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血清IGF-1、IGFBP-3水平对妊娠期糖尿病初产妇不良妊娠结局的评估价值

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[摘 要] **目的：**探讨血清胰岛素样生长因子1(insulin-like growth factor-1，IGF-1)、胰岛素样生长因子结合蛋白3(insulin-like growth factor-binding protein-3，IGFBP-3)对妊娠期糖尿病(gestational diabetes mellitus，GDM)初产妇不良妊娠结局的评估价值。**方法：**选取GDM初产妇160例(GDM组)与健康孕产妇54例(对照组)，均于孕晚期检测血清IGF-1、IGFBP-3水平，对比2组IGF-1、IGFBP-3水平差异；分析IGF-1、IGFBP-3水平与GDM血糖控制状况(分为控制不良组与控制良好组)及妊娠结局(分为不良妊娠结局组与良好妊娠结局组)的关系，并应用受试者操作特征(receiver operating characteristic，ROC)曲线评价IGF-1、IGFBP-3及其联合对不良妊娠结局的预测效能。**结果：**相比对照组，GDM组孕晚期血清IGF-1水平显著降低(P<0.05)，IGFBP-3水平显著增高(P<0.05)。相比控制良好组，控制不良组IGF-1水平显著降低(P<0.05)，IGFBP-3水平显著增高(P<0.05)。相比良好妊娠结局组，不良妊娠结局组糖化血红蛋白(glycosylated hemoglobin，HbA1c)、IGFBP-3水平均显著增高(均P<0.05)，IGF-1水平显著降低(P<0.05)。Logistic回归分析显示：血清IGF-1、IGFBP-3是GDM初产妇出现不良妊娠结局的独立影响因素(均P<0.05)。ROC曲线分析显示：IGF-1预测GDM不良妊娠结局的曲线下面积(area under the curve，AUC)为0.732(95% CI：0.656~0.799)，IGFBP-3的AUC为0.648(95% CI：0.568~0.722)，二者差异无统计学意义(Z=1.251，P=0.165)；二者联合的AUC为0.771(95% CI：0.698~0.833)，优于单独使用IGF-1、IGFBP-3(Z=2.314、2.725，P=0.013、0.006)。**结论：**血清IGF-1、IGFBP-3与GDM初产妇不良妊娠结局有关，二者联合检测可提高对不良妊娠结局的预测价值。

[关键词] 妊娠期糖尿病；妊娠结局；胰岛素样生长因子1；胰岛素样生长因子结合蛋白3

Evaluation value of serum IGF-1 and IGFBP-3 levels on adverse pregnancy outcomes in primipara with gestational diabetes mellitus

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ABSTRACT **Objective:** To investigate the predictive value of serum insulin-like growth factor-1 (IGF-1)

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and insulin-like growth factor-binding protein-3 (IGFBP-3) on adverse pregnancy outcomes of primipara with gestational diabetes mellitus (GDM).

Methods: A total of 160 primiparous women with GDM (GDM group) and 54 healthy pregnant women (control group) were selected. The serum levels of IGF-1 and IGFBP-3 were measured at late pregnancy and compared between the 2 groups. The relationship between the levels of IGF-1 and IGFBP-3, blood glucose control (divided into a group with good blood glucose control and a group with poor blood glucose control) and pregnancy outcomes (divided into a good pregnancy outcome group and a adverse pregnancy outcome group) in GDM was analyzed. The receiver operating characteristic (ROC) curve was used to evaluate the predictive effect of IGF-1, IGFBP-3, and their combination on adverse pregnancy outcomes.

