ORIGINAL ARTICLE

Prevalence of gestational diabetes mellitus among women born in Greenland: measuring the effectiveness of the current screening procedure

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Received 13 October 2009; Accepted 7 April 2010

ABSTRACT

Objectives. To estimate the prevalence of gestational diabetes mellitus (GDM) among Greenlanders and to evaluate the quality of the current screening procedure for gestational diabetes.

Study design. Observational retrospective study of consecutive birth-log data and medical records on pregnant women who had given birth in Nuuk during 2008.

Methods. Information about maternal weight, weight gain in pregnancy, height, blood pressure, result of oral glucose tolerance test, family history of diabetes, smoking and alcohol habits, ethnicity, delivery and birth weight and length was collected for women who had given birth in Nuuk, Greenland, during 2008.

Results. A total of 233 women born in Greenland who had given birth to a singleton in Nuuk 2008 were included in the study. Of those, 37% were defined as having a high risk for GDM and thus met the screening criteria for GDM used in Greenland. However, only 54% of those women were screened. The prevalence of gestational diabetes was calculated to be 4.3% among high-risk Greenlandic pregnant women (2/46) (95% CI 0–10.0%).

Conclusions. Despite a suboptimal screening rate, the prevalence of GDM among Greenlanders seems to be relatively low and Greenlanders may thus be less prone to develop GDM. However, diabetes mellitus is a relatively new disease in Greenland, and glucose intolerance in pregnancy is more likely to affect the next generation. The screening rate is suboptimal, and it is recommended that the screening procedure be optimized in order to find and treat all women with GDM. The number of screened women compared to the number of births occurring annually could be used as an indicator of screening efficacy. Diabetes prevention initiatives should be given high priority to avoid high rates of GDM in the future, as increasing prevalence of the disease is now seen worldwide, regardless of race.

(Int J Circumpolar Health 2010;69(x):352–360)

Keywords: Greenland, diabetes mellitus, pregnancy, gestational diabetes mellitus, Inuit
INTRODUCTION

Previously, type 2 diabetes mellitus (T2DM) was almost non-existent in Greenland (1). However, an increase in the disease has been tracked over the past two decades. Epidemiological studies performed from 1999 to 2002 have reported a high prevalence of T2DM among Greenlanders (2). A high prevalence of diabetes has also been reported among Greenlandic migrants living in Denmark (3). The prevalence of diagnosed T2DM in Greenland has been relatively low, reported at around 2% among adults at or above 40 years of age in the beginning of 2008 (4).

Contrary to what is found in many other populations, no gender difference was seen in DM prevalence in the youngest age groups, where screening for gestational diabetes mellitus (GDM) contributes to early diagnosis of diabetes among women (4). The number of patients in Greenland with T2DM has, however, been reported to have increased within the last 3 years (5). The prevalence of overweight and obesity has also increased both among children and adults in Greenland (6,7). The increase has been most dominant among women (7). Increasing prevalence of diabetes mellitus (DM) has also been reported in other circumpolar areas (8–11). The prevalence has been considered higher for the Alaska Native in general than for Alaska Inuit (formerly termed Alaskan Eskimos) (8). However, the increase in prevalence has been highest among the Inuit (8–12). The prevalence of GDM was reported to vary with ethnicity (13), with high prevalence among Yup’ik Inuit (14) and other ethnic groups (13,15–19). The prevalence of GDM among Yup’ik Inuit is thus twice as high as the U.S rate for all races, despite the fact that the prevalence of GDM among Greenlanders is, however, unknown.

Despite increased prevalence of DM and overweight in the general population and guidelines for screening for DM in pregnancy, GDM does not seem to have created a major clinical problem.

The aim of this study was therefore to estimate the prevalence of diabetes in pregnancy in Nuuk, Greenland, and to evaluate the efficacy in the screening procedure used there.

