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Correlation of HbA1c with a Basic Math Test in Gestational Diabetes

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Abstract

Background: A good metabolic control in Gestational Diabetes Mellitus (GDM) is crucial to avoid complications in the mother and the offspring. A limitation to reach a desired HbA1c in GDM is the education level of the mothers.

Aims: The aim of this study was to determine the correlation between the HbA1c and the points obtained in a basic mathematical test.

Study Design: cross-sectional study.

Methods: This was a pilot study, prospective and cross-sectional. Pregnant women, older than 18 years old, diagnosed with GDM were invited to participate resolving a mathematical test of ten questions. HbA1c was done in the first consultation. Spearman correlation test was used between HbA1c and the punctuation of the mathematical test.

Results: 31 patients with a mean age of 29 ± 6.7 years old accepted to participate. The education level was as follows: 5 (16.12%) with Primary School, 20 (64.51%) with High School, 2 (6.45%) with Preparatory School, 2 (6.45%) with technical studies and 1 (3.22%) that finished the University. The Spearman test showed a negative correlation between the mathematical test and the HbA1c (r^2 = -0.395, $P \leq 0.001$).

Conclusion: A low mathematics knowledge limits the expectation to get an optimal metabolic control in GDM.

Key-words: Gestational Diabetes, Glycated Hemoglobin A, Mathematical Concepts.

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INTRODUCTION

Gestational diabetes mellitus (GDM) is defined as glucose intolerance diagnosed for the first time with an oral glucose tolerance test (OGTT) of 75 grams based on International Association of the Diabetes and Pregnancy Study Groups (IADPSG) criteria that has been recently approved by the WHO (1). The estimated global prevalence of GDM ranges from 5.4% in white women to 11.9% in Asian and Pacific Islander women (2). In Mexico, the GDM prevalence is increasing as a consequence of the obesity massive increase in the young population and that in fact has been accentuated since childhood (3,4), complicating 8 to 12% of pregnancies.

Pregnancy is considered a diabetogenic state, and starting with overweight or obesity causes an increase in insulin resistance, which causes depletion of the ß-cells ability to secrete the amount of insulin required by pregnancy, increasing the risk of developing GDM (5). In fact, maternal hormonal and metabolic factors related to the placenta, adipose tissue, and the growth hormone axis are associated with variation in insulin sensitivity during pregnancy (6).

Both GDM and the presence of maternal hyperglycemia are associated with perinatal complications and with a high risk of developing obesity and type 2 diabetes mellitus (T2DM), later in both the mother and the child.

The risk factors for gestational diabetes (age over 30 years, obesity, hypertension, glycosuria, previous GDM, family history of diabetes, family history of macrosomia) identify only 50% of pregnancies with gestational diabetes. Pre-gestational body mass index (BMI) has a higher association than high gestational weight gain, with GDM and glucose intolerance in pregnancy. In this sense, it is clear that the increase in adiposity is an important contributing factor. It also seems that the adipose tissue localization is important, with visceral accumulation being the most associated with a cardiometabolic problem; so patients who have more visceral fat in the first trimester, are more likely to have a positive glucose tolerance curve (GTC) at 24-28 weeks of gestation (WG) (7).

Diabetes mellitus during pregnancy can lead to serious or fatal complications for the mother or the unborn product, such as polyhydramnios, preeclampsia, abortion, neonatal asphyxia, fetal death, macrosomia, and others, therefore, GDM detection is very important as well as the instauration of the correct and early treatment.

The goal of diabetes management during pregnancy is the fasting blood glucose maintenance between 105 and 120 mg/dl two hours after meals. The basic pillars of GDM treatment are diabetes education, a healthy diet with the calculation of recommended calories, exercise, and sometimes insulin (8,9). Prenatal control, birth supervision, as well as postnatal follow-up of the mother and the product are necessary (9). It is undisputed that the GDM treatment is effective in reducing the incidence of macrosomia, preeclampsia and shoulder dystocia (10). Insulin is the first agent recommended for the GDM treatment in the USA. In turn, several

controlled trials support the efficacy and safety of metformin in the short-term (11) and of glyburide (12) for the GDM treatment, both considered as recommendation category B (13).

Intervention programs have been shown to be effective in achieving better metabolic control in T2DM (14) but in gestational diabetes have been less studied (15,16). In addition to the above, there is the problem of the understanding of the indications by the patient.

Even so, for the large number of patients worldwide who develop GDM, it is paradoxical the existence of few publications that talk about intervention programs to get a better control and success rates, with few information about the factors that limit reaching the control goals.

It has been stated that measurement of HbA1c, either at the time of diagnosis of GDM or toward the end of pregnancy, can provide prognostic information with regard to adverse pregnancy outcomes; the contribution will be greater when stratifying pregnant women according to their level of HbA1c (17). The aim of this study was to determine if a barrier to achieving control goals in GDM is a low understanding of minimum knowledge of mathematics so that patients cannot carry a precise self-control of their caloric intake and therefore their insulin requirements.

