The Challenge of Estimating the Prevalence and Predictors of Gestational Diabetes Mellitus in St. Vincent and the Grenadines

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ABSTRACT

Background: Gestational diabetes mellitus (GDM) is a disease which results in numerous consequences for both pregnant women and their infants.

Objective: The study aimed to estimate the prevalence of gestational diabetes and determine the predictors associated with the development of gestational diabetes in a population of pregnant women in the Caribbean island of St. Vincent and the Grenadines (SVG).

Methods: A retrospective study was performed from August to October 2011 at 29 antenatal clinics throughout SVG using perinatal and antenatal records for 454 pregnant women who had singleton pregnancies. Statistical analyses of continuous and categorical variables were performed using t test and chi square test respectively to compare differences between pregnant women with impaired glucose tolerance (IGT) and GDM and women without IGT and GDM. Fisher's exact test was used for analyses involving small numbers.

Results: Of the 454 pregnant women, only 11 had a documented oral glucose tolerance test (OGTT). Of these 11, 5 women had IGT and 2 had GDM. Significant predictors for the development of GDM were higher first documented weight ($p < 0.001$), higher last documented weight ($p < 0.001$), having a previous stillborn ($p = 0.030$) and a past medical history of a reproductive tract surgery ($p = 0.005$). Predictors that showed a tendency were higher pre-pregnancy weight ($p = 0.056$) and a previous caesarean section ($p = 0.055$). The significant pregnancy outcomes were a higher neonate birth weight ($p = 0.002$) and macrosomia ($p = 0.002$). Large quantities of missing data were present particularly for maternal height and pre-pregnancy weight limiting conclusions. Heights were missing for 71% of women with IGT/GDM and 66% of women without the conditions. There was 71% missing data for pre-pregnancy weight for those with IGT/GDM and 55% for women without IGT/GDM.

Conclusion: Predictors associated with GDM were a higher first and last documented weight, having a previous stillborn and reproductive tract surgery and the associated pregnancy outcomes were increasing neonatal birth weight particularly a neonate birth weight greater than 4000 grams. The prevalence of gestational diabetes in St. Vincent and the Grenadines remains unknown as there is no routine screening.

Keywords**:** gestational diabetes mellitus, St. Vincent and the Grenadines, prevalence, predictors

RÉSUMÉ

Contexte: Le diabète gestationnel (DG) est une maladie qui se traduit par de nombreuses conséquences affectant à la fois les femmes enceintes et leurs bébés.

Objectif : L'étude visait à estimer la prévalence du diabète gestationnel et déterminer les prédicteurs associés avec le développement du diabète gestationnel dans une population de femmes enceintes dans l'île antillaise de Saint-Vincent-et-les Grenadines (SVG).

Méthodes : Une étude rétrospective a été réalisée d'août à octobre 2011 dans 29 cliniques prénatales à travers l'île en utilisant les dossiers prénataux et anténataux de 454 femmes enceintes ayant eu une grossesse unique. Les analyses statistiques de variables continues et nominales ont été effectuées en utilisant le test T et le test chi carré, respectivement, afin de comparer les différences entre les femmes enceintes ayant une intolérance au glucose (IGT) et le diabète gestationnel (DG) et les femmes sans IGT et DG. La méthode exacte de Fisher a été utilisée pour les analyses impliquant un petit nombre.

Résultats : Sur les 454 femmes enceintes, seulement 11 avaient fait un test d'hyperglycémie provoqué par voie orale (HPO). Parmi ces 11 femmes, 5 avaient un IGT et 2 un DG. Des prédicteurs significatifs pour le développement du DG étaient les premiers poids documentés ($p < 0,001$), les derniers poids documentés ($p<0,001$), ayant eu un mort-né précédemment ($p=0,030$) et des antécédents médicaux d'une chirurgie de l'appareil génital ($p=0,005$). Les prédicteurs qui ont montré une tendance étaient un poids plus élevé avant la grossesse ($p=0,056$) et ayant eu une césarienne précédemment ($p=0,055$). Les résultats pour les femmes atteintes de IGT/DG étaient un poids à la naissance du nouveau-né plus élevé ($p = 0,002$) et une macrosomie ($p = 0,002$). De grandes quantités de données manquantes étaient présentes en particulier concernant la taille de la mère et le poids avant la grossesse, ce qui limite les conclusions. Les données sur la taille manquaient pour 71% des femmes atteintes d'IGT/DG et environ 66% des femmes sans ces conditions. Il y avait 71% de données manquantes pour le poids avant la grossesse et 55% pour les femmes sans IGT/DG.

Conclusion: Les prédicteurs associés avec le IGT/DG étaient un premier et dernier poids plus élevé, l'occurrence d'un mort-né précédemment et une chirurgie de l'appareil génital et les résultats associés à la grossesse ont été l'augmentation du poids néonatal avec un poids à la naissance de plus de 4000 g. La prévalence du diabète gestationnel à Saint-Vincent-et-les Grenadines reste inconnue car il n'y a pas de dépistage systématique.

***Mots-clés*:** diabète gestationnel, Saint-Vincent-et-les Grenadines, prévalence, prédicteurs

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INTRODUCTION

Overview of St. Vincent and the Grenadines

St. Vincent and the Grenadines (SVG) is an English-speaking island in the Lesser Antilles which is located in the Caribbean [1, 2]. The appellation Caribbean denotes a region of the Americas which comprises the Caribbean Sea along with its numerous islands and islets [3]. St. Vincent and the Grenadines (SVG) consists of thirty two islands, islets and cays which cover an area of 345 kilometers squared with a population of 106 253 (according to the 2001 population census) [1, 2]. St. Vincent is the largest of all the islands in the country and is commonly referred to as the mainland; 91 percent of the population resides here. Although the Grenadines consist of numerous islands, only seven are inhabited which include Bequia, Mustique, Canouan, Union Island, Mayreau, Palm Island and Petit St. Vincent. In St. Vincent and the Grenadines, greater than 70 percent of the population is of African ancestry [2]. A person who is a citizen of St. Vincent and the Grenadines is usually referred to as a Vincentian or in more colloquial language, a ‘Vincy’. Whilst St. Vincent and the Grenadines still remains unknown to many, particularly researchers; it is imperative that persons be cognizant of the fact that the country has a lot of potential with regards to conducting epidemiological studies for scholarly research.

Background

The incidence and prevalence of diabetes mellitus is on the rise in developing countries and the Caribbean is no exception. According to the International Diabetes Foundation (IDF), an estimated 366 million individuals worldwide had diabetes mellitus in 2011, a prevalence of 8.5 [4]. By the year 2030, it is projected that this number will rise to 552 million individuals, an increase greater than 50 percent. St. Vincent and the Grenadines is a developing country and, unfortunately, the majority of individuals affected by diabetes live in developing countries [5]. Of all the persons classified as diabetics globally in 2011, 80 percent occurred in low and middle income countries [4].

The Caribbean is among the regions experiencing an epidemiologic transition from infectious diseases to chronic non-communicable diseases [6, 7]. In 2000, Latin America and the Caribbean had an estimated 35 million people living with diabetes and this number is expected to increase to 64 million by 2025 [8]. The World Health Organization (WHO) estimates that by 2030, approximately 9 000 individuals in St. Vincent and the Grenadines would be affected by diabetes, an increase of almost 50 percent from the 5 000 affected individuals in 2000 [9]. Of all the reported cases of diabetes in St. Vincent and the Grenadines in 2009, 41 cases from a total of 2189 pregnancies (1.9 percent) were attributable to gestational diabetes (derived from personal communication with the chief epidemiologist in SVG). According to the latest estimates (derived from personal communication with the chief epidemiologist in SVG), the incidence of gestational diabetes in St. Vincent and the Grenadines is on the rise; the 2010 estimates concluded that there were 176 reported cases of GDM out of 1785 pregnancies, four times the 2009 reported figures.

Numerous studies have identified several modifiable and non-modifiable predictors for the development of gestational diabetes. Although pre-pregnancy weight indicative of overweight and obesity as defined by body mass index (BMI) and diet and exercise are two of the most frequently mentioned modifiable predictors of GDM, some of the risk factors for the development of GDM cannot be modified including increased maternal age, diabetes in a first degree relative, ethnicity, being of African descent, and history of abnormal glucose tolerance [10, 11]. Gestational diabetes can result in both short and long term consequences for the pregnant woman, fetus and infant. The most significant of the long term consequences are that women who have previously been diagnosed with gestational diabetes are at an increased risk for the development of type 2 diabetes after pregnancy while the infants of women with GDM have an increased risk of obesity and type 2 diabetes at some stage in the later years of life [10-12].

The abovementioned clearly highlights the link between gestational diabetes and type 2 diabetes thus triggering the hypothesis that if the rates of gestational diabetes can be reduced, the rates of type 2 diabetes can subsequently be reduced in women. Also, if the rates of gestational diabetes can be reduced, it means that the number of infants born to women with gestational diabetes will further be reduced thereby decreasing the infants' susceptibility to type 2 diabetes which with optimism can result in a decrease in the number of future diabetes cases.

At present, limited data are available on published epidemiological studies on the prevalence and risk factors of diabetes among adults in the English-speaking Caribbean. Furthermore, the few published articles encompass the larger English-speaking Caribbean countries such as Jamaica, Barbados and Trinidad and Tobago but seldom or never SVG. St. Vincent and the Grenadines has no published studies on the prevalence or risk factors of gestational diabetes. The population estimates aforementioned were derived from the various

health centers/clinics in the country. The intent of this study is to determine the prevalence of gestational diabetes as well as some of the risk factors associated with the disease in SVG. The Ministry of Health, Wellness and the Environment will be made aware of the study findings and hopefully, the results can encourage the implementation of policies and programmes targeted at improved monitoring for diabetes during pregnancy which can result in early detection of GDM. The study findings can also promote the implementation of appropriate interventions aimed at reducing the incidence, predictors, complications and severity of GDM.

The prevalence of diabetes is on the rise in the Caribbean region. The IDF estimated that 14.5 million women and 11.2 million men had diabetes in Latin America and the Caribbean (LAC) in 2010 [13]. With the ascension of diabetes prevalence in the Caribbean, particularly in women, a known association between GDM and the development of type 2 diabetes and the unavailability of published diabetes data in SVG, the timing for this study is pertinent. To the researcher's knowledge, there are no documented studies in St. Vincent and the Grenadines on the prevalence and predictors for the development of gestational diabetes.

In 2011, 4.6 million deaths were attributable to diabetes worldwide [4]. Latin America and the Caribbean accounted for 239 000 of all deaths in 2010 of which 125 000 occurred in females [13]. Diabetes is a disease that threatens the lives of numerous individuals. In the English speaking Caribbean, diabetes costs US 812.4 million dollars in indirect costs due to loss of productivity as a result of disability and premature mortality in 2000 [14]. In 2000, direct costs related to medications, hospitalisations, consultations and complications which arose from diabetes amounted to US 218.1 million dollars. St. Vincent and the Grenadines as a developing country has moderate availability of financial resources. Hence, if this study can in any manner,

be it great or small, contribute to reducing the burden due to the direct and indirect cost of diabetes placed on the country in the long-term, it would be a vital contribution.

The study is also important as the findings can be used to encourage major national stakeholders to unite and work towards the prevention and reduction of gestational diabetes in SVG. The benefits of this study surpass SVG; other English-speaking Caribbean countries can also benefit from the study findings which can serve to give an estimate of gestational diabetes prevalence and risk factors in a smaller English-speaking Caribbean country.

Research Objectives

The main study objective was to estimate the prevalence of gestational diabetes mellitus in a population of pregnant Vincentian women.

Secondary objectives

1. To determine the predictors associated with the development of gestational diabetes mellitus in St. Vincent and the Grenadines.

2. To determine the pregnancy outcomes associated with gestational diabetes mellitus in St. Vincent and the Grenadines.

LITERATURE REVIEW

This section will examine the definition, epidemiology, pathophysiology, screening and diagnostic criteria used for gestational diabetes. Some of the major predictors and pregnancy outcomes of GDM, particularly those included in the study questionnaire will also be covered. The author attempted to look at journal articles published within the last ten years; however, to fully examine the past screening and diagnostic criteria used for GDM, it was imperative to look at articles published before 2002 as well.

Definition and Epidemiology

Gestational diabetes mellitus is defined as glucose intolerance that results in hyperglycemia of varying degrees of severity which begins or is first recognised during pregnancy [11, 12, 15, 16]. The definition for GDM may include women with pre-existing glucose intolerance or pre-gestational diabetes that was undiagnosed prior to pregnancy but was uncovered as gestation progressed and the pregnant women were screened for GDM [15, 17]. The prevalence of GDM can vary between 1-14 percent of all pregnancies and is subject to the population studied, and the diagnostic tests and threshold values used [10-12]. Due to the aforementioned, the global incidence and hence prevalence of GDM becomes difficult to determine in a large number of countries worldwide [15].

Pathophysiology

Pregnancy results in an increase in the concentration of the hormones such as oestrogens and progestins which lower the concentrations of fasting glucose and fat deposition, delay gastric emptying and increase appetite [15]. The period mid-gestation marks the stage in a normal pregnancy when insulin sensitivity is reduced by 50-60 percent overall and insulin resistance is

increased [18]. The further a pregnancy develops, the more a steady increase is seen in postprandial glucose concentration as tissue sensitivity to insulin decreases [15]. In GDM, women have greater reductions in insulin sensitivity compared to women who are pregnant with normal glucose tolerance (NGT) [18]. During a normal pregnancy, insulin resistance is an impaired response to insulin; this insulin resistance results in an increase in insulin secretion by the beta-cells of the pancreas [15]. Gestational diabetes is identified by insufficient insulin levels to meet the demands of insulin [17]. Pregnant women diagnosed with GDM are unable to increase the production of insulin to compensate for increases in insulin resistance [18, 19]. Autoimmune beta-cell dysfunction, beta-cell dysfunction associated with chronic insulin resistance and strong genetic abnormalities which lead to impaired insulin secretion are the three categories in which insulin insufficiency in GDM are identified[17]. However, insulin resistance and relative insulin deficiency as a result of beta-cell dysfunction are the major changes seen in women with GDM [18, 19].

