A GUIDE TO THE UNDERSTANDING, PREVENTION, AND TREATMENT OF GESTATIONAL DIABETES

By

STEPHANIE MARISSA ZANKMAN

A Thesis Submitted to The Honors College

In Partial Fulfillment of the Bachelors degree

With Honors in

Physiology

THE UNIVERSITY OF ARIZONA

MAY 2011

Approved by:

Randi Weinstein, Ph.D.

Department of Physiology

The University of Arizona Electronic Theses and Dissertations
Reproduction and Distribution Rights Form

Name (Last, First, Middle)	Zankman, Stephanie, Marissa
Degree title (eg BA, BS, BSE, BSB, BFA):	BS
Honors area (eg Molecular and Cellular Biology, English, Studio Art):	Physiology
Date thesis submitted to Honors College:	5/4/11
Title of Honors thesis:	A Guide to the Understanding Prevention, and Treatment of Gestational Diabetes
:The University of Arizona Library Release	I hereby grant to the University of Arizona Library the nonexclusive worldwide right to reproduce and distribute my dissertation or thesis and abstract (herein, the "licensed materials"), in whole or in part, in any and all media of distribution and in any format in existence now or developed in the future. I represent and warrant to the University of Arizona that the licensed materials are my original work, that I am the sole owner of all rights in and to the licensed materials, and that none of the licensed materials infringe or violate the rights of others. I further represent that I have obtained all necessary rights to permit the University of Arizona Library to reproduce and distribute any nonpublic third party software necessary to access, display, run or print my dissertation or thesis. I acknowledge that University of Arizona Library may elect not to distribute my dissertation or thesis in digital format if, in its reasonable judgment, it believes all such rights have not been secured. Signed: [signature] Date: 5/4/11

Last updated: Nov 15, 2009

Introduction

The obesity epidemic that plagues the United States has its indications in a variety of disease states, including Type 2 Diabetes and Gestational Diabetes Mellitus (GDM). According to the Center for Disease Control, in 2009 thirty-three states in the U.S. had a 25% or greater prevalence of obesity, defined as a Body Mass Index (BMI) of 30 or greater (16). The explanation for this increasing trend toward an obese nation is multifactorial, including genetic predisposition, ethnic background, poor nutritional and exercise habits, and the overall adoption of a more sedentary lifestyle. For women specifically, one-third were found to be obese between the ages 20-49 in the year 2003-2004 alone (1). Obesity prior to pregnancy places women at considerable risk of developing diabetes during their pregnancy, and it is in this fashion that the rising prevalence of Gestational Diabetes in the United States correlates with the obesity epidemic.

The higher incidence rates of GDM is of great concern from a public health perspective, specifically, as it not only has the potential to affect the perinatal health of the neonate, but also contributes to the development of Type 2 Diabetes on an individual and global scale. The potential evolution of a mother's diabetes during pregnancy to postpartum Type 2 Diabetes, as well as metabolic imprinting upon the child, is representative of the vicious progression of diabetes in this nation. This review provides a comprehensive understanding of Gestational Diabetes, from both a clinical and national health perspective, while examining the issue of divergent access to health care and patient perspective among various ethnic groups.

Gestational Diabetes: An Overview

GDM is classically defined as abnormal glucose tolerance with onset or initial recognition occurring during pregnancy (2). While normal pregnancy is characterized by insulin resistance, the pancreas of a pregnant woman readily compensates for this by an increase in insulin secretion. Pregnancy-induced insulin resistance itself is a condition in which, despite the sufficient production of insulin necessary to maintain glucose homeostasis, the body's muscle, liver, and fat cells do not respond appropriately to the insulin, reducing glucose removal from the bloodstream. Individuals can quickly become hyperglycemic, at which point the pancreas will perceive this excess of plasma glucose as a reflection of inadequate levels of insulin necessary to meet the body's needs. The pancreas will then secrete excess insulin, in an attempt to reach euglycemia. In a normal, non-diabetic pregnancy, insulin-mediated glucose uptake from the blood is reduced by roughly 50% as a characteristic of this insulin resistance, and insulin secretion, as a means to combat this decreased glucose removal, is increased nearly 200-250% (11). Despite the defective insulin action, the surplus of insulin still facilitates ample glucose removal from the blood.

The hallmark of a GDM pregnancy, however, is the inability to meet this increased insulin demand. The expected insulin resistance that complicates all pregnancies is likewise present in the case of GDM, but the pancreas is unable to secrete the excess insulin necessary to combat the resistance. In a pregnancy complicated by diabetes, pancreatic beta cell dysfunction preventing the secretion of the excess insulin, coupled with the insulin resistance of normal pregnancy, results in severe hyperglycemia that has dire consequences for both the mother and child.