Results: Compared with the control group, the serum IGF-1 level in the GDM group at late pregnancy was significantly decreased (P<0.05), and the IGFBP-3 level was significantly increased (P<0.05). Compared with the group with good blood glucose control, the IGF-1 level in the group with poor blood glucose control was significantly decreased (P<0.05), and the IGFBP-3 level was significantly increased (P<0.05). Compared with the good pregnancy outcome group, the levels of glycosylated hemoglobin (HbA1c) and IGFBP-3 in the adverse pregnancy outcome group were significantly increased (both P<0.05) and the level of IGF-1 was significantly decreased (P<0.05). Logistic regression analysis showed that serum IGF-1 and IGFBP-3 were independent factors affecting adverse pregnancy outcomes in GDM primiparas (both P<0.05). ROC curve analysis showed that the area under the curve (AUC) of IGF-1 in predicting adverse pregnancy outcomes of GDM was 0.732 (95% CI 0.656 to 0.799), and the AUC of IGFBP-3 was 0.648 (95% CI 0.568 to 0.722). There was no significant difference between the 2 groups (Z=1.251, P=0.165). The AUC of the combination was 0.771 (95% CI 0.698 to 0.833), which was better than that of single IGF-1 or IGFBP-3 (Z=2.314, 2.725; P=0.013, 0.006).

Conclusion: Serum levels of IGF-1 and IGFBP-3 are associated with adverse pregnancy outcomes in GDM primipara, and the combined detection of them can improve the predictive value of adverse pregnancy outcomes.

KEY WORDS gestational diabetes mellitus; pregnancy outcome; insulin-like growth factor-1; insulin-like growth factor-binding protein-3

妊娠期糖尿病(gestational diabetes mellitus，GDM)是妊娠期常见并发症之一，是指妊娠期间首次发生或发现糖耐量异常[1]。研究[2-3]表明GDM的发生可增加流产、早产、新生儿低血糖、胎儿畸形、死胎等不良妊娠结局风险，严重威胁母婴安全。故早期识别和预防GDM对于改善孕产妇妊娠结局有着重要意义。GDM的发病机制至今仍未完全阐明，其中胰岛素抵抗与肥胖是主要因素。胰岛素样生长因子1(insulin-like growth factor-1，IGF-1)是一种多功能细胞因子，对细胞增殖、分化和能量代谢以及脂肪代谢有着重要调控作用[4]。胰岛素样生长因子结合蛋白3(insulin-like growth factor-binding protein-3，IGFBP-3)是机体细胞分化、生长的重要调节因子，在糖脂代谢中起关键作用，参与GDM的发病[5]。目前，关于IGF-1、IGFBP-3与GDM的关系已有报道[6]，但关于IGF-1、IGFBP-3与GDM不良妊娠结局的关系较少研究涉及。为此，本研究通过对GDM孕产妇血清IGF-1、IGFBP-3水平进行检测，

探讨它们对不良妊娠结局的预测价值。

1 对象与方法

1.1 对象

选取2019年3月至2022年3月就诊于池州市人民医院的160例GDM孕产妇(GDM组)，年龄22~40(27.89±4.37)岁，孕周37~40(39.26±1.39)，体重指数22~31(26.84±3.57) kg/m^2。纳入标准：1)符合GDM诊断标准[7]；2)初产妇、单胎妊娠；3)临床资料完整。排除标准：1)孕前患1型或2型糖尿病；2)多胎妊娠；3)有其他妊娠合并症如妊娠期高血压、心脏病；4)严重精神异常；5)不愿意配合检查。另选取同期在池州市人民医院接受产前检查并分娩的54例健康孕妇(对照组)，年龄22~39(28.11±3.98)岁，孕周37~40(39.11±1.25)，体重指数22~30(26.39±3.24) kg/m^2，均无妊娠合并症，智力正常，自愿配合研究。2组孕周、年龄、体重指数等方面的差异均无统计学意义(均P>0.05)。本研究通过池州市人民医院医学伦理委员会审批(审批号：医伦[A2022023]号)。