Insulin resistance

Women who develop GDM exhibit two forms of insulin resistance. During late pregnancy, the first form, physiological insulin resistance is present [17]. The insulin resistance is due to defects by the post receptor in the insulin-signaling cascade in the skeletal muscle (a major tissue for glucose disposal of the whole-body); the down regulation of the insulin receptor substrate-1 (IRS-1) may be the contributing factor to the decreased insulin-mediated glucose uptake [15]. Placental growth hormone and tumor necrosis factor (TNF)-α are both pregnancy induced factors which are known to mainly cause insulin resistance. The second form of insulin resistance is present prior to pregnancy and is more chronic, and is worsened by the physiological changes during pregnancy which result in insulin resistance; because of the

acquired and chronic insulin resistance in the majority of women who develop GDM during late pregnancy, these women are slightly more insulin resistant than women with NGT. The transmission of the insulin signal which enables the uptake of glucose is as a result of the phosphorylation of insulin receptor tyrosine; a decline in the insulin receptor capacity to undergo tyrosine phosphorylation in muscle is a potential cellular mechanism for insulin resistance and evident in obese women with GDM [15, 17]. Increased serine phosphorylation of the insulin receptor and IRS-1 can impair glucose uptake and the evidence is emerging to support such a mechanism [20]. Increased serine phosphorylation inhibits the insulin-stimulated insulin receptor and IRS-1 tyrosine phosphorylation thereby reducing insulin signaling in GDM [17, 20]. Subsequent to pregnancy, insulin resistance is suppressed [17].

Beta-cell function

Women with GDM have lower levels of insulin secretion for the extent of insulin resistance compared to women with NGT [17]. Insulin secretion is associated with insulin sensitivity via a feedback loop which permits the beta-cells to counterbalance any changes in insulin sensitivity by a proportionate and reciprocal change in insulin secretion. In pregnancy, the beta-cells need to increase the secretion of insulin to offset the resultant decrease in insulin sensitivity and maintain normoglycemia during pregnancy [15, 18]. As a result, a chronic beta-cell defect becomes present in women with GDM; this defect means that if there is an increase in insulin secretion to compensate for the insulin resistance in pregnancy, it will be insufficient to completely counteract this insulin resistance [18]. Thus the result is hyperglycemia which causes GDM.

As the years progress, a deterioration in insulin secretion in comparison to chronic insulin resistance occurs and results in hyperglycemia which is progressive and primarily type 2 diabetes

[17]. Although beta-cell dysfunction associated with chronic insulin resistance is evident in the majority of women who develop GDM, a significant minority do not have this dysfunction; autoimmune beta-cell dysfunction may be evident in these women. Cytoplasmic islet cell antibodies and antibodies directed against GAD65, the membrane tyrosine phosphatise and insulin were all evidence presented for GDM in some women at the Fifth International Workshop Conference on GDM in 2005 [17].

Fetal and Maternal Effects

This section will cover the consequences of GDM for the fetus and mother. Many fetal complications are associated with GDM; however, this literature review can in no means cover them all and will seek to cover the most frequently mentioned complications.

The predominate interface through which glucose moves freely from the mother to the fetus is the placenta; however, the same cannot be said for maternal insulin [15, 17]. Increased glucose concentrations in pregnant women with gestational diabetes make the fetus vulnerable to glucose concentrations higher than normal thus resulting in increased production of insulin by the fetus. When the fetus produces excess insulin as a response to maternal gestational diabetes, a possible consequence is excessive fetal growth which is also referred to as large for gestational age (LGA) [15]. Macrosomia is a fetus with a birth weight greater than 4000 grams or 4500 grams; any fetus with a birth weight above the aforementioned is often referred to as a macrosomic fetus[15, 21]. Increased insulin concentration in the fetal blood and amniotic fluid are associated with an increased likelihood of fetal macrosomia [15]. Although LGA and macrosomia are terms which are used interchangeably, the two terms must not be confused because there is a distinct difference between them. Large for gestational age is high birth weight for gestational age whereas macrosomia is a fixed cutoff weight for full term infants. Vaginal birth delivery for

macrosomic fetuses can result in an increased risk of injury and for this reason, caesarean sections are recommended despite the increased trauma which the mother would endure [15].

After delivery, many complications exist for fetuses which have been exposed to high concentrations of glucose such as cardiomyopathy, hypoglycaemia, hypomagnesaemia, polycythaemia and hyperviscosity [15, 21]. Although after birth the high concentrations of glucose which the fetuses were exposed to do abate, the infants are faced with increased risks of glucose intolerance and obesity [15]. The increased risks are due to insulin from the fetus which may alter placental gene expression, glycogen deposition and vascular expansion; all resulting in long term complications in the offspring of women with GDM, such as the development of metabolic syndrome in early childhood and an increased risk of obesity and type 2 diabetes during adolescence [15, 21].

During pregnancy, a series of metabolism imbalances are activated which result in a diabetogenic condition for women who have a genetic predisposition to the development of diabetes [17]. Gestational diabetes results in maternal effects such as an increased risk for the development of the metabolic syndrome and type 2 diabetes [15]. A greater risk for the development of the metabolic syndrome is evident in women with a previous history of GDM and obesity compared to mothers without a history of GDM or obesity. The development of type 2 diabetes in a great number of women; 50-60 percent, during the first 10 years following a pregnancy in which they were formerly diagnosed with GDM is extremely common [17, 21]. Gestational diabetes may also increase the risk for adverse perinatal consequences such as the development of preeclampsia; a hypertensive disorder, and increased risk of maternal morbidity from caesarean delivery in women with hyperglycemia [21].

Predictors and Pregnancy Outcomes

During pregnancy, numerous predictors/risk factors are associated with the development of GDM. These numerous predictors have been known to significantly increase the development of many outcomes for the pregnant woman and fetus. This section will highlight some of the most commonly reported risk factors and consequences of GDM.

Several risk factors for GDM which have been frequently reported are high maternal age, weight, parity, previous delivery of a macrosomic infant and a strong family history of type 2 DM or GDM in a first degree relative [15, 22]. Gestational diabetes prevalence is 7-10 times higher in pregnant women who are older than 24 years compared to women younger than 24 years of age [15]. This therefore reinforces a recommendation which will be mentioned in the section on screening and diagnosis of GDM, that women under the age of 24 years who are at low risk for GDM do not require any glucose testing. Obesity or excess body weight prior to pregnancy is a risk factor which has a strong association with the development of GDM [10, 15]. As the obesity rates increase, the prevalence of GDM also increases independent of age [10].

Gestational diabetes risk is increased in subsequent pregnancies in women who had a previous history of GDM [15]. Women who have previously been diagnosed with gestational diabetes are also at an increased risk of developing type 2 diabetes after pregnancy [10, 11, 15]; however, the risk is decreased in those who lose weight between pregnancies. Some other risk factors known to cause GDM to develop include glucosuria, ethnicity such as being of African descent, a history of abnormal glucose tolerance and a history of fetal death [10, 15]. Some other risks factors for the development of gestational diabetes, which are frequently reported particularly in pregnant women who are genetically susceptible, are education, knowledge/intelligence, culture, economic status, attitudes, diet and exercise and stature [15, 23].

The previously mentioned social, demographic and behavioural risk factors can negatively or positively contribute to the development of GDM in pregnant women.

GDM is associated with poor outcomes in pregnancy and an increased risk for adverse consequences for the mother and child as discussed in detail in the section on fetal and maternal effects [10]. Some of the consequences to the child include macrosomia as mentioned prior and others which include neonatal hypoglycaemia, jaundice, polycythemia and hypocalcemia [10, 11, 24]. As previously mentioned, children of women with GDM also have an increased risk of obesity, glucose intolerance, and type 2 diabetes during the later years of life [10, 11]. Dyslipidemia, maternal hypertensive disorders such as pre-eclampsia and gestational hypertension, and caesarean delivery are all consequences of GDM in the pregnant woman [11].

This section highlighted that some of the many predictors/risk factors such as a family history of gestational diabetes (genetics) and increasing maternal age are all risk factors which cannot be modified while maternal factors such as obesity or excess weight and diet and exercise are all modifiable risk factors.

Screening and Diagnosis

Currently, many countries employ various methods for the screening and diagnosis of GDM, which has resulted in different established diagnostic criteria and threshold values globally. When pregnant women are screened for GDM, it allows for the detection of many risk factors [15]. The majority of screening tests are administered between 24-28 weeks of gestation when a pregnant woman has an average risk of GDM. However, exceptions apply based on the risk assessment for GDM. The risk assessment should be conducted at the first prenatal visit, and women who have a high risk of GDM should be screened prior to 24 weeks of pregnancy; those with a previous history of GDM should ideally be screened at 16-18 weeks of gestation [15, 25].

When a woman has a low risk of GDM, no glucose testing is required. Table 1 depicts the characteristics of low risk, average risk and high risk assessment of GDM. After the risk assessment for GDM is conducted, women with an average risk or high risk are administered an oral glucose tolerance test (OGTT), the diagnostic test for GDM [15, 17].

The diagnosis of GDM is centered on two approaches; the one-step approach and the two-step approach. The one-step approach involves carrying out diagnostic OGTT on all individuals with an average risk [17]. The WHO has recommended the use of the one-step approach in which a 75-g OGTT is administered and blood glucose is measured fasting and at 2-h after glucose intake [15, 26]. The organization has recommended this approach particularly for use in developing countries. A diagnosis of GDM according to the WHO is based on the organization's criteria for diabetes mellitus or impaired glucose tolerance (IGT) [27]. Currently, gestational diabetes mellitus is diagnosed using the WHO criteria if either the fasting glucose or the 2-h glucose value is ≥7.0 mmol/L or ≥7.8 mmol/L respectively whereas IGT is diagnosed if the fasting glucose value is <7.0 mmol/L and if the 2-h glucose value is ≥7.8 and <11.1 mmol/L [26, 28]. The WHO diagnostic criteria for GDM and IGT are summarized in Table 2. The European Association for the Study of Diabetes (EASD) recommended that the WHO criteria for GDM be modified; the association suggested a reduction of the fasting plasma glucose and an increase in the 2-h threshold values to incorporate the physiological changes in glucose tolerance which occurs during pregnancy [26].

The two step approach, as its name implies, uses two steps in the diagnosis of GDM. Firstly, this involves screening by a 50-g oral glucose challenge test (OGCT) [12]. Pregnant women are given a drink which contains 50-g of glucose and after 1-h, blood glucose is measured [15].

Table 1 Screening Strategy for Detecting GDM [17]

GDM risk assessment: Should be ascertained at the first prenatal visit

Low risk: Blood glucose testing not routinely required if all of the following characteristics are present:

- Member of an ethnic group with a low prevalence of GDM
- No known diabetes in first-degree relatives
- Age <25 years
- Weight normal before pregnancy
- Weight normal at birth
- No history of abnormal glucose metabolism
- No history of poor obstetric outcome

Average risk: Neither low nor high risk. Perform blood glucose testing at 24–28 weeks using either:

- Two-step procedure: 50 g glucose challenge test (GCT) followed by a diagnostic oral glucose tolerance test in those meeting the threshold value in the GCT.
- One-step procedure: Diagnostic oral glucose tolerance test performed on all subjects

High risk: Perform blood glucose testing as soon as feasible, using the procedures described above if one or more of these are present:

- Severe obesity
- Strong family history of type 2 diabetes
- Previous history of: GDM, impaired glucose metabolism, or glucosuria

If GDM is not diagnosed, blood glucose testing should be repeated at 24–28 weeks or at any time a patient has symptoms or signs that are suggestive of hyperglycaemia.

Table 2 WHO Criteria for the Diagnosis of GDM and IGT [26, 28]

	Glucose Values (mmol/L)	
75-g Glucose Load	***GDM*[a]**	***IGT*[b]**
Fasting (0-h)	≥7.0	<7.0
2-h	≥7.8	≥7.8 and <11.1

[a] only one glucose value is needed for the diagnosis; either fasting or 2-h glucose

[b] both fasting and 2-h glucose values must be met for the diagnosis

A normal blood glucose concentration is any value below 7.8 mmol/L using a 50-g OGCT. If the normal threshold value on the OGCT is exceeded, a second screening by a 100-g 3-h diagnostic OGTT should be given to confirm the diagnosis of GDM [12, 15]. This second screening is used to avoid false-positive test results after a pregnant woman is given a 50-g OGCT [15]. In North America, the 100-g, 3-h OGTT is considered the gold standard for the diagnosis of GDM. The American Diabetes Association (ADA) recommends the use of the two-step approach [26]. However, the two-step approach to diagnose GDM is disadvantageous because it is costly to administer and in numerous developing countries may not be suitable, particularly due to the many economic constraints.

The current diagnostic criteria and threshold values for GDM were derived from recommendations published over 40 years ago. The first proposal for the diagnosis of GDM was proposed in 1964 by O'Sullivan and Mahan [29]. O'Sullivan and Mahan proposed the use of a 100-g, 3-h OGTT during pregnancy to detect glucose values for the diagnosis of GDM. A total of 752 women were administered a 100-g 3-h OGTT during the second and third trimesters of pregnancy and two or more blood glucose values greater than 2 standard deviations (SDs) above

the mean deemed as abnormal [26, 29]. The threshold values were validated based on predictive ability to develop subsequent diabetes after pregnancy among a second cohort of 1013 women who were administered an OGTT while pregnant [29]. The O'Sullivan and Mahan criteria examined the probability for a woman to develop diabetes after pregnancy but was unable to examine any association to pregnancy outcomes [26]. This study used venous whole blood samples to analyse blood glucose levels but following the study completion, these samples were replaced by plasma/serum samples in analysis.

In 1979, due to the change in the type of samples use to analyse blood glucose levels, the National Diabetes Data Group (NDDG) adopted the criteria used by O'Sullivan and Mahan and recommended that the threshold values used for the diagnosis of GDM be increased [26, 29]. A factor of 1.14 was applied to convert the whole blood samples to plasma/serum samples [26]. The ADA recommended the use of the NDDG threshold values for GDM until 1999 after which new values were to be adopted [29].

Carpenter and Coustan recommended in 1982 that new threshold values for GDM be established based on the O'Sullivan and Mahan criteria [29]. It was proposed that the threshold values be lowered by 0.28 mmol/L prior to the addition of 14 percent to allow for the changes in the analysis of blood glucose levels; from whole blood to plasma [26, 29]. The ADA in 2000 modified the recommendations for the diagnosis of GDM and suggested that the diagnostic criteria used included the threshold values from Carpenter and Coustan rather than those from the NDDG [29]. The ADA also recommended that a 2-h 75-g glucose tolerance test be included with the same threshold values as those used by Carpenter and Coustan [26]. Due to the lowering of the threshold values for plasma glucose, the prevalence of GDM will hence be increased [29].

The prior mentioned OGTT criteria for gestational diabetes mellitus and threshold values are summarized in Table 3.

Although the glucose tolerance test is the accepted screening test for GDM, fasting blood glucose and random blood glucose tests have gained a lot of interest due to the simplicity and convenience with which these tests can be carried out [15, 26]. Despite the aforementioned, there is limited scientific evidence on the reproducibility, sensitivity and specificity of these tests [15]. Fasting glucose measurements can identify GDM but evidence exists which indicated that the period between meals affected blood glucose in some of the pregnant women diagnosed with GDM as evidenced by the high blood glucose only after a meal. Other screening tests include glycosylated haemoglobin, capillary blood glucose measurement with a haemocue, breakfast tests, lunch tests, glycosuria, blood fructosamine and the fetal abdominal circumference [15, 26].