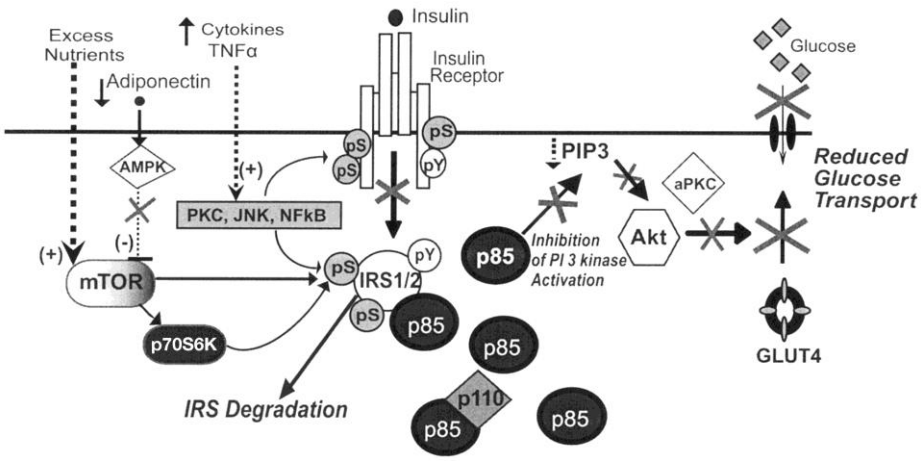
The most frequent manifestation of onset GDM results from increased insulin resistance beyond the scope of normal pregnancy. While GDM may be caused by autoimmune pancreatic β cell dysfunction similar to that seen in Type 1 Diabetes, or by monogenic forms of diabetes resulting from mutations in specific autosomoal genes, these forms are more infrequent and are likely to represent a condition of pre-existing diabetes (2). In order to understand the dysregulation present in gestational diabetes, a comparison of the insulin resistance of normal pregnancy and that of GDM is necessary.

Insulin Resistance of Normal Pregnancy versus a GDM Pregnancy

There are several potential mechanisms that could account for the expectant insulin resistance of normal pregnancy. The mechanism of insulin-stimulated glucose uptake into skeletal muscle is often impaired by pregnancy, with a 40% reduction in normal pregnancy and a 65% reduction in GDM (11). Under normal circumstances, insulin acts as a ligand to bind to the insulin receptor (IR) of skeletal muscle cells. The IR then phosphorylates Insulin Receptor Substrate 1 and 2 (IRS-1 and IRS-2) on tyrosine residues (pY). The phosphorylation of the tyrosine residues leads to the downstream signaling effects that ultimately cause the translocation of GLUT-4 (Glucose Transporter-4) to the cell membrane to allow the passage of glucose into the cell. The uptake of glucose into the skeletal muscle is what helps the expectant mother counterbalance the extreme hyperglycemia of pregnancy.

In the case of GDM, however, the inability to phosphorylate the tyrosine residues of IRS-1, and thus initiate the downstream effects triggering GLUT-4 translocation, prevents the skeletal muscle from uptaking glucose, as demonstrated in **Figure 1** (11):

Figure 1:



In GDM, inhibitory serine phosphorylation of IRS-1 is dominant to normal phospohorylation on tyrosine residues, along with an overall decrease in the IRS-1 protein levels. The proposed mechanisms by which serine phosphorylation in GDM is increased involve adiponectin and TNF-α. High levels of TNF- α in GDM lead to the activation of the enzymes JNK and protein kinase C (PKC), both of which activate serine phosphorylation. The reduced levels of adiponectin seen in a GDM pregnancy also have an effect on serine phosphorylation. Ordinarily, adiponectin stimulates AMP-acivated protein kinase (AMPK) , which has an inhibitory effect on the mTOR-p70S6 signaling pathway that is responsible for increasing serine phosphorylation on IRS-1. Since the inhibitory effect of AMPK is reduced due to the decreased levels of adiponectin, serine phosphorylation is no longer inhibited, and serves to block GLUT-4 translocation. Another means of negative regulation of GLUT-4, in both normal pregnancy and GDM cases, is achieved by markedly increased levels of p85α that interfere with the downstream signaling effects necessary to initiate GLUT-4 (11).

Another possible explanation for the insulin resistance of both normal pregnancy and GDM, aside from abnormal signaling mechanisms, lays in the influence of placental hormones.

The relevance of placental hormones during pregnancy has been indicated due to the cessation of insulin resistance shortly after parturition. Hormones such as placental lactogen, placental growth hormone, and somatostatin have been demonstrated to influence the insulin resistance of pregnancy, but the exact mechanisms are unclear (11, 12) Increases in placental growth hormone, specifically, have been shown to interfere with the signaling cascade that leads to glucose uptake into skeletal muscle (11). Additionally, evidence supports that the placenta can synthesize adipokines, hormones such as leptin, adiponectin, TNF- α, interleukin-6, and resistin, that are ordinarily secreted by adipose tissue. These placental adipokines also play a role in the insulin resistance of pregnancy and especially GDM. The effects of the most relevant cytokines, TNF- α, leptin, and adiponection, with pregnancy and GDM, are summarized in **Table 1**. Overall, increased levels of leptin and TNF- α, coupled with a decrease in adiponectin, contribute to fetal adiposity and insulin resistance.

