



DOI: 10.20514/2226-6704-2026-16-4-278-283

УДК 618.3-06:616.379-008.64-07

EDN: DOMKQD

**А.А. Есжанова, М.А. Бекетова**

НАО «Медицинский университет Астана», кафедра акушерства и гинекологии № 2, Астана, Республика Казахстан

РАННИЕ ПРЕДИКТОРЫ ГЕСТАЦИОННОГО САХАРНОГО ДИАБЕТА И ПРЕЭКЛАМПСИИ: ОБОСНОВАНИЕ ПЕРСОНАЛИЗИРОВАННОЙ СТРАТЕГИИ СКРИНИНГА В I ТРИМЕСТРЕ

A.A. Yeszhanova, M.A. Beketova

NJSC «Astana Medical University», Department of Obstetrics and Gynecology No. 2, Astana, Republic of Kazakhstan

Early Predictors of Gestational Diabetes Mellitus and Preeclampsia: Rationale for A Personalized Screening Strategy in The First Trimester

Резюме

Цель исследования: выявить ранние клинико-метаболические предикторы гестационного сахарного диабета (ГСД) и преэклампсии в I триместре беременности и обосновать необходимость персонализированной стратегии скрининга. **Материалы и методы:** Проведено ретроспективное когортное исследование типа «случай-контроль» на базе Многопрофильной городской больницы № 2 г. Астаны (n=600). Основную группу составили 300 беременных с ГСД, контрольную — 300 женщин с физиологической беременностью. Проанализированы антропометрические данные (ИМТ), анамнез и лабораторные показатели (глюкоза натощак, HbA1c) при постановке на учет до 12 недель. Статистический анализ включал U-критерий Манна-Уитни, расчет отношения шансов (OR) и ROC-анализ. **Результаты:** пациентки с ГСД имели достоверно более высокий ИМТ (ожирение у 31,0 % против 9,0 %, $p < 0,001$) и возраст. Частота преэклампсии в группе ГСД составила 7,3 % против 3,3 % в контроле; установлено, что наличие ГСД повышает риск развития преэклампсии более чем в два раза ($OR=2,295$; 95 % CI: 1,067–4,934). ROC-анализ выявил высокую диагностическую ценность отдельных маркеров в I триместре. Глюкоза натощак при пороговом значении $>4,49$ ммоль/л показала чувствительность 71,6 % и специфичность 76,6 % ($AUC=0,787$; 95 % ДИ: 0,745–0,825). Гликированный гемоглобин (HbA1c) при уровне $>5,27$ % продемонстрировал чувствительность 63,8 % и высокую специфичность 85,7 % ($AUC=0,792$; 95 % ДИ: 0,653–0,894). Разработанная комбинированная прогностическая модель (HbA1c + глюкоза натощак) показала наивысшую предсказательную ценность с площадью под ROC-кривой (AUC) 0,849, обеспечивая чувствительность 90,0 % и специфичность 78,2 %. **Заключение:** Гликированный гемоглобин и тощачовая гликемия в I триместре являются независимыми предикторами ГСД и ассоциированной преэклампсии. Внедрение балльной оценки риска при первой явке позволяет выделить группу для раннего начала персонализированной профилактики, не дожидаясь стандартных сроков перорального глюкозотолерантного теста (24–28 недель), что может снизить частоту акушерских осложнений.

Ключевые слова: гестационный сахарный диабет, преэклампсия, ранний скрининг, HbA1c, прогнозирование, первый триместр

Конфликт интересов

Авторы заявляют, что данная работа, её тема, предмет и содержание не затрагивают конкурирующих интересов

Источники финансирования

Авторы заявляют об отсутствии финансирования при проведении исследования

Соответствие принципам этики

Исследование одобрено Локальным этическим комитетом НАО «Медицинский университет Астана» (Протокол № 7 от 16.01.2026 г.). Исследование проведено в соответствии с Хельсинкской декларацией Всемирной медицинской ассоциации.

Статья получена 21.01.2026 г.

Одобрена рецензентом 23.03.2026 г.

Принята к публикации 21.04.2026 г.

