

·临床研究·

不同孕期血脂值与妊娠并发症的关系

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摘要:【目的】探讨不同孕期的血脂值及其与妊娠期并发症的关系。【方法】纳入2018年1月至2018年8月期间在中山大学附属第一医院分娩及产检的孕妇1 017例,分析不同孕期血脂水平。使用单因素Logistic回归模型检测妊娠期并发症的影响因素,多因素Logistic回归模型检测不同孕期的血脂水平与妊娠期并发症的发病风险。根据95%参考值范围计算出本院孕期血脂临界值。【结果】孕期血脂水平总体呈升高趋势,升高幅度最显著的是甘油三酯(TG)。年龄、孕前体质指数、血脂水平均与妊娠期并发症相关。在孕中、晚期,随着TG的升高,妊娠期并发症的发病风险升高;随着高密度脂蛋白胆固醇(HDL-c)的增高,妊娠期并发症的发病风险降低。本研究得出本院各孕期血脂临界值如下。孕早期:总胆固醇(TC) < 6.09 mmol/L, TG < 2.39 mmol/L, HDL-c > 1.17 mmol/L, 低密度脂蛋白胆固醇(LDL-c) < 3.61 mmol/L;孕中期:TC < 7.80 mmol/L, TG < 3.51 mmol/L, HDL-c > 1.38 mmol/L, LDL-c < 4.73 mmol/L;孕晚期:TC < 8.50 mmol/L, TG < 5.61 mmol/L, HDL-c > 1.28 mmol/L, LDL-c < 5.25 mmol/L。【结论】孕期血脂值随孕周变化,孕中晚期TG水平升高、HDL-c水平下降与妊娠期并发症风险增加相关。

关键词:孕期血脂;参考值范围;妊娠期并发症

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Maternal Lipid Levels during Pregnancy and Their Relation with Pregnancy Complications

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Abstract:【Objective】To determine the serum lipid levels during different trimesters of pregnancy and investigate their relation with pregnancy complications.【Methods】The study recruited 1 017 pregnant women who were examined and delivered in the First Affiliated Hospital of Sun Yat-sen University between January 2018 and August 2018. Serum lipid levels during different trimesters of pregnancy were reviewed. Univariate and multivariate logistic regression models were used to analyze the risk factors of pregnancy complications and the relation between lipid levels and pregnancy complications. The threshold values of lipid levels during pregnancy were determined based on the 95th percentile.【Results】Total lipid levels during pregnancy increased, with triglyceride (TG) levels increasing the most. Age, pre-pregnancy body mass index (p-BMI) and lipid levels were associated with pregnancy complications. In the second and third trimesters, the increased level of TG and decreased level of high-density lipoprotein cholesterol (HDL-c) were correlated with increased risk of pregnancy complications. The threshold values of lipid levels during pregnancy in our hospital were total cholesterol (TC) < 6.09 mmol/L, TG < 2.39 mmol/L, HDL-c > 1.17 mmol/L and low-density lipoprotein cholesterol (LDL-c) $<$

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3.61 mmol/L in the first trimester; TC<7.80 mmol/L, TG<3.51 mmol/L, HDL-c>1.38 mmol/L and LDL-c<4.73 mmol/L in the second trimester; TC<8.50 mmol/L, TG<5.61 mmol/L, HDL-c>1.28 mmol/L and LDL-c<5.25 mmol/L in the third trimester. 【Conclusions】 Lipid levels vary with the stage of pregnancy. In the second and third trimesters of pregnancy, the increased level of TG and decreased level of HDL-c are associated with increased risk of pregnancy complications.

Key words: maternal lipid levels during pregnancy; reference range; pregnancy complications