Table 1:

Leptin	TNF- α	Adiponectin
- Overproduction of placental leptin with GDM - Increased levels of leptin activate the biosynthesis of ω-3 fatty acids, whose accumulation in the placenta is correlated with increased fetal adiposity (13)	- Overproduction of placental TNF-α with GDM - Increased levels of TNF- α activate the biosynthesis of ω-3 fatty acids, whose accumulation in the placenta is correlated with increased fetal adiposity (13) - TNF- α contributes to insulin resistance of GDM by increasing inhibitory serine phosphorylation of IRS-1 (11)	- Adiponectin normally stimulates glucose uptake by skeletal muscle and reduces hepatic glucose production (11) - Adiponectin levels are significantly reduced in pregnancy, but even more so in GDM (11) - Decreased levels contribute to hyperglycemia in pregnancy and correlate with the insulin resistance seen in obesity, type 2 diabetes, and GDM (11)

In summary, the insulin resistance of normal pregnancy is intensified in GDM, primarily by the mechanisms of increased p85α levels, as well as increased serine phosphorylation of IRS-1. It can be evidenced, then, that the marked insulin resistance seen in GDM in comparison to normal pregnancy is caused by a multitude of factors, including impaired signaling cascades involving glucose uptake, as well as the influence of placenta hormones. Further investigation into the pathophysiology of GDM is necessary, as well, as it would likely reveal additional mechanisms of dysregulation.

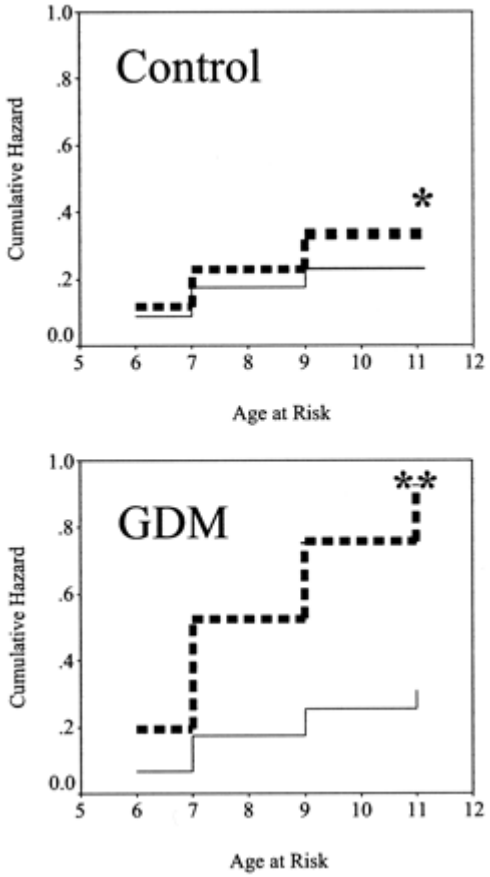
Complications of GDM for Mother and Child

Gestational Diabetes can have severe short term and long term implications on the health of both the mother and child. Fetal macrosomia, or abnormally large birth size defined as over 4000g, is a frequent outcome of GDM pregnancies. During the third trimester, when the expectant mother experiences the highest level of hyperglycemia, glucose is able to cross the placenta and enter the bloodstream of the fetus, however insulin is not able to follow. The fetus, in turn, must secrete an excess amount of insulin to counterbalance the hyperglycemia it is experiencing as a result of its mother's diabetes. Insulin in the developing fetus acts as a growth hormone allowing the baby to develop to an abnormally large size prior to delivery (9). Associated with this macrosomia, is the increased risk that the fetus will have organomegaly, or enlarged internal organs, as well. Due to the neonate's size, the baby is prone to even more risks upon exiting the birth canal, including shoulder dystocia, clavical fractures, damage to the brachial plexus , and may also suffer from respiratory distress syndrome (6). Fetal macrosomia also increases the likelihood of the mother undergoing a cesarean delivery, as a vaginal delivery

of such an enlarged neonate increases the risk of postpartum hemorrhage and vaginal lacerations. Finally, preeclampsia, or high blood pressure during pregnancy, is also a common complication of women experiencing gestational diabetes. Of greatest concern from a public health perspective, however, is the risk of both the mother and the child progressing to develop Type 2 Diabetes.

While the diabetes a pregnant women experiences in onset GDM can resolve itself postpartum, it has been reported that nearly 50% of women are likely to progress to Type 2 Diabetes during the immediate 5 years following their pregnancy (3). In general, the risk of postpartum Type 2 Diabetes appears to increase with time, and is often correlated with various predictive factors including ethnicity, elevated 1-hour postprandial blood glucose levels, and increasing BMI (10). Similarly, children who are large for their gestational age (LGA) after being born to a mother with GDM are at greater risk for developing Metabolic Syndrome later in life (10). **Figure 2** represents the cumulative risk of progression to Metabolic Syndrome for children exposed to diabetes in utero versus children born to a mother whose pregnancy was not complicated by diabetes (10). (Solid lines represent neonates that are AGA (appropriate for gestational age); dashed lines represent LGA).

