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PREDICTION MODEL FOR THE RISK OF GESTATIONAL DIABETES

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Abstract

This article presents the results of research aimed at developing a mathematical model for predicting the gestational diabetes mellitus in pregnant women with risk factors for its development. To accomplish this task, one of the methods of multivariate statistical analysis was used - discriminant analysis and as a result a decision rule was obtained in the form of a canonical equation that classifies newly arrived pregnant women according to their respective groups and thereby predicting GDM.

Keywords: mathematical prediction model, risk factors, gestational diabetes mellitus, discriminant analysis

The prevalence of diabetes in pregnancy, the majority of which is gestational diabetes mellitus (GDM), has been increasing in many jurisdictions [1]. GDM is defined as glucose intolerance that first occurs or is first diagnosed during pregnancy and usually resolves soon after delivery [2]. It raises substantial health concerns both for its short-term adverse effects on pregnancy outcomes and for potential serious long-term consequences for both mothers and their offsprings [3,4].

Over the past decade, the prevalence of GDM has rapidly risen and ranges from 3 up to 35% [5,6,7] depending on the definitions used and populations studied [8,9]. This parallels the emerging trends in obesity, population aging, and diabetes mellitus type II. The rising prevalence of GDM contributes to an increasing number of adverse perinatal outcomes, such as macrosomia, shoulder dystocia, caesarean delivery, and neonatal hypoglycemia [10].

Early predicting GDM by using the model will help prevent adverse pregnancy outcomes in women at high risk of developing GDM. Since timely prevention is a major component in reducing adverse outcomes in GDM, clinicians need predictive models that can be used early in pregnancy. In addition, since absolutely all pregnant

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women should be examined for the presence of GDM; models that include readily available information are preferred.

The aim of the study is to use discriminant analysis to improve pregnancy and childbirth outcomes by predicting the likelihood of developing GDM in the early stages.

Materials and methods

625 women from two regions of the Republic of Uzbekistan (Namangan region 323, Kashkadarya region 302) were examined at a period of 18-32 weeks of pregnancy. During the questioning of a pregnant woman, all socio-economic and clinical indicators were recorded, including the date of visit, the patient's age, gestational age, education, and occupation. Clinical findings included a history of type 2 diabetes mellitus in close relatives. In addition, participants were asked about risk factors such as parity (primiparous or multiparous), history of miscarriage, missed pregnancies, stillbirths, and prior preeclampsia. Anthropometric measurements included measurements: weight (kg) and height (cm), for calculating BMI (kg / m2); weight before pregnancy (kg); BMI before pregnancy (kg / m2); weight gain during pregnancy (kg); circumference of the middle third of the shoulder (OP), systolic and diastolic blood pressure (mm Hg); study of glucose level in venous blood on an empty stomach and after OGTT (75 g of glucose). The diagnosis of gestational diabetes mellitus was made based on the criteria (International Diabetes and Pregnancy Association) 2010 [11].

Statistical analysis

To process the data and as a result of obtaining the necessary quantitative values of estimates for constructing classification models for patients with GDM, one of the procedures of the supervised pattern recognition method was used - discriminant analysis, which is contained in the statistical software package SSPS 21 [12,13,14].

The essence of discriminant analysis is that to predict the belonging of observation objects to previously known groups, a multidimensional array using training samples is converted into a one-dimensional indicator, which is a new generalized indicator, the values of which differ as much as possible for objects assigned to different groups.

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The calculation of the classification functions of the GDM is made according to the formula:

$$Y_i = c_i + w_{i1}*x_1 + w_{i2}*x_2 + ... + w_{im}*x_m$$

i is the index of the corresponding population;

Y_i - function of classification of a pregnant woman in the *i*-th population;

c_i - constant for the *i*-th population;

w_{ij} - coefficients of variables;

$x_j - j$ - independent variable, $i=1..n;\ j=1…m.$

Results

In total, 625 pregnant women were screened, of which 323 in Namangan region and 302 in Kashkadarya region.

Considering the above criteria, 65 (10.4%) patients were identified with a diagnosis of GDM.

According to the results of the screening, pregnant women were divided into 2 groups: group 1 - 65 patients who had GDM (main) and group 2 - 95 women without abnormalities in carbohydrate metabolism (healthy pregnant women), who were the control group. The average age of pregnant women was 26.8 ± 4.9.

After processing the data of two groups of pregnant women, the discriminant analysis program at the initial stage gives information about the actual and missing values. The mean values, standard deviations, the number of observations for each group separately and the total values for both groups are calculated.

At the next stage, the program makes calculations to compose the classification functions. The classification functions are designed to assign each object with the greatest probability to its own group. There are as many classification functions as there are groups.

Coefficients of the classifying function

	Predictint GDM	
	GDM	No GDM
x1	0,281	0,271
x2	1,118	1,114
x3	-0,234	-0,226
x4	0,193	0,171
x5	0,513	0,460

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x6	8,503	9,081
x7	17,084	17,158
x8	-13,944	-13,991
x9	0,016	0,016
x10	37,535	37,750
x11	4,753	4,814
x12	-2,222	-2,275
(const)	-1452,481	-1465,082

Fisher Linear Discriminant Functions

Each function allows for each sample and for each population to calculate the coefficients for the classification of pregnant women using the formulas:

$$Y_1 = -1452,481+0,281*\mathbf{x_1} + 1,118*\mathbf{x_2} - 0,234*\mathbf{x_3} +0,193*\mathbf{x_4} +0,513*\mathbf{x_5} +8,503*\mathbf{x_6} +17,084*\mathbf{x_7} -13,944*\mathbf{x_8} +0,016*\mathbf{x_9} +37,535*\mathbf{x_{10}} - 4,753*\mathbf{x_{11}} -2,222*\mathbf{x_{12}}$$

$$Y_2 = -1465,08+0,271*\mathbf{x_1} + 1,114*\mathbf{x_2} - 0,226*\mathbf{x_3} +0,171*\mathbf{x_4} +0,46*\mathbf{x_5} +9,081*\mathbf{x_6} +17,158*\mathbf{x_7} -13,991*\mathbf{x_8} +0,016*\mathbf{x_9} +37,750*\mathbf{x_{10}} - 4,814*\mathbf{x_{11}} - 2,275*\mathbf{x_{12}}$$

- ***x1*** - Systolic pressure
- ***x2*** - Diastolic pressure
- ***x3*** - Age
- ***x4*** – Gestational age
- ***x5*** - Gravidity
- ***x6*** - Parity
- ***x7*** - Height
- ***x8*** - Weight
- ***x9*** - BMI
- ***x10*** - circumference of the middle third of the shoulder
- ***x11*** - Weight before pregnancy
- ***x12*** - Weight gain (kg).

Substituting the measured values of the indicators into each of the two equations and multiplying their coefficients standing with them and then adding the results, we

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calculate the values of Y1 and Y2. When comparing the quantitative values of Y1 and Y2, the one that is larger than the other indicates the group where the patient should belong. For example, if the Y1 value is greater than the Y2 value, then the pregnant woman is predicted to be a patient with GDM with several risk factors, if on the contrary, then the pregnant woman is healthy, although she has a number of risk factors.

Modeling of the risk of GDM development by significant factors was carried out using the linear discriminant Fisher function with the achieved prediction accuracy equal to 63.8%.

Conclusion

The proposed method is quite accessible for predicting the likelihood of GDM development and can be performed using an engineering calculator.

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