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为满足胎儿生长发育的需要,妊娠期母体的代谢会发生一系列生理性变化,如妊娠期间的血脂水平呈生理性升高^[1-2]。然而研究提示,妊娠期孕妇血脂水平的异常升高增加妊娠并发症,包括妊娠期糖尿病(gestational diabetes mellitus, GDM)、妊娠期高血压疾病(hypertensive disorders of pregnancy, HDP)、早产、子痫前期(preeclampsia, PE)和巨大儿等^[3-6]。并增加母亲产后血糖血脂异常风险^[7-9],还可能引起子代的糖代谢紊乱^[10]。然而,有关妊娠期血脂正常值范围、妊娠期血脂异常的诊断与管理研究尚少,国际上尚无共识如何处理。《威廉姆斯产科学(第24版)》^[11]、北京^[12]及我们^[13]分别提出欧美人群、中国北方人群以及中国南方人群妊娠中期的血脂参考值范围。然而血脂随孕期变化及其与妊娠期的并发症关系亦可能不同,本研究旨在对本院妊娠期妇女不同孕期的血脂谱进行分析,并分析各孕期血脂水平与妊娠期并发症的关系,以第5、95百分位数计算本院各孕期血脂临界值,为孕期血脂管理提供依据。

1 材料与方法

1.1 研究对象

本研究共纳入于2018年1月至2018年8月在中山大学附属第一医院进行产检及分娩的妇女1260例。符合以下其中一项者被排除:①孕前明确诊断糖尿病;②患有甲状腺功能亢进症或患有甲状腺功能减退症;③患有慢性肾病或肝功能受损;④患有自身免疫性疾病史、其他严重全身性疾病或慢性消耗性疾病等疾病;⑤多胎妊娠;⑥少血脂检测结果;⑦患有多种妊娠期并发症。最终共有1 017例纳入分析。本研究已通过我院伦理委员会审批(伦审[2020]048号),所有患者知情同意。

1.2 临床资料收集

通过查阅中山大学附属第一医院病历系统收

集入组患者的临床资料,包括年龄、孕前体质量、身高、孕前体质指数(pre-pregnancy body mass index, p-BMI)、经济水平、职业、孕次、产次、既往分娩方式、妊娠不良事件及结局、孕期血脂水平等数据。所有患者的血脂值均在我院生化检验室由专业人员在AEROSET生化仪(雅培公司,美国)上测定。甘油三酯(triglyceride, TG)均采用酶法测定,总胆固醇(total cholesterol, TC)采用胆固醇氧化酶法测定,高密度脂蛋白胆固醇(high-density lipoprotein cholesterol, HDL-c)和低密度脂蛋白胆固醇(low-density lipoprotein cholesterol, LDL-c)均采用匀相测定法测定。计算每4周的平均血脂水平,观察孕期血脂变化。

1.3 妊娠期并发症的诊断标准

GDM诊断标准参照《中国2型糖尿病防治指南(2020年版)》^[14],符合以下任意一条的诊断:空腹血糖 ≥ 5.1 mmol/L; OGTT 1 h血糖 ≥ 10.0 mmol/L; OGTT 2 h血糖 ≥ 8.5 mmol/L。妊娠期高血压疾病(hypertensive disorders of pregnancy, HDP)包含妊娠期高血压、子痫前期-子痫、妊娠合并慢性高血压和慢性高血压伴发子痫前期。参考《妊娠期高血压疾病诊治指南(2020)》^[15],妊娠期高血压定义为:妊娠20周后首次发现的收缩压 ≥ 140 mmHg和(或)舒张压 ≥ 90 mmHg,且尿蛋白检测阴性。子痫前期(pre-eclampsia, PE)定义为:妊娠20周后首次发现的收缩压 ≥ 140 mmHg和(或)舒张压 ≥ 90 mmHg,且伴有以下任一项:①尿蛋白 ≥ 0.3 g/24 h,②尿蛋白/肌酐比值 ≥ 0.3 ,③随机尿蛋白 $\geq (+)$ 。早产的诊断标准为分娩时孕周 < 37 周。巨大儿的诊断标准为新生儿出生后1 h内体质量 $\geq 4 000$ g,并与分娩时孕周无关。

1.4 统计学分析

本研究应用SPSS 24.0进行统计分析。连续性变量使用均数 \pm 标准差表示,使用 t 检验比较两组间的连续性变量差异。分类变量使用频数表示。使

用单因素 Logistic 回归分析妊娠期并发症的影响因素,以 $P < 0.10$ 为有统计学差异,有差异的因素纳入多因素 Logistic 回归分析中。使用多因素 Logistic 回归分析不同孕期血脂水平与妊娠期并发症的关联。以第 5 或 95 百分位数计算本院的血脂临界值。TC、TG、LDL-c 以大于第 95 百分位数为异常, HDL-c 以低于第 5 百分位数为异常。采取双侧检验,以 $P < 0.05$ 为有统计学差异。

