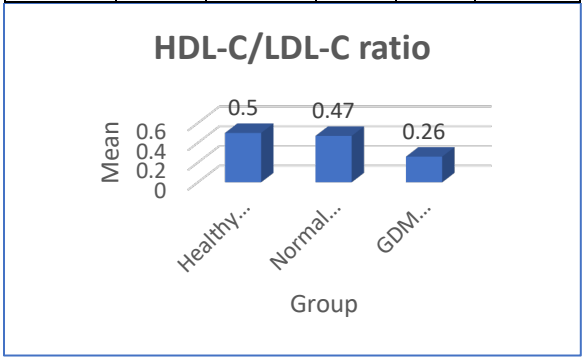

Figure 2. Comparison of HDL-C/LDL-C Ratio Among the Study Groups (N=90)

Table 6. Pairwise Comparison of Metabolic and Lipid Parameters Among the Study Groups (N=90)

Parameter	Healthy vs normal pregnancy (p-value)	Healthy vs GDM (p-value)	Normal pregnancy vs GDM (p-value)	Statistical test
Height	1.00	0.99	1.00	Tukey's post-hoc
Weight	<0.001	<0.001	<0.001	Tukey's post-hoc
Fasting blood glucose	0.53	<0.001	<0.001	Tukey's post-hoc
Postprandial blood glucose	0.23	<0.001	<0.001	Tukey's post-hoc
HbA1c	0.01	<0.001	<0.001	Adjusted nonparametric pairwise test
Total cholesterol	<0.001	<0.001	<0.001	Holm-adjusted Mann–Whitney U
Triglycerides	<0.001	<0.001	<0.001	Tukey's post-hoc
HDL-C	<0.001	<0.001	<0.001	Tukey's post-hoc
LDL-C	<0.001	<0.001	<0.001	Tukey's post-hoc
VLDL-C	<0.001	<0.001	<0.001	Tukey's post-hoc
HDL-C/LDL-C ratio	0.27	<0.001	<0.001	Tukey's post-hoc

DISCUSSION

In the present study, mean body weight was significantly higher in women with GDM (69.14 ± 6.49 kg) compared with normal pregnant women (59.21 ± 6.21 kg) and healthy controls (52.01 ± 5.40 kg; p<0.001), whereas height was comparable among the groups (p=0.960). Benhalima et al. [14] highlighted maternal obesity and metabolic risk factors as important considerations in GDM screening and management. These observations were consistent with the higher body weight observed in our GDM group, although differences in gestational age and prepregnancy adiposity could have influenced the findings. Fasting blood glucose was significantly higher in women with GDM (117.65 ± 7.43 mg/dL) than in normal pregnancy (81.12 ± 8.15 mg/dL) and healthy controls (83.87 ± 7.50 mg/dL; p<0.001). Similarly, postprandial glucose was highest in GDM (163.20 ± 11.03 mg/dL), followed by healthy controls