MATERIAL AND METHODS

The health care system in Greenland is divided into 16 districts. Around 40% of all birth deliveries in Greenland are performed in Nuuk, where the only obstetrics department in Greenland is situated. Complicated cases are referred to Nuuk. The rest of the births take place locally in the districts.

Screening for GDM is based on the following criteria: overweight (body mass index [BMI] above 27 kg/m²), family history of DM among first-degree relatives or grandparents, former birth of child with birth weight (BW) above 4,500 g and DM in earlier pregnancies. Finally, all pregnant women with glucosuria are screened. All birth deliveries in Nuuk, Greenland are registered in the obstetrics department. Medical data are recorded by midwives on a systemized record sheet (referred to hereafter as the perinatal journal, PJ).

Study group

In the current study, information about maternal age, weight, weight gain in preg-
nancy, height, blood pressure, examination of urine for glucose, results from oral glucose tolerance test, former pregnancies, family history of DM, history of chronic disease and use of medicine, smoking and alcohol habits, ethnicity, delivery and birth weight and length was collected for all patients who had given birth in Nuuk, Greenland, during 2008. Women born in Greenland were considered Greenlanders while women born outside Greenland were considered non-Greenlanders. To be born in Greenland is a good indicator of Greenlandic ethnicity for people living in Greenland because 97% of those born in the country perceive themselves to be Greenlanders (20). Only Greenlanders and only singleton mothers were included in this study. Women with known diabetes and women treated with oral steroids were excluded from the study.

**Measurements**

The oral glucose tolerance test (OGTT) was performed in fasting pregnant women with the administration of 75 g pure glucose diluted in water. Capillary blood was examined just before and 2 hours after the administration for glucose by Hemocue®, which was calibrated weekly. GDM was defined according to the WHO definition as 2-hour blood glucose concentration at or above 7.8 mmol/L or fasting glucose at or above 6.1 mmol/L (21) in this study. GDM is, however, only clinically diagnosed in Greenland when the 2-hour blood glucose concentration is 9 mmol/L or above according to the clinical guidelines from the Danish Society of Obstetrics and Gynecology (22).

Body mass index (BMI) was based on the self-reported weight before pregnancy. Weight gain during pregnancy was calculated as weight at gestational age (GA) 38±2 weeks minus self-reported weight before pregnancy. Blood pressure measured once during the first consultation by a midwife was used in this study.

The women were divided into smokers and non-smokers according to their self-reported smoking status. The self-reported average intake of alcoholic beverages (12 g of alcohol) on a weekly basis was used as indicator of alcohol intake.

The prevalence of gestational diabetes was calculated as the percentage of women with GDM from all screened women. The efficacy in the screening procedure was measured as the percentage of women meeting the screening criteria (see above) that were actually screened with an OGTT.

**Statistics**

Statistical analyses were performed using Microsoft Office Excel 2003 and SPSS 17.0. Q-Q plots were used to analyse the distribution. Means and standard deviations (SD) were used to describe normal distributed parameters and medians and quartiles (Q1 and Q3) were given for variables that were not normally distributed. Means were compared with t-tests and medians with Mann-Whitney tests. Ninety-five percent confidence intervals (CI) were used in this study.

**RESULTS**

Two hundred and thirty-three women born in Greenland who had given birth to a singleton in Nuuk 2008 were included in the study. The selection procedure is illustrated in Figure 1.
A total of 830 children were born in Greenland during 2008 (23). Of these, 342 (40%) were born in Nuuk by 341 mothers. Complete data on 268 women (79%) were obtained from PJ. No difference in mean age (27 and 26 years old \(p=0.17\)) nor ethnicity fraction (81 and 88% Greenlanders \(p=0.71\)) was observed among the women with or without available PJ. Two hundred and thirty-four (87%) were categorized as Greenlanders due to birthplace. Twenty-nine born in Denmark and 4 born elsewhere were excluded from this study. No women were excluded due to known DM or intake of oral steroid. One woman was excluded due to birth of twins. No woman gave birth more than 1 time in this study group. Clinical, demographical, biochemical and other characteristics of the women born in Greenland are shown in Table I.