In St. Vincent and the Grenadines, a dipstick test for glycosuria is used at antenatal clinics as the primary screening tool to detect GDM in pregnant women. This test is administered in conjunction with consideration of an individual's risk for GDM based on predictors such as ethnicity, family history of diabetes, age and body weight prior to pregnancy. A positive dipstick result leads to the recommendation of an OGTT. Although the use of a urine dipstick test is low cost and convenient for measuring glycaemia and yielding rapid results, the reliability and validity of this type of testing is limited because of its low sensitivity [26, 30]. The sensitivity of the dipstick test is the proportion of diseased individuals with a positive test for diabetes while the specificity is the proportion of individuals without the disease with a negative dipstick test result [31]. In a prospective study conducted by Anderson et al. (1993) in Sweden where glycosuria testing was used to diagnose diabetes, they found a sensitivity of 23 percent and a specificity of 99 percent [32]. Another study that used glycosuria testing conducted by Davies

and Day (1994) in the United Kingdom found a sensitivity of 43 percent and a specificity of 98 percent [33]. In 1997, Friderichsen and Maunsbach (1997) reported a sensitivity of 20.80 and a specificity of 99.14 among study participants in Denmark [34]. Urine dipstick testing despite its low sensitivity, may still be useful in low resource settings where it is impossible to carry out alternative testing [30].

Table 3 Diagnostic Criteria for Gestational Diabetes Mellitus and Threshold Values [26, 28, 35]

			Glucose Values			
Organization/Authors	**Glucose Load**	**No. abnormal values**	**0 h**	**1 h**	**2 h**	**3 h**
O'Sullivan and Mahan, 1964	100 g	≥2	≥5.0	≥9.2	≥8.1	≥7.0
NDDG, 1979	100 g	≥2	≥5.8	≥10.6	≥9.2	≥8.1
WHO, 1980	75g	1	≥8.0	___	≥8.0	___
Carpenter & Coustan , 1982	100 g	≥2	≥5.3	≥10.0	≥8.6	≥7.8
WHO, 1985	75 g	1	≥7.8	___	≥7.8	___
EASD, 1991	75 g	≥1	≥6.0	___	≥9.0	___
ADA[a], 1997	50 g	1	___	≥7.8	___	___
ADA, 1997	100 g	≥2	≥5.8	≥10.6	≥9.2	≥8.1
WHO, 1999	75 g	1	≥7.0	___	≥7.8	___
ADA, 2000	100 g	≥2	≥5.3	≥10.0	≥8.6	≥7.8
ADA, 2000	75 g	≥2	≥5.3	≥10.0	≥8.6	___

Adopted and modified from Hanna et al. 2002, Hunt et al. 2007

[a]A glucose challenge test (GCT)

Treatment

The main goal in treating GDM lies in reducing the hyperglycemia known to cause the consequences associated with GDM [36]. Gestational diabetes is managed by the use of frequently employed methods such as medical nutrition therapy (MNT) and diet, blood glucose monitoring, treatment with insulin and exercise [12, 15, 36].

Medical Nutrition Therapy

Medical nutrition therapy is "the first line of management of women with GDM" [15]. The American Diabetes Association (ADA) recommends that medical nutrition therapy be used in the treatment of GDM with a focus on blood glucose levels maintenance by the management of carbohydrate intake [36]. The ADA also recommends that all women diagnosed with GDM must receive nutritional counseling by a registered dietitian based on the developed association guidelines [12]. The MNT should be based on the individual needs of the pregnant women according to maternal weight and height. Furthermore, the MNT should provide the adequate calories and nutrients required to meet pregnancy needs consistent with the blood glucose goals of the mother. One study has shown that for obese women (BMI > 30), a 30-33 percent calorie restriction (to approximately 25 kcal/kg) actual weight per day) can lower hyperglycemia, while another showed that a restriction of carbohydrates to 35-40 percent of calories causes a reduction in the glucose levels of mothers and improve the consequences for both the mother and fetus [12, 15].

Blood Glucose Monitoring

This is often recommended because the monitoring of postprandial hyperglycemia shows an association that is closely linked to the fetal macrosmia rates and has a known correlation with blood glucose [36]. Blood glucose monitoring allows the health care provider to clearly examine glycemic control and provide the pregnant woman with comments relating to progress made during the management of GDM. Pregnant women with GDM are also able to monitor blood glucose concentrations without the aid of a health care provider at any time thus allowing early interventions to decrease the associated complications with GDM in the long-term for both the fetus and mother [15].

Exercise

Dietary therapy and exercise are often used simultaneously to help maintain recommended blood glucose levels [36]. Exercise performed in pregnancy has been shown to prevent fetal complications while prenatal exercises can delay or avert GDM occurrence [15]. There are no recommendations for exercise in gestational diabetes due to lack of supporting evidence; however, moderate physical activity has been proven to be beneficial in lowering maternal blood glucose concentration in women who have GDM [12]. A prospective study conducted by Zhang et al. to assess whether the amount, type and intensity of pregravid physical activity and sedentary behaviours are associated with GDM showed that women who spent 20 hours per week or more watching television and who did not do any vigorous activity had an increased risk of developing GDM when compared to women who spent less than 2 hours per week watching television and engaged in physical activity [23].

Insulin Therapy

When combined with MNT, insulin therapy is known to reduce morbidities in the fetus [12]. However, insulin therapy and other anti-hyperglycemia medications are typically used as a final resort when diet and exercise and lifestyle modification can no longer maintain glycemic goals and is supplemented to allow better control when GDM is not able to be managed by diet or exercise and blood glucose levels remain elevated [15, 36].

Conclusion

The information summarized in this review of literature was related to the prevalence and predictors/risk factors of gestational diabetes. The section highlighted that GDM is a condition which only affects a small number of pregnancies but has many adverse effects. Gestational diabetes occurs due to increased insulin resistance during pregnancy and relative insulin deficiency due to beta-cell dysfunction which results in a decreased insulin secretion. Some of the frequently mentioned short and long term adverse effects of GDM for the fetus and mother were discussed. The screening methods recommended for GDM and the two approaches used to diagnose the disease and the various diagnostic and threshold values were reviewed in detailed. The literature review concluded by highlighting the main methods used in the management of gestational diabetes.

METHODOLOGY

In this section, an in-depth examination of the methods carried out in two studies will be discussed. The first study that will be examined is a cross-sectional study while the second is a retrospective cohort study. Each study will be further broken down and looked at by participants/population, study details, development and use of the various data collection tools and data analysis. Prior to examining each study in detail, the sample size and ethical considerations will be discussed as they are similar if not the same in both studies.

Sample size calculations

Before the sample size was determined, the prevalence of GDM in St. Vincent and the Grenadines in 2009 was calculated. The data used to calculate the prevalence of GDM (1.87 percent) were derived from Dr. Jennifer George, the chief Epidemiologist in SVG via email correspondences. The various health districts provided the raw data used by the epidemiologists to generate statistics for various conditions and diseases.

The following formula was used for the sample size calculation:

$$\text{n} = \left(\frac{Z_{1-\alpha/2}}{d}\right)^2 P\,(1-P)$$

Where:

- n is the sample size
- $Z_{1-\alpha/2}$ is Z test statistic for a 95% confidence level (1.96)
- d is the margin of error; precision (0.00935) .The value used for d was chosen because Naing et al. recommended that if the prevalence is less than 0.1 (10 %), the margin of error should be half of the prevalence [37].
- P is the estimated prevalence or proportion (0.0187)

The sample size calculated based on the above formula was **806**. This figure is very high due to the very low and possibly underestimated figures available to work with. Due to time constraints and limited resources, a more realistic prevalence of 5 percent, which is in keeping with the global prevalence rates of gestational diabetes as previously mentioned in the literature review was used in addition with an error of ± 2 percent to calculate a new sample size of approximately **400**.

Ethical considerations

Ethics approval was obtained from the Research Ethics Board in the Faculty of Agricultural and Environmental Science at McGill University, Macdonald Campus in Canada. Approval was also granted by the National Research Ethics Committee in St. Vincent and the Grenadines. Written informed consent was also obtained from each participant in study 1.

Study 1

Participants

Pregnant Vincentian women who were 18 years or older and between 24-32 weeks gestation were the sample for this study. These women were recruited from antenatal clinics on the mainland St. Vincent. The exclusion criteria included women with pre-gestational diabetes (pre-existing Type 1 or Type 2 Diabetes), multiple gestations and women who were less than 24 weeks gestation or more than 32 weeks.

Antenatal clinics selection

For this study, 8 antenatal clinics on the mainland St. Vincent were chosen. In St. Vincent and the Grenadines, there are 9 health districts and each district has its associated health care centers/clinics. There are 7 health districts on the mainland St. Vincent and 2 in the Grenadines. Based on convenience and accessibility of clinics, the two health districts in the Grenadines were excluded. After excluding the clinics in the Grenadines, the ten largest antenatal clinics on the mainland were then retained. These clinics were Belair, Calliaqua, Campden Park, Chateaubelair, Georgetown, Kingstown, Marriaqua, Retreat, Sion Hill and Stubbs (see Figure 1). Only clinics within relative proximity to SVG's main hospital Milton Cato Memorial Hospital (MCMH) were further selected; this was done to allow ease of access to the pregnant women who needed to go to the laboratory. Hence, Georgetown and Chateaubelair were further excluded as they are both located far on the Windward and Leeward side of the island respectively. The days of operation for the remaining eight clinics, Belair, Calliaqua, Campden Park, Kingstown, Marriaqua, Retreat, Sion Hill and Stubbs, were examined. Due to clashes in the antenatal clinics operational days and a chance that the same individuals will be seen every week at a particular clinic, the clinics were rotated weekly, beginning with the first 4 clinics at Belair, Campden Park, Kingstown and Retreat and followed by the last 4 clinics at Calliaqua, Sion Hill, Marriaqua and Stubbs.

Figure 1 A map of mainland St. Vincent showing the antenatal clinics used in Study 1

KEY

★	Antenatal Clinics
★	Antenatal Clinic/Hospital Laboratory

Study description

This cross-sectional study was conducted from July 18 to August 29 2011 at 8 antenatal clinics on the mainland of SVG. Figure 1 shows the 3 main steps involved in the study.

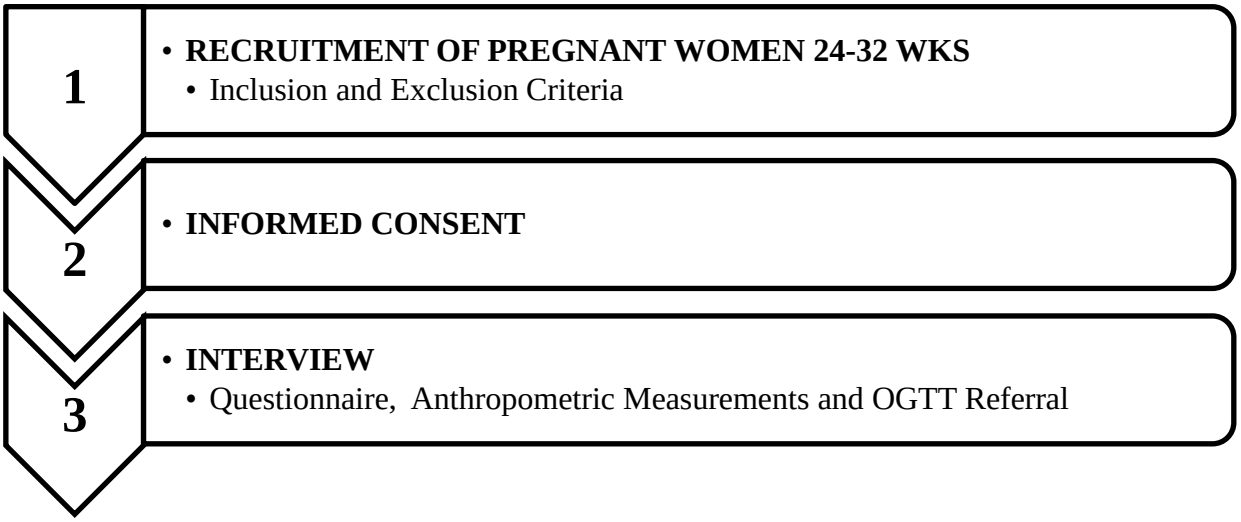

Figure 2 Steps involved in Study 1

In the first step, all study participants who were between 24-32 weeks gestation were identified by the appropriate nurses at each clinic during antenatal visits. After the nurses identified potential participants, they were approached by the researcher to determine eligibility for the study; if the pregnant women met the inclusion and exclusion criteria, they were recruited. The researcher then obtained informed consent from the pregnant women (see Appendix 1). This was sought to gain access to the participants' medical files and for the blood tests which determined whether GDM was present or absent, and for use of the interview information. Once consent was obtained, an interview was conducted which was approximately 10 minutes in duration. In this step, the researcher completed a structured questionnaire which screened for the risk factors of gestational diabetes, acquired anthropometric measurements and completed the laboratory referral forms for the oral glucose tolerance tests (OGTTs) for each

study participant (see Appendices 2 and 3). Every participant was given a urine cup after the referral form was completed and instructed to go to the laboratory at the Milton Cato Memorial Hospital (MCMH) at the earliest most convenient date to have the OGTT performed. The participants were also instructed to fast for at least 10 hours the night prior to the OGTT and urinate in the cup given to them the morning of the test and take it with them to the laboratory.

Five weeks after the study inception, it was observed that the recruitment rate was exceedingly slow; only 10 participants had been recruited in the said time period. A choice was made to terminate the current study due to the slow recruitment rate and limited time frame in which to collect data. In addition, the women enrolled did not all go to the screening setting as requested to assess their glucose status; only 4 women went to the screening. Hence, a decision was made to find another feasible means (Study 2) of collecting the data which reflected the research objectives.

Data collection tools

Interviews were conducted during which data were collected via questionnaires. These questionnaires were used to gather information on both modifiable and non-modifiable predictor variables for GDM and complications associated with the disease. The information gathered from the questionnaires on weight and height will be used to calculate pre-pregnancy BMI and pregnancy weight gain. Oral glucose tolerance tests also served as a primary tool for data collection. These tests were used to diagnose GDM, the outcome variable.

Questionnaire

The questionnaire consisted of 26 items; 23 questions were on maternal factors such as demographic characteristics, years of education, number of gravidities and parities, alcohol

consumption, smoking and physical activity; 3 questions were based on the pregnant women's family history of diabetes (family was defined as parents and siblings); and the last 3 questions were on anthropometric measurements such as height, pre-pregnancy weight and pregnancy weight gain (see Appendix 2). A space was also included on the questionnaire to record the results of the OGTT at a later date. The majority of the questions used for the formulation of the questionnaire were taken from several studies [11, 22, 23, 38-43].