1.2 GDM诊断标准

孕妇于妊娠24~28周进行75 g葡萄糖耐量试验：空腹血糖≥5.1 mmol/L、服糖后1 h血糖≥10.0 mmol/L、2 h血糖≥8.5 mmol/L，满足以上任何一项条件即可诊断为GDM。确诊的GDM患者，予以饮食和运动管理。血糖控制目标：餐前血糖不超过5.3 mmol/L，餐后2 h血糖不超过6.7 mmol/L，若饮食及运动管理仍未获得良好血糖控制，则予以胰岛素进行降糖干预。参照2018年美国糖尿病协会指南[8]，根据血糖控制情况，以糖化血红蛋白(glycosylated hemoglobin，HbA1c)水平将GDM孕妇分为控制不良组(HbA1c≥7.0%)与控制良好组(HbA1c<7.0%)。

1.3 标本采集与测定

于孕晚期(32~40周)产前检查时，采集孕妇外周静脉血3 mL，离心(3 000 r/min，10 min)分离血清，将血清标本放置于−80 ℃环境保存待测，采用化学发光法进行IGF-1、IGFBP-3的测定，试剂盒均为英国西门子医学诊断产品有限公司产品，检测操作严格按试剂盒说明书进行。此外，采用乳胶聚集反应法检测HbA1c水平。

1.4 不良妊娠结局的定义及分组

孕产妇均随访至分娩结束。出现产妇产后出血、羊水过多、产妇感染及新生儿窒息、新生儿呼吸窘迫、巨大儿、围产儿死亡等判定为不良妊娠结局；而产妇生产顺利，未发生不良事件，则判定妊娠结局良好。根据GDM产妇是否发生不良妊娠结局分为不良妊娠结局组(n=56)和良好妊娠结局组(n=104)。

1.5 统计学处理

应用SPSS 26.0统计软件进行数据处理。计量资料(IGF-1、IGFBP-3等均满足正态分布)采用均数±标准差($\bar{x}\pm s$)进行描述，组间差异分析用成组t检验；计数资料用例(%)进行描述，组间差异分析用χ^2检验；根据GDM初产妇妊娠结局分类应用logistic回归模型对IGF-1、IGFBP-3进行多因素分析；并采用受试者操作特征(receiver operating characteristic，ROC)曲线对IGF-1、IGFBP-3及其联合预测不良妊娠结局的诊断效能进行评价，并根据约登指数确定最佳诊断阈值，曲线下面积(area under the curve，AUC)的比较用秩和检验；以Hosmer-Lemeshow拟合优度检验分析指标对不良妊娠结局的预测能力。以α=0.05作为检验水准，P<0.05为差异有统计学意义。

2 结 果

2.1 GDM组与对照组孕晚期血清IGF-1、IGFBP-3水平比较

相比对照组，GDM组孕晚期血清IGF-1水平显著降低(P<0.05)，IGFBP-3水平显著增高(P<0.05，表1)。

2.2 不同血糖控制效果GDM孕妇血清IGF-1、IGFBP-3水平比较

相比控制良好组，控制不良组IGF-1水平显著降低(P<0.05)，IGFBP-3水平显著增高(P<0.05，表2)。

2.3 GDM不同妊娠结局组孕妇临床资料比较

相比良好妊娠结局组，不良妊娠结局组HbA1c、IGFBP-3水平均显著增高(均P<0.05)，IGF-1水平显著降低(P<0.05)；2组年龄、孕周、体重指数比较差异均无统计学意义(均P>0.05，表3)。

2.4 GDM孕产妇不良妊娠结局的多因素logistic回归分析

以妊娠结局为因变量，将表3单因素分析中存在统计学意义(P<0.05)的因素作为变量进行logistic回归分析，结果显示血清IGF-1、IGFBP-3是GDM初产妇出现不良妊娠结局的独立影响因素(均P<0.05，表4)。

表1　GDM组与对照组孕晚期血清IGF-1、IGFBP-3水平比较($\bar{x}\pm s$)

Table 1　Comparison of serum IGF-1 and IGFBP-3 levels in late pregnancy between the GDM group and the control group ($\bar{x}\pm s$)