MATERIAL AND METHODS

This was a clinical, prospective and cross-sectional study developed from August to December 2018. Pregnant women, older than 18 years old, diagnosed with GDM, who were managed in the Maternal-Fetal Service of the "Mónica Pretelini Sáenz" Maternal-Perinatal Hospital (HMPMPS), Health Institute of the State of Mexico (ISEM), were invited to participate. Patients with incomplete medical files were discarded from the final analysis. The sample was set with a convenience non-probability sampling.

Anthropometry

The nursery staff registered the body weight, height (Seca 700; Germany) and blood pressure (Riester Big Ben®, Germany). Body Mass Index (BMI) was calculated as weight (kg) divided by height (m) squared.

Diet

All patients were oriented with a personalized diet. The adherence to diet was considered with three alternatives: 1) consumption of 80 to 120% of the indicated kcal, 2) less than 80% of the indicated kcal, and 3) greater than 120% of the indicated kcal. All volunteers were asked to solve a basic mathematical test of ten questions (Table 1).

Table 1. Basic mathematics questionnaire for the patient

Do the following operations:
1. Make a circle and divide it into halves, then shade one-half.
2. Make a circle and divide it into quarters, then shad two quarters.
3. Imagine the shaded parts of the previous two circles and tell how much you get.
4. Add 27 + 13:
5. Add 2.1 + 4.2 + 6.4 + 12.8 =

6. Add ½ + 2/4
7. Say how many apples are 10% (ten percent) of 100 apples.
8. Multiply 20.4 X 4.1 =
9. Divide: 4 / 0.5
10. Divide: 10.2 /2.1

Laboratory

Glycated hemoglobin (HbA1c) was done in the first consultation according to standardized procedures recommended by the International Federation of Clinical Chemistry and Laboratory Medicine (IFCC) in the State Laboratory of Reference.

Statistics

The data tabulation was represented with measures of central tendency. The Spearman correlation test was used between HbA1c and the mathematical test punctuation. From a list of countries with similar cut-off point of metabolic control for gestational diabetes the Spearman test was performed between the percentage of pregnant women that were classified in the group that registered HbA1c $\leq$ 6.5 and the Education Index of the country where the study was performed. All data was registered in an Excel sheet and analyzed with a free online Statistical Web Page (18) considering a p value of less than 0.05 as significant.

Ethics

The Research Committee and the Ethics on Research Committee of the HMPMPS (code 2016-10-487) approved the study. The process complied with the ethical principles of the Declaration of Helsinki (Fortaleza, Brazil), and written informed consent was obtained from all patients.

RESULTS

31 patients with a mean age of 29 ± 6.7 years old accepted to take part in the survey. Table 2 shows the general characteristics of them. The education level was as follows: 5 (16.12%) with Primary School, 20 (64.51%) with High School, 2 (6.45%) with Preparatory School, 2 (6.45%) with technical studies and 1 (3.22%) that finished the University. Their occupations were home: 23 (74.19%), merchant: 2 (6.45%), stained glass: 1 (3.22%), dedicated to sewing: 1 (3.22%), cooking: 1 (3.22%), sewing: 1 (3.22%), security job: 1 (3.22%) and self-business 1 (3.22%).

Table 2. General characteristics of the patients

Variable	Value
Age (years)	29.03 ± 6.8
Gestational age (weeks)	21.93 ± 6.9
Mathematics knowledge test (0-10)	4.32 ± 2.77
HbA1c (%)	6.92 ± 1.45
Indicated diet (kcal)	1686.21 ± 148.14
Family history of diabetes (%)	83.87
Smoking before pregnancy (%)	61.29
Active smoking (%)	19.35
Hypertension (%)	54.84

Obesity (%)	54.84
Family history of VCD (%)	32.26
Dyslipidemia (%)	29.03
Alcoholism before pregnancy (%)	41.94
Active alcoholism (%)	19.35

HbA1c: glycated hemoglobin

Table 3 shows more examples of reports around the world of target percentages in pregnant diabetic women and the information about the education level of the country (19).

The Spearman test showed a negative correlation between the mathematical test punctuation and the HbA1c (r^2 = -0.395, $p \leq 0.001$) but a lack of correlation between the percentage of pregnant women that were classified in the group that registered HbA1c ≤ 6.5 and the Education Index of the country where the study was performed (r^2 = -0.8, p = 0.10409).