The categories used for the question on annual household income were derived from a telephone conversation with the Department of Labour within the Ministry of National Reconciliation, The Public Service, Labour, Information and Ecclesiastical Affairs in SVG (see Appendix 2). The question on physical activity was taken from the Monica Optional Study of Physical Activity (MOSPA) questionnaire. This questionnaire was developed by the Centers for Disease Control and Prevention (CDC) and is an addition to the WHO's Monitoring Trends and Determinants of Cardiovascular Disease (WHO-Monica) study [43]. All heights and pregnancy weights were measured by the researcher using Detecto balance beam doctor/physician scales with height rods present at the health centers/clinics. Pre-pregnancy weights were self-reported. Heights were calculated to the nearest 0.1 centimeter (cm) and weights to the nearest 0.1 kilogram (kg). The pregnant women's pre-pregnancy body mass index and pregnancy weight gain will later be calculated using statistical analysis software. The formula used to calculate the pregnancy weight gain was:

Pregnancy weight gain = Weight at time of recruitment – Pre-pregnancy weight

Oral Glucose Tolerance Test

An OGTT is a blood test that is performed to diagnose gestational diabetes in pregnant women. According to the World Health Organization, pregnant women meeting the diagnostic criteria for diabetes or impaired glucose tolerance (IGT) are characterized as having GDM [27]. The diagnostic criteria for gestational diabetes currently used in St. Vincent and the Grenadines are based on the recommended one-step approach of the WHO. For this study, 2-h 75-g OGTTs were administered using the threshold values indicated in table 2 in the literature review under the section, screening and diagnosis of GDM.

On the day of the OGTT, blood was drawn at fasting upon arrival to the laboratory. The fasting urine sample was then tested for the presence of glucose using a dipstick. If glucose was present in the fasting urine sample, the fasting blood sample that was drawn was then tested. When tested, if the fasting blood glucose is greater than or equal to 8.0mmol/L, no further tests were administered. If no glucose was found in the fasting urine sample, a 75-g glucose beverage was further administered to the participant. Two hours after the glucose drink was consumed, another urine sample was taken. Blood was drawn every hour for 2 hours. The blood samples were used to measure the blood glucose levels and diagnose GDM. All OGTTs were performed at the MCMH laboratory free of charge. The results from the OGTTs were forwarded to the participants corresponding clinics by the laboratory as a routine procedure. The researcher also obtained the results from the laboratory. Study participants were informed during the interview that they would only be contacted if the test result was positive for IGT or GDM.

Data analysis

Descriptive statistics including mean and standard deviation (SD) were used for continuous variables and frequency distribution was used for categorical variables; these

analyses were performed on all the predictor and pregnancy outcome variables. Pre-pregnancy BMI and pregnancy weight gain were also calculated. All statistical analyses were computed using the statistical software IBM SPSS version 19.

Study 2

Population

The data used in this study was also derived from various antenatal clinics in St. Vincent and the Grenadines. Data were extracted chiefly from perinatal records of pregnant Vincentian women who had a last menstrual period (LMP) during 2010/2011 and who had already given birth. Antenatal records were also used as a source for data extraction particularly for data on the 2-h 75-g OGTT and neonatal sex and birth weight. Records from each clinic were excluded if the pregnant woman was less than 18 years and had a nationality other than Vincentian as indicated by the perinatal records.

Antenatal clinics selection

For the second study, a sample of 403; one-half the calculated sample size, was deemed attainable. Given that the original estimate for the prevalence of GDM is likely very low, less than 2 percent, a prevalence of 5 percent along with setting a wider margin of error, allowed for a sample size of 403 to be used. To achieve such a sample size, data were collected from 29 antenatal clinics; 26 clinics on the mainland St. Vincent and 3 clinics in the Grenadines as shown in Table 4 (see Figures 3 and 4). From these 29 clinics, information was extracted for 456 pregnancies.

Table 4 Antenatal Clinics included in Study 2

Clinics on mainland St. Vincent		Clinics in the Grenadines
1. Barrouallie	18. Owia	1. Canouan
2. Belair	19. Retreat	2. Paget Farm
3. Biabou	20. Richland Park	3. Port Elizabeth
4. Byera	21. Rosehall	
5. Calder	22. Sandy Bay	
6. Calliaqua	23. Sion Hill	
7. Campden Park	24. South Rivers	
8. Chateaubelair	25. Stubbs	
9. Clare Valley	26. Troumaca	
10. Diamonds		
11. Enhams		
12. Georgetown		
13. Greggs		
14. Kingstown		
15. Lowmans Windward		
16. Marriaqua		
17. Overland		

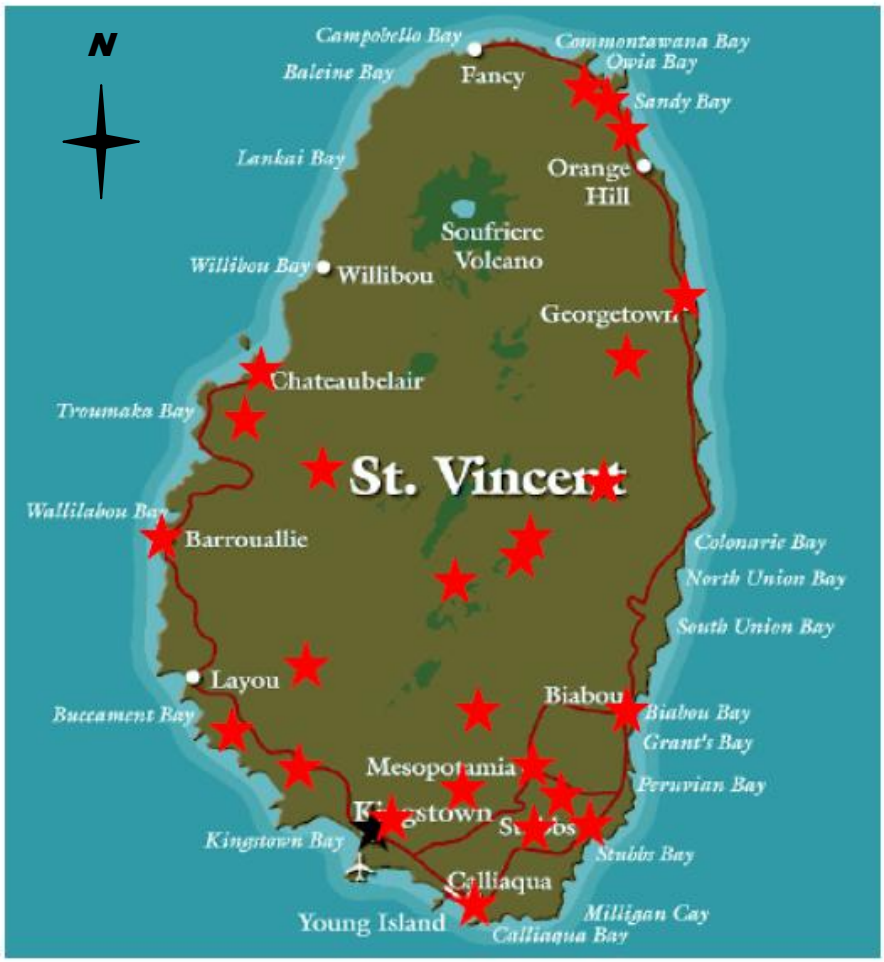

Figure 3 A map of mainland St. Vincent showing the antenatal clinics used in Study 2

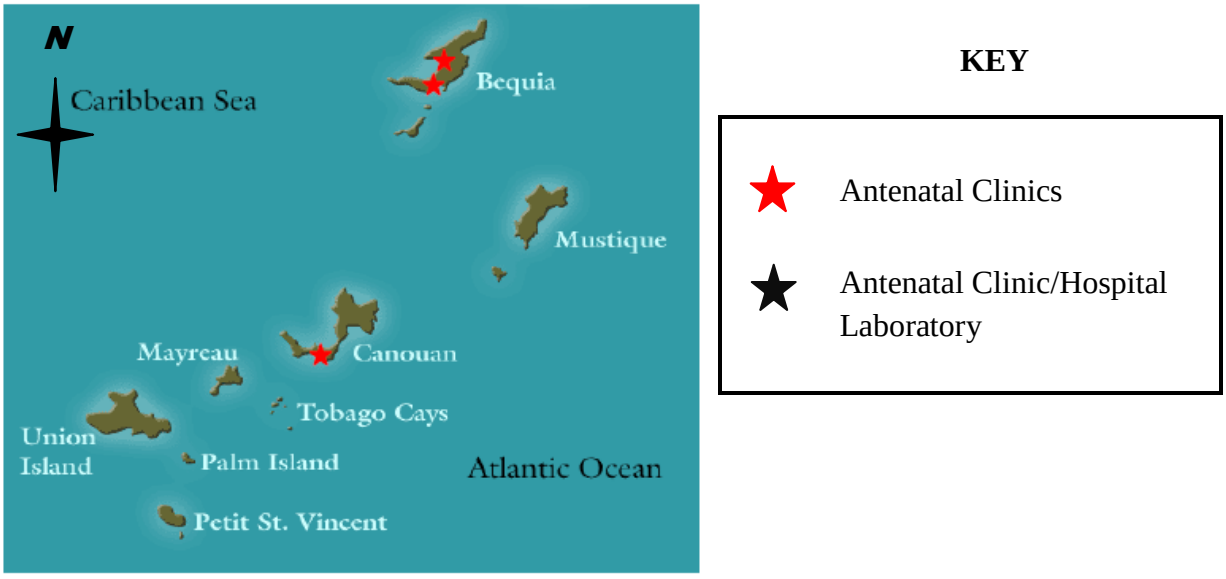

Figure 4 A map of the Grenadines showing the antenatal clinics used in Study 2

Study description

Data extraction for study 2 began on August 29, 2011 and terminated on October 24, 2011. On the day of data extraction, a particular antenatal clinic was visited and all perinatal records and corresponding antenatal records (in paper format) for 2010/2011 were collected from the nurse in charge or the most appropriate nurse and reviewed by the researcher to determine if the records met the inclusion and exclusion criteria. Perinatal records that did not meet these criteria were excluded. If the only sections completed on these records were the demographic variables and the history sections, these records were also excluded. It is important to note that these records were not organized in any particular order, whether by subject or chronologically. All perinatal records were in tri-fold card format whereas the antenatal records were a compilation of miscellaneous medical documents including various blood and diagnostic test results, hospital discharge letters and other documents.

After all these exclusions were made, data extraction from the perinatal and antenatal records of pregnant Vincentian women began via a data abstraction form (see Appendix 4). Upon completion of data extraction, all records were returned to the person from whom they were collected from. However, in the case of Canouan clinic, the Senior Nursing Officer (SNO) Community Nursing, Sister Ferosa Roache arranged with the nurse in charge of that clinic to have the perintal and antenatal records delivered to her office on one of her visits to the mainland St. Vincent. This was done to avoid costs associated with accessibility to that particular Grenadine Island. The records for Canouan were collected by the researcher and taken to the main office in the Dietetics Department at the MCMH; these records were reviewed and data were extracted before all records were returned to the SNO.

Data collection tools

The only data collection tool used for study 2 was a data abstraction form. This form was designed around the perinatal card (see Appendix 5) which is currently in use at antenatal clinics throughout St. Vincent and the Grenadines. The design and contents of the data abstraction form will be discussed further.

Data abstraction form

This form was designed to screen for the prevalence of gestational diabetes and predictors and pregnancy outcomes known to have associations with the disease. It was broken down into sections which were based on maternal demographic characteristics, family, personal and obstetric history, present pregnancy, the neonate and the OGTT. The section on maternal demographic characteristics included information on the pregnant womens' date of birth, age, race, literacy, education (level and years) and marital status. The following section was broken down into 3 subsections; family history, personal history and obstetrical history. Family and personal history included information on disease history. Family history in study 2 differed from that in study 1; in study 2, family was defined as parents, siblings, grandparents and offspring. Obstetrical history recorded information pertaining to gravidities, abortions, caesarean sections, stillborns, parities and last previous pregnancy such as previous macrosomia and preeclampsia/eclampsia. Information on present pregnancy was included in the next section; data on pre-pregnancy weight, height, smoking, drug use, alcohol consumption, gestational age, antenatal visits, type of pregnancy and maternal pathologies were found here. Maternal pathologies were defined as diseases in the current pregnancy. Weights and heights were recorded on the data abstraction form in the units' kilogram and centimeter respectively. The

neonate section consisted of data on the neonate's sex, birth weight and weight for gestational age. The final section was on the OGTT: whether an OGTT was performed and if such a test was performed, the results of the test. The diagnosis of GDM was based on the WHO 2-h 75-g OGTT. A blank page was inserted at the end of the data abstraction form for important abstractor's notes. This was where the researcher noted any particulars or inconsistencies observed in the pregnant woman's record.

Data analysis

Data abstraction forms which indicated multiple gestations were excluded from all data analyses. All statistical analyses were computed using the statistical software IBM SPSS version 19 and SAS. Continuous variables were described as mean and standard deviation and categorical variables as frequency distributions. Student's t-test was used to determine the difference between two groups for continuous variables and the Pearson's chi-square test was used to compare categorical variables. Fisher's exact test was used when the minimum expected count was less than 5 for a 2 x 2 contingency table. All statistical analyses mentioned above were computed in SPSS. Multivariate statistics were not undertaken given the small number of women with recorded GDM. The statistical analysis software SAS was used to compute Fisher's exact tests for contingency tables larger than 2 x 2. Statistical significance was set at $p < 0.05$.

Pre-pregnancy BMI and pregnancy weight gain were calculated using SPSS. Pre-pregnancy BMI was calculated using the formula (wt/ (ht) **2)*10000. The entire formula was multiplied by 10 000 to convert from centimeters to meters. For the calculation of BMI, all heights less than 134 cm were excluded as outliers due to excessive shortness in the sample as evident by extremely high BMIs (BMI $\geq$ 60). The formula used to calculate pregnancy weight gain in this study follows on the subsequent page.

The formula used to calculate pregnancy weight gain in study 2 was:

Pregnancy wt gain = Last documented weight (kg) – First documented weight (kg) ≤ 20wks

RESULTS

Study 1

Oral Glucose Tolerance Test Results

Of the 10 women who completed the questionnaires in study 1, only 4 went to the laboratory to have the OGTT done. Table 6 depicts the test results for these 4 women. All the test results were negative for IGT and GDM.

Table 5 2-h 75-g Oral Glucose Tolerance Test Results

Patient	FBS (mmol/L)	2-h (mmol/L)
A	4.9	7.6
B	4.6	5.4
C	4.0	7.5
D	4.2	4.9

Baseline and Anthropometric Characteristics

This study included 10 pregnant women who attended antenatal clinics at 8 health centers/clinics. The mean gestational age of these women was 26 weeks 8 days (SD = 2.3) and the average maternal age was 23.3 years (SD = 5.3) (Table 7). The study population was predominantly black (Afro-Caribbean) with 2 single, 3 married and 5 in relationships. Over half of the population attained at least a secondary level of education (12-13 years of education) and 3 persons completed less than a primary level of education (less than 7 years of education). Four of the pregnant women reported having an average monthly household income between Eastern Caribbean (EC$) 3000 – 5000 dollars (US$ 1111 – 1852). The unemployment rate in this study was relatively high, of the 10 pregnant women, 8 were without jobs. The pregnant women

seemed cognizant of the detrimental effects of smoking and alcohol consumption on the fetus; only 1 of the women both smoked and drank during the pregnancy. All women were physically active with the exception of 1 person who was on bed rest. Most women engaged in light physical activity (n = 6).