组别	*n*	IGF-1/(ng·mL^{-1})	IGFBP-3/(ng·mL^{-1})
GDM组	160	291.36±71.29	4 125.58±894.55
对照组	54	390.58±86.87	3 674.62±713.84
t		8.352	3.359
P		<0.001	0.001

GDM：妊娠期糖尿病；IGF-1：胰岛素样生长因子1；IGFBP-3：胰岛素样生长因子结合蛋白3。

表2　不同血糖控制效果GDM孕妇血清IGF-1、IGFBP-3水平比较($\bar{x}\pm s$)

Table 2　Comparison of serum IGF-1 and IGFBP-3 levels in GDM pregnant women with different blood glucose control effects ($\bar{x}\pm s$)

血糖控制效果	*n*	IGF-1/(ng·mL^{-1})	IGFBP-3/(ng·mL^{-1})
控制不良	66	271.55±67.59	4 389.41±805.42
控制良好	94	305.27±65.71	3 940.34±836.72
t		3.158	3.394
P		0.002	0.001

GDM：妊娠期糖尿病；IGF-1：胰岛素样生长因子1；IGFBP-3：胰岛素样生长因子结合蛋白3。

2.5 血清IGF-1、IGFBP-3对不良妊娠结局的预测效能

ROC曲线分析显示：IGF-1预测GDM不良妊娠结局的AUC为0.732，IGFBP-3的AUC为0.648，二者差异无统计学意义(Z=1.251，P=0.165)；二者联合的AUC为0.771，优于单独使用IGF-1、IGFBP-3(Z=2.314、2.725，P=0.013、0.006；表5，图1)。Hosmer-Lemeshow拟合优度检验显示，IGF-1联合IGFBP-3对不良妊娠结局有良好预测能力(χ^2=12.511，P=0.125)。

表3　不良妊娠结局组与良好妊娠结局组临床资料比较($\bar{x}\pm s$)

Table 3　Comparison of clinical data between the adverse pregnancy outcome group and the good pregnancy outcome group ($\bar{x}\pm s$)

组别	*n*	年龄/岁	孕周	体重指数/(kg·m^{-2})	HbA1c/%	IGF-1/(ng·mL^{-1})	IGFBP-3/(ng·mL^{-1})
不良妊娠结局组	56	28.31±4.12	39.12±1.25	27.11±3.49	5.92±1.15	267.26±68.49	4 468.61±816.87
良好妊娠结局组	104	27.66±4.25	39.34±1.47	26.69±3.38	5.41±0.89	304.33±65.79	3 940.87±835.67
t		0.933	0.950	0.741	3.113	3.351	3.840
P		0.353	0.344	0.460	0.002	0.001	<0.001

HbA1c：糖化血红蛋白；IGF-1：胰岛素样生长因子1；IGFBP-3：胰岛素样生长因子结合蛋白3。

表4　GDM孕产妇不良妊娠结局的多因素logistic回归分析结果

Table 4　Multivariate logistic regression analysis results of adverse pregnancy outcomes of GDM pregnant women

变量	β	*SE*	Wald χ^2	*P*	OR	95% CI
HbA1c	0.289	0.243	1.414	0.235	1.335	0.829~2.150
IGF-1	−0.512	0.178	8.274	0.004	0.599	0.423~0.849
IGFBP-3	0.681	0.241	7.895	0.005	1.976	1.232~3.169

GDM：妊娠期糖尿病；HbA1c：糖化血红蛋白；IGF-1：胰岛素样生长因子1；IGFBP-3：胰岛素样生长因子结合蛋白3。

表5 血清IGF-1、IGFBP-3预测GDM不良妊娠结局的ROC曲线分析结果

Table 5 ROC curve analysis results of serum IGF-1 and IGFBP-3 in predicting adverse pregnancy outcomes of GDM

指标	截断值	AUC	95% CI	*P*	敏感度/%	特异度/%
IGF-1	<303.26*	0.732	0.656~0.799	<0.001	82.1	51.9
IGFBP-3	>4 317.15*	0.648	0.568~0.722	<0.001	60.7	72.1
IGF-1+IGFBP-3	—	0.771	0.698~0.833	<0.001	76.8	69.2