Self-reported smoking was observed in 51% (119). Of those, 112 (94%) had declared they smoked 1 or more cigarettes on a daily basis. Self-reported use of alcohol on a weekly basis was only observed in 4% (9 cases) and in none of the women who met the screening criteria. Eighty-six (37%) fulfilled the criteria Figure 1. Selection procedure of the study where 233 singleton mothers born in Greenland were included.
for screening for GDM, 67 had BMI above 27 kg/cm², 22 had at least 1 case of glucose in the urine, 12 had a family history of DM and 9 had given birth to a child with a birth weight above 4,500 g. Twenty-four had more than 1 indication. Forty-six (54%) of those with indications were actually screened for GDM with an OGTT (see Table II).

The screening rate was lowest for overweight as an indication, whereas most of the women with glucose in the urine were screened (see Table III). Women screened for GDM had higher gestational age (p=0.024), greater birth length (p=0.012) and lower parity (p=0.012). Two Greenlanders were categorized with GDM. One based on fasting blood glucose of 6.1 mmol/L (2-hour value of 7.1 mmol/L following OGTT) and 1 based on 2-hour blood glucose value of 7.9 mmol/L after OGTT according to the WHO criteria. Thus, the prevalence of GDM among women who fulfilled the criteria for screening in this study is 4.3% (2/46) (95% CI 0–10%). None of the women were diagnosed with clinical GDM according to the criteria used in Greenland, indicating a prevalence of clinical GDM below 2% (1/46) (95% CI 0–6.0%).

Table I. Clinical, demographical, biochemical and other characteristics of the Greenlandic women.

| Characteristic or variable | Greenlanders, n=233 |
|---------------------------|---------------------|
| Mean±SD (Range)           |                     |
| Age (years)               | 27±5.9 (15-43)      |
| Height (cm)               | 162±6.8 (136-181)   |
| Weight before pregnancy (kg) | 68±15.2 (40-132) |
| BMI (kg/m²)               | 26±5.5 (16-50)      |
| Weight gain (kg)          | 15±5.9 (-3-28)      |
| Blood pressure (1.trimester) |                     |
| Systolic (mmHg)           | 116±11.5 (80-145)   |
| Diastolic (mmHg)          | 69±8.6 (47-95)      |
| Gestational age (weeks)   | 38±2.5 (20-43)      |
| Birth weight (g)          | 3,462±687 (280-5330) |
| Birth length (cm)         | 51±3.7 (24-58)      |
| Parity                    | 1±0 (2*;0-8)        |
| Smokers                   | 119 (51%)           |
| Birth weight > 4,500 g in former pregnancy | 9 (4%)         |
| Diabetes in former pregnancy | 0                |
| Diabetes in family        | 12 (5%)             |
| BMI >27                   | 67 (29%)            |
| Glucose in urine          | 22 (9%)             |
| OGTT indicated            | 86 (37%)            |

*Median (Q1;Q3)

Table II. Screening rates for GDM.

| Screening criteria                      | Number of women | Number of screened | Screening rate (%) |
|-----------------------------------------|-----------------|--------------------|--------------------|
| BMI > 27 kg/m²                           | 67              | 34                 | 51                 |
| Family history of diabetes              | 12              | 9                  | 75                 |
| Former GDM                              | 0               | 0                  | –                  |
| Birth weight > 4,500 g in former pregnancy | 9              | 5                  | 55                 |
| Glucose in urine                        | 22              | 19                 | 86                 |
| All                                     | 86*             | 46                 | 54                 |

*Some of the women had more than one indication for screening, and thus the “All” figure is less than the sum of each indication.
DISCUSSION

The prevalence of GDM seems to be low compared to other Inuit populations, with a prevalence of 4.3% among high-risk Greenlandic pregnant women. Thus, the prevalence is likely to be even lower in the total population of Greenlandic pregnant woman.