(113.91 ± 9.61 mg/dL) and normal pregnancy (108.72 ± 10.63 mg/dL; p<0.001). Median HbA1c was also elevated in GDM [6.88% (6.71–6.99)] compared with normal pregnancy [4.81% (4.61–4.99)] and healthy controls [5.06% (4.85–5.26)]. Metzger [15] recommended GDM diagnostic thresholds of fasting glucose ≥92 mg/dL, 1-hour OGTT glucose ≥180 mg/dL, and 2-hour OGTT glucose ≥153 mg/dL. Benhalima et al. [14] emphasized standardized screening and glycaemic assessment. The elevated fasting glucose and HbA1c observed in our study supported the presence of substantial glycaemic disturbances in women with GDM. Median total cholesterol was significantly higher in women with GDM [249.12 (234.84–258.40) mg/dL] compared with normal pregnancy [213.01 (210.51–218.35) mg/dL] and healthy controls [168.43 (157.43–177.36) mg/dL], with all original pairwise comparisons showing p<0.001. Koukkou et al. [16], in a study involving 20 women with GDM and 22 normoglycemic pregnant controls, reported no significant difference in total cholesterol between the groups. This contrasted with our findings and suggested possible differences in pregnancy-related lipid alterations across study populations. Mean triglyceride levels were significantly elevated in the GDM group (244.58 ± 17.95 mg/dL) compared with normal pregnancy (176.65 ± 13.21 mg/dL) and healthy controls (120.81 ± 16.95 mg/dL; p<0.001). Koukkou et al. [16] similarly reported higher triglyceride concentrations in women with GDM than in normoglycemic pregnant controls (2.91 vs 2.10 mmol/L). Huhtala et al. (2020) [19], studying 217 women with GDM (110 receiving metformin and 107 receiving insulin), observed increasing triglyceride concentrations during late pregnancy, with a greater increase in the metformin group (p<0.01). These findings supported the pronounced hypertriglyceridaemia observed in our study. Mean HDL-C was significantly lower in women with GDM (41.13 ± 4.80 mg/dL) compared with normal pregnancy (55.18 ± 5.77 mg/dL) and healthy controls (49.41 ± 5.95 mg/dL; p<0.001). In contrast, Koukkou et al. [16] reported no significant difference in HDL-C concentrations between women with GDM and normoglycaemic pregnant controls. The discrepancy may have reflected differences in maternal characteristics, gestational age, and metabolic status. Mean LDL-C was highest in women with GDM (159.94 ± 13.24 mg/dL), followed by normal pregnancy (119.07 ± 11.23 mg/dL) and healthy controls (98.63 ± 9.09 mg/dL; p<0.001). Conversely, Koukkou et al. [16] reported lower LDL-C concentrations in women with GDM (3.08 ± 1.20 mmol/L) than in normoglycaemic pregnant controls (4.01 ± 1.10 mmol/L). These contrasting findings suggested variability in LDL-C alterations associated with GDM. Mean VLDL-C was significantly higher in the GDM group (48.92 ± 3.59 mg/dL) compared with normal pregnancy (35.32 ± 2.64 mg/dL) and healthy controls (24.17 ± 3.40 mg/dL; p<0.001). Huhtala et al. (2020) [19] reported increasing VLDL cholesterol and triglyceride concentrations between approximately 30 and 36 weeks of gestation among women with GDM. They also observed positive associations between baseline VLDL lipid concentrations and neonatal birth weight. These observations were consistent with the elevated VLDL-C concentrations in our GDM group. The HDL-C/LDL-C ratio was significantly reduced in women with GDM (0.26 ± 0.04) compared with normal pregnancy (0.47 ± 0.07) and healthy controls (0.50 ± 0.07; p<0.001). Huhtala et al. (2020) [19] investigated the apolipoprotein B/A-1 ratio and reported associations with neonatal birth weight. Although this was a different lipid ratio, their findings highlighted the potential clinical relevance of lipoprotein balance in GDM. The reduced HDL-C/LDL-C ratio in our study reflected an altered lipid profile among women with GDM.

CONCLUSION

The present study demonstrated significantly elevated glycaemic parameters, total cholesterol, triglycerides, LDL-C, and VLDL-C among women with GDM compared with normal pregnant women and healthy controls. HDL-C levels and the HDL-C/LDL-C ratio were significantly reduced in women with GDM, indicating altered lipid metabolism. These findings highlighted the coexistence of hyperglycaemia and dyslipidaemia in GDM and supported the clinical relevance of metabolic and lipid profile assessment during pregnancy.

LIMITATIONS

The study was limited by its single-centre design and relatively small sample size of 90 participants, which restricted the generalizability of the findings. The lack of adjustment for gestational age, prepregnancy BMI, dietary factors, and treatment status, along with the observational design, limited causal interpretation.

DECLARATION

- **Consent for Publication**: Not applicable.
- **Availability of Data and Materials:** The datasets generated and analysed during the study are available from the corresponding author upon reasonable request, subject to institutional and ethical restrictions.
- **Competing Interests:** The authors declare no competing interests.•
- **Funding:** No external funding was received for this study.
- **Authors' Contributions:** S.S.: Conceptualization, methodology, investigation, sample collection, laboratory

analysis, data analysis, and manuscript drafting. S.K.B.: Research supervision, study design, methodological guidance, interpretation of findings, critical manuscript revision, and final review. Both authors reviewed and approved the final manuscript and agreed to be accountable for their contributions.