Для цитирования: Есжанова А.А., Бекетова М.А. РАННИЕ ПРЕДИКТОРЫ ГЕСТАЦИОННОГО САХАРНОГО ДИАБЕТА И ПРЕЭКЛАМПСИИ: ОБОСНОВАНИЕ ПЕРСОНАЛИЗИРОВАННОЙ СТРАТЕГИИ СКРИНИНГА В I ТРИМЕСТРЕ. Архивъ внутренней медицины. 2026; 16(4): 278-283. DOI: 10.20514/2226-6704-2026-16-4-278-283. EDN: DOMKQD

Abstract

Aim: To identify early clinical and metabolic predictors of gestational diabetes mellitus (GDM) and preeclampsia in the first trimester of pregnancy and to justify the need for a personalized screening strategy. **Materials and Methods:** A retrospective case-control cohort study was conducted at the Multidisciplinary City Hospital No. 2 in Astana (n=600). The main group consisted of 300 pregnant women with GDM, and the control group comprised 300 women with physiological pregnancy. Anthropometric data (BMI), medical history, and laboratory indicators (fasting glucose, HbA1c) recorded at registration (up to 12 weeks) were analyzed. Statistical analysis included the Mann-Whitney U-test, odds ratio (OR) calculation, and ROC analysis. **Results:** Patients with GDM had significantly higher BMI (obesity in 31.0 % vs. 9.0 %, $p<0.001$) and age. The incidence of preeclampsia in the GDM group was 7.3 % vs. 3.3 % in the control group; it was established that GDM increases the risk of preeclampsia by more than two times (OR=2.295; 95 % CI: 1.067–4.934). ROC analysis revealed high diagnostic value of individual markers in the first trimester. Fasting glucose at a threshold of >4.49 mmol/L showed a sensitivity of 71.6 % and specificity of 76.6 % (AUC=0.787; 95 % CI: 0.745–0.825). Glycated hemoglobin (HbA1c) at a level >5.27 % demonstrated a sensitivity of 63.9 % and high specificity of 85.7 % (AUC=0.792; 95 % CI: 0.653–0.894). The developed combined prognostic model (HbA1c + fasting glucose) showed the highest predictive value with an area under the ROC curve (AUC) of 0.849, providing a sensitivity of 90.0 % and specificity of 78.2 %. **Conclusion:** Glycated hemoglobin and fasting glycemia in the first trimester are independent predictors of GDM and associated preeclampsia. Implementing a risk score assessment at the first antenatal visit allows for the identification of a group for early initiation of personalized prevention, without waiting for the standard OGTT timing (24–28 weeks), which may reduce the incidence of obstetric complications.

Key words: *gestational diabetes mellitus, preeclampsia, early screening, HbA1c, prediction, first trimester*

Conflict of Interest

The authors declare that this work, its topic, subject matter, and content do not affect any competing interests

Funding Sources

The study was performed without external funding

Compliance with the principles of ethics

The study was approved by the Local Ethics Committee of the NJSC "Astana Medical University" (Protocol No. 7 dated January 16, 2026). The study was conducted in accordance with the Declaration of Helsinki of the World Medical Association

Article received on 21.01.2026

Reviewer approved 23.03.2026

Accepted for publication on 21.04.2026

For citation: Yeszhanova A.A., Beketova M.A. Early Predictors of Gestational Diabetes Mellitus and Preeclampsia: Rationale for A Personalized Screening Strategy in The First Trimester. The Russian Archives of Internal Medicine. 2026; 16(4): 278–283. DOI: 10.20514/2226-6704-2026-16-4-278-283. EDN: DOMKQD

GDM — gestational diabetes mellitus, BMI — body mass index, OGTT — oral glucose tolerance test, HbA1c — glycated haemoglobin, CI — confidence interval, OR — odds ratio, AUC — area under the ROC curve

Introduction

At the present stage of obstetrics development, metabolic disorders during pregnancy are not an isolated endocrinological problem, but a fundamental risk factor of severe obstetrical and perinatal complications. There is a persistent global trend of a higher rate of hyperglycaemia: global studies show that carbohydrate metabolism disorders are reported in 7.5 % to 27 % depending on the area and diagnostic criteria [1, 2]. A meta-analysis of the data in the USA and Canada for 2023 shows 6.9 % to 13.7 %, which confirms the immensity of the problem [2].

