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Research Article

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Quantitative Analysis of Oral Glucose Tolerance Test Using Two Glucose Doses on Pregnant Women Attending Nyahururu County Hospital Laikipia County Kenya

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Keywords

Diabetes,
Pregnancy,
oral glucose doses.

Abstract

Background: Gestational diabetes mellitus is a major disease condition affecting pregnancy. Approximately 10% of pregnant women are affected by diabetes. Diabetes during pregnancy accounts for up to 87.5% of all pregnancy related complications which may persist even after pregnancy. Type 1 diabetes contributes to 7.5 percent of pregnancy complications whereas type 2 accounts for only up to 5 percent. It is thought that gestational diabetes is a variant of type 2 diabetes. **Objective:** To establish the most appropriate dose of oral glucose challenge in determining diabetes among the pregnant women attending Nyahururu County Hospital. **Design:** Comparative cross-sectional study. **Setting:** Nyahururu county hospital, Laikipia County, Kenya. **Subjects:** One hundred and twenty eight (128) pregnant women. **Results:** The data was subjected to a Pearson correlation test and the obtained r- values 0.1008, 0.1253, 0.0568, 0.0096, 0.0427 and 0.12275 for the respective time intervals were less that the r-critical value of 0.2461 thus there was no significant variation between the two oral glucose doses at 95% confidence interval. **Conclusion:** There was no statistically significant quantitative variation in oral glucose challenge doses used in diagnosing gestational diabetes mellitus among pregnant women attending antenatal clinic in Nyahururu County Hospital. Therefore the null hypothesis was accepted.

Introduction

Approximately 10% of pregnant women are affected by diabetes that accounts for up to 87.5% of all pregnancy related complications which may persist even after pregnancy. Type 1 diabetes contributes to 7.5percent of pregnancy complications whereas type 2 accounts for only up to 5 percent [1]. Poorly controlled diabetes in pregnancy may lead to intrauterine fetal death during the last Four to Eight weeks, Macrosomia, and respiratory distress. In future pregnant women with untreated diabetes have high chances of developing type 2 diabetes mellitus and very occasionally Type 1. They also have high chances of undergoing caesarian and developing

pre-eclampsia. Their children are prone to obesity and type 2 diabetes [2] . Donovan further noted that the majority of the pregnant women can manage their diabetes by modifying their diet and engaging in light exercises except for those who require anti-diabetic drugs such as insulin. Amos and McCarty (1997) as quoted by [3] noted that this condition has negative effects to the society as a whole due to the cost involved the economy is affected and the productivity of the family involved.

In the past similar diagnostic methods have been used for GDM and for non-pregnant persons. However this changed in 1964 after O'Sullivan and Mahan noted that carbohydrate metabolism was affected by pregnancy. They therefore came up with diagnostic criteria after using 100g OGTT for 3 hours on 752 randomly selected pregnant women. This was done at different times within the pregnancy and their results were used to diagnose GDM. A lot of adjustments have been made over the last 30 years. In the past 20 years glucose challenge test has become the common test for screening diabetes in pregnancy. Different races and ethnic groups have different susceptibility to GDM, insulin dependent diabetes mellitus (IDDM) and non-insulin-dependent diabetes mellitus (NIDDM). Other predisposing factors to GDM may include but not limited to age, obesity, history of glycosuria and family history of diabetes. These differences hindered the clear understanding of GDM due to divergences among populations [3].

This study aimed at establishing the most effective dose of oral glucose challenge to be used on pregnant women in order to determine potential diabetic cases. In this study two level approaches were applied i.e. monitoring of blood sugar after administering the glucose orally and monitoring urine glucose clearance so as to establish the most effective oral glucose dosage in determining the diabetic cases and establish the quantitative variation in blood glucose levels among pregnant women challenged with various oral glucose doses.