Figure 2:

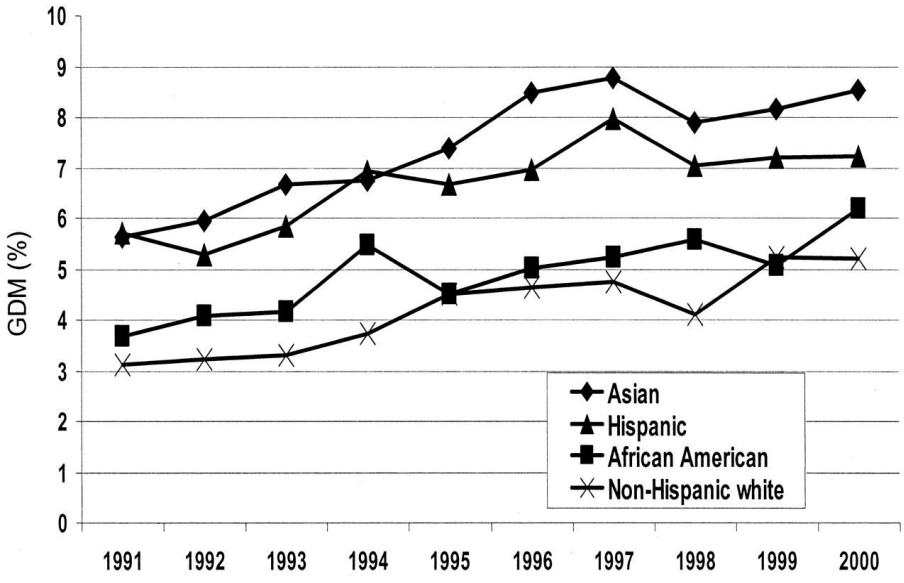


The consequence of metabolic imprinting on children exposed to a diabetic environment as a fetus has dire implications on the national diabetes and obesity epidemic. Considering that 18% of U.S. pregnancies are complicated by diabetes, whether due to onset GDM or pre-existing diabetes, the contribution of gestational diabetes to childhood obesity and progression to Type 2 Diabetes on a national scale is considerable.

Prevalence of Gestational Diabetes Mellitus

The prevalence of GDM is highly variable, with differences existing between racial and ethnic groups, as well as the diagnostic criterion that is enforced clinically. Nonetheless, it can be estimated that GDM affects anywhere from 7-14% of pregnant women in the U.S. each year (17). According to the Northern California Kaiser Permanente study, in which pregnant women from 1991 to 2000 were evauluated, the overall prevalence of GDM, adjusted for age and ethnicity, increased two-fold from 3.7% in 1991 to 6.6% in 1997 (3). More specifically, the Kaiser group represented the varying prevalence of GDM by ethnic groups, with Asian and Hispanic women demonstrating the highest prevalence, African Americans revealing intermediate prevalence, and non-Hispanic white women showing the least prevalence. **Figure 3** depicts this increasing trend by ethnicity (3).

Figure 3:



The Kaiser study did not identify any direct correlations between the characteristics of these various ethnic groups and their increased risk; however, it is likely a combination of

various factors including diet, exercise, and genetic predisposition specific to each individual group. Regardless of the underlying correlation, belonging to a particular ethnic group may increase an individual's risk of GDM.

The increase of GDM in the United States is undeniable; yet many challenges to qualitatively assessing this trend exist. One of the greatest issues in evaluating the rising trend of GDM is the consideration of whether the incidences of GDM were reported using the same diagnostic criteria. If a reliable trend is to be established, first clinicians must be unified in their assessment of plasma glucose levels in GDM, and the national diagnostic standards for GDM must remain relatively constant over time. In general, the first diagnosis of GDM can be made at the initial prenatal visit, where GDM is evidenced as a plasma fasting glucose level of greater than 92mg/dl. If the fasting plasma glucose is above 126mg/dl at this time, the expectant mother is diagnosed with overt diabetes, either Type 1 or Type 2, that went previously undiagnosed. If neither GDM nor overt diabetes is evident at this initial visit, further testing will be administered between weeks 24 and 28 of pregnancy, when the insulin resistance of pregnancy is expected to be the highest. The Oral Glucose Tolerance Test (OGTT) is universally given to all pregnant women at this stage.

In January 2011, the American Diabetes Association (ADA) released new guidelines for the universal screening in the third trimester. Previously, screening was a two step process that first involved a 50g glucose challenge, followed by a 100g, 3 hour OGTT that required two elevated blood glucose values over the 3 hour time span. As the diagnoses using this approach were often not specific enough and involved unnecessary steps, the ADA now suggests a one-step 75g glucose, 2 hours OGTT. This test only requires one reading of elevated plasma glucose

levels over the course of two hours, and thus is more easily tolerated by patients. The plasma glucose levels sufficient for diagnosis of GDM are summarized in **Table 2** (4):

Table 2:

Fasting Plasma Glucose	**Plasma Glucose 1Hr Postprandial**	**Plasma Glucose 2Hr Postprandial**
92mg/dl	180mg/dl	152mg/dl

The prevalence rates of GDM will vary significantly depending on whether physicians will adopt the new criteria set out by the ADA or will continue to utilize the previous standards set by the two-step diagnostic method.

