Journal of Obstetrics and Gynaecology (November 2003) Vol. 23, No. 6, 640–642

Taylor & Francis
healthsciences

OBSTETRICS

Fasting plasma glucose levels in normal pregnant Nigerians

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Summary

A study was undertaken to determine a reference value for fasting plasma glucose in a group of apparently normal pregnant Nigerian women. Three hundred and twenty women were tested; 260 pregnant and 60 non-pregnant. There were 60, 100 and 100 subjects in the first, second and third trimesters, respectively. Fasting plasma glucose was measured in each of the women using the glucose oxidase method. The mean fasting plasma glucose level was 4.64 ± 0.79 mmol/l in the control group and 3.72 ± 0.58, 3.78 ± 0.81 and 3.81 ± 0.85 mmol/l in the first, second and third trimesters of pregnancy, respectively. Mean fasting plasma glucose + 2 standard deviations (SD) of all the pregnant women was 5.3 mmol/l, which is much lower than the World Health Organisation value for the diagnosis of diabetes mellitus.

Introduction

Fasting glucose measurements are used in the diagnosis of diabetes in pregnancy and to monitor the patients' glycaemic control during the course of pregnancy. They have also been found to be useful in screening for gestational diabetes (Perucchini *et al*., 1999; Hanna and Peters, 2002). The reference levels currently in use are derived mainly from studies conducted on pregnant patients from the United States of America (O'Sullivan and Mahan, 1964) and on non-pregnant adults (WHO, 1985). It is known that the prevalence of gestational diabetes is highly dependent on ethnicity (Dornhorst, 1994). Some authors have also found worsening glucose tolerance as pregnancy advances (Hatem *et al*., 1988) and it may thus be necessary that different populations have their own reference glucose levels so as to prevent the complications that may occur from inadequate diagnosis and monitoring of women with diabetes in pregnancy. The aim of this study is to determine the reference level for fasting blood glucose in a population of normal pregnant Nigerian women in different stages of pregnancy.

Material and methods

The patients were recruited from the antenatal clinic of the Lagos University Teaching Hospital after giving informed consent to participate in the study. Recruitment into the study was performed consecutively and included women who were sure of their last menstrual dates. Other inclusion criteria were ages 18–35 and good health. The following patients with risk factors for gestational diabetes were excluded: known diabetic patients, patients with significant medical disorders such as hypertension, cardiac and renal disease, smokers and patients with obstetric complications such as pre-eclampsia and polyhydramnios. Patients with predisposing factors for diabetes such as previous baby weighing more than 4000 g, history of stillborn birth, early neonatal death of unknown cause, infant with congenital malformation, family history of diabetes and weight greater than 85 kg at booking were also excluded.

A second group of healthy non-pregnant subjects, also between the ages of 18–35, was recruited from the gynaecological and staff clinics and the School of Nursing and Midwifery. Patients who were on oral or injectable contraceptives or body mass index greater than 25 were excluded from this group.

All tests were performed in the morning, from 0900 hours, after an overnight fast of about 12 hours. After resting for 30 minutes, 3 ml of blood was collected in fluoride oxalate bottles for the fasting glucose level in each patient. The blood samples were centrifuged immediately, and the plasma was separated and stored at -20°C. All samples were analysed within 5 days of collection.

Plasma glucose was analysed using the glucose oxidase method, with the Peridochrom Glucose Kit (GOD–PAP method), obtainable from Boehringer Mannheim, Germany (cat. no. 676543).

Statistical analysis was by the independent *t*-test and analysis of variance, where appropriate, using the SPSS® statistical software. The proposed upper limit of normal for fasting plasma glucose was calculated by adding the mean fasting glucose level to 2 SD of the mean (O'Sullivan and Mahan, 1964).

Results

Of 331 women, 320 completed the study, five having been excluded because of severe nausea and vomiting and another six because of evidently diabetic fasting blood sugar levels. There were 60 non-pregnant controls and 60, 100 and 100 patients in their first, second and third trimesters of pregnancy, respectively. The distribution of age and maternal weight among the groups is as shown in Table I. The mean birth weight of all the babies was 3.19 ± 0.45 kg. There were six babies greater than 4 kg in weight and the maximum birth weight was 4.50 kg.

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ISSN 0144-3615 print/ISSN 1364-6893 online/03/060640-03
DOI: 10.1080/01443610310001604420

Table II shows the mean fasting plasma glucose levels in the different groups of women studied. The mean fasting plasma glucose was higher in the non-pregnant controls than in all the pregnant women pooled together and this was statistically significant, $P < 0.001$. The mean fasting plasma glucose level of the control group was also significantly higher than that of each of the individual trimesters, $P < 0.001$ in each case. There was no significant difference in mean fasting plasma glucose between the three trimesters of pregnancy.