Of special concern is the close pathogenetic association between gestational diabetes mellitus (GDM) and hypertensive disorders, particularly preeclampsia [3]. Both conditions share the common origin, that is endothelial dysfunction, chronic systemic inflammation, and insulin resistance [4]. Maternal hyperglycaemia, which affects the foetus, not only causes gigantism and birth traumas, but also programs long-term vascular health of descendants [5].

However, despite the proven risks, the currently used screening approaches need reviewing. According to the current Clinical Protocol of the Ministry of Health of the Republic of Kazakhstan, all pregnant women, who

come for their first visit, undergo mandatory glucose level measurement (fasting venous plasma) to rule out manifestations of diabetes mellitus. A traditional algorithm for GDM diagnosis includes an oral glucose tolerance test (OGTT) at week 24–28 for all pregnant women having risk factors [6, 7]. Clinically, this timing is rather late: by the end of the second trimester, placentation is complete, and the main vascular modifications are over. The therapeutic window, i.e. first trimester, when angiogenesis can be most successfully corrected, is lost [7–9].

The objective of the study is to use a retrospective analysis to identify statistically significant clinical and laboratory parameters of GDM and preeclampsia during the first trimester and to justify the early risk stratification.

Materials and methods

Study design. A retrospective cohort (case-control) study was conducted in the obstetrics unit of Multidisciplinary Hospital No. 2 (Astana). Study duration: 2024–2025. The study was approved by the Local Ethics Committee (Minutes No. 7 dated 16.01.2026).

Sample description. The study included 600 pregnant women.

- **Main group (n=300):** patients with GDM confirmed with laboratory test results.
- **Control group (n=300):** patients with uncomplicated pregnancy, similar age and parity.
- **Exclusion criteria:** symptomatic type 1 or type 2 diabetes mellitus, multiple pregnancy, severe comatic pathology.

Methods of analysis. Since the study was retrospective, informed consent was not required; patient data were anonymised. Data were collected from forms 077/y, 096/y, and 097/y. Body mass index (BMI) was calculated using anthropometric data (height and weight) recorded at the first visit to register as pregnant during the first trimester. SPSS Statistics 26.0 package was used for statistical processing. Mann-Whitney U test, Pearson’s

chi-square test (χ^2), and ROC analysis with AUC calculation were used.

Results

A comparative analysis showed statistically significant intergroup differences (Table 1). Patients with GDM were significantly older (34.51 ± 4.69 vs. 32.93 ± 5.21 years old, $p=0.0002$). A pivotal factor was obesity: BMI ≥ 30.0 kg/m² was reported three times more frequently in the main group (31.0 % vs. 9.0 %, $p < 0.0001$).

The analysis of laboratory parameters during the first trimester demonstrated that the mean fasting glucose levels in the main group were 4.81 ± 0.62 mmol/L (controls: 4.25 ± 0.49 mmol/L, $p < 0.001$). HbA1c values were also significantly higher: 5.57 ± 0.46 % vs. 4.32 ± 1.63 % ($p < 0.003$).

Table 1. Clinical and Anamnestic Characteristics of the Groups

Indicator	Group with GDM (n = 300)	Control group (n = 300)	P-level
Age, years (M $\pm$ SD)	34.51 $\pm$ 4.69	32.93 $\pm$ 5.21	0.0002
BMI, obesity (≥ 30 kg/m ²), n (%)	93 (31.0 %)	27 (9.0 %)	<0.0001
BMI, normal (18.5–24.9 kg/m ²), n (%)	105 (35.0 %)	201 (67.0 %)	<0.0001
Inheritance of diabetes, n (%)	47 (15.7 %)	15 (5.0 %)	0.00002
HSD in the anamnesis, n (%)	57 (19.0 %)	7 (2.3 %)	<0.0001