*单位为ng/mL。IGF-1：胰岛素样生长因子1；IGFBP-3：胰岛素样生长因子结合蛋白3；GDM：妊娠期糖尿病；ROC：受试者操作特征；AUC：曲线下面积。

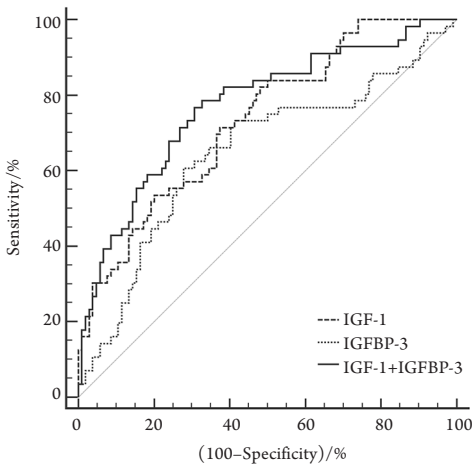

图1 血清IGF-1、IGFBP-3预测GDM不良妊娠结局的ROC曲线

Figure 1 ROC curve of serum IGF-1 and IGFBP-3 in predicting adverse pregnancy outcome of GDM

IGF-1: Insulin-like growth factor-1; IGFBP-3: Insulin-like growth factor-binding protein-3; GDM: Gestational diabetes mellitus; ROC: Receiver operating characteristic.

3 讨 论

GDM为妊娠常见并发症之一，随着我国生育政策的调整及晚孕群体的增加，我国GDM发病率逐年上升[9]。孕期高血糖不但会导致孕妇宫内感染、生殖道感染等风险增高，还不利于胎儿生长发育，进入胎儿体内的葡萄糖增多，会诱导脂肪和蛋白质合成，易导致巨大儿[10]。高血糖状态还可引发羊水过多、自然流产以及新生儿低血糖等不良妊娠结局[11]。GDM孕产妇即便通过干预将血糖控制于正常水平，其不良妊娠结局相比健康孕妇仍显著增高[12]。早期识别高危人群对于改善GDM孕妇的妊娠结局有着重要意义，因此寻找能够预测GDM不良妊娠结局的指标成为临床研究的热点。本研究结果表明：血清IGF-1、IGFBP-3与GDM初产妇不良妊娠结局相关，是预测不良妊娠结局的独立因子。

IGF-1是一种有着胰岛素样生物活性的碱性多肽，在肝、胎盘组织中均可合成，对于物质代谢、细胞增殖和分化及个体生长和发育均有调节作用。研究[13]发现：IGF-1可通过其胰岛素效应，调节机体的物质代谢，促进糖、蛋白质合成，抑制其分解，从而使得血糖水平降低；并可与胰岛素受体结合，改善胰岛素敏感性，从而改善妊娠期间因激素水平增高所致的生理性胰岛素抵抗，对于维持正常妊娠血糖水平和胎儿的生长发育有着至关重要的作用。IGF-1合成减少，对胰岛素分泌产生的负反馈调节作用减弱，使得胰岛素分泌增多，加重胰岛素抵抗，进而促进GDM的发生和发展[14]。IGFBP-3是参与IGF-1储存和转运的一种重要分泌蛋白，约90%的IGF-1与IGFBP-3相结合存在于血清中以防止被降解，使得生物活性受影响[15]。此外，IGFBP-3还可以不依赖于IGFs的方式对个体的生长、发育发挥调节作用[16]。本研究结果显示：GDM孕妇血清IGF-1、IGFBP-3水平均显著高于健康孕妇，且相比血糖控制良好组，血糖控制不良组IGF-1降低，IGFBP-3升高，说明IGF-1、IGFBP-3与GDM发病相关，且与血糖控制程度关联，与既往文献[6]报道相符。