2 结果

2.1 入组孕妇的一般情况

本研究纳入 1 260 例孕妇,最终纳入分析的为 1 017 例孕妇。入组孕妇的年龄为 (32.47 ± 4.73) 岁,

孕前 BMI 为 (21.15 ± 2.80) kg/m^2 。其中诊断为 GDM、HDP、子痫前期和早产人数分别为:222 人 (21.2%), 56 人 (5.3%), 31 人 (3.0%) 和 143 人 (13.6%)。分娩巨大儿的有 32 人 (3.2%)。如表 1, 有妊娠并发症的孕妇的年龄、孕前 BMI、肥胖率显著高于没有妊娠并发症的孕妇。

2.2 孕妇不同孕期血脂水平

图 1 展示了妊娠期妇女每 4 周的血脂水平变化。各孕期 TC、TG、HDL-c 和 LDL-c 的平均浓度与第 5、95 百分位数如表 2。随着孕周和孕期的增长,血脂水平总体呈升高趋势,其中变化最显著的是 TG。孕晚期的 TG 水平是孕早期的 2.30 倍。此外,孕晚期 TC、HDL-c 和 LDL-c 的水平分别是孕早期的 1.32、1.05 和 1.37 倍。根据第 5 或 95 百分位数

表 1 孕妇的基线特征
Table 1 Basic characteristics of the pregnant women [$\bar{x} \pm s, n(\%)$]

	Without adverse outcomes ($n=644$)	With adverse outcomes ($n=374$)	t/χ^2	P
Maternal age /year	31.97 \pm 4.64	33.52 \pm 4.75	-5.712	< 0.001
p-BMI/ (kg/m^2)	20.71 \pm 2.60	22.10 \pm 2.96	-7.38	< 0.001
< 18.5	128(19.9)	34(9.1)		
18.5-24	430(66.8)	258(69.0)		
24-28	79(12.3)	65(17.4)		
≥ 28	7(1.0)	17(4.5)		
Gravidity/ times	2.19 \pm 1.16	2.24 \pm 1.26	-1.232	0.087
Parity/ times	1.44 \pm 0.56	1.47 \pm 0.59	-1.886	0.060
Primiparity				
Yes	328(50.9)	205(54.8)	1.487	0.223
No	316(49.1)	169(45.2)		
Previous cesarean delivery	168(53.2)	99(58.6)	1.441	0.230
Economic income/yuan			0.530	0.467
<10 000	120(18.6)	63(16.8)		
$\geq 10 000$	524(81.4)	311(83.2)		
Occupations			6.031	0.197
Intellectuals and technical professionals	138(21.4)	80(21.4)		
Individual household	13(2.0)	7(1.9)		
Civil servants and office staff	420(65.3)	228(61.0)		
Unemployment	11(1.7)	5(1.3)		
Others	62(9.6)	54(14.4)		

p-BMI: pre-pregnancy body mass index. P value indicates a significant difference between the without adverse outcome group and the with adverse outcomes group.

表2 妊娠妇女不同孕期的血脂水平
Table 2 Serum lipids in pregnant women during different trimester

	Trimester	$\bar{x} \pm s$	Percentile	
			5%	95%
TC/ (mmol/L)	First (n=101)	4.84±0.83	3.51	6.09
	Second (n=917)	6.08±1.05	4.40	7.80
	Third (n=843)	6.45±1.24	4.62	8.50
TG/ (mmol/L)	First (n=101)	1.41±0.52	0.74	2.39
	Second (n=917)	2.13±0.80	1.19	3.51
	Third (n=843)	3.20±1.43	1.66	5.61
HDL-c/ (mmol/L)	First (n=101)	1.73±0.33	1.17	2.24
	Second (n=917)	1.93±0.35	1.38	2.54
	Third (n=843)	1.83±0.39	1.28	2.45
LDL-c/ (mmol/L)	First (n=101)	2.72±0.53	1.85	3.61
	Second (n=917)	3.45±0.73	2.32	4.73
	Third (n=843)	3.77±0.84	2.51	5.25

TC: total cholesterol; TG: triglycerides; HDL-C: high-density lipid cholesterol; LDL-C: low-density lipid cholesterol.