Oral glucose tolerance test (OGTT) is a rapid diagnostic procedure in which varied doses of glucose are administered orally and the absorption and clearance rates monitored by taking periodical blood samples. Diabetes, insulin resistance and impaired cell function are usually screened using the OGGT. It further diagnoses the body's capacity to utilize glucose which is the main source of energy as well as diagnosing pre-diabetes and gestational diabetes [4]. Over the years, many quantitative variations in doses of OGTT have been used to screen gestational diabetes mellitus. With different standard doses of glucose at 50g for screening of gestational diabetes if elevated levels it is followed with 100g for pregnant women. In adults 75g oral dose is used to determine diabetes whereas in children, various doses are used depending on the weight [5]. Confirmatory tests done along with OGTT include urine samples which are also collected for testing along with blood sugar tests to help detect the presence of glucose in urine i.e. glycosuria. This study will establish the presence of glucose in urine among pregnant women challenged with various oral glucose doses and also to establish how the varied oral glucose levels among the patients compares.

Materials and Methods

Study Design

A comparative cross-sectional study design was adopted. This is a study that involves a single point of data collection for each participant or system being investigated. This entails investigation of static phenomena and involves data collection from a population or sample at a particular point in time.

Study Area

This study was done at Nyahururu County Hospital Antenatal clinic (ANC) and Laboratory department. Nyahururu County Hospital is one of the two major hospitals in Laikipia County thus it provided adequate data for the study. Nyahururu is a rural-urban town in Laikipia West Sub-county, Laikipia County.

Study Population

All pregnant women attending Nyahururu County Hospital ANC who consented, with no history of diabetes, pancreatic diseases, any form of cancer or chronic illness.

Sample Size determination

The sample size for this study was estimated using the Daniel formula of 1999[6] and the sample size was 128 respondents.

Sampling Procedure

A systematic sampling procedure was used where the 1st respondent was selected randomly after which every 3rd client was selected. The patient came to the laboratory from the antenatal clinic, the purpose and importance of the study was well explained. The patient was taken through the procedure of the tests. Those who agreed

signed the consent form. The screening glucose challenge test was done to the consented patient, where a random blood sugar was tested using capillary blood and a glucometer (using hexokinase) method. The patient was then given a solution of 50g of glucose load dissolved in 150ml of water to which citric acid was added to reduce nauseating effect to drink, which they ingested between 5- 10 minutes. After one hour the blood sugar was repeated and the results was recorded in the data sheet and also in a request form. All the patients were booked for the next visit for the OGTT and they were advised to fast overnight the day prior to the test and come early by 8.00am. Those with blood sugars of ≥7.8mmol/l were treated as the cases whereas those with ≥7.8mmol/l were treated as the controls.

The fasting blood sugar done after which some of the patients were challenged with 100g glucose load and others with 75g glucose load dissolved in 250ml of water to be taken between 5-10minutes. The patients were advised to restrict physical activity during the period of the test and were given health education materials to read and there after blood sugar test was done every 30 minutes up to a period of two and half hours.

Testing of glucose in urine

The first sample was collected after which other urine samples were collected every one hour up to two hours. The patient was given a urine container which was well labeled with the patient's details. Clear instructions were given on how to collect the urine sample. Once the specimen was brought to the laboratory, it was tested for glucose, protein and ketones using uristix.

The data recorded in the data sheet was used for analysis for the research purposes. Those with no GDM were released to continue with the normal antenatal clinic whereas those who were diagnosed with GDM were taken to a consultant for management and were referred to care as per NCH protocols for proper follow-ups.

Experimental and laboratory techniques

A capillary blood was drawn from the patient. Using an alcohol swab the finger was sterilized and allowed to air dry. A finger prick was done using a sterile disposable needle, the first drop was wiped using sterile dry gauze and the second drop was used to perform the blood sugar test. The blood sugar was tested using a glucometer and glucostix (hexokinase method) and the results obtained recorded in a patients request form and also entered in a data sheet.

Hexokinase method

Glucose reagent is used to measure the concentration of glucose by a timed end point reaction method. In the reaction, hexokinase catalysed the transfer of phosphate group from adenosine triphosphate (ATP) to glucose to form adenosine diphosphate (ADP) and glucose-6-phosphate. The glucose-6-phosphate was then oxidized to 6-phosphogluconate with the concomitant reduction of ß-nicotinamide adenine dinucleotide (NAD) to reduced ß-nicotinamide adenine dinucleotide (ß-NADH) by the catalytic action of glucose-6-phospate dehydrogenase (G6PDH).

$$\text{Glucose} + \text{ATP} \xrightarrow{\text{HK}} \text{Glucose-6-phosphate} + \text{ADP}$$

$$\text{Glucose-6-phophatase} + \text{NAD} \xrightarrow{\text{+G6P-DH}} \text{6-phosphagluconate} + \text{NADH} + \text{H}^{+}$$

Quality control

A quality control solution was tested every morning using a glucometer and glucostix; this was done to ensure quality results were obtained and that the machine was working properly. The results of the control were also recorded in the data sheet.