DISCUSSION

Despite the available information in internet and social media, pregnant women and specifically those with GDM still believe that the health professionals are important resources for their health (29). However, due to lack of time in the real every-day clinical life, the advice from the

Table 3. Percentage of gestational diabetic patients that reach a metabolic targets and the Education Index of the country

Country	**Education Index**	**Recommended cut off point**	**% that reached target**
Australia(20)	0.929	HbA1c < 5.9%	90
Brazil(21)	0.686	HbA1c ≤ 6.5%	84.37
Malaysia(22)	0.719	FPG < 5.6 mmol/L (HbA1c < 5.15%)	59.6
Mexico(23)‡	0.678	HbA1c ≤ 6.5%	79.8
New Zeeland(17)	0.917	Improved	24.51
Peru(24)	0.689	HbA1c < 7%	55.81
Qatar(25)*	0.698	HbA1c < 6.5%†	34.6
South Africa(26)	0.708	HbA1c < 6.2%	51.06
UK (27)	0.914	HbA1c < 6.5%	Mean 25.65 (14.3 for type 1, 37.0 for type 2).
USA(28)	0.903	HbA1c < 6.5%	23.63

*With Type 1 Diabetes mellitus, ‡: Patients with Diabetes mellitus Types 1 and 2 and with recently diagnosis of Gestational Diabetes.

† In the last trimester

professionals might not be enough, leading to scarce information about self-monitoring of blood glucose, diet election, physical activity, etc.

Education level and targets in the self-control of diabetes have been extensively studied. For example Carolan et al showed that lower levels of health literacy and risk awareness of GDM might relate to a risk for poorer self-management of GDM (30). As a matter of fact, in USA, Caucasians reach higher education level than African-American women and the latter begin their pregnancy with higher HbA1c levels (31). Reinforcing this notion, previous studies have shown that lower levels of health literacy and risk awareness of GDM might relate to a risk for poorer self-management of GDM (30,32). Even more, persistent postpartum glucose metabolism disorders are frequent in women with GDM and associated with lower maternal educational level (33).

Epidemiologic risk factors for poor glycemic control have been studied in non-pregnant diabetic patients but not during pregnancy (34,35). Although there are many publications in relation to HbA1c in GDM (36,37), in general, few report the percentage of the studied populations that reach a defined control target and even less discuss the education level of the patients.

In this survey, it is clear the handicap of our patients, being more of them poor, condition that has not been overcome, is a wall to get access to for a better education. The low score in the mathematics test suggests that they cannot understand the indications about calories count and we must then define a time schedule to offer an education plan about GDM explaining the basic knowledge to reach a good metabolic target.

Once a systematic review was made in PubMed, with the terms: "gestational diabetes mellitus + A1c (glycated hemoglobin or HbA1c)", a considerable heterogeneity was found in the biochemical variables (fasting glucose, glucose curve with oral load of 50 or 75 g of glucose, HbA1c), to define an adequate metabolic control during pregnancy, and not only in the cut-off point of the last one but also in the pregnancy period in which the sample was taken. Thus, the lack of correlation between the Education Index and the percentage of women with GDM, with HbA1c values lower than 6.5%, in a random sample of studies developed in Brazil, Mexico, Qatar, USA and UK, reflects the heterogeneity of criteria to include pregnant women with hyperglycemia (Type 1 Diabetes Mellitus, T2DM, GDM), the time of HbA1c quantification (early pregnancy, third trimester) or the type of intervention (diet, exercise, education, etc.).

In the specific case of the State of Mexico, the HMPMPS is a referral hospital for the care of high-risk obstetrical patients. Within the complexity that they carry, it is added the fact of being of an unfavorable socioeconomic level stratum, with educational levels below the national average and even speakers of some native language of Mexico, all of which limit the assimilation and practice of the recommendations indicated by the health team, to achieve a desirable metabolic control.

Our hospital attends vulnerable people and is expected to find similar difficulties such as those describe for black women such as racism, lack of knowledge, misinformation about diabetes, lack of access to care, poverty, and cultural values (38). Interventions aimed at this risk group may contribute towards a decrease in postpartum prevalence of glucose metabolism disorders. The strategy of designing education plans for patients with diabetes may be the only effective tool to compensate for the lack of health literacy and low education level of the patients (39).

The present study focused on vulnerable pregnant population in Mexico, which is the most valuable issue of this project. However, there are limitations in the study. First, the present qualitative study used small sample size, so the findings can only represent these women in this study, and second it was lacking of serial measures of HbA1c. Thus, it should be desirable to continue the research line in a prospective way to evaluate the effect of educative interventions in pregnant women with GDM focused at reaching the optimal metabolic control, and one of the research edges should be taken into account the preference in the diet for foods with low glycemic index (40).

CONCLUSIONS

Limit knowledge in basic mathematics restricts the expectation to get an optimal metabolic control in gestational diabetes mellitus.

An education program, target to pregnant women with GDM designed in every medical center, taking in consideration the culture of the population being attended, offers the best option to compensate the low educative level that might have some social groups and the scarce health literacy that physicians faces continuously.

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Conflict of interest

All authors declare that there is no conflict of interests.

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