Prior to the most recent release of the ADA criteria, there had been two different diagnostic methods, those set by the National Diabetes Data Group (NDDG) and those established by the Carpenter and Coustan standard. The guidelines instituted by the National Diabetes Data Group prior to 1998 were a fasting glucose threshold of 105mg/dl, a 1 hour postprandial level of 190mg/dl, a 2 hour measurement of 165mg/dl, and finally a 3-hr of 145mg/dl. Then, in 1998, Carpenter and Couston lowered the metabolite parameters in each category, such that the prevalence of GDM increased by nearly 50% in a comparative study between the diagnostic methods (5). As the Carpenter and Couston criteria were adopted in 2000 by the ADA, this could be one possible explanation for the universal rise in the prevalence of GDM.

Another issue at stake when assessing the prevalence of GDM is the acknowledgement that many women diagnosed with GDM during pregnancy may have had asymptomatic overt

Type I or Type 2 diabetes previously. To allow clinicians to make a distinction between gestational diabetes and overt diabetes, the ADA established specific criterion for each in January 2011 (4):

Table 3:

Gestational Diabetes	**Overt Diabetes**
Fasting plasma glucose ≥92 mg/dL [5.1 mmol/L], but <126 mg/dL [7.0 mmol/L]	Fasting plasma glucose ≥126 mg/dL [7.0 mmol/L]
At 24 to 28 weeks of gestation: 75 gram 2 hour OGTT with at least one abnormal result: fasting plasma glucose ≥92 mg/dL [5.1 mmol/L], but <126 mg/dL [7.0 mmol/L] or one hour ≥180 mg/dL (10.0 mmol/L) or two hour ≥153 mg/dL (8.5 mmol/L)	A1C ≥6.5 percent using a standardized assay

These diagnostic criteria have not yet been instituted by practitioners, but they may serve as a useful tool to help clinicians identify diabetes in pregnancy as either overt Type I or Type II that went previously undiagnosed, or as onset GDM. Under these ADA regulations, diabetes itself, whether overt or onset, is present in about 18% of pregnancies against a background risk of 10% for diabetes and 26% for pre-diabetes in the adult US population, age 20 years and older (4). Significant nationwide efforts must be made by health care providers and patients themselves if there is any hope for reversing this rising trend.

Risk Factors for the Development of Gestational Diabetes

Many of the risk factors for the development of diabetes during pregnancy are avoidable by simple lifestyle modifications; however, some factors are not within a woman's range of control. Inalterable predispositions to GDM include a woman's ethnic background or family history of diabetes, especially among first degree relatives (4). If a woman belongs to an ethnicity at greater risk of contracting GDM or has the disease in her family history, there is not much she can do to alleviate those preexisting threats. Risk factors within a woman's control include maternal age, pre-pregnancy weight, dietary habits, and exercise.

Advanced maternal age is a significant indicator for the development of GDM, with a pregnant woman above the age of 25 already at greater risk (4). In a Kaiser Permanente study in Southern California, women with GDM were typically older with a mean age of 31.7 of a population of 175,249 woman between 1999-2005 (1). While a woman's age prior to pregnancy may seem like an intrinsic factor beyond her control, if she is planning to have a child she may choose to become pregnant at an earlier age to help alleviate the age-associated risks.

Another lifestyle characteristic that is within a woman's control is her pre-pregnancy weight. Maternal obesity has been correlated with an increased risk of development of GDM by a factor of two, four, and eight among overweight, obese, and severely obese women respectively (6). Contributing to this maternal obesity, the influence of the pregravid diet on the risk of developing GDM is significant. A pre-pregnancy diet low in fiber and high in glycemic load was linked to increased risk (7). Dietary fiber may contribute to reduced appetite, the delay of gastric emptying and slower digestion rate of high fiber foods, resulting in a reduced rate of glucose absorption and thus insulin levels. An individual with a higher glycemic load will have

higher levels of glucose in the bloodstream, ultimately contributing to higher insulin demand and increasing the risk of GDM. Finally, women who are more physically active prior to pregnancy or even early on in pregnancy may reduce their risk of GDM considerably (8). Exercise has been demonstrated to stimulate glucose transport and uptake into muscle cells via an insulin-independent mechanism, so for a woman in the early stages of pregnancy, it may serve as a regulator of glucose homeostasis. While certain characteristics, such as race, and genetic predisposition, are beyond the control of the expectant mother, the maternal age, the pre-pregnancy diet, exercise regimen, and other lifestyle habits can all be managed to greatly reduce the risk of GDM and the complications it creates for the mother and baby.

Prevention of Gestational Diabetes Mellitus

The prevention of Gestational Diabetes Mellitus is often achieved by simple lifestyle modifications. If a woman is overweight or obese, she should attempt to achieve a healthy weight prior to pregnancy. Similarly, the adoption of a regular exercise regimen prior to pregnancy has been shown to reduce the risk of GDM, and the maintenance of this regimen throughout the pregnancy may also decrease the chances of the woman progressing to Type 2 Diabetes postpartum (4). If a woman is genetically predisposed to GDM or has had GDM in previous pregnancies, establishing a strict diet and exercise plan to be implemented during the pregnancy may reduce the severity of the diabetes during her pregnancy and result in a better prognosis for her and her child. Overall, it is important that patients and clinicians establish a personalized diet and exercise plan for each pregnant woman, and that the woman herself be committed to her own health and the health of her infant.