The health of the population was further reflected in the BMI (mean = 22.9, SD = 4.3); 7 pregnant women had healthy BMI's (BMI 18.5-24.9 kg/m^2). Of the 4 women who had an OGTT performed, 3 were of normal weight (BMI 18.5-24.9 kg/m^2) and 1 was obese (BMI $\geq$ 30 kg/m^2). The study participants had a mean height of 162.6 cm (SD = 5.9) and a mean pre-pregnancy weight of 60.6 kg (SD = 11.0). All weights and heights for the study participants are depicted in Table 6. The average weight gained in pregnancy was 13.3 kg (SD = 3.7).

No known history of diabetes in a first-degree relative or a history of abnormal glucose metabolism in pregnancy was reported among these pregnant women. For the majority of pregnant women, this was their first pregnancy as evidenced by 6 women reporting zero gravidities. Of those who reported 1 or more gravidities, 3 were primiparous and 1 was multiparous.

The 10 pregnant women had a low risk for GDM as indicated by no previous macrosomic infants, still births, hypertension in current or previous pregnancies and 1 previous caesarean section. Nine women reported no adverse obstetrical outcomes.

Table 6 Baseline and Anthropometric Characteristics of Pregnant Vincentian Women

Variables	n	Mean ± SD
Gestational age (weeks)	10	26.8 ± 2.3
Maternal age (years)	10	23.3 ± 5.3
Race		
African/Black	9	
Mixed	1	
Marital status		
Single	2	
Married	3	
Other	5	
Education (years)		
Less than 7	3	
12-13	6	
14 or more	1	
Employment status		
Unemployed	8	
Employed	2	
Annual household income (EC$)		
$7 200 or less	1	
$7 201-$18 000	2	
$36 001-$60 000	4	
Missing	3	
Alcohol consumption		
Yes	1	
No	9	
Smoking status		
Non-smoker	9	
Current smoker	1	

Physical activity		
Yes	9	
No	1	
Physical activity classes		
No weekly activity	1	
Only light physical activity	6	
Vigorous physical activity: once/twice per week	1	
Vigorous physical activity: 3 times or more per week	2	
Previous GDM		
No	10	
Family history of Type 2 DM		
No	9	
I don't know	1	
GDM history in your mother		
No	2	
I don't know	8	
Number of gravidities (pregnancies)		0.5 ± 0.7
0	6	
1	3	
2	1	
Number of parities (live births)		1.5 ± 0.7
Nulliparous (0)	6	
Primiparous (1)	3	
Multiparous (2-4)	1	
Maternal height (cm)	10	162.6 ± 5.9
Pre-pregnancy weight (kg)	10	60.6 ± 11.0
Pregnancy weight (kg)	10	73.9 ± 12.3
Pregnancy weight gain (kg)	10	13.3 ± 3.7

Pre-pregnancy BMI (kg/m^2)		22.9 ± 4.3
Underweight (< 18.5)	1	
Normal weight (18.5 – 24.99)	7	
Overweight (25.0 – 29.99)	1	
Obese (≥ 30)	1	

Height and Weights for the 10 pregnant women between 24-32 weeks gestation

Participant	Heights (cm)	Pre-pregnancy Wts (kg)	Pregnancy Wts (kg)
1	162	48.6	58.6
2	164	46.8	65.4
3	162	59.1	71.4
4	170	72.7	92.7
5	166.5	63.6	74.1
6	173.5	68.2	79.1
7[a]	156.5	81.3	96.8
8[a]	156.5	56.8	68.0
9[a]	157.5	58.2	68.2
10[a]	158	51.8	65.0

[a] heights and weights for study participants A, B, C, D

Study 2

Tables 7 and 8 and Figures 2-4 describe a sample of the population of pregnant women who conceived between 2010/2011 and have delivered in St. Vincent and the Grenadines. The results are displayed as women with known IGT or GDM, those not tested for IGT or GDM and the total sample. When interpreting the results, particularly percentages, caution must be taken due to the large quantity of missing data in the study. The missing data were attributed to poor documentation, record keeping and completion of perinatal records at the various health centers/clinics.

Prevalence of GDM

Results were obtained for 454 pregnant women using perinatal and antenatal records at 29 health centers/clinics. All pregnant women in this study were likely prescreened for GDM using urine dipstick tests. These urine dipstick tests are unreliable, insensitive and non-specific screening and/or diagnostic tools. Nevertheless, a few of these women were screened for GDM using the 2-h 75-g OGTT and diagnosed according to the WHO criteria.

Of these 454 pregnant women, only 11 had documented testing for an OGTT. Seven of the women with a documented OGTT had IGT (n = 5) or GDM (n = 2) (Table 7). In the group of women undetected for IGT or GDM (n=447), only 4 subjects were actually documented as having IGT or GDM and all others had unknown status. Despite the uncertainty of how many persons in this group had IGT or GDM, the women were compared to those with known IGT or GDM in an attempt to highlight the group that was screened and found to have IGT or GDM. Data obtained for 2 pregnant women with twin pregnancies were excluded from the analyses.

Impaired glucose tolerance or GDM were present in 1.5 percent of the population of pregnant women. However, this figure does not represent the prevalence of GDM as many of the

pregnant women in this study presumably had undetected IGT or GDM. As a result, the prevalence of GDM cannot be estimated and remains unknown. Many women had risk factors for GDM and these risk factors are described.

Baseline Characteristics and Predictors of GDM

Pregnant women with IGT or GDM had an average age of 29.6 years (SD = 7.9) while the average age for women untested for GDM was 26.2 years (SD = 6.3) (Table 7). More than 50 percent of the entire sample population was less than 25 years old. As expected, 95 percent of the total pregnant women (n = 400) were blacks (Afro-Caribbean). Forty-nine percent (n = 206) of the total untested women for GDM had a family history of diabetes which may put them at an elevated risk for GDM and thus, this group of women should have been tested according to the WHO guidelines. One person had type 1 DM and 6 had type 2 DM; all these pregnant women belonged to the group of women untested for GDM. Most of the pregnant women in this study did not smoke, use drugs or consume alcohol; 98 percent, 98 percent and 95 percent respectively. Women with IGT or GDM visited the antenatal clinics more frequently (n = 4, mean = 10.2 visits, SD = 4.0) compared to untested women (n = 312, mean = 9.1 visits, SD = 4.0).

The average maternal height for women with IGT or GDM was 169.2 cm (SD = 15.8) and 163.6 (SD = 7.5) for women untested for GDM. Maternal heights were missing for 71.4 percent (n = 5) of women with IGT or GDM and 65.5 percent (n = 293) of untested women. A weight loss of 2.3 kg (SD = 3.2) was observed among the 2 women with IGT or GDM while a weight gain of 5.1 kg (SD = 4.7) was observed among 47.9 percent (n = 214) of the women untested for GDM between the first and last recorded weights. Body mass index was calculated for all pregnant women using the first recorded weights. Based on these weights, BMI could only be calculated for 2 women with IGT or GDM; the mean BMI was 25.6 (SD = 3.9). In many

records, height was not recorded thus making it difficult to ascertain the extent to which women untested for GDM were from the expected high risk group. Women who were not tested for GDM had a mean BMI of 26.7 (SD = 6.3). In addition, of all the women untested for GDM, 56 percent (n = 85) were categorized as overweight (BMI $\geq$ 25) which increases their risk for GDM. Figure 2 illustrates the BMI distribution for the women using first recorded weights.

There were significant differences in the first documented weight for IGT or GDM (n = 7, mean = 101.3, SD = 25.0) and women untested for GDM (n = 447, mean = 73.3, SD = 18.2; $p < 0.0001$) and the last documented weight for IGT or GDM (n = 7, mean = 103, SD = 21.3) and untested women (n = 447, mean = 77.7, SD = 17.4; $p < 0.0001$). The histogram in Figure 3 illustrates the first documented weights for approximately 99 percent (n = 449) of all pregnant women. Most women over 73 kg were considered overweight with the exception of very tall women; a great proportion of women were overweight and this is depicted in Figure 3. The highest first documented weight was greater than 155 kg. The first documented weights for women with IGT or GDM were: 70.9, 130.9, 74.4, 107.3, 127.3, 115.0, 83.2; the corresponding last documented weights were: 79.1, 126.4, 75.9, 104.5, 127.3, 116.0, 91.8.Weight during pregnancy affects a pregnant woman's chance for an increased risk of IGT or GDM.

A great proportion of the women in this study had high pre-pregnancy body weights. The mean pre-pregnancy weight for those with IGT or GDM (n = 7) was 95.7 (SD = 38.9) and the mean pre-pregnancy weight for women untested for GDM (n = 447) was 70.3 (SD = 18.4), $p = 0.056$. Although there was no significant difference between the groups, the result cannot be ruled out as not being due to chance. Many data points were missing thus reducing the effective sample size and statistical power. The histogram illustrated in Figure 4 depicts the pre-pregnancy

weight among these pregnant women for those with this measure (n = 201). A great percentage of these women had high pre-gravid weights.

Since weights were often not reported and there were many missing values for the variables pre-pregnancy weight and first documented weight; histograms were plotted to get the best guesstimate for the portion of women overweight pre-gravid (Figures 3 and 4).

There were no significant differences between the comparison groups for smoking, alcohol consumption, drug use, weight gain, number of antenatal visits, family history and past medical maternal history of diabetes.

Table 7 Baseline Characteristics and Predictors of GDM

Variables	IGT/GDM (n = 7)		No Observed IGT/GDM (n=447)		Total (n = 454)		P value
	n	%	n	%	n	%	
Maternal age (years)*	29.6 ± 7.9		26.2 ± 6.3		26.2 ± 6.3		0.13
Maternal age groups							0.50
Less than 25	3	42.9	237	53.0	240	52.9	
26-34	2	28.6	151	33.8	153	33.7	
35 and more	2	28.6	59	13.2	61	13.4	
Race							0.30
Black	6	85.7	394	95.2	400	95.0	
Missing	___	___	33	7.4	33	7.3	
Education (level)							0.63
None	___	___	1	0.2	1	0.2	
Elementary	3	50.0	132	32.0	135	32.2	
Secondary	3	50.0	218	52.8	221	52.7	
Tertiary	___	___	62	15.0	62	14.8	
Missing	1	14.3	34	7.6	35	7.7	

Marital status							0.36
Married	2	28.6	51	14.0	53	11.7	
Common law wife	___	___	90	24.7	90	19.8	
Single	5	71.4	213	58.5	218	48.0	
Other	___	___	10	2.7	10	2.2	
Missing	___	___	83	18.6	83	18.3	
Family History of Diabetes							1.00
No	4	57.1	215	51.1	219	51.2	
Yes	3	42.8	206	48.9	209	48.8	
Missing	___	___	26	5.8	26	5.7	
Number of antenatal visits*	10.2 ± 4.0		9.1 ± 4.0		9.2 ± 4.0		0.59
Missing	3	42.9	135	30.2	138	30.4	
Maternal height (cm)*	169.2 ± 15.8		163.6 ± 7.5		163.7 ± 7.6		0.31
Missing	5	71.4	293	65.5	298	65.6	
Pre-pregnancy weight (kg)*	95.7 ± 38.9		70.3± 18.4		70.6 ± 18.6		0.056
Missing	5	71.4	248	55.5	253	55.7	
First documented weight (kg)*	101.3 ± 25.0		73.3 ± 18.2		73.7 ± 18.6		<0.0001
Missing	___	___	5	1.1	5	1.1	

Last documented weight (kg)*	103 ± 21.3		77.7 ± 17.4		78.2 ± 17.7		<0.0001
Missing	___	___	36	8.0	36	7.9	
Weight gain (kg)*	- 2.3 ± 3.2		5.1 ± 4.7		5.1 ± 4.7		0.28
Missing	5	71.4	233	52.1	238	52.4	
BMI using 1st recorded wts (kg/m^2)							1.00
Underweight (< 18.50)	___	___	6	4.0	6	3.9	
Normal weight (18.50 – 24.99)	1	50.0	60	39.7	61	39.9	
Overweight (25.00 – 29.99)	1	50.0	46	30.5	47	30.7	
Obese (≥ 30.00)	___	___	39	25.8	39	25.5	
Missing	5	71.4	296	66.2	301	66.3	
Smoking							1.00
No	7	100	382	98.4	389	98.5	
Yes	___	___	6	1.5	6	1.5	
Missing	___	___	59	13.2	59	13.0	
Drug use							1.00
No	7	100	364	97.6	371	97.6	
Yes	___	___	9	2.4	9	2.4	
Missing	___	___	74	16.5	74	16.3	

Alcohol consumption							1.00
No	7	100	369	94.6	376	94.7	
Yes	___	___	21	5.4	21	5.3	
Missing	___	___	57	12.7	57	12.5	