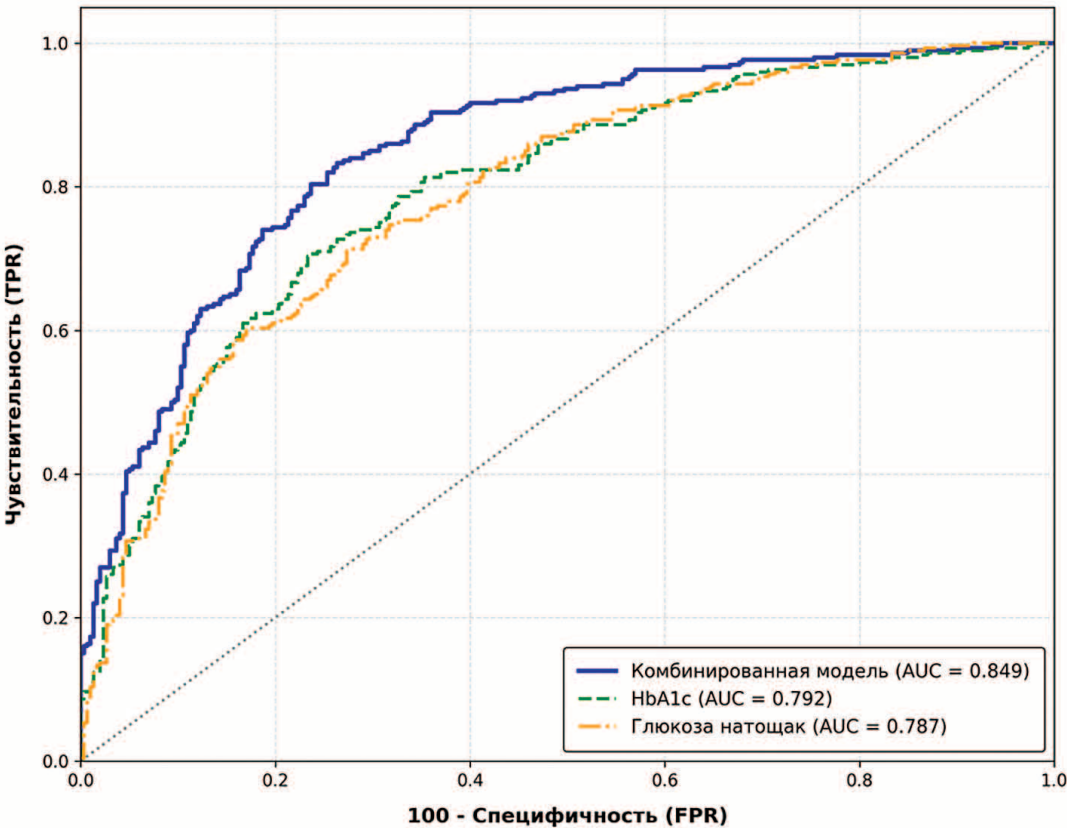


Figure 1. Comparison of the predictive value of monomarkers and the combined model (ROC analysis)

Association with preeclampsia. The rate of pre-eclampsia in the main group was 7.3 % (n=22); it is more than twice as high as in controls (3.3 % (n=10)). GDM increases the risk of preeclampsia by 2.29 times (OR=2.295; 95 % CI: 1.067–4.934).

ROC analysis. In order to evaluate the prognostic value, the following cut-off values were recorded:

- **HbA1c:** > 5.27 % (AUC=0.792; p < 0.0001).
- **Fasting glucose:** > 4.49 mmol/L (AUC=0.787; p < 0.0001).

Combined model (HbA1c + glucose): the best result was demonstrated, with AUC=0.849, sensitivity of 90.0 %, and specificity of 78.2 %.

The analysis of significant predictors and ROC analysis (Figure 1) were used to develop a patient-specific prognostic model. For the practical use, a scoring (Table 2) was suggested, which allows stratifying patients at their first visit before week 12 of pregnancy.

The identified pathogenetic association between GDM and preeclampsia necessitates some changes in the screening paradigm. The scale will allow routing patients into two groups (Figure 2).

The low-risk group (less than three points) will follow the standard protocol. Patients scoring **three and more points** will be routed along the “red corridor”, requiring patient-specific preventive measures.