Data collection, management and presentation

Data collection tools included a structured questionnaire that was administered at the time of recruitment for collection of demographic information. Recruitment was conducted from Monday to Friday when the ANC was open. The results of the OGTT were entered in a data sheet.

Data was then coded and input in the computer using acceptable statistical package SPSS version 20.0 for windows 7. Data was cleaned and subjected to Pearson's coefficients test to test for any variation and r-value of ≥0.2461 was taken to be statistically significant. Also F-test was used to test for effectiveness of the two methods and f-value of ≥1.60 was taken to be statistically significant. Descriptive analysis was done by the use of frequency distributions and means as measured by percentages and presented in form of tables and line graphs, then discussions. Recommendations were drawn from the inferences obtained from the study findings.

Ethical Considerations

Institutional approval of the study was sought from Nyahururu County Hospital and Laikipia County Health Department. Ethical clearance was obtained from the

Mount Kenya University Ethics Review committee (Ref. No. MKU/ERC/0075). A research permit was also obtained from NACOSTI (Permit. No. NACOSTI/P/16/59842/13755). All information and data obtained from the patient who consented and was treated with utmost confidentiality and used for research purposes only.

Results

Table 1: Glycosuria levels using 75g and 100g OGTT

	75g OGTT		75g OGTT	
	1 hour	**2 hours**	**1 hour**	**2 hours**
Positive	3(2%)	3(2%)	3(2%)	3(2%)
Negative	125(98%)	125(98%)	125(98%)	125(98%)
TOTAL	**128**	**128**	**128**	**128**

Table1: Results for glycosuria at 1 Hour and 2 Hour intervals for the 75g OGTT and 100g OGTT doses. The two glucose two tests for glycosuria levels showed no significant variation. Both tests recorded 98% negative for glycosuria result for I hour and 2 hours and 2% positive for glycosuria for both 75 g and 100 g OGTT loads.

Table 2: Variation between 75g and 100g OGTT

	Mean		Mean Pearson's Coefficient (r)
	75g-OGTT	**100-g OGTT**	
0 Hours	4.305	4.319	0.1008
0.5 Hours	6.447	6.4469	0.1253
1Hour	6.542	6.5422	0.0568
1½ Hours	6.270	6.2703	0.0096
2Hours	5.919	5.9188	0.0427
2 ½ Hours	5.3234	5.1844	0.12275