IGF-1及IGFBP-3在GDM中的作用日益受到关注，但目前关于它们与GDM不良妊娠结局的关系文献报道较少。研究[17]表明IGF-1与多囊卵巢综合征患者的妊娠结局相关，可作为预测不良妊娠结局的指标。IGF-1可影响免疫炎症，减轻β细胞损伤，改善胰岛素抵抗，是糖尿病的保护因子[18]。在对GDM患者的研究[19]中发现，母血IGFBP-3水平与胎儿宫内发育紧密关联。本研究结果显示：IGF-1<303.26 ng/mL时，IGF-1预测GDM不良妊娠结局的敏感度为82.1%，特异度为51.9%；IGFBP-3>4 317.15 ng/mL时，IGFBP-3预测的敏感度为60.7%，特异度为72.1%；二者AUC比较，差异无统计学意义。这表明IGF-1、IGFBP-3对GDM

不良妊娠结局有较高预测价值，但其具体机制仍有待深入研究。

本研究还显示：IGF-1、IGFBP-3联合预测的AUC为0.771，优于单独使用IGF-1、IGFBP-3，结合Hosmer-Lemeshow拟合优度检验发现，IGF-1联合IGFBP-3对不良妊娠结局有着良好的预测能力。这表明IGF-1、IGFBP-3联合检测可提高对GDM不良妊娠结局的预测效能。本研究存在局限性：1)样本量较小，难免存在统计偏差，关于其结论仍有待大样本量研究进一步验证；2)仅观察GDM孕晚期血清IGF-1、IGFBP-3的水平，未分析IGF-1、IGFBP-3随着孕周的变化情况，这有待未来完善。

综上，血清IGF-1、IGFBP-3是GDM初产妇不良妊娠结局的独立因素，均对不良妊娠结局有较高预测价值，其联合检测可提高预测效能。

利益冲突声明：作者声称无任何利益冲突。

参考文献

[1] McIntyre HD, Catalano P, Zhang C, et al. Gestational diabetes mellitus[J]. Nat Rev Dis Primers, 2019, 5(1): 47. https://doi.org/10.1038/s41572-019-0098-8.

[2] Li K, Li X, Morse AN, et al. Residual risk associations between initial hyperglycemia and adverse pregnancy outcomes in a large cohort including 6709 women with gestational diabetes[J]. Diabetes Metab, 2022, 48(1): 101320. https://doi.org/10.1016/j.diabet.2022.101320.

[3] 王雪影, 周莉. 妊娠期糖尿病患者孕前体重指数及孕期体重增加量与妊娠结局及产科并发症关系研究[J]. 中国实用妇科与产科杂志, 2020, 36(8): 757-761. https://doi.org/10.19538/j.fk2020080119.
WANG Xueying, ZHOU Li. Relationship of pre-pregnancy body mass index and gestational weight gain with obstetric complications and pregnancy outcome in patients with gestational diabetes mellitus[J]. Chinese Journal of Practical Gynecology and Obstetrics, 2020, 36(8): 757-761. https://doi.org/10.19538/j.fk2020080119.

[4] 李博文, 冯丽丽, 田振军. 胰岛素样生长因子-1与代谢性疾病及运动干预的研究进展[J]. 生理学报, 2021,73(2): 342-352. https://doi.org/10.13294/j.aps.2021.0014.
LI Bowen, FENG Lili, TIAN Zhenjun. Research progress of the role of IGF-1 in metabolic diseases and the effect of exercise intervention[J]. Acta Physiologica Sinica, 2021, 73(2): 342-352. https://doi.org/10.13294/j.aps.2021.0014.

[5] Gęca T, Kwaśniewska A. The influence of gestational diabetes mellitus upon the selected parameters of the maternal and fetal system of insulin-like growth factors (IGF-1, IGF-2, IGFBP1-3)-a review and a clinical study[J]. J Clin Med, 2020, 9(10): 3256. https://doi.org/10.3390/jcm9103256.