建立了血脂临界值,孕早期:TC < 6.09 mmol/L, TG < 2.39 mmol/L, HDL-c >1.17 mmol/L, LDL-c < 3.61 mmol/L;孕中期:TC < 7.80 mmol/L, TG < 3.51 mmol/L, HDL-c >1.38 mmol/L, LDL-c < 4.73 mmol/L;孕晚期:TC<8.50 mmol/L, TG<5.61 mmol/L, HDL-c > 1.28 mmol/L, LDL-c<5.25 mmol/L。

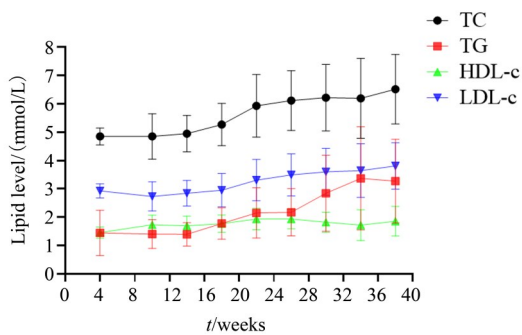


图1 妊娠期间血脂水平的变化曲线

Fig.1 The changing curve of lipids level during pregnancy

2.3 妊娠期并发症的单因素 Logistic 回归分析

单因素 Logistic 回归分析发现年龄、孕前 BMI 是妊娠期并发症的危险因素。孕次、产次、既往剖宫产、经济水平和职业与妊娠期并发症无明显关联。在孕早期,TC、TG 和 LDL-c 水平与妊娠期并发

症的关联具有统计学意义($P < 0.10$)。在孕中期, TG 和 HDL-c 水平是妊娠期并发症的影响因子($P < 0.10$)。而在孕晚期,TC、TG、HDL-c、LDL-c 水平均与妊娠期并发症具有关联性($P < 0.10$;表3)。

2.4 血脂与妊娠并发症

校正年龄和孕前 BMI 后,使用多因素 Logistic 回归分析不同孕期血脂水平与妊娠并发症的关系。结果显示孕早期血脂水平和妊娠并发症无明显相关。孕中期 TG 每升高 1 mmol/L, GDM 和早产的风险分别增加 53.0% 和 36.3% [OR (95%CI) : 1.530 (1.266, 1.850), 1.363 (1.127, 1.649)]。HDL-c 每升高 1mmol/L, HDP、子痫前期和早产的发生风险分别降低 64.6%、78.1%、及 47.6% [OR (95%CI) : 0.354 (0.140, 0.890), 0.219 (0.060, 0.795), 0.524 (0.312, 0.882)](表4)。在孕晚期,我们发现 TG 每升高 1 单位,发生 GDM 和巨大儿的风险就会增加 [OR (95%CI) : 1.150 (1.013, 1.306), 1.225 (1.027, 1.460)],而 HDL-c 的升高使早产的发生风险降低 [OR (95%CI) : 0.462 (0.239, 0.892)](表5)。本研究未发现 TC 和 LDL-c 水平与妊娠并发症的发生风险相关。

表3 妊娠并发症的单因素Logistic回归分析
Table 3 Univariate logistic regression analysis of adverse pregnancy outcomes