Limitations

Limitations in this study include a small study group with a relatively low screening rate. Thus 36% of the Greenlanders fulfilled the criteria for screening for GDM, of those 67 (78%) due to overweight with BMI>27kg/m². Only 46 (54%) of the high-risk women were actually screened, which represents a weakness in the study. The lower parity among those screened may lead to a possible underestimation of the true prevalence since parity is associated to GDM. Furthermore, the women included in this study only represent those who gave birth in Nuuk, which may not be representative of all Greenlandic women. There is a potential over-representation of women with pathological pregnancies, which might lead to an overestimation of the prevalence of GDM. The number of missing PJs (69) is quite high, which probably can be explained by the use of a manual archive system. There is, however, no reason to believe that this selection may be systemic since no difference in mean age or in ethnicity fraction was demonstrated among those with and without PJ (see results).

Gestational diabetes mellitus among other Inuit and Indians

The prevalence of GDM among high-risk pregnant women demonstrated in this study is low compared to the prevalence reported among Yup’ik Inuit (based on O’Sullivan criteria) with a prevalence of 6.7% among all women in

| Characteristic or variable                  | Screened (n=46) Mean±SD | Not screened (n=40) Mean±SD | p     |
|--------------------------------------------|-------------------------|----------------------------|-------|
| Age (years)                                | 27±5.9                  | 29±5.0                     | 0.275 |
| Height (cm)                                | 163±7.5                 | 162±17.7                   | 0.825 |
| Weight before pregnancy (kg)               | 83±19.0                 | 79±10.1                    | 0.230 |
| BMI (kg/m²)                                | 32±6.7                  | 31±4.1                     | 0.423 |
| Weight gain (kg)                           | 13±6.3                  | 15±7.0                     | 0.201 |
| Blood pressure (1 trimester)               |                         |                            |       |
| Systolic (mmHg)                            | 121±11.7                | 115±24.6                   | 0.162 |
| Diastolic (mmHg)                           | 71±9.5                  | 71±9.2                     | 0.720 |
| Gestational age (weeks)                    | 39±1.9                  | 38±2.9                     | 0.024 |
| Birth weight (g)                           | 3734±626                | 3471±725                   | 0.077 |
| Birth length (cm)                          | 52±2.9                  | 50±4.9                     | 0.012 |
| Party                                      | 1 (0;1) *               | 1(1;2) *                   | 0.012 |
| Smokers                                    | 20 (43%)                | 17 (43%)                   | 0.945 |
| Former birth big child                     | 4 (8.7%)                | 4 (10%)                    | 0.843 |
| Diabetes in former pregnancy               | 0                       | 0                          | –     |
| Diabetes in family                         | 8 (17 %)                | 3 (8.3 %)                  | 0.201 |
| BMI >27                                    | 34 (74 %)               | 33 (83 %)                  | 0.653 |
| Glucose in urine                           | 19 (41 %)               | 3 (7.5 %)                  | 0.002 |

*Median (Q1;Q3).
This study population had a mean age of 25.6 years, mean parity of 1.9 and mean BW at 3,567 g, which is quite similar to the present study group (see Table I). More recent studies also demonstrated high prevalence of GDM among Indigenous groups in Canada at 8.4% (for Ojibwa-Cree women) among all pregnancies (16), at 8.5% (for Swampy Cree women) of all pregnancies (24) and at 12.8% (for James Bay Cree women) of all pregnancies (25). Gestational diabetes mellitus among the Swampy Cree women was associated with a maternal age of 35 years or above, history of GDM in previous pregnancy, diastolic blood pressure of 80 mmHg or above at first prenatal visit, weight above 80 kg at first prenatal visit or having a first-degree relative with diabetes (24). Among the James Bay Cree women, GDM was also associated with maternal age, weight before pregnancy and parity (25). High prevalence of GDM was also reported among Zuni Indians in the U.S., measured at 15.3% (26). Gestational diabetes among women in Greenland was associated with a maternal age of 35 years or above, history of GDM in previous pregnancy, diastolic blood pressure of 80 mmHg or above at first prenatal visit, weight above 80 kg at first prenatal visit or having a first-degree relative with diabetes (24). Among the James Bay Cree women, GDM was also associated with maternal age, weight before pregnancy and parity (25). High prevalence of GDM was also reported among Zuni Indians in the U.S., measured at 15.3% (26).