[6] 毛邱娴, 尹春艳. IGF-1/IGFBP-1与妊娠期糖尿病的相关性[J]. 中国妇幼保健, 2012, 27(3): 442-443.
MAO Qiuxian, YIN Chunyan. Correlation between insulin like growth factor-1/insulin like growth factor binding protein-1 and gestational diabetes mellitus[J]. Maternal & Child Health Care of China, 2012, 27(3): 442-443.

[7] 中华医学会妇产科学分会产科学组, 中华医学会围产医学分会妊娠合并糖尿病协作组. 妊娠合并糖尿病诊治指南(2014)[J]. 中华妇产科杂志, 2014, 49(8): 561-569. https://doi.org/10.3760/cma.j.issn.0529-567x.2014.08.001.
Department of Obstetrics and Gynecology, Chinese Medical Association, Cooperative Group on Pregnancy Complicated with Diabetes of Perinatal Medicine. Guidelines for diagnosis and treatment of gestational diabetes mellitus (2014) [J]. Chinese Journal of Obstetrics and Gynecology, 2014, 49(8): 561-569. https://doi.org/10.3760/cma.j.issn.0529-567x.2014.08.001.

[8] 李琳, 李全民. 糖尿病肾病美国糖尿病协会指南更新要点及治疗进展[J]. 中华糖尿病杂志, 2020, 12(6): 424-428. https://doi.org/10.3760/cma.j.cn115791-20200320-00166.
LI Lin, LI Quanmin. Update and progress of American Diabetes Association guidelines for diabetic kidney disease[J]. Chinese Journal of Diabetes Mellitus, 2020, 12(6): 424-428. https://doi.org/10.3760/cma.j.cn115791-20200320-00166.

[9] 杨西林, 胡刚. 天津妊娠期糖尿病预防项目：20年妊娠期糖尿病及并发症防治历程[J]. 中华糖尿病杂志, 2022, 14(1): 12-16. https://doi.org/10.3760/cma.j.cn115791-20210202-00067.
YANG Xilin, HU Gang. Tianjin Gestational Diabetes Mellitus Prevention Project: 20 years of experience in prevention and control of gestational diabetes mellitus and its complications[J]. Chinese Journal of Diabetes Mellitus, 2022, 14(1): 12-16. https://doi.org/10.3760/cma.j.cn115791-20210202-00067.

[10] Huhn EA, Linder T, Eppel D, et al. Effectiveness of real-time continuous glucose monitoring to improve glycaemic control and pregnancy outcome in patients with gestational diabetes mellitus: a study protocol for a randomised controlled trial[J/OL]. BMJ Open, 2020, 10(11): e040498[2022-06-08]. https://doi.org/10.1136/bmjopen-2020-040498.

[11] 陆文茜, 于祥田, 罗明娟, 等. 妊娠期糖尿病不良妊娠结局的危险因素和代谢组学联合分析[J]. 中华糖尿病杂志, 2021, 13(6): 578-583. https://doi.org/10.3760/cma.j.cn115791-20210329-00182.
LU Wenqian, YU Xiangtian, LUO Mingjuan, et al. Combination analysis of risk factors and metabolomics on gestational diabetes mellitus with adverse pregnancy outcomes[J]. Chinese Journal of Diabetes Mellitus, 2021, 13(6): 578-583. https://doi.org/10.3760/cma.j.cn115791-20210329-00182.

[12] Castling ZA, Farrell T. An analysis of demographic and pregnancy outcome data to explain non-attendance for postpartum glucose testing in women with gestational

diabetes mellitus: why are patients missing follow-up? [J]. Obstet Med, 2019, 12(2): 85-89. https://doi. org/10.1177/1753495X18797201.