Factors	<i>b</i>	<i>S_b</i>	Wald χ^2	<i>P</i>	\overline{OR}	OR 95%CI
Maternal age	0.080	0.014	31.12	< 0.001	1.083	(1.053, 1.114)
p-BMI	0.165	0.025	44.96	< 0.001	1.180	(1.124, 1.238)
Gravidity	0.091	0.066	1.890	0.169	1.094	(0.962, 1.246)
Parity	0.181	0.149	1.484	0.223	1.198	(0.896, 1.604)
Previous cesarean delivery	0.363	0.225	2.595	0.107	1.438	(0.924, 2.236)
Economic income	-0.072	0.171	0.177	0.674	0.931	(0.666, 1.301)
Occupations						
Intellectuals and technical professionals	—	—	4.356	0.360	—	—
Individual household	-0.183	0.294	0.386	0.534	0.833	(0.468, 1.482)
Civil servants and office staff	0.033	0.701	0.002	0.963	1.033	(0.261, 4.081)
Unemployment	0.592	0.554	1.142	0.285	1.808	(0.610, 5.355)
Others	0.491	0.309	2.518	0.113	1.633	(0.891, 2.992)
First trimester						
TC	0.548	0.248	4.883	0.027	1.730	(1.064, 2.813)
TG	0.958	0.419	5.219	0.022	2.606	(1.146, 5.924)
HDL-c	-0.118	0.590	0.040	0.842	0.889	(0.280, 2.286)
LDL-c	0.842	0.384	4.803	0.028	2.321	(1.093, 4.927)
Second trimester						
TC	-0.040	0.063	0.403	0.526	0.961	(0.850, 1.086)
TG	0.562	0.091	37.893	< 0.001	1.755	(1.467, 2.099)
HDL-c	-0.602	0.195	9.561	0.002	0.548	(0.374, 0.803)
LDL-c	0.037	0.090	0.168	0.682	1.038	(0.870, 1.238)
Third trimester						
TC	-0.140	0.056	6.284	0.012	0.869	(0.779, 0.970)
TG	0.178	0.049	12.908	< 0.001	1.194	(1.084, 1.316)
HDL-c	-0.309	0.175	3.126	0.077	0.734	(0.521, 1.034)
LDL-c	-0.208	0.083	6.267	0.012	0.812	(0.690, 0.956)

OR: odds ratio; CI: confidence interval; GDM: gestational diabetes mellitus; HDP: hypertensive disorders of pregnancy; PE: preeclampsia; TC: total cholesterol; TG: triglycerides; HDL-C: high-density lipid cholesterol; LDL-C: low-density lipid cholesterol. The model was established by univariate logistic regression.

3 讨论

本研究分析了本院孕妇的全孕期血脂谱,探讨了各孕期血脂水平与妊娠期并发症的关系及其临界值。结果发现,孕期血脂水平总体呈升高趋势,其中TG的升高幅度最显著,TC、HDL-c、LDL-c升高幅度较小。孕早期血脂与妊娠期并发症无明显相关,而孕中晚期,随着TG水平的升高和HDL-C

水平的降低,不良妊娠结局的发生风险显著上升。由于95%参考值范围是一种通用的医学参考值范围计算方法^[16],根据第5和95百分位数,本研究得到孕期血脂临界值分别为:早期,TC < 6.09 mmol/L、TG < 2.39 mmol/L、HDL-c > 1.17 mmol/L、LDL-c < 3.61 mmol/L;中期,TC < 7.80 mmol/L、TG < 3.51 mmol/L、HDL-c > 1.38 mmol/L、LDL-c < 4.73 mmol/L;晚期,TC <

表4 孕中期妊娠并发症的多因素 Logistic 回归分析

Table 4 Multiple logistic regression analysis of adverse pregnancy outcomes in the second trimester of pregnancy

Outcomes	Factors	<i>b</i>	<i>S_b</i>	Wald χ^2	<i>P</i>	\overline{OR}	OR 95%CI
GDM	Intercept	-8.036	1.007	63.737	< 0.001	—	—
	Maternal age	0.066	0.018	13.557	< 0.001	1.068	(1.031, 1.106)
	p-BMI	0.165	0.029	32.374	< 0.001	1.180	(1.114, 1.248)
	TG	0.425	0.097	19.288	< 0.001	1.530	(1.266, 1.850)
	HDL-c	0.058	0.240	0.058	0.809	1.060	(0.662, 1.697)
HDP	Intercept	-5.458	1.754	9.680	0.002	—	—
	Maternal age	0.054	0.033	2.759	0.097	1.056	(0.990, 1.125)
	p-BMI	0.118	0.048	5.954	0.015	1.125	(1.023, 1.237)
	TG	0.042	0.155	0.072	0.789	1.042	(0.769, 1.412)
	HDL-c	-1.040	0.471	4.870	0.027	0.354	(0.140, 0.890)
PE	Intercept	-3.692	2.381	2.405	0.121	—	—
	Maternal age	0.084	0.044	3.612	0.057	1.087	(0.997, 1.185)
	p-BMI	-0.014	0.072	0.040	0.841	0.986	(0.856, 1.135)
	TG	0.179	0.175	1.051	0.305	1.196	(0.849, 1.684)
	HDL-c	-1.519	0.658	5.331	0.021	0.219	(0.060, 0.795)
Preterm birth	Intercept	-3.091	1.050	8.662	0.003	—	—
	Maternal age	0.028	0.020	1.980	0.159	1.028	(0.989, 1.069)
	p-BMI	0.031	0.032	0.924	0.336	1.031	(0.969, 1.098)
	TG	0.310	0.097	10.198	0.001	1.363	(1.127, 1.649)
	HDL-c	-0.645	0.265	5.924	0.015	0.524	(0.312, 0.882)
Macrosomia	Intercept	-8.175	2.173	14.148	< 0.001	—	—
	Maternal age	-0.080	0.043	3.526	0.060	0.923	(0.849, 1.004)
	p-BMI	0.223	0.059	14.459	< 0.001	1.250	(1.114, 1.402)
	TG	0.162	0.209	0.601	0.438	1.176	(0.780, 1.773)
	HDL-c	1.051	0.539	3.804	0.051	2.860	(0.995, 8.223)