CI= 95%

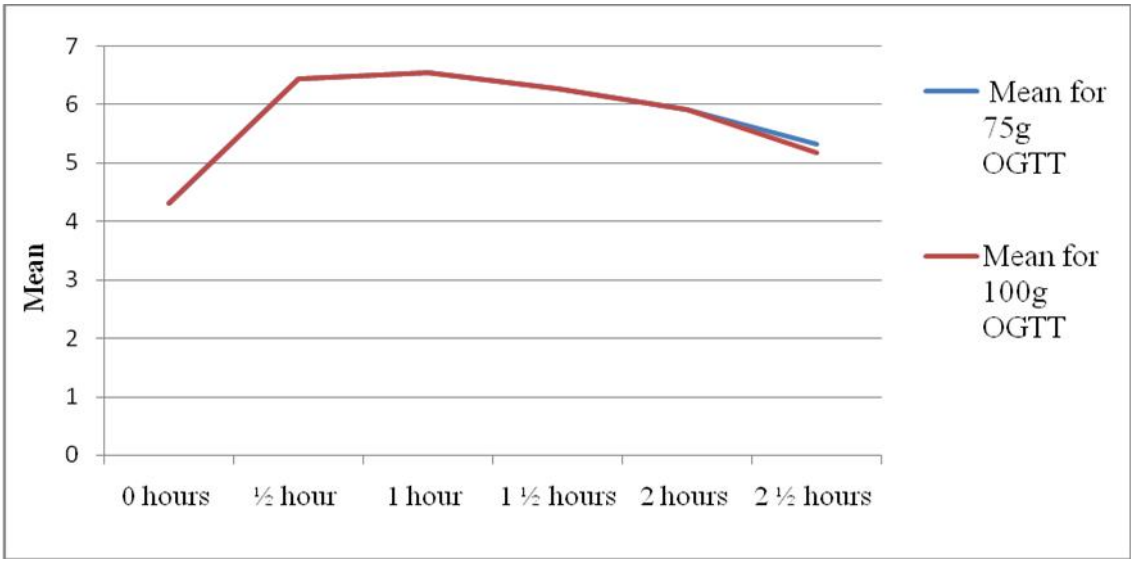

Figure 1 Variation between 75g and 100g OGTT

Table 2 and figure 1: There was no significant variation in oral glucose challenge doses used in determining GDM among pregnant women attending ANC in Nyahururu County Hospital. Means of 75g OGTT at fasting, 0.5hours, 1hour, 1.5 hours, 2 hours and 2.5 hours were compared with the means of 100g OGTT at similar time intervals and there was no significant variation in the blood sugar levels.

The blood sugar levels at fasting, 0.5hours, 1hour, 1.5 hours, 2 hours and 2.5 hours were subjected to a pearson correlation test and the obtained r- values 0.1008, 0.1253, 0.0568, 0.0096, 0.0427 and 0.12275 respectively were less that the r-critical value of 0.2461 thus there was no significant variation between the two oral glucose doses used in determining the GDM among pregnant women attending ANC at Nyahururu County Hospital.

Table 3: Effectiveness of 75g and 100g OGTT

Time	75g-OGTT	100-g OGTT	F-test (Critical value 1.60)
0 Hours	4.305	4.319	0.5555
0.5 Hours	6.447	6.4469	0.9332
1 Hour	6.542	6.5422	0.6502
1½Hours	6.270	6.2703	0.5803
2Hours	5.919	5.9188	0.3619
2 ½ Hours	5.3234	5.1844	0.1878
Standard deviation	**0.8563**	**0.8689**	

Table 3 indicates that these two methods of OGTT are equally effective in diagnosing GDM since the standard deviations were 0.8563 for 75g OGTT and 0.8689 for 100g OGTT. The data was subjected to F-test to test the effectiveness of the two diagnostic methods and the values for the respective time intervals were less than the critical value of 1.60 thus were falling within the acceptance region which also showed that the two methods were equally effective.