*Data are represented as mean ± SD

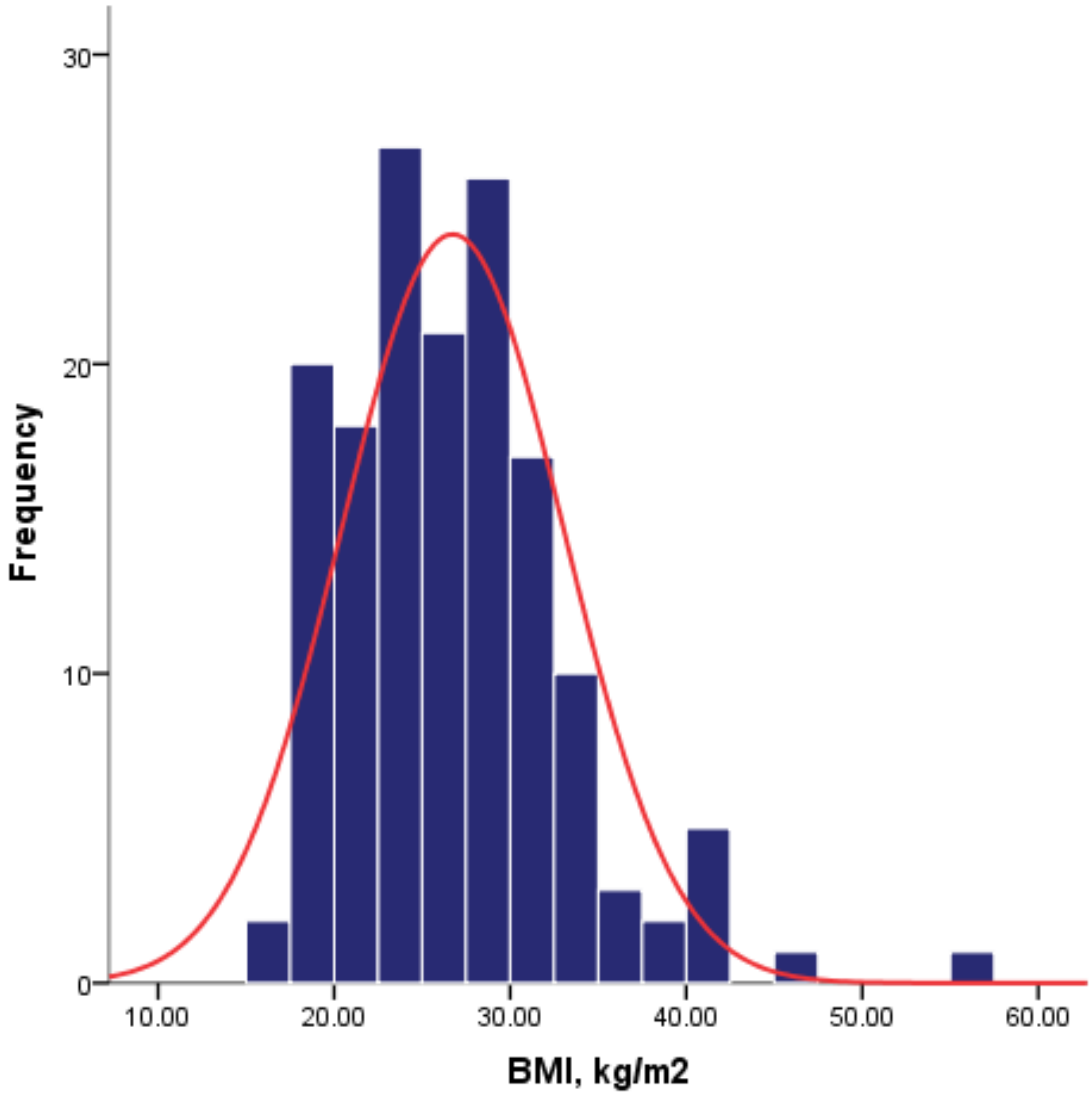

Figure 5 Histogram illustrating Body Mass Index using First Documented Weights (n = 153)

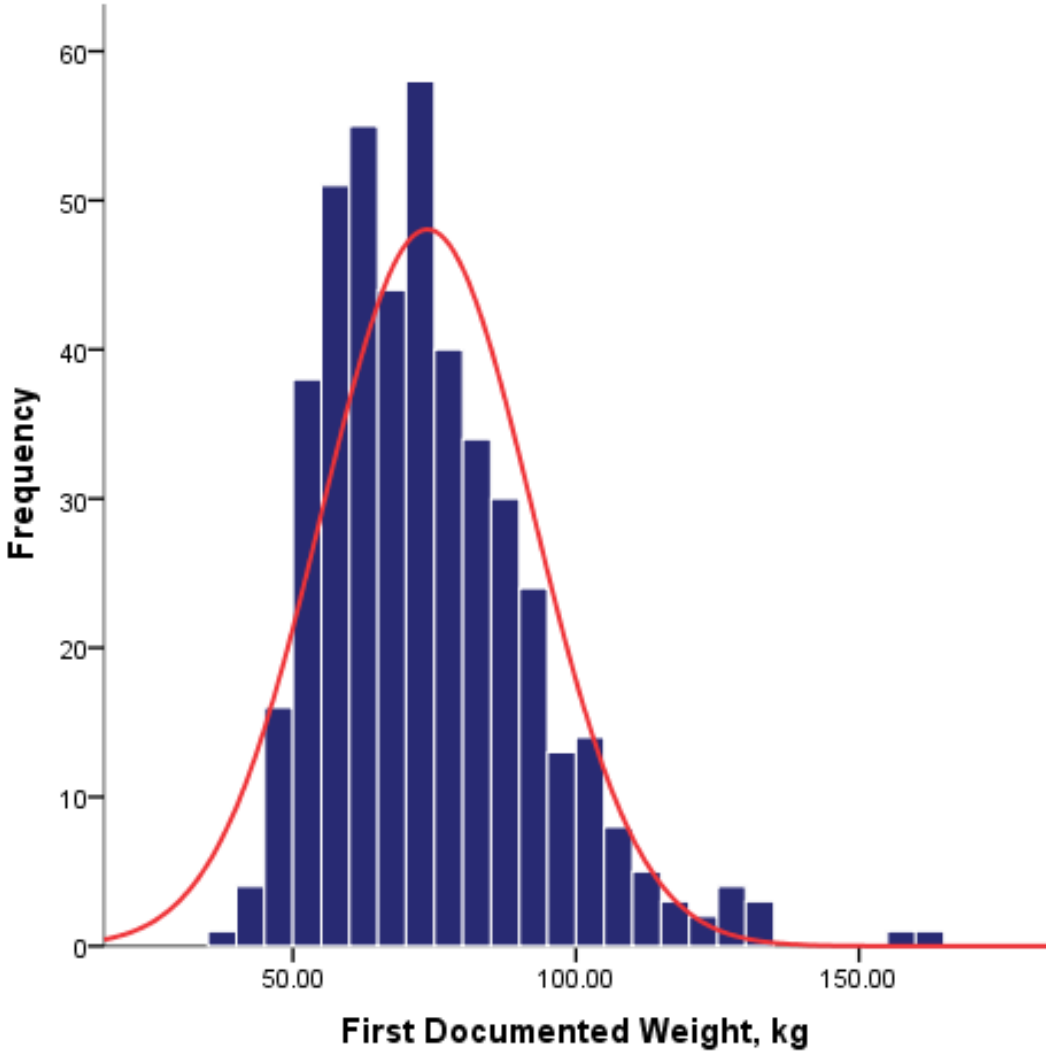

Figure 6 Histogram illustrating First Documented Weights (n = 449)

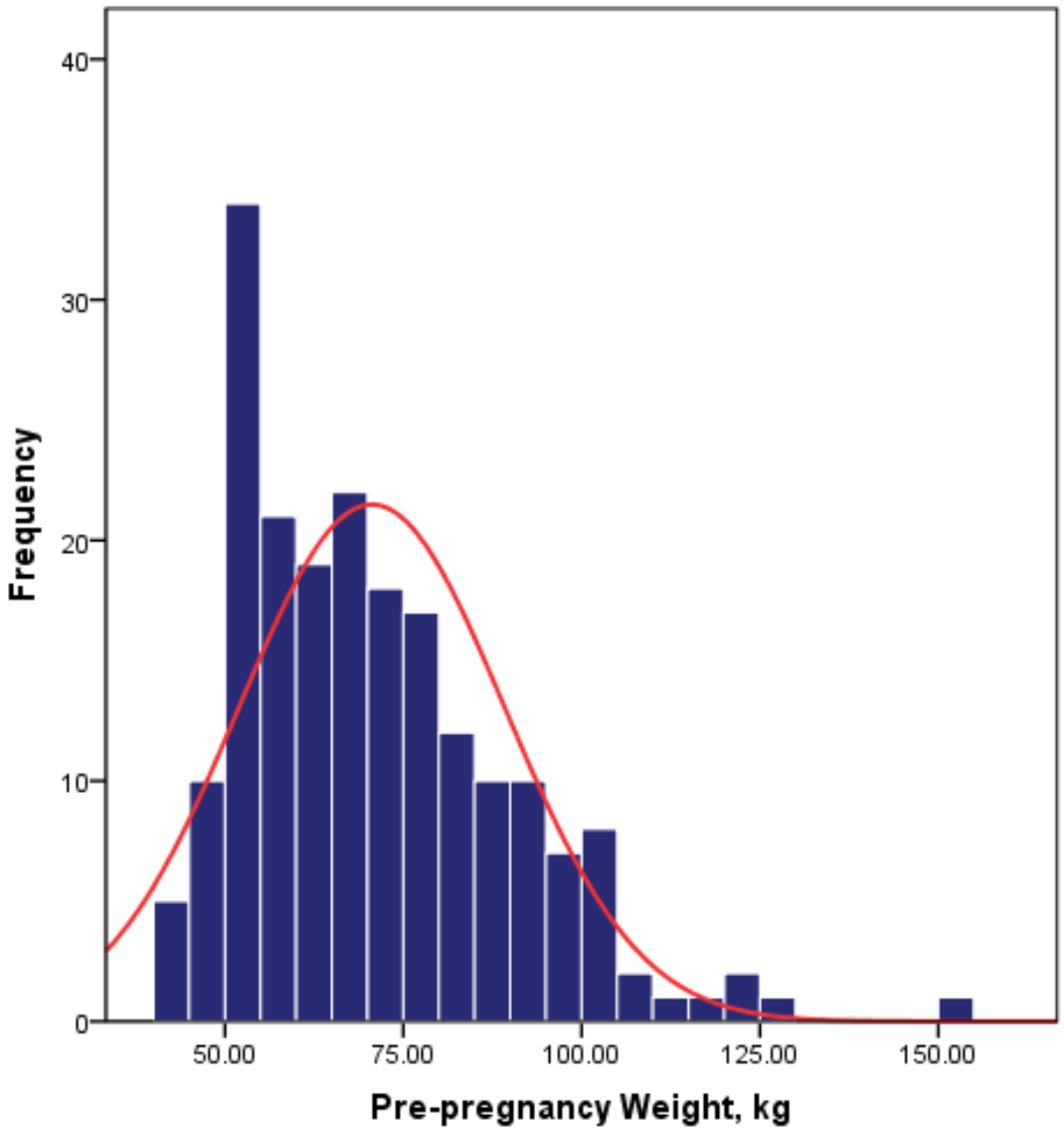

Figure 7 Histogram illustrating Pre-pregnancy Weights (n = 201)

Obstetrical History and Pregnancy Outcomes

Pregnant women with IGT or GDM (n = 7) had an average of 3 gravidities (SD = 2.8) and the women untested for GDM had an average of 2.2 gravidities (SD = 1.7). Women with IGT or GDM had no prior history of abortions while 28 percent (n = 68) of women untested for GDM reported having a previous abortion. One caesarean section was reported for women with IGT or GDM and one also for untested women (SD = 0.2). Women with IGT or GDM had 1 stillborn and women untested for GDM had an average of 1.2 stillborns (SD = 0.2). Pregnant women with IGT or GDM had an average of 2.6 liveborns (SD = 2.4) and women who were untested for GDM had an average of 1.7 liveborns (SD = 1.6).

There were no significant differences shown for the number of previous pregnancies (gravidities) and liveborns (parities), previous and number of abortions, number of caesarean sections, sex and weight for gestational age of the neonate, past medical history of pre-eclampsia or eclampsia and maternal pathologies for hypertension induced pregnancy, pre-eclampsia, eclampsia and diabetes between those women with IGT or GDM and those untested for GDM. A greater percentage of women with IGT or GDM (60 percent) (n = 3) had a prior caesarean section compared to women untested (18.8 percent) (n = 33; p = 0.055).

When obstetrical history and pregnancy outcomes were compared between women with IGT or GDM (n = 7) and women untested for GDM (n = 447), significant differences were found for the last documented gestational age, neonatal birth weight, having a previous stillborn and a past reproductive tract surgery (Table 8). Women with IGT or GDM had a significantly lower last documented gestational age (mean = 34.2, SD = 0.1) than the women untested for GDM (mean= 36.7, SD = 1.6; p = 0.034). Neonates born to women with IGT or GDM had significantly higher birth weights (mean = 3.8, SD = 0.2) than neonates born to women untested for GDM

(mean = 3.2, SD = 0.5; p = 0.002). Forty-three percent (n = 3) of women with IGT or GDM had neonates with birth weights greater than 4000 grams compared with 3 percent (n = 14) of women untested for GDM. The high mean birth weights and proportion of macrosomic infants are potentially indicative of poor glucose control during pregnancy. Fifty percent (n = 2) of women with IGT or GDM had a prior stillborn child compared with 7 percent (n = 11) of untested women, p = 0.03. A past medical history of reproductive tract surgery was reported in 50 percent (n = 3) of women with IGT or GDM and in 6 percent (n = 26) of women untested for GDM, p = 0.005.

Table 8 Obstetrical history and pregnancy outcomes of GDM

Variables	IGT/GDM (n = 7)		No Observed IGT/GDM (n=447)		Total (n = 454)		P value
	n	%	n	%	n	%	
First GA*	19.3 ± 8.6		18.4 ± 6.8		18.4 ± 6.8		0.78
Missing	2	28.6	72	16.1	74	16.3	
Last GA*	34.2 ± 0.1		36.7 ± 1.6		36.6 ± 1.6		0.034
Missing	5	71.4	298	66.6	303	66.7	
Previous stillborns							0.030
No	2	50.0	154	93.3	156	92.3	
Yes	2	50.0	11	6.6	13	7.7	
Missing	3	42.8	282	63.1	285	62.8	
Number of stillborns*	1.0 ± 0.0		1.2 ± 0.4		1.0 ± 0.2		0.51
Prior Reproductive tract surgery							0.005
No	3	50.0	382	93.6	385	93.0	
Yes	3	50.0	26	6.4	29	7.0	
Missing	1	14.3	39	8.7	40	8.8	

Neonate birth weight*	3.8 ± 0.7		3.2 ± 0.5		3.2 ± 0.5		0.002
Missing	___	___	8	1.8	8	1.8	
Neonate birth weight, groups							0.002
< 4000 grams	4	57.1	422	96.8	426	96.2	
> 4000 grams	3	42.9	14	3.2	17	3.83	
OGTT performed							<0.0001
Yes	7	100	4	0.9	11	2.4	
Not documented	___	___	443	99.1	443	97.6	

*Data are represented as mean ± SD

DISCUSSION

The main objective of study 1 and 2 was to estimate the prevalence of gestational diabetes mellitus in a population of pregnant Vincentian women. Both studies also aimed to determine the predictors and pregnancy outcomes associated with the development of gestational diabetes in St. Vincent and the Grenadines.

Study 1

In this study, the prevalence of gestational diabetes could not be calculated as the study had to be terminated. The risk of gestational diabetes would have been low due to the low maternal age of the women as well as the study population exhibiting good health characteristics. The majority of pregnant women in the study did not consume alcohol or participate in smoking cigarettes or marijuana. The good health of this population was also evidenced by the large percentage of women who engaged in physical activity and were classified as normal weight (BMI 18.5 – 24.9). In this study, pregnant women had an average weight gain of 13.3 kg. The Institute of Medicine (IOM) recommends a total gestational weight gain of 25 – 35 pounds (lbs) (11.36 – 15.90 kg) for women with a healthy pre-pregnancy BMI [44]. Excessive weight gain during pregnancy contributes to a pregnant woman's increased risk for type 2 diabetes independent of GDM and weight retention following the pregnancy [10]. Hence, the women in this study were not at an increased risk for either of these conditions. The low number of gravidities and parities, lack of fetal and maternal complications associated with GDM and no family history of diabetes could have all been contributing factors to the absence of GDM among these women. Upon further examination of the study results, the only scientific reported predictor known to cause gestational diabetes that was present in this study was ethnicity; the

study population was predominately black. Ethnicity, particularly of African descent is a known predictor of GDM [15].