GDM in the pregnancies was associated with increased risk of developing diabetes during an average of 5.5 years of follow-up (26). Among other Indians in the U.S., the prevalence has, however, been reported somewhat lower at 5.2% among Tohono O’odham pregnancies (27) and as low as 3.4% among Navajo Indians (19). In the latter case, women with former GDM were excluded, resulting in a lower calculated prevalence.

Given this ethnic variation in the prevalence of GDM, Greenlanders may be less prone to develop GDM, though it is much more likely that Greenland is lagging temporally behind the rising worldwide epidemic of obesity and subsequent glucose intolerance. Thus, increasing prevalence of GDM was demonstrated in the U.S. in a universally screened multi-ethnic population (13), suggesting that the vicious cycle of diabetes in pregnancies initially described among Pima Indians may occur in other populations (13). The metabolic abnormalities associated with diabetic pregnancy among Pima Indians have proven to result in long-term effects for their offspring, including insulin resistance, obesity and diabetes, which may contribute to the risk of the same problem developing in the next generation (28,29).

**Low prevalence of GDM among Greenlanders**

On the one hand, DM is a relatively new disease in Greenland (1–4) and one explanation of the low prevalence of GDM could be that women in this study are not likely to have been exposed to intrauterine hyperglycemia. On the other hand, there is strong evidence from animal studies that maternal deprivation leads to diabetes and insulin resistance in offspring (30) and low birth weight is associated with diabetes in offspring (30). The so-called thrifty phenotype hypothesis proposes that in undernourished foetuses and infants, metabolic changes occur that cause diabetes later in life (31,32). The mean birth weight in Greenland has increased slightly during the last 50 years from 3,251 g (1954) to 3,490 g (2005) (33), which probably can be explained by the better living conditions in general, better food supplies and a modern health care system. The women in this study were not likely to have been exposed to severe intrauterine or early infancy malnutrition which may also contribute to the low prevalence of GDM. The prevalence of overweight and obesity at school entry and in adolescence among children in Nuuk has, however, increased in the period
1972 to 2002 (6) and the fact that almost one-third (29%) of the Greenlandic women in this study have a BMI>27 gives rise to concern for future mothers.

GDM is a risk factor for diabetes later in life for these women (17,18,26), and as mentioned above has also been linked to increased birth weight and increased risk of obesity and diabetes among the offspring (28,29) in young Pima Indians. This underlines the importance of a good screening procedure.

Conclusions
The prevalence of GDM seems to be low among high-risk Greenlandic pregnant women. However, the increasing prevalence of overweight and obesity among children in Nuuk gives rise to concern about an increasing prevalence of GDM in the near future. The screening rate is currently suboptimal, and it is recommended that the screening procedure be optimized in order to find and treat all women with GDM. The number of screened women compared to the number of births occurring annually could be an indicator of screening efficacy. Diabetes prevention initiatives should be given high priority to avoid an increasing prevalence of glucose intolerance in the future as is now seen worldwide irrespective of race.

Acknowledgement
We want to thank Novo Nordisk A/S for their financial support of the Greenlandic Health Care System, which made this study possible.

Abbreviations: BMI (body mass index), BL (birth length), BW (birth weight), CI (confidence interval), DM (diabetes mellitus), GA (gestational age), GDM (gestational diabetes mellitus), N (number), OGGT (oral glucose tolerance test), PI (perinatal journal), Q1 and Q3 (quartile one and three), SD (standard deviation), T2DM (type 2 diabetes mellitus).

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