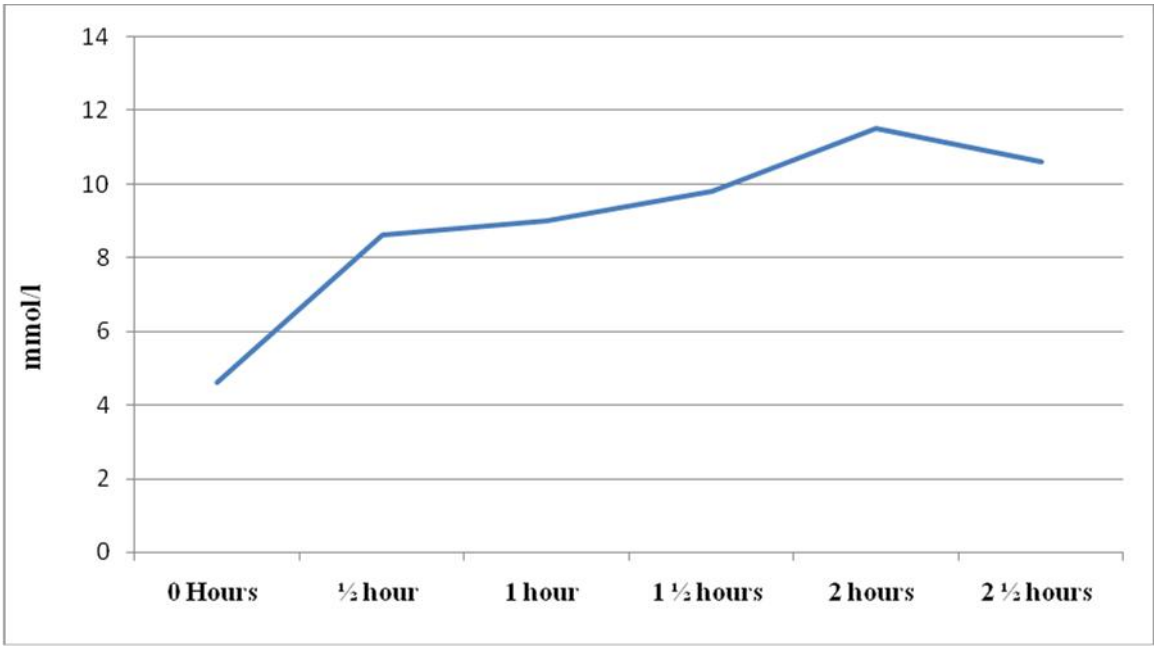

Figure 2: Result for a patient who was diagnosed to have GDM

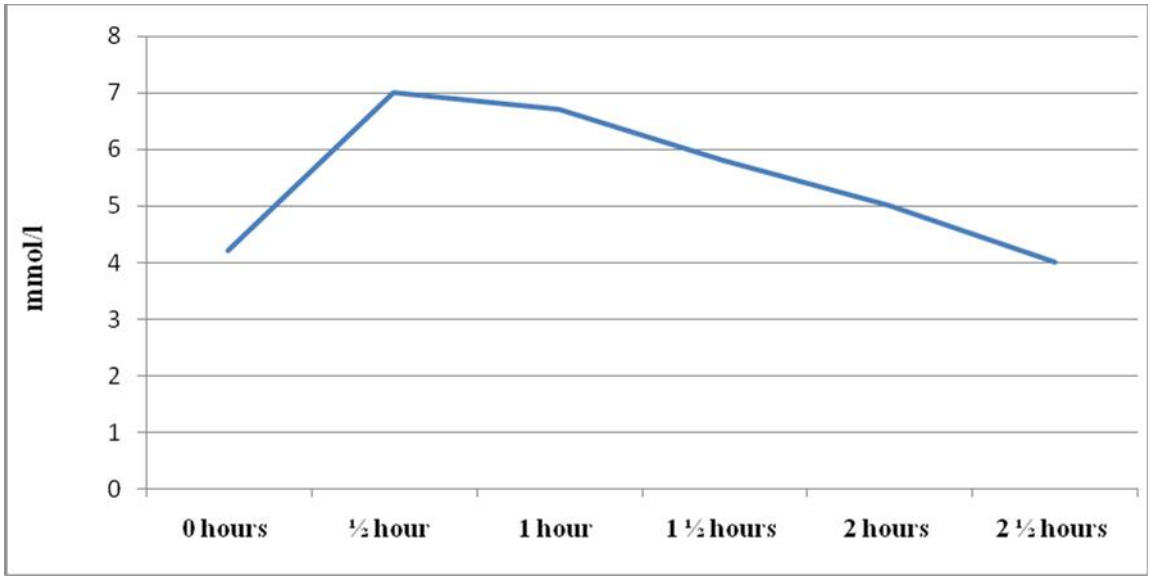

Figure 3: Results for the study control.

Discussion

Summary of the study

The study comprised of 128 patients who were challenged with glucose doses. 64 patients were challenged with 75g oral glucose dose and the other 64 patients with 100g glucose dose. The means of 75g OGTT at fasting, 0.5hours, 1hour, 1.5 hours, 2 hours and 2.5 hours were compared with the means of 100g OGTT at similar time intervals and were found to be as follows. For the 75g OGTT: 4.305, 6.447, 6.542, 6.270, 5.919 and 5.3234 at the respective hours. Those for the 100g OGTT were: 4.319, 6.4469, 6.5422, 6.2703, 5.1988 and 5.1844 at the respective hours. The data was subjected to a Pearson correlation test at 95% CI and the obtained r- values 0.1008, 0.1253, 0.0568, 0.0096, 0.0427 and 0.12275 for the respective time intervals were less that the r-critical value of 0.2461 thus there was no significant variation between the two oral glucose doses used in determining the GDM among pregnant women attending ANC at Nyahururu County Hospital. Earlier studies had noted that there is no agreement on the analytical method to be used in diagnosing GDM [7]. But a comparative study by [8]found out that there was a significant variation between 100g and 75g OGTT since the prevalence of GDM was higher for 100g OGTT than 75g OGTT. There was a weak agreement in the results of GDM for 100g and 75g OGTT[9].