Treatment of GDM

Most treatment plans for GDM consist of nutritional therapy as well as consistent glucose monitoring, with insulin or other anti-hyperglycemia agents provided when necessary. The pregnancy complications associated with GDM, including large for gestational age infants, macrosomia, shoulder dystocia, and caesarean delivery, have been significantly reduced in treatment groups compared to women receiving no treatment for their diabetes during pregnancy (19). In this regard, intervention during the course of a GDM pregnancy can help improve the overall health of the expectant mother and the neonate.

Assuming a woman has access to health care upon diagnosis with GDM, a registered dietician should help her establish an individualized dietary plan to be implemented throughout the course of her pregnancy. In general, the most important considerations are caloric allotment, caloric distribution, as well as carbohydrate intake (18). Daily caloric intake is based upon a woman's BMI and weight, and the allotments are summarized in **Table 4** (18):

Table 4:

Body Mass Index (BMI)	**Daily Caloric Intake**
Less than 22 (underweight)	40kcal/kg body weight
Between 22-25 (normal weight)	30kcal/kg body weight
Between 26-29 (overweight)	24kcal/kg body weight
Greater than 30 (obese)	12-15kcal/kg body weight

According to these standards, a woman who is 72.5kg (160 pounds) and has a BMI that places her in a healthy weight range, can consume 2175 calories per day. If a woman is

significantly overweight or obese at the start of her pregnancy, it may be necessary to restrict her caloric intake early on to help reduce the chances of fetal macrosomia or type 2 diabetes for the woman postpartum. In regard to carbohydrates, they should be restricted to 33-40% of the daily calorie intake, with a subsequent 40% dedicated to fat and 20% to protein (18). As carbohydrates are converted to glucose in the bloodstream, their restriction is essential to help women with GDM achieve euglycemia. When selecting carbohydrates, complex carbs such as those found in starches or vegetables are preferable to those found in simple sugars, because they are less likely to raise blood glucose concentrations. In accordance with the daily caloric and carbohydrate intake, it is also important to consider how the calories should be distributed throughout the course of the day.

The insulin resistance a pregnant woman with GDM experiences is highest in the morning, and it is at this time that her blood glucose levels are likely to be highest. It is suggested that the breakfast meal be small and only comprise 10% of the total daily calories. Lunch and dinner may each constitute 30% of the daily caloric intake, leaving a remaining 30% to be divided up as snacks when necessary (18). It is important that a woman with GDM not exceed the healthy, recommended weight gain, relative to her BMI, during her pregnancy; and if the weight gain is excessive, it may be necessary to enforce a more strict nutritional therapy.

Another element to the treatment plan for gestational diabetes is the regular glucose monitoring that the pregnant woman must endure. Elevated glucose levels pose a threat to the developing fetus, and it is for this reason that the pregnant woman must try to maintain her plasma glucose levels in a healthy range. A daily log of the glucose levels is especially helpful and allows the woman and physician to notice any patterns or changes, dependent on her unique behaviors or metabolism. It is recommended that women with GDM measure their plasma

glucose levels at fasting and then one hour after the first bite of every meal, for a total of four times daily (18).

Another clinical test that helps assess the pregnant woman's plasma glucose concentration is the glycolated hemoglobin, or A1C, levels. The glycolated hemoglobin test provides an average blood glucose measurement, representative of the patient's glucose levels during the previous six to twelve weeks. A1C levels are measured roughly every two to four weeks in a GDM pregnancy to make sure that the at home daily glucose monitoring is accurate (18). It is important that the glucometer represents glucose levels accurately because, as alluded to previously, the mother's hyperglycemia may have profound effects on the health of the neonate. According to the Hyperglycemia and Adverse Pregnancy Outcome trial (HAPO) a fasting glucose level greater than 105 mg/dL [5.8 mmol/L] was associated with a risk of macrosomia five-fold greater than that with a fasting glucose level less than 75 mg/dL [4.2 mmol/L] (20). In cases where the plasma glucose levels reflected by the glucometer and A1C tests exceed the acceptable range for a pregnant woman with GDM and cannot be maintained by nutritional therapy, insulin therapy is often instituted. Health care professionals may often prescribe insulin therapy to individuals whose plasma glucose levels fall within the range illustrated by **Table 5** on two or more occasions within the span of two weeks.