b: standardized regression coefficients; *S_b*: standard error; 95% CI: 95% confidence intervals; TG: triglycerides; HDL-C: high-density lipid cholesterol; GDM: gestational diabetes mellitus; HDP: hypertensive disorders of pregnancy; PE: preeclampsia; The model was established by multiple logistic regression.

8.50 mmol/L、TG<5.61mmol/L、HDL-c>1.28mmol/L、LDL-c<5.25mmol/L。

与 Zheng 等^[5] 在中国北方地区人群的研究相似,本研究发现随着孕期的升高,孕妇的血脂水平也逐渐升高,其中 TG 的升高幅度最大。与本人群的发现不同的是,该研究发现孕早期 TG 水平与巨大儿的发生相关,这与本人群的发现不同。这可能由于本样本人群主要来源于南方地区,巨大儿发病率较低^[17],以及本研究孕早期的血脂检测率较低有关,需要更大样本研究进行验证。

与既往研究的发现一致^[18-20],本研究中在孕中期,随着 TG 水平的升高,发生 GDM 和早产的风险升高;随着 HDL-c 水平的升高,发生 HDP、子痫前期和早产的风险降低。在孕晚期,随着 TG 水平进一步升高,发生 GDM 和巨大儿的风险进一步升高;而随着 HDL-c 水平的升高,发生早产的风险降低。显示孕中晚期的 TG 与 HDL 水平对妊娠期并发症的发生有重要影响。

多项研究发现^[4, 21-23],孕期 TG 水平是 GDM 的预测因子,与 GDM 的发生具有紧密关联,本课题组

表5 孕晚期妊娠并发症的多因素 Logistic 回归分析

Table 5 Multiple logistic regression analysis of adverse pregnancy outcomes in the third trimester of pregnancy