The two glucose loads for testing for glycosuria levels showed no significant variation. Both tests recorded 98% negative for glycosuria result for I hour and 2 hours while the fasting results were 2% positive for glycosuria for both 75 g and 100 g OGTT loads. So far no study has been carried out comparing the glycosuria levels among pregnant women or other individual using 100g and 75g OGGT. The 98% who presented no glycosuria was because their blood glucose level was within the normal and had a normal renal threshold and thus their renal tubules were able to reabsorb all the glucose back to the blood stream. The 2% who had glycosuria in their urine was as a result of high blood glucose levels which led to low renal threshold that their renal tubules were unable to absorb all the glucose that was presented. This could also be as a result of pregnancy, during that period the renal threshold for glucose may be lowered[10].

In the test of the effectiveness of the two doses i.e. 75g OGTT and 100G OGTT in diagnosing GDM Standard deviations of their means were 0.85631766 and 0.86886408 respectively which indicated a statistically insignificant variation. The data was also subjected to F-test at 95% CI to test for the effectiveness of the two diagnostic methods and the values for the respective time intervals; 0.5555, 0.9332, 0.6502, 0.5803, 0.3619 and 0.1878 were less than the critical value of 1.60 thus were falling within the acceptance region. The two methods are equally effective and thus either can be adopted in the diagnosis. These findings were in agreement with ADA (2002) as quoted in [11]which stated that the values of the two GDM screening methods (75g and 100g OGTT) are similar. Insulin plays an important role in the metabolism of

carbohydrates, proteins and fats by enhancing the absorption of glucose from the blood into fats, liver and skeletal muscle cells. Under normal circumstances increased levels of glucose in the blood stimulates the beta cells of the pancreas to release insulin which in turn acts on the cells to enhance uptake, utilization and storage of glucose. After an oral glucose dose challenge, the blood glucose level rises and stimulates the production of insulin which enhances the uptake and utilization of the blood glucose and thus after the 2 and ½ hours in a non-diabetic patient the glucose levels return back to normal. In a diabetic patient, the blood glucose levels remain high due to the insufficient levels of insulin or due to insulin resistance. The high level of pregnancy hormones leads to insulin resistance and reduces its sensitivity [12].

Conclusions

Statistically there was no significant quantitative variation in oral glucose challenge doses used in diagnosing gestational diabetes mellitus among pregnant women attending ANC in Nyahururu County Hospital. Therefore the null hypothesis was accepted.

The two doses were equally effective in the determination of glycosuria levels since 98% tested negative for 75 g and 100 g doses at 1 hour and 2 hours while only 2% tested positive for the two tests.

The use of 75 g OGTT and 100 g OGTT loads were found to be equally effective in GDM diagnosis as was shown by the standard deviation of the means and F-test. Therefore the two analytical quantitative oral glucose tolerance tests can be used in the diagnosis of gestational diabetes mellitus interchangeably in clinical diagnostic laboratories.

Recommendations

Nyahururu county hospital should adopt the use of 75g glucose dose for the purpose of standardization of the process of screening and diagnosis of gestational diabetes mellitus, since the 100g glucose dose is too much and thus nauseating leading to vomiting hence premature end of the test.

To the Laikipia county department of health and the Ministry of health at large in diagnosis of GDM in future the research recommends adoption of 75 g glucose dose in performing OGTT since there is no statistical variation with the commonly used 100 g dose and it is also cost effective.

There is a need for further studies to determine the cause of persistent glycosuria in-cases where the blood sugar is consistently normal. Also a follow up study should be carried out to assess the impacts of gestational diabetes mellitus on fetal and maternal outcome in our hospital setup.

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