Strengths and Limitations

As with any study, there are strengths and limitations. Study 1 was a cross sectional study which is most appropriate for determining prevalence and examining associations [45] and it was relatively inexpensive to conduct, with a short duration. The OGTT was performed for the study participants free of charge thus enabling persons who were economically disadvantaged a chance to be tested for GDM. Since participation was voluntary and there was a lack of incentive to participate, these factors may have influenced the refusal rate. The study participants were not provided with transportation to the laboratory to have the OGTT performed and this may have been a contributing factor to women not showing up for the test. Of the 10 women, only 4 went for the free testing. Another limitation of the study was too few women being eligible to participate given the specific gestational age range: 24-32 weeks. A modification of study 1 design can potentially result in the known GDM prevalence in SVG. With funding to provide transportation for study participants to the laboratory for the administration of oral glucose tolerance tests, increased number of study centers/clinics and trained researchers for each health center/clinic as well as a longer study duration, the likelihood of ascertaining the prevalence of GDM in SVG can be increased. Study 1 results can by no means be generalized to pregnant Vincentian women due to the small sample size and hence could not be used to examine the prevalence and predictors of GDM.

Study 2

The prevalence of GDM could not be established in this study. This was due primarily to the use of a urine dipstick test to screen for diabetes and failure to apply the ADA screening criteria and 2-h 75-g OGTT using the WHO diagnostic criteria in more pregnant Vincentian women, and partially to poor documentation and record keeping, and incompletion of perinatal records. The number of persons untested for GDM in the study 2 population indicates that the sensitivity for diabetes was low in this group and that the urine dipstick test may not have been used in all subjects on a regular basis. Sensitivity is increased in individuals with a high risk for GDM; in the group of untested women, many had a known family history of diabetes and were overweight or obese yet they were not diagnosed as having IGT or GDM. To solve the problem of undetected cases of GDM in the population among relatively high risk women, the ADA screening strategy for detecting GDM in pregnant women, particularly the administration of an OGTT to all pregnant women between 24-28 weeks should be considered. The low sensitivity of the dipstick test for glycosuria suggests that even if the vast majority of pregnant women are screened for diabetes using this test, a large proportion of these women will not be identified. Screening for GDM in pregnant Vincentian women based on the associated risk factors will help to identify more at risk women in the population.

Pre-pregnancy body weight has a strong association with the development of gestational diabetes [10, 15]. Women with IGT or GDM in this study had much higher pre-pregnancy weights than the women who were not tested for GDM. A high pre-pregnancy body weight will further add to the risk for developing GDM.

Many women in both groups, those with IGT or GDM and those with no observed IGT or GDM, were overweight or obese and thus need to lower their body weights immensely

postpartum. Due to the high prevalence of overweight as indicated by pre-pregnancy and first documented weights, it is evident that there is an important need for better weight monitoring and glucose screening at the antenatal clinics in SVG. The missing data in this study was a major factor particularly for basic anthropometric measures like height and weight which are vital for the calculation of further variables like BMI and pregnancy weight gain. Stature, pre-pregnancy weight, weight gained during pregnancy and overweight and obesity as defined by a BMI are all important predictors of gestational diabetes [10, 15, 23].

It was presumed that the number of antenatal visits to the clinic would have derived a significant or close to significant difference between the two comparison groups. It was assumed that the frequency of the visits might somehow increase the chance for the pregnant woman to be screened and thus increase the likelihood of an OGTT being administered especially when the mean maternal age in the study for women with IGT and GDM was 29.6. However, there was no significant difference in the number of antenatal visits between the two groups. High maternal age is a risk factor for GDM; the prevalence of the disease increases 7-10 times in pregnant women older than 24 years compared to women who are younger [15]. Study 2 like study 1 saw the majority of women being predominantly black. Ethnicity as mentioned prior is a risk factor for GDM. However, there was no association with GDM and ethnicity in this sample population of pregnant Vincentian women as there were few non-black women. Although education and a family history of diabetes are predictors of GDM, this study did not find any such associations. No associations were found for GDM with smoking, drug use and alcohol consumption. The only predictor variables known to be significantly different between the groups were first and last documented weights.

The last documented gestational age was significantly different for women with IGT or GDM compared to the women untested for GDM. Women with IGT or GDM had a lower last gestational age than women without the conditions, probably because these women delivered neonates with a significantly higher birth weight, and this may have resulted in the delivery of the neonate prior to 36 weeks of gestation as it was a possibility that these women were at risk for pregnancy complications associated with increased fetal weight. The number of parities and gravidities were expected to show significant differences between the women with IGT or GDM and those untested for GDM but that was not the case. Comparing the two groups has a number of limitations. It is not known how many persons in the untested group had GDM. This misclassification means that significant study findings may not be identified. A past medical history of reproductive tract surgery was also significant in this study. While extracting data, it was noticed that numerous perinatal records had 'c-section' written in red ink above reproductive tract surgery. Based on this observation, it was assumed that reproductive tract surgery also may indicate a prior history of having a caesarean section. If this is the case, the nurses need to be more cognizant of the form and document the relevant information under the appropriate sections because in some circumstances, reproductive tract surgery may be documented under personal history on the prenatal record but there may or may not be any record of a previous caesarean under obstetrical history. In this study, having a previous stillborn was another variable that was significantly different between the groups; so likely, if a pregnant woman had a previous stillborn, she was monitored more closely and had a test for GDM administered. Gravidities, parities, caesarean sections and still births are all possible consequences of pregnancy for those with GDM as previous indentified in the literature review. The birth weight of the neonate was significantly higher in the group of women with IGT or GDM in this study

which coincides with the literature review which states that macrosomia is a possible consequence to the infant of poorly controlled GDM. If the mothers chance for GDM is increased, so too will be the neonate's chance for developing diabetes as an adolescent or an adult. The prevalence of type 2 diabetes is already present more in females than males so women need to be targeted at an early age and informed about diabetes and its many risk factors.

Strengths and Limitations

Study 2 which was a retrospective study, allowed for pre-existing data to be collected and used for a relatively large sample which made the study inexpensive to conduct and faster to perform in a limited time. Recall bias may have been evident in this study particularly for the pre-pregnancy weight variable. Nevertheless, the study may have also had a reduced bias as the outcome of interest, GDM was not the reason the data were collected for originally [45]. The nurses as well as the pregnant women would have clearly been oblivious to the use of the perinatal or antenatal records in any future studies thereby reducing recall bias in relation to this particular study. In this study, as with many retrospective studies, there was a large quantity of missing data. This is something that the researcher has no control over as there is a heavy reliance on record keeping done by someone else besides the researcher. Another problem was lost and misplaced records; this was a common problem among health centers/clinics which probably believe stems from poor record keeping, lack of importance of old records to the health care workers and constant changes in registered nurses. If weight gain is not followed extremely closely and screening for GDM is not done in high risk women, the short and long term consequences associated with GDM will go undetected thereby putting both the mother and fetus at risk for numerous pregnancy complications. Inadequate or excessive weight gain during pregnancy is associated with an increased risk for adverse pregnancy outcomes including

premature and macrosomic infants and caesarean deliveries. Screening for GDM is especially important in high risk women as this group of women will need to be screened at an earlier gestational age than 24 weeks to minimise the associated pregnancy outcomes and any detrimental effects.

CONCLUSIONS

Both studies have tried to ascertain the prevalence of gestational diabetes in St. Vincent and the Grenadines, however, the prevalence still remains unknown. In study 1, the primary objective was not met due to slow recruitment of study participants and a short time span in which to collect data. In study 2, the underlying challenges for establishing the prevalence of GDM in SVG were the use of urine dipstick tests to prescreen for GDM, the limited administration of 2-h 75-g OGTT, poor documentation and record keeping, and incompletion of perinatal records.

Due to the termination of study 1, significant predictors and pregnancy outcomes associated with GDM were not determined. Nevertheless, study 2 showed that the predictors associated with GDM were increased first and last documented weights and having a previous stillborn and reproductive tract surgery, while the pregnancy outcomes associated with the condition were a lower last documented gestational age and increased neonatal birth weight; particularly a birth weight greater than 4000 grams. In this study, the predictors of IGT or GDM were in keeping with the literature on gestational diabetes risk factors [10, 15], with the exception of a prior reproductive tract surgery, and the pregnancy outcomes indicated a higher mean birth weight which is indicative of GDM and may be indicative of poorly controlled GDM [15, 21].

Both studies conducted can contribute towards the future development of additional studies aimed at determining the prevalence and predictors for diabetes. These findings may also serve as pilot studies on gestational diabetes in St. Vincent and the Grenadines. To my knowledge, these were the first studies to be conducted in SVG on the prevalence and predictors of gestational diabetes, and it is hoped, that the government and/or other stakeholders realize the need for more studies of this nature to be conducted. These studies can be a stepping stone for

not only research in academia, but also research on a national level where the findings can be used to encourage the implementation of policies, programmes, and screening and treatment manuals for gestational diabetes, all with the common goal of abating the incidence of gestational diabetes and its many consequences.

Before a disease can be treated, the prevalence of the condition as well as the associated risk factors must be determined. The risk factors further need to be classified as modifiable and non-modifiable to derive the most appropriate means of prevention. The incidence of gestational diabetes subsequently increases the incidence and prevalence of type 2 diabetes, so it is important to curtail type 2 diabetes particularly in young women in the Caribbean region where the prevalence of diabetes is on the rise and affecting more women than men.

Although the studies were unable to provide population estimates on the prevalence and predictors of gestational diabetes, the data can still be considered useful, especially in the area of public health nutrition and epidemiology.

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APPENDICES

Appendix 1

School of Dietetics and Human Nutrition
Faculty of Agricultural and Environmental Sciences
McGill University
Macdonald Campus

École de diététique et nutrition humaine
Faculté des sciences de l'agriculture et de l'environnement
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Campus Macdonald

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21,111 Lakeshore
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Québec, Canada H9X 3V9

INFORMED CONSENT TO PARTICIPATE IN RESEARCH

Title of Research: Prevalence and Predictors of Gestational Diabetes Mellitus in St. Vincent and the Grenadines

Researcher:

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M.Sc. Thesis Candidate
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Ministry of Health, Wellness and the Environment
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Purpose of the research:

The prevalence of Gestational Diabetes Mellitus (GDM) in St. Vincent and the Grenadines is not known. The main aim of this research is to estimate the prevalence of Gestational Diabetes Mellitus in St. Vincent and the Grenadines. Risk factors associated with the development of GDM will also be identified via this study.

Why are you being targeted:

Pregnant women in several antenatal district clinics on mainland St. Vincent will be targeted as GDM is only prevalent among pregnant women.

What is involved in participating:

Participation in this study involves:

1. An interview – a brief interview will be conducted for approximately 15 minutes during which a questionnaire will be administered and informed consent obtained for the administration of an Oral Glucose Tolerance Test (OGTT) and to gain access to your medical file.

2. OGTT – after the interview, an appointment will be scheduled for the OGTT. The OGTT is a blood test which is performed to determine if a pregnant woman has GDM. The World Health Organization (WHO) recommended 2-h 75-g OGTT will be administered.

N.B. The night before this test is performed, it is very important that you fast for at least 10 hours. It is recommended that you do not eat or drink anything after midnight.

On the day of the OGTT:

1. You will bring the urine cup given to you at the clinic with your urine specimen.
2. Blood will be drawn upon your arrival at the laboratory.
3. Firstly, the fasting urine sample will be tested for the presence of glucose using a dipstick.
4. If glucose is present in the urine sample, the fasting blood sample that was drawn will then be tested. If the fasting blood glucose is ≥8.0mmol/L, no further tests will be administered.
5. If no glucose is detected in the urine sample, a 75-g glucose beverage will then be administered to you. Two hours after consuming this glucose drink, you will be asked for another urine sample and your blood will be drawn for a second time. The urine and blood samples will then be used to measure your blood glucose levels.

The blood for this test will only be drawn by lab technicians. All blood tests will be performed free of charge. The OGTT will be carried out from 10 a.m. at the Milton Cato Memorial Hospital laboratory in Kingstown from Monday to Friday.

If you agree to take part in this research study, all efforts will be made to keep your information confidential. All consent forms and questionnaires will be stored in locked filing cabinets; questionnaires will be exclusive of participants' names and will only include a study code.

Data from this study will be used for publication in a peer-reviewed journal and presentations at McGill School of Dietetics and Human Nutrition colloquium as well as various conferences. No individuals will be identified in any publications and/or presentations.

Risks and Benefits:

Risks

There are minimal risks in participation in this study. The risks associated with the blood test include the possibility of fainting or feeling light headed, infection or slight bruising at the site of the puncture.

Benefits

Once a pregnant woman has been diagnosed with GDM, she can be monitored and treated for maternal complications associated with this condition such as pre-eclampsia, gestational hypertension, preterm labor, caesarean delivery and increased risk for type 2 diabetes after pregnancy. Treating GDM can also reduce fetal complications such as jaundice, macrosomia (large-for-gestational-age), shoulder dystocia, stillbirth, perinatal morbidity and mortality and also further reduce long term complications such as childhood obesity and early onset type 2 diabetes in adolescence or adulthood.

The data derived from this study can also be very beneficial to the government of St. Vincent and the Grenadines in screening, diagnosing and treating GDM.

Research Ethics Board Contact Information:

If you have questions about your rights as a research participant, or if you would like to verify the ethical approval of this study, please feel free to contact any of the following:

Canada contact:

McGill University
Ms. Lynda McNeil
Research Ethics Officer (Human Subjects)
Vice-Principal Research & International Relations
845 Sherbrooke St. West
Montreal, Quebec H3A 2T5
Canada

Tel: (514) 398-6831 or by e-mail: lynda.mcneil@mcgill.ca

SVG contact:

Chief Medical Officer
National Ethic Research Committee
Ministry of Health and the Environment
Ministerial Bldg
Kingstown
St. Vincent and the Grenadines

Tel: (784) 456-1111 or by e-mail: mohesvg@vincysurf.com

Consent:

By signing this consent form, I confirm that I have read and understood the information and had the opportunity to ask questions. I understand that my participation is entirely voluntary and I am free to withdraw at any point from the study, without any reason. I also understand that a decision to not participate will not affect the availability of health care services provided.

I have read the above information and I agree to participate in this study.