[13] 陈秋玲, 李文霞, 李华, 等. 妊娠期糖尿病合并低维生素D孕妇血清IGF-1、炎性因子表达[J]. 中国计划生育学杂志, 2022, 30(1): 151-154, 159. https://doi. org/10.3969/j. issn. 1004-8189.2022.01.035.
CHEN Qiuling, LI Wenxia, LI Hua, et al. Expression and significance of serum insulin like growth factor-1 and inflammatory factors of pregnant women with gestational diabetes mellitus complicated with low vitamin D status[J]. Chinese Journal of Family Planning, 2022, 30(1): 151-154, 159. https://doi.org/10.3969/j.issn.1004-8189.2022.01.035.

[14] 何勤燕, 盛碧霞, 潘聪女. 妊娠期糖尿病产妇胰岛素分泌及糖代谢特点对比分析[J]. 中国妇幼保健, 2020, 35(10): 1825-1827. https://doi. org/10.19829/j. zgfybj. issn. 1001-4411.2020.10.020.
HE Qinyan, SHENG Bixia, PAN Congnü. Comparative analysis of insulin secretion and glucose metabolism in pregnant women with gestational diabetes mellitus[J]. Maternal & Child Health Care of China, 2020, 35(10): 1825-1827. https://doi. org/10.19829/j. zgfybj. issn. 1001-4411.2020.10.020.

[15] Bademler S, Ucuncu MZ, Sari M, et al. Role of insulin-like growth factor 1 (IGF-1) and insulin-like growth factor binding protein-3 (IGFBP-3) in the diagnosis of pancreatic adenocarcinoma and monitoring treatment response[J]. Acta Medica Mediterranea, 2019, 35(1): 71-75. https://doi. org/10.19193/0393-6384_2019_1_12.

[16] Tu W, Yang B, Leng X, et al. Testis-specific protein, Y-linked 1 activates PI3K/AKT and RAS signaling pathways through suppressing IGFBP3 expression during tumor progression[J]. Cancer Sci, 2019, 110(5): 1573-1586. https://doi. org/10.1111/cas.13984.

[17] 胡勇, 谭超. 多囊卵巢综合征患者妊娠母血及脐血中胰岛素样生长因子-1水平对妊娠结局的影响[J]. 实用医学杂志, 2016, 32(1): 73-75. https://doi. org/10.3969/j. issn. 1006-5725.2016.01.022.
HU Yong, TAN Chao. Effects of insulin-like growth factor-1 at varied levels on pregnancy outcome in pregnancy maternal serum and cord serum of patients with PCOS[J]. The Journal of Practical Medicine, 2016, 32(1): 73-75. https://doi.org/10.3969/j.issn.1006-5725.2016.01.022.

[18] 陈春莹, 程丽琴, 付艳霞. 妊娠期糖尿病孕妇IGF-1表达与新生儿免疫球蛋白和T细胞亚群的相关性分析[J]. 中南医学科学杂志, 2018, 46(3): 286-288, 292. https://doi.org/10.15972/j.cnki.43-1509/r.2018.03.013.
CHEN Chunying, CHENG Liqin, FU Yanxia. Expression of IGF-1 in placenta tissue of gestational diabetes mellitus and its effect on Immunoglobulin and T cell subsets in newborns[J]. Medical Science Journal of Central South China, 2018, 46(3): 286-288, 292. https://doi. org/10.15972/j. cnki. 43-1509/r.2018.03.013.

[19] 陶丽静, 李小花, 朱妙珊. 妊娠期糖尿病和妊娠期高血压患者血清IGFBP-3、Lp-PLA2对胎儿生长发育的影响[J]. 国际检验医学杂志, 2019, 40(23): 2872-2876. https://doi.org/10.3969/j.issn.1673-4130.2019.23.013.
TAO Lijing, LI Xiaohua, ZHU Miaoshan. The effects of serum IGFBP-3 and Lp-PLA2 on fetal growth and development in patients with gestational diabetes mellitus and gestational hypertension[J]. International Journal of Laboratory Medicine, 2019, 40(23): 2872-2876. https://doi. org/10.3969/j. issn. 1673-4130.2019.23.013.

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