Table 5 (18):

Fasting plasma glucose	Greater than or equal to 90mg/dl (5mmol/L)
One hour postprandial	Greater than or equal to 120mg/dl (6.7mmol/L)

Only about 15% of pregnant women with GDM require insulin therapy. The dosage of insulin is typically 0.7 to 2 units per kilogram body weight but varies, along with the type of insulin, dependent upon the particular glucose dysregulation the patient is experiencing – whether the fasting plasma levels are elevated, or if the levels are high pre- or post-prandial. As the concentration of plasma glucose at specific times often determines the type of insulin therapy regimen, the pregnant woman must now check her glucose levels with her glucometer six times a day, pre- and postprandial for each meal. While insulin therapy is the recommended approach in the United States, other countries have found concomitant success with oral anti-hyperglycemic agents, including the drugs tolbutamide and chlorpropamide, glyburide, and metformin. The sulfonylureas tolbutamide and chlorpropamide, specifically, are not suggested for use in pregnancy, as they cross the placenta and can induce hyperinsulinemia in the neonate (18). Evidence suggests that the use of oral agents glyburide and metformin to achieve glycemic control in pregnancy is safe, but the agents have not been approved by the Food and Drug Administration. Until the safety of these drugs has been evaluated in greater detail, The American College of Obstetricians and Gynecologists recommends that their use be limited (26).

Finally, the effects of regular exercise on a pregnancy affected by GDM are substantial. Exercise stimulates GLUT-4 translocation and subsequent glucose uptake from the bloodstream via an insulin-independent mechanism (21). Cardiovascular conditioning exercises, as well as circuit resistance training, during pregnancy have been shown to increase tissue-level insulin sensitivity, and thereby reduce the plasma concentrations of glucose (18). In general, the ADA recommends that all pregnant women, especially those experiencing gestational diabetes, incorporate moderate levels of exercise into their pregnancy plan (18).

Overall, the institution of nutritional therapy, glucose monitoring, insulin therapy when necessary, and moderate levels of exercise are common approaches to regulate a woman's diabetes during pregnancy, and hopefully reduce her risk of complications. These treatment standards have implications beyond pregnancy as well, and when implemented, have been correlated with a decreased risk of the progression to Type 2 Diabetes. Similarly, breastfeeding postpartum has been shown to have positive implications for both the mother and the baby, regardless of whether a woman's pregnancy was complicated by diabetes or not (22). For a woman with previous GDM, breastfeeding results in reduced blood glucose levels and may prevent her progression to Type 2 Diabetes; and likewise, the mother's nutrients are not only beneficial to the developing baby, but have also been shown to lower the risk of developing obesity, hypertension, cardiovascular disease, and diabetes later on in the child's life (23).

Social Commentary: Beliefs Among Pregnant Women and Divergent Access to Care

The risks, preventative measures, and treatment modalities for a disease like GDM are well known among health care providers. Ultimately, though, it is the patient's prerogative to become educated about their own disease state and then enforce the lifestyle modifications necessary to improve their prognosis. Health care providers are expected to know what is in the best interest of their patients, but in order to convince the patients themselves to institute the often necessary lifestyle changes, it is useful for clinicians to understand the various factors affecting individual patient beliefs about health and well-being. One particular study sought to comprehend the exercise beliefs and behaviors among postpartum women who had experienced GDM (24). Women in this study believed that the most significant advantage to exercise during

pregnancy was that it helps control plasma glucose levels; yet only a small percentage thought that exercise postpartum could reduce their chances of contracting Type 2 Diabetes. In regard to understanding a woman's motivational factors to exercise during pregnancy and postpartum, the study found that a woman's husband or partner exerted the most influence upon their exercise habits. The main obstacles to exercise during the course of pregnancy seemed to be fatigue, whereas the major barrier postpartum was a lack of time (24).

In another study the risk perception of Type 2 Diabetes among women with previous GDM cases was examined (28). While more that 90% of the women in the study were aware that their previous GDM was a risk factor for the development of Type 2 Diabetes in the future, less than one-fifth of these women actually considered themselves at risk, since they had intentions of modifying their lifestyles. Among women who had no intentions of changing their health behaviors, still only one-third assumed that they were actually at risk. This suggests a disconnect between the known facts and the information presented to the patient, and what they actually chose to believe.

When taken into consideration, these behaviors and beliefs that women with GDM typically have could be used to influence the treatment plan during the course of their pregnancy. If physicians could better understand the factors that seem to motivate or detract women to exercise or improve their diet, modifications to the treatment plan could be made for the individual patient. Of great concern, too, is the possibility that health care providers may not be allocating the necessary time with each patient to ensure that they both understand the nature of their disease state and the necessary steps to improve their condition. Ultimately it is the patient's responsibility to be a positive agent in their own health; but physicians can better educate and motivate them if they understand the foundation of their beliefs and behaviors.

One of the greatest challenges to the improvement of the national diabetes epidemic is alarming absence of health care access. In a nation where diabetes during pregnancy is projected to affect nearly 18% of all pregnancies (4), one might expect that significant governmental funding would be allotted to ensure that all pregnant women would be screened for GDM and have access to the clinicians necessary to institute a pregnancy plan. In a study of almost 5000 woman between the ages of 18 and 44 with GDM, one-fifth reported no health insurance, with the absence of a primary care provider (25). One-fourth of the population had no physical examination in the last year, suggesting that they may have missed glucose screening opportunities, family planning strategies, and diet and exercise planning prior to their pregnancy. Hispanic women belong to one of the ethnic groups at greatest risk for the development of GDM; and in this study, they reported the most barriers to health care access when compared to African Americans, non-Hispanic whites, Native Americans, and Asians or Pacific Islanders, including the lack of insurance and a primary care provider. Latina women of this study were more likely to be of lower socioeconomic status, overweight, and unemployed without a high school education than non-Hispanic white women with GDM (25).