Table 2. Scoring of Risk Factors

Risk Factor	Criteria	Points
Chronic arterial hypertension (CAH)	Presence	3
Obesity (BMI)	≥30 кг/м²	3
History of gestational diabetes (GDM)	Past occurrence	3
Glycated hemoglobin (HbA1c)	≥5,51 %	2
Fasting glucose	≥4,81 ммоль/л	2
Family history of diabetes mellitus (DM)	Presence	2
Age	≥30	1

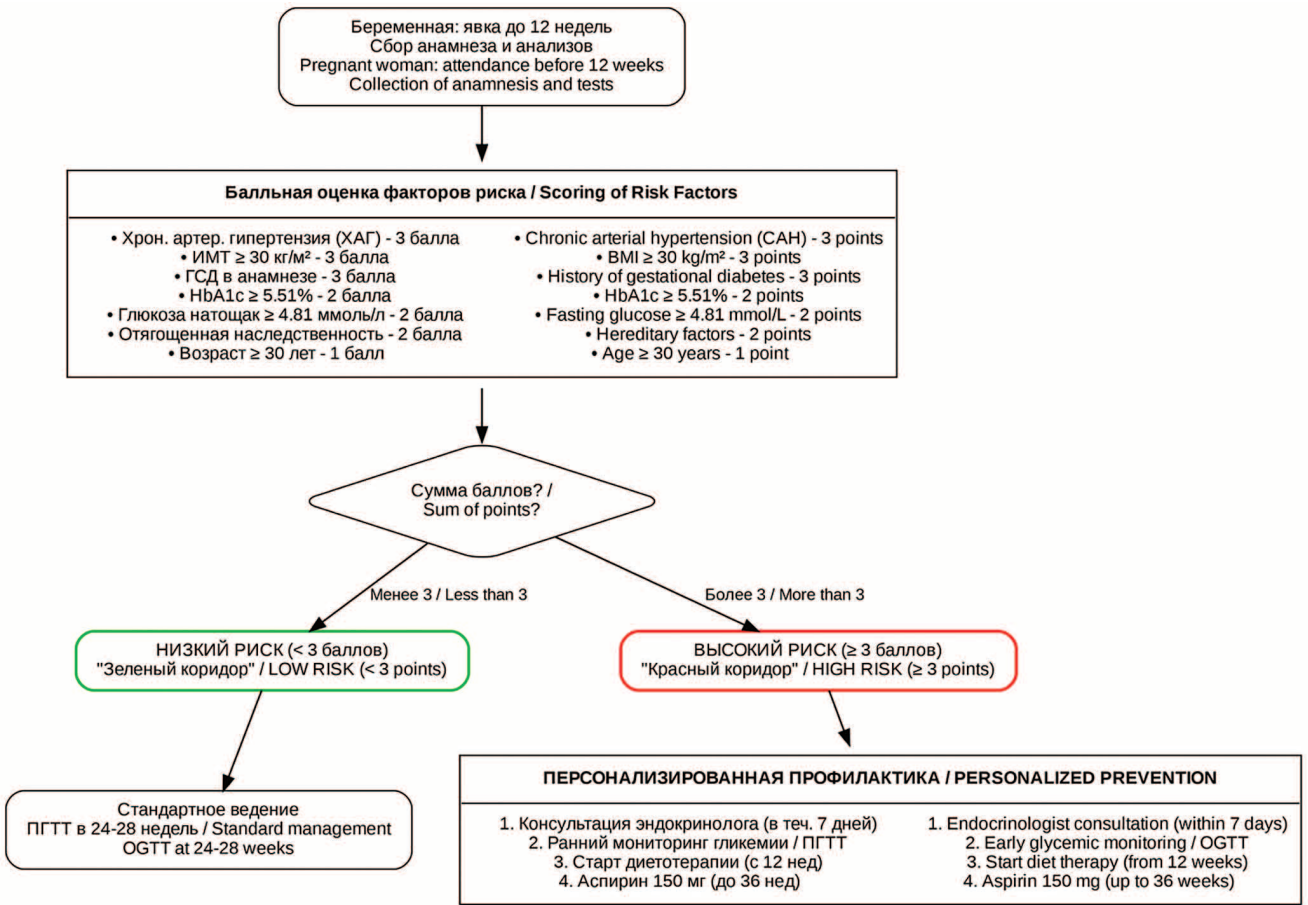


Figure 2. Algorithm for risk-oriented two-level routing of pregnant women at the primary healthcare stage