The mean fasting plasma glucose plus 2 SD of all the pregnant patients pooled together was 5.3 mmol/l.

Discussion

We found an upper limit of normal for fasting plasma glucose that was much lower than the WHO diagnostic criteria for both gestational and non-gestational diabetes mellitus, which is a fasting plasma glucose of 7.8 mmol/l and above. The report of a recent WHO consultation recommended that the diagnostic fasting plasma glucose level be reduced to 7.0 mmol/l (WHO, 1999). Even when compared to this, the proposed upper limit of 5.3 mmol/l found in our study was still much lower. Similar figures to, and even lower than, our fasting glucose figures have been found in other Nigerian studies (Famuyiwa *et al.*, 1988; Okonofua *et al.*, 1995) (Table III), one of which studied an unselected group of pregnant women (Okonofua *et al.*, 1995). Studies from different ethnic groups have also found levels lower than the WHO criteria for their own populations of low-risk women (Hatem *et al.*, 1988; Cheng and Salmon, 1993) (Table III) and it has been suggested that different populations should have their own reference values (Famuyiwa *et al.*, 1988). Measurement of the levels of anti-insulin hormones such as cortisol, human placental lactogen and glucagon in pregnancy may help determine the cause of the reduced fasting glucose levels seen in our population.

We found that the mean fasting plasma glucose of the non-pregnant controls was significantly higher than that of the pregnant patients when pooled together and when analysed by each trimester. This is expected, as fasting glucose concentrations are known to be lower in pregnancy than in the non-pregnant state (MacDonald *et al.*, 1971; Hanna and Peters, 2002; Nelson-Piercy, 2002). We also found no difference in fasting glucose levels between any of the different trimesters of pregnancy. Although glucose tolerance is often said to decrease progressively with increasing gestation (Sacks *et al.*, 1995; Nelson-Piercy, 2002), fasting glucose concentration does not appear to be influenced by gestational age in normal pregnancies (MacDonald *et al.*, 1971; Sacks *et al.*, 1995; Perucchini *et al.*, 1999) and our study corroborates this finding. Taylor *et al.* (1981) did not find a significant change in fasting blood

Table I. Comparison of age and weight between controls and all pregnant women pooled together

	Control (n = *60)*	*Pregnant* (n = *260)*	*Significance**
Age			
Mean	27.03	28.43	$P = 0.02$
Median (range)	26.5 (19–35)	28.5 (19–35)	
Mean weight in kg	66.59	64.54	NS

*Independent *t*-test. NS = not significant.

Table II. Mean fasting plasma glucose levels in all the groups of patients studied

	Control (n = *60)*	*1st trimester* (n = *60)*	*2nd trimester* (n = *100)*	*3rd trimester* (n = *100)*	*Significance**
Mean fasting	(4.64 ± 0.79)	(3.72 ± 0.58)	(3.78 ± 0.81)	(3.81 ± 0.85)	$P < 0.001$ (C: 1,2,3)
Plasma		(3.72 ± 0.58)	(3.78 ± 0.81)		$P = 0.66$
Glucose		(3.72 ± 0.58)		(3.81 ± 0.85)	$P = 0.51$
(mmol/l ± SD)			(3.78 ± 0.81)	(3.81 ± 0.85)	$P = 0.79$

*One-way analysis of variance. SD = standard deviation. (C: 1,2,3) = *P* value for difference between control group and all pregnant patients.

Table III. Table of comparison of different proposed upper limits for fasting plasma glucose concentration

Study	*Proposed upper limit for fasting plasma glucose concentration in mmol/l*
Famuyiwa *et al.* (*n* = 20)	5.3
Okonofua *et al.* (*n* = 127)	4.8
Hatem *et al.* (*n* = 212)	4.9
Cheng and Salmon (*n* = 64)	4.9
Present study (*n* = 260)	5.3

glucose levels throughout pregnancy in a study of normal pregnant Nigerians.

Our patients were comparable in age and weight. The distribution of birth weight of the babies also shows that the patients were likely to have truly been non-diabetic patients.

Different women were studied in the three trimesters of pregnancy for this study. Longitudinal data in one group of women would yield stronger results in confirming the lack of change of fasting blood glucose with gestational age in this study.

The patients in this study were of low risk for diabetes mellitus and this may explain the lower fasting glucose levels. Studying an unselected population would clarify this further. Nevertheless, the fact that our population have a much lower fasting plasma glucose concentration than the regularly used diagnostic criteria must be taken into consideration when screening for or monitoring diabetes in pregnancy.

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