- **Acknowledgements:** The authors sincerely acknowledge Shree Guru Gobind Singh Tricentenary University, Gurugram, for providing institutional support and research facilities. The authors also thank all participants for their valuable cooperation.

REFERENCES

1. Leary J, Pettitt DJ, Jovanovic L. Gestational diabetes guidelines in a HAPO world. Best Pract Res Clin Endocrinol Metab. 2010;24(4):673-85.
2. Powe CE, Allard C, Battista MC, Doyon M, Bouchard L, Ecker JL, et al. Heterogeneous contribution of insulin sensitivity and secretion defects to gestational diabetes mellitus. Diabetes Care. 2016;39(6):1052-5.
3. Nolan CJ. Controversies in gestational diabetes. Best Pract Res Clin Obstet Gynaecol. 2011;25(1):37-49.
4. Leary J, Pettitt DJ, Jovanovic L. Gestational diabetes guidelines in a HAPO world. Best Pract Res Clin Endocrinol Metab. 2010;24(4):673-85.
5. Butte NF. Carbohydrate and lipid metabolism in pregnancy: normal compared with gestational diabetes mellitus. Am J Clin Nutr. 2000;71(5 Suppl):1256S-61S.
6. Cibickova L, Schovanek J, Karasek D. Changes in serum lipid levels during pregnancy in women with gestational diabetes. A narrative review. Biomed Pap Med Fac Univ Palacky Olomouc Czech Repub. 2021;165(1):8-12.
7. Knopp RH, Chapman M, Bergelin R, Wahl PW, Warth MR, Irvine S. Relationships of lipoprotein lipids to mild fasting hyperglycemia and diabetes in pregnancy. Diabetes Care. 1980;3(3):416-20.
8. Ryckman KK, Spracklen CN, Smith CJ, Robinson JG, Saftlas AF. Maternal lipid levels during pregnancy and gestational diabetes: a systematic review and meta-analysis. BJOG. 2015;122(5):643-51.
9. Layton J, Powe C, Allard C, Battista MC, Doyon M, Bouchard L, et al. Maternal lipid profile differs by gestational diabetes physiologic subtype. Metabolism. 2019;91:39-42.
10. O'Malley EG, Reynolds CME, Killalea A, O'Kelly R, Sheehan SR, Turner MJ. Maternal obesity and dyslipidemia associated with gestational diabetes mellitus (GDM). Eur J Obstet Gynecol Reprod Biol. 2020;246:67-71.
11. Herrera E, Ortega-Senovilla H. Implications of lipids in neonatal body weight and fat mass in gestational diabetic mothers and non-diabetic controls. Curr Diab Rep. 2018;18(2):7.
12. Sharami SH, Ranjbar ZA, Alizadeh F, Kazemnejad E. The relationship of hyperlipidemia with maternal and neonatal outcomes in pregnancy: a cross-sectional study. Int J Reprod Biomed. 2019;17(10):739-48.
13. Toescu V, Nuttall SL, Martin U, Nightingale P, Kendall MJ, Brydon P, et al. Changes in plasma lipids and markers of oxidative stress in normal pregnancy and pregnancies complicated by diabetes. Clin Sci (Lond). 2004;106(1):93-8.
14. Benhalima K, Devlieger R, Van Assche A. Screening and management of gestational diabetes. Best Pract Res Clin Obstet Gynaecol. 2015;29(3):339-49.
15. Metzer BE International Association of Diabetes and Pregnancy Study Groups Recommendations on the Diagnosis. Classification of Hyperglycemia in Pregnancy. Diabetes Care.
16. Koukkou E, Watts GF, Lowy C. Serum lipid, lipoprotein and apolipoprotein changes in gestational diabetes mellitus: a cross-sectional and prospective study. J Clin Pathol. 1996;49(8):634-7.