Discussion

Our thesis about the required start of the therapy at 10–12 weeks of pregnancy corresponds to the data reported by McIntyre et al. (2018) and Benhalima et al. (2024) [8, 9]. Early intervention allows targeting angiogenesis prior to placentation completion, which is essential for hypertension prevention. Thus, early diagnosis of metabolic predictors makes it possible to achieve the preventative potential, which is usually lost by 24–28 weeks of pregnancy.

Management depending on the risk group

A key tool of the proposed strategy is dividing patients into risk groups when they come for their pregnancy registration visit. Patients scoring **under three points** are in the low-risk group (“green corridor”); their management falls under the standard procedure, and they undergo OGTT at 24–28 weeks of pregnancy.

A high-risk group (**three and more points**, “red corridor”) requires immediate start of patient-specific prevention. The following measures are proposed for this group of patients (Figure 2):

- Consultation by an endocrinologist within 7 days.
- Early glycaemia monitoring or early OGTT.
- Diet therapy starting from week 12 of pregnancy.
- Low-dose acetylsalicylic acid (Aspirin) (150 mg/day, up to 36 weeks of pregnancy) in the high-risk group (pregnant women with metabolic disorders, obesity and chronic arterial hypertension) to prevent associated preeclampsia is clinically justified and is strictly regulated by the current Clinical Protocol of the Ministry of Health of the Republic of Kazakhstan, as well as by the current international guidelines, particularly by the recommendations of the International Federation of Gynaecology and Obstetrics (FIGO, 2019) and the United States Preventive Services Task Force (USPSTF, 2021) [8, 10].
- The proposed approach makes it possible to use the therapeutic window of the first trimester, which is pathogenetically justified to lower the rate of obstetrical complications.

Study limitations: retrospective single-centre design, requiring cautious data extrapolation.

Conclusion

1. Glycated haemoglobin ($\geq 5.51\%$) and fasting glycaemia (≥ 4.81 mmol/L) in the first trimester are the most significant independent predictors of GDM and preeclampsia.
2. Introduction of the scoring allows objectifying the risk of GDM and preeclampsia as early as at the first pregnancy visit.

3. Use of the «Red corridor» strategy (sum of points) ensures early start of the patient-specific prevention and interdisciplinary monitoring, which is a must for better perinatal outcomes.

The results confirm the hypothesis of the pathogenic association between early carbohydrate metabolism disorders and obstetric complications. The risk of preeclampsia (OR=2.295) established in this study is in line with the global data [3,4]. The key observation is that metabolic predictors (glucose > 4.8 mmol/L, HbA1c $> 5.51\%$) are diagnosed at the very first visit.

The current use of OGTT at 24–28 weeks of pregnancy is the golden standard of diagnostics; however, it is too late for prevention. High rates of C-section in the main group (69.3%) is a result of delayed diagnosis. Given the high accuracy of the combined model (AUC=0.849), we propose to introduce risk scoring. Patients with a combination of factors (age > 30 , BMI > 25 , glucose > 4.5) should have patient-specific prevention, and therapy should be initiated as early as 10–12 weeks of pregnancy.

Вклад авторов:

Все авторы внесли существенный вклад в подготовку работы, прочли и одобрили финальную версию статьи перед публикацией

Есжанова А.А.: концепция, сбор данных, статистика, написание статьи

Бекетова М.А.: научное консультирование, статистика, написание статьи

Author Contribution:

All the authors contributed significantly to the study and the article, read and approved the final version of the article before publication

Yeszhanova A.A.: concept and design development, data collection and processing, statistical analysis, writing the manuscript

Beketova M.A.: scientific consulting, critical review of intellectual content, approval of the manuscript for publication.