Name (please print): **X**	Researcher's signature:
Signature: **X**	Date:

Appendix 2

PREVALENCE AND PREDICTORS OF GESTATIONAL DIABETES IN ST. VINCENT AND THE GRENADINES

A questionnaire to screen for reported risk factors for Gestational Diabetes

This questionnaire will aid in determining the risk factors of Gestational Diabetes in a population of pregnant Vincentian women on mainland St. Vincent. Please circle the most appropriate answers that apply to you and fill in the necessary spaces.

MATERNAL FACTORS

1. What is your age (years)?

   _____

2. How many years of education have you attained?
   a) Less than 7
   b) 7-11
   c) 12-13
   d) 14 or more

3. What is your current marital status?
   a) Single
   b) Married
   c) Separated
   d) Divorced
   e) Widowed
   f) Other_____

4. What is your race/ethnicity?
   a) African/Black
   b) Carib
   c) East Indian
   d) Mixed
   e) Other _____

5. What is your current employment status?
   a) Unemployed
   b) Retired
   c) Employed
   d) Student

6. What is your annual household income?
   a) $7200 or less
   b) $7201-$18 000
   c) $18 001-$36 000
   d) $36 001-60 000
   e) Greater than $60 000

7. Do you consume alcohol during this pregnancy?
   a) Yes
   b) No

8. If so, how many drinks per week?
   a) 1-2
   b) 3-4
   c) 5 or more

9. What is your smoking status?
   a) Non-smoker
   b) Previous smoker
   c) Current smoker

10. What is the number of gravidities you had?

    _____

11. What is the number of parities (live births) you had?
    a) Nulliparous (0)
    b) Primiparous (1)
    c) Multiparous (2-4)
    d) Grand multiparous (5+)

12. Did you have Gestational Diabetes in a prior pregnancy?
    a) Yes
    b) No

13. Have you ever had a previous delivery of a macrosomic infant?
    a) Yes
    b) No

14. Have you ever had a still birth?
    a) Yes
    b) No

15. Have you ever had a caesarean section?
    a) Yes
    b) No

16. Do you have hypertension in this pregnancy?
    a) Yes
    b) No
    c) I don't know

17. Have you ever had hypertension in pregnancy?
    a) Yes
    b) No
    c) N/A

18. Are you physically active?
    a) Yes
    b) No

19. If so, which of the following four activity classes best describes your present activity? Please consider transportation to and from work and other physical effort during your leisure time like household chores or dancing.
    a) No weekly physical activity
    b) Only light physical activity in most weeks
    c) Vigorous physical activity at least 20 minutes once or twice a week
       (Vigorous activity causes shortness of breath, a rapid heart rate and sweating)
    d) Vigorous physical activity for at least 20 minutes three or more times a week

FAMILY HISTORY OF DIABETES MELLITUS

20. Do your family members (parent/sibling) have Type 2 Diabetes Mellitus?
    a) Yes
    b) No
    c) I don't know

21. If yes, who in your family has/have Type 2 Diabetes Mellitus?
    a) Parent(s)
    b) Sibling(s)
    c) Both parent(s) and sibling(s)

22. Did your mother have Gestational Diabetes Mellitus?
    a) Yes
    b) No
    c) I don't know

ANTHROPOMETRIC MEASUREMENTS

23. Height (cm):	
24. Pre-pregnancy weight (kg):	
25. Pregnancy weight (kg):	

*Pre-pregnancy BMI will be calculated using SPSS

END OF QUESTIONNAIRE

*****THANK YOU FOR YOUR PARTICIPATION IN THE STUDY*****

RESULTS OF ORAL GLUCOSE TOLERANCE TEST

Appendix 3

MILTON CATO MEMORIAL HOSPITAL

Phone: 784 456 1185 ext. 108
Fax: 784 451 2296
E-mail: kghlab@vincysurf.com

PATHOLOGY LABORATORY

PATIENT REGISTRATION NUMBER	**PATIENT ACCESSION NUMBER**
SURNAME (PLEASE PRINT)	**REQUESTING DOCTOR** (PLEASE PRINT) **SIGNATURE**
FORENAMES (PLEASE PRINT)	
ADDRESS	**HOSPITAL** **WARD/CLINIC**
DATE OF BIRTH **SEX** (male/female)	**SPECIMEN** **DATE & TIME OF COLLECTION**

CLINICAL DETAILS/DIAGNOSIS/THERAPY

TEST(S) REQUIRED

LAB USE ONLY

DATE & TIME RECEIVED	**TECHNOLOGIST'S SIGNATURE**	**DATE REPORTED**

Appendix 4

Prevalence and Predictors of Gestational Diabetes Mellitus in St. Vincent and the Grenadines

A data abstraction form to screen for the prevalence and risk factors for Gestational Diabetes

This collection form will aid in the extraction of information mainly from the perinatal records as well as the antenatal and patient delivery records. These records and oral glucose tolerance test results will aid in determining the prevalence and risk factors for Gestational Diabetes in a population of pregnant Vincentian women on mainland St. Vincent. Please circle/underline the

PERINATAL CLINICAL RECORDS	
A. Maternal Characteristics	
Data Item	**Data Entry Field**
22. Date of birth	__/__/____ dd/mm/yyyy
23. Age (years)	
24. Race	1=Black 2=Indigenous 3=White 4=Other 98=Missing
25. Literacy	0=No 1=Yes 98=Missing
26. Education (level)	1=None 2=Elementary 3=Secondary 4= Tertiary 98=Missing
27. Highest Level of Education (yrs)	
28. Marital status	1=Married 2=Common law wife 3=Single 4=Other 98=Missing

B. Family, Personal and Obstetric History	
Family History	
8. Family history * parents, siblings, grandparents, offspring's	1. TBC: 0=No 1=Yes 98=Missing
	2. Diabetes: 0=No 1=Yes [Type1] [Type2] 98=Missing
	3. Hypertension: 0=No 1=Yes 98=Missing
	4. Preeclampsia/Eclampsia: 0=No 1=Yes 98=Missing
	5. Other: 0=No 1=Yes 98=Missing
Personal History	
9. Personal history	1. TBC: 0=No 1=Yes 98=Missing
	2. Diabetes: 0=No 1=Yes [Type1] [Type2] 98=Missing
	3. Hypertension: 0=No 1=Yes 98=Missing
	4. Preeclampsia/Eclampsia: 0=No 1=Yes 98=Missing
	5. Other: 0=No 1=Yes 98=Missing
	6. Reproductive tract surgery: 0=No 1=Yes 98=Missing
	7. Infertility: 0=No 1=Yes 98=Missing
	8. HIV+: 0=No 1=Yes 98=Missing
	9. Cardio/Nephro problems: 0=No 1=Yes 98=Missing
	10. Severe medical condition: 0=No 1=Yes 98=Missing

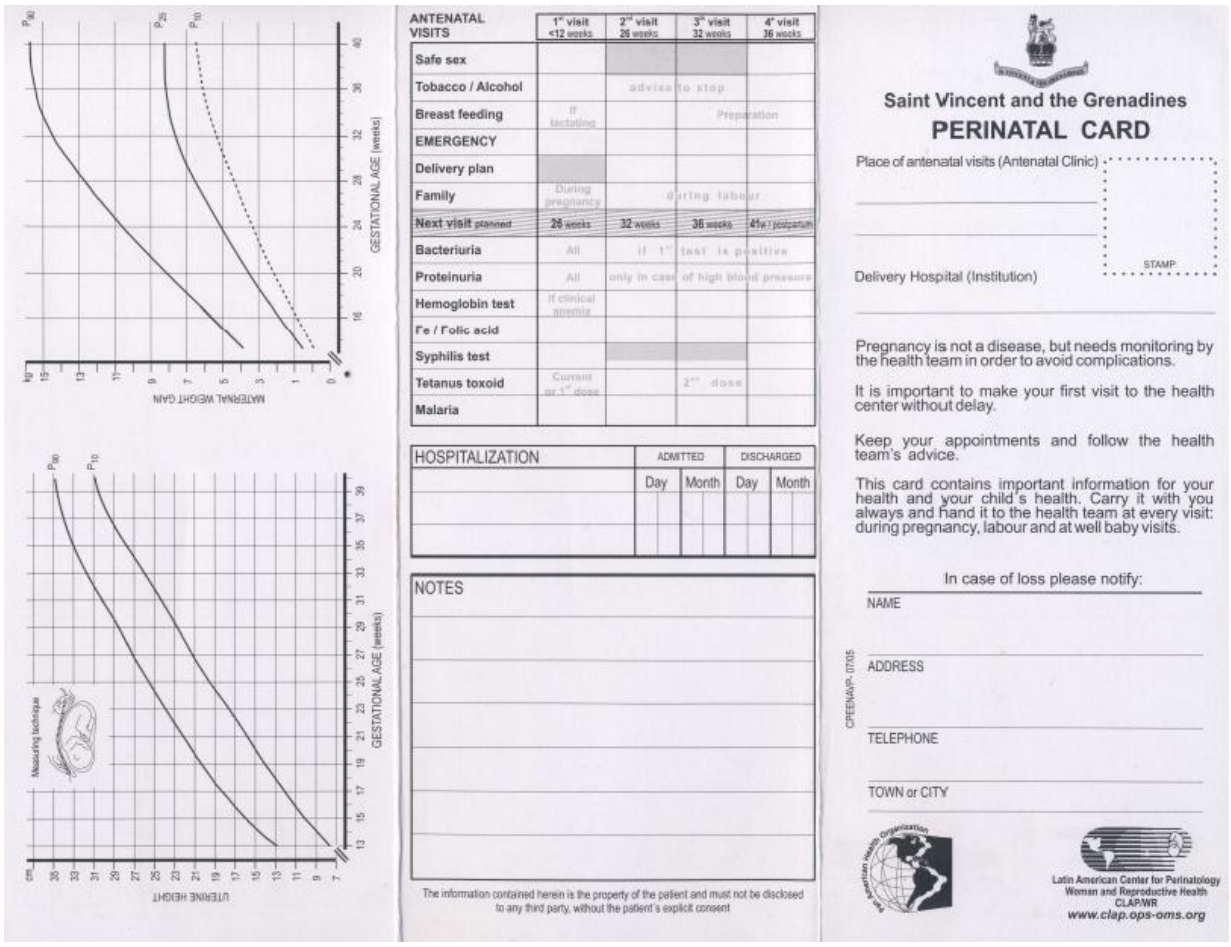
Obstetrical History	
9. Number of gravidities (previous pregnancies excluding present)	
10. Previous abortions	0=No 1=Yes 98=Missing
11. Number of abortions	
12. Previous caesarean section	0=No 1=Yes 98=Missing 99=Not Applicable
13. Number of caesarean sections	
14. Previous stillborns	0=No 1=Yes 98=Missing
15. Number of stillborns	
16. Number of parities (liveborns)	1=Nulliparous (0) 2=Primiparous (1) 3=Multiparous (2-4) 4=Grand multiparous (5+)
17. Last pregnancy	1=Neonatal birth weight <2500g 2=Neonatal birth weight >4500g 3=Preeclampsia/Eclampsia 98=Missing 99=Not Applicable
C. Present Pregnancy	
18. Usual weight (kg)	
19. Height (cm)	
20. Cigarette smoking	0=No 1=Yes 98=Missing

21. Cigarettes per day	1=1 cigarette per day 2=2 cigarettes per day 3= 3 cigarettes per day 4= 4 cigarettes per day 5= 5 or more cigarettes per day 98=Missing 99=Not Applicable	
22. Drug use	0=No 1=Yes 98=Missing	
23. Alcohol consumption	0=No 1=Yes 98=Missing	
24. First documented weight and gestational age	Gest. age:	Weight:
	98=Missing	
26. Last documented weight and gestational age	Gest. age:	Weight:
	98=Missing	
27. Total number of antenatal visits		
28. Type of pregnancy	1= Singleton 2= Multiple	
Maternal Pathologies		
29. Maternal Pathologies	1. Previous HT: 0=No 1=Yes 98=Missing	
	2. HT induced pregnancy: 0=No 1=Yes 98=Missing	
	3. Pre-eclampsia: 0=No 1=Yes 98=Missing	
	4. Eclampsia: 0=No 1=Yes 98=Missing	
	5. Cardiac/renal: 0=No 1=Yes 98=Missing	
	6. Diabetes: 0=No 1=Yes [1] [2] [Gest.] 98=Missing	
	7. Chorioamnionitis: 0=No 1=Yes 98=Missing	
	8. Urinary infection: 0=No 1=Yes 98=Missing	

	9.Threatening premature labour: 0=No 1=Yes 98=Missing
	10. I.U.G.R: 0=No 1=Yes 98=Missing
	11. Premature rupture of membranes: 0=No 1=Yes 98=Missing
	12. Other: 0=No 1=Yes 2=Severe 98=Missing
	13. None
D. Neonate	
30. Sex	1=Female 2=Male
31. Birth weight	
32. Weight for gest. age	1= Appropriate 2= Small 3= Large
E. Oral Glucose Tolerance Tests results	
33. Was an OGTT performed?	0=No 1=Yes 2= Not documented
34. Results of OGTT	1= -ve IGT 2= +ve IGT 3=-ve GDM 4= +ve GDM

IMPORTANT ABSTRACTOR'S NOTES

Appendix 5



P90
P75
P10
GESTATIONAL AGE (weeks)
MATERNAL WEIGHT GAIN
kg
P90
P10
GESTATIONAL AGE (weeks)
UTERINE HEIGHT
Measuring technique
ANTENATAL VISITS
1st visit <12 weeks
2nd visit 26 weeks
3rd visit 32 weeks
4th visit 36 weeks
Safe sex
Tobacco / Alcohol
advise to stop
Breast feeding
If lactating
Preparation
EMERGENCY
Delivery plan
Family
During pregnancy
during labour
Next visit planned
26 weeks
32 weeks
36 weeks
4 to 7 postpartum
Bacteriuria
All
if 1st test is positive
Proteinuria
All
only in case of high blood pressure
Hemoglobin test
If clinical anemia
Fe / Folic acid
Syphilis test
Tetanus toxoid
Current or 1st dose
2nd dose
Malaria
HOSPITALIZATION
ADMITTED
DISCHARGED
Day
Month
Day
Month
NOTES
The information contained herein is the property of the patient and must not be disclosed to any third party, without the patient's explicit consent
Saint Vincent and the Grenadines
PERINATAL CARD
Place of antenatal visits (Antenatal Clinic)
STAMP
Delivery Hospital (Institution)
Pregnancy is not a disease, but needs monitoring by the health team in order to avoid complications.
It is important to make your first visit to the health center without delay.
Keep your appointments and follow the health team's advice.
This card contains important information for your health and your child's health. Carry it with you always and hand it to the health team at every visit: during pregnancy, labour and at well baby visits.
In case of loss please notify:
NAME
ADDRESS
TELEPHONE
TOWN or CITY
CPEENAP- 07/05
Latin American Center for Perinatology Woman and Reproductive Health
CLAP/WR
www.clap.ops-oms.org

Appendix 5 (cont'd)