The conclusions that can be drawn from this study reflect a health care system that does not provide equal access to health education, preventative measures, or treatment of disease. While the divergent access to health care coverage among different ethnic groups is of great concern and must be addressed, the government should also be supporting the development of extension and community education outreach programs in relation to Gestational Diabetes Mellitus. As many of the risks for development of the disease, as well as the treatment plans, involve the modification of lifestyle choices regarding diet and exercise, patients without

sufficient access to health care could have the chance to improve their prognosis if they were simply educated.

In an attempt to provide information to Hispanic women in a Tucson area of lower socioeconomic classes, I collaborated with a local OB/GYN and offered free lectures about gestational diabetes to already pregnant women, or women of reproductive age. We created advertisements for our lectures and distributed them at various clinics in the Tucson area. While health care providers at the distinctive clinics seemed supportive of our efforts and understood the gravity of gestational diabetes, they were not committed to dedicating any extra time to the issue or necessarily encouraging their patients to attend our lectures. Despite the access to free health care information from a certified medical doctor, patients did not attend our lectures and no one benefitted from the information we had to provide. This reality elicited many important questions in regard to the health care system and patients' investment in their own health. If clinicians were not overtly responsive to our efforts to help educate the community, it is reasonable to consider whether or not they are taking the time to educate their own patients sufficiently in their office visits. Limited access to transportation and free time, disinterest in improving their own health, or overall ignorance to the severe implications a pregnancy complicated by diabetes can have, were all possible explanations for why patients themselves did not respond to our educational outreach. All of these questions, among many others, would need to be addressed by governmental health agencies prior to implementing health education programs for GDM among racially and culturally diverse communities in this nation.

The brochure that follows this review was created, in both English and Spanish, to be delivered to various clinics in the Tucson area in an attempt to provide the relevant information regarding GDM to patients, whether or not they were willing to solicit it themselves.

Conclusion

Gestational diabetes is a serious pregnancy complication for women and their children; and on a global scale, it has a detrimental impact on the diabetes epidemic in the United States. The Center for Disease Control reports that between 1980 and 2009, the number of Americans diagnosed with diabetes rose from 5.6 million to 19.7 million (14). As the diabetes trend continues on an upward scale, the contribution from gestational diabetes cannot be ignored. In economic terms, diabetes care cost the United States roughly $174 billion in 2007 alone (15). It has been estimated that if the number of women with GDM who progress to Type 2 Diabetes is reduced by 50% over the duration of ten years, $331 million dollars could be spared in diabetes care expenses (27). From both a fiscal and population health perspective, the government must increase its funding for education, prevention, and further research into the treatment of Gestational Diabetes. Similarly, for the Hispanic population to have such limited access to health care in the face of GDM is a daunting reality, considering that the Hispanic population itself is on the rise in the United States.

Supposing that the government were to increase its efforts in support of patient education and outreach, the patients must then assume the responsibility of ensuring their own health and well-being. Oftentimes, individuals are unwilling to dedicate the appropriate energy and commitment to their own health, or are in denial that they are at risk if they refuse to change their habits and behaviors. In order for the United States to reverse this rising trend of diabetes, and Gestational Diabetes Mellitus specifically, there will have to be a coordinated effort between the investment of governmental agencies, physicians educating their patients, and finally, patients who will render themselves accountable to attend to their own health.

Monitoring Blood Glucose Levels

A device called a glucometer is used by individuals with diabetes to measure blood glucose levels.

A lancet pokes your finger to withdraw a small sample of blood. From that sample, the glucometer can calculate the amount of glucose running through your bloodstream at that particular time.

It is recommended that you perform at least 4 tests a day: before breakfast, 1 hour after each meal, and any time you deviate from your meal plan

Here are the healthy values for blood glucose levels that you should try to achieve:

- Fasting blood sugar: 60-90mg/dl
- 1hr after meals: <140mg/dl
- 2 hr after meals: <120mg/dl

Insulin Therapy

Insulin therapy is necessary in about 15% of GDM cases where the glucose levels are so high that they cannot be controlled. In these cases, insulin injections are needed to bring the blood glucose levels back into the normal range.

Ford-Martin, Paula, and Ian Blumer. "Gestational Diabetes." *The Everything Diabetes Book: from Diagnosis and Diet to Insulin and Exercis, All You Need to Live a Healthy, Active Life*. Avon, MA: Adams Media, 2004. Print.

Useful Links

For more information regarding Gestational Diabetes Mellitus, consult any of the following websites:

- **Gestational Diabetes: A Guide for Pregnant Women**

http://effectivehealthcare.ahrq.gov/ehc/products/107/162/2009_0804GDM_Cons_singlpgs.pdf

- **Sweet Success Diabetes Prevention Program**

http