Список литературы/References:

1. Chivese T., Hoegfeldt C.A., Werfalli M., et al. The prevalence of pre-existing diabetes in pregnancy — A systematic review and meta-analysis of studies published during 2010–2020. *Diabetes Res Clin Pract.* 2022;183:109049. doi: 10.1016/j.diabres.2021.109049.
2. Eades C.E., Burrows K.A., Andreeva R., et. al. Prevalence of gestational diabetes in the United States and Canada: a systematic review and meta-analysis. *BMC Pregnancy Childbirth.* 2024;24(1):204. doi: 10.1186/s12884-024-06378-2.
3. Xie J., Wang M., Long Z., et al. Global burden of type 2 diabetes in adolescents and young adults, 1990–2019: systematic analysis of the global burden of disease study 2019. *BMJ.* 2022;379:e072385. doi: 10.1136/bmj-2022-072385.
4. Pace R., Brazeau A.-S., Meltzer S., et al. Conjoint associations of gestational diabetes and hypertension with diabetes, hypertension, and cardiovascular disease in parents: a retrospective cohort study. *Am J Epidemiol.* 2017;186(10):1115–1124. doi: 10.1093/aje/kwx263
5. Hoodbhoy Z., Mohammed N., Nathani K.R., et al. The impact of maternal preeclampsia and hyperglycemia on the cardiovascular

- health of the offspring: a systematic review and meta-analysis. *Am J Perinatol*. 2023;40(4):363–374. doi: 10.1055/s-0041-1728823
6. McIntyre H.D., Kapur A., Divakar H., et al. Gestational diabetes mellitus — Innovative approach to prediction, diagnosis, management, and prevention of future NCD-mother and offspring. *Front Endocrinol (Lausanne)*. 2020;11:614533. doi: 10.3389/fendo.2020.614533
7. Osmundson S.S., Zhao B., Kunz L., et al. First trimester hemoglobin A1c and subsequent gestational diabetes. *Am J Perinatol*. 2016;33(10):977–982. doi: 10.1055/s-0036-1581055.
8. Poon LC, McIntyre HD, Hyett JA, et al.. The first-trimester of pregnancy — A window of opportunity for prediction and prevention of pregnancy complications and future life. *Diabetes Res Clin Pract*. 2018 Nov;145:20–30. doi: 10.1016/j.diabres.
9. Benhalima K., Minschart C., Van Crombrugge P., et al. The 2024 Flemish consensus on screening for gestational diabetes mellitus early and later in pregnancy. *Acta Clin Belg*. 2024;79(3):217–224. doi: 10.1080/17843286.2024.2384258
10. Davidson K.W., Barry M.J., Mangione C.M., et al. Aspirin Use to Prevent Preeclampsia and Related Morbidity and Mortality: US Preventive Services Task Force Recommendation Statement. *JAMA*. 2021;326(12):1186–1191. doi: 10.1001/jama.2021.14781.

Информация об авторах

Есжанова Алия Абдигалиевна  — ассистент кафедры акушерства и гинекологии № 2 НАО «Медицинский университет Астана», Астана, Казахстан, e-mail: a.eszhanova@list.ru, ORCID ID: <https://orcid.org/0009-0002-6770-390X>.

Бекетова Макпал Аманбаевна — магистр медицинских наук, ассистент кафедры акушерства и гинекологии № 2, НАО «Медицинский университет Астана», Астана, Казахстан, e-mail: makpal.beketova0807@gmail.com, ORCID ID: <https://orcid.org/0000-0003-3014-0170>

Author information

Aliya A. Yeszhanova  — Assistant, Department of Obstetrics and Gynecology No. 2, NJSC "Astana Medical University", Astana, Kazakhstan, e-mail: a.eszhanova@list.ru, ORCID ID: <https://orcid.org/0009-0002-6770-390X>.

Beketova Makpal Amanbaevna — Master of Science in Medicine, Assistant Professor, Department of Obstetrics and Gynecology No. 2, NAO «Astana Medical University», Astana, Kazakhstan, e-mail: makpal.beketova0807@gmail.com, ORCID ID: <https://orcid.org/0000-0003-3014-0170>.

 Автор, ответственный за переписку / Corresponding author