Outcomes	Factors	<i>b</i>	<i>S_b</i>	Wald χ^2	<i>P</i>	\overline{OR}	OR 95%CI
GDM	Intercept	-7.177	1.018	49.746	< 0.001	—	—
	Maternal age	0.064	0.019	11.628	0.001	1.066	(1.028, 1.106)
	p-BMI	0.183	0.031	34.086	< 0.001	1.200	(1.129, 1.276)
	TC	0.050	0.216	0.053	0.817	1.051	(0.688, 1.606)
	TG	0.140	0.065	4.694	0.030	1.150	(1.013, 1.306)
	HDL-c	-0.050	0.179	0.079	0.779	0.951	(0.670, 1.350)
	LDL-c	-0.227	0.309	0.538	0.463	0.797	(0.435, 1.461)
HDP	Intercept	-6.683	1.567	18.197	< 0.001	—	—
	Maternal age	0.024	0.030	0.641	0.423	1.024	(0.966, 1.087)
	p-BMI	0.200	0.045	19.253	< 0.001	1.221	(1.117, 1.335)
	TC	-0.635	0.375	2.866	0.090	0.530	(0.254, 1.105)
	TG	-0.058	0.122	0.229	0.633	0.944	(0.744, 1.197)
	HDL-c	0.155	0.174	0.794	0.373	1.168	(0.830, 1.642)
	LDL-c	0.743	0.549	1.834	0.176	2.102	(0.717, 6.161)
PE	Intercept	-3.264	2.043	2.554	0.110	—	—
	Maternal age	0.012	0.038	0.102	0.749	1.012	(0.939, 1.092)
	p-BMI	0.083	0.061	1.858	0.173	1.086	(0.964, 1.224)
	TC	0.236	0.697	0.115	0.735	1.267	(0.323, 4.966)
	TG	-0.221	0.186	1.416	0.234	0.801	(0.556, 1.154)
	HDL-c	-1.703	0.881	3.737	0.053	0.182	(0.032, 1.024)
	LDL-c	0.013	0.890	< 0.001	0.988	1.013	(0.177, 5.801)
Preterm birth	Intercept	-2.464	1.173	4.415	0.036	—	—
	Maternal age	0.028	0.020	1.982	0.159	1.028	(0.989, 1.069)
	p-BMI	0.012	0.034	0.118	0.731	1.012	(0.947, 1.081)
	TC	0.009	0.094	0.009	0.925	1.009	(0.840, 1.212)
	TG	0.002	0.065	0.001	0.981	1.002	(0.882, 1.137)
	HDL-c	-0.773	0.336	5.282	0.022	0.462	(0.239, 0.892)
	LDL-c	0.102	0.122	0.694	0.405	1.107	(0.872, 1.406)
Macrosomia	Intercept	-4.129	2.467	2.801	0.094	—	—
	Maternal age	-0.121	0.053	5.297	0.021	0.886	(0.799, 0.982)
	p-BMI	0.155	0.071	4.813	0.028	1.167	(1.017, 1.340)
	TC	-0.171	0.467	0.134	0.714	0.843	(0.337, 2.106)
	TG	0.203	0.090	5.100	0.024	1.225	(1.027, 1.460)
	HDL-c	0.202	0.272	0.549	0.459	1.223	(0.717, 2.086)
	LDL-c	-0.155	0.284	0.297	0.586	0.857	(0.491, 1.494)

b: standardized regression coefficients; *S_b*: standard error; 95% CI: 95% confidence intervals; TC: total cholesterol; TG: triglycerides; HDL-C: high-density lipid cholesterol; LDL-C: low-density lipid cholesterol; GDM: gestational diabetes mellitus; HDP: hypertensive disorders of pregnancy; PE: preeclampsia; The model was established by multiple logistic regression.

和Lai等^[7,24]均发现孕期TG水平还与产后代谢状态相关。Sulaiman等^[25]提出,HDL-c对妊娠期母体的血管内皮具有积极的保护作用。此外,TG/HDL-c是评估胰岛素抵抗常用的替代指标^[26-27],而胰岛素抵抗会引起GDM发病,并且引起早产、剖宫产率、巨大儿等不良妊娠结局的增加^[28]。同时,TG/HDL-c还与巨大儿、大于胎龄儿、胎儿窘迫等不良妊娠结局的发生相关^[18,21]。因此,孕中晚期更应关注TG和HDL-c的水平变化,加强对孕妇的生活方式干预,以减少不良妊娠结局的发生。

综上所述,本研究发现孕期血脂水平总体呈升高趋势。孕中期和孕晚期的TG水平升高、HDL-c水平降低会增加妊娠并发症的发生风险。本研

究结果提示应建立孕期特异的血脂参考值范围,本研究建议的不同孕期血脂临界值如下:早期,TC < 6.09 mmol/L、TG < 2.39 mmol/L、HDL-c > 1.17 mmol/L、LDL-c < 3.61 mmol/L;中期,TC < 7.80 mmol/L、TG < 3.51 mmol/L、HDL-c > 1.38 mmol/L、LDL-c < 4.73 mmol/L;晚期,TC < 8.50 mmol/L、TG < 5.61 mmol/L、HDL-c > 1.28 mmol/L、LDL-c < 5.25 mmol/L。本研究结果对妊娠期妇女的血脂管理提供有益参考数据,但本研究为单中心的回顾性研究,研究样本量偏小,尤其孕早期的数据量较小,并且未能追踪同一孕妇的孕期血脂值。因此,本研究结果需在后续前瞻性的多中心、大样本量研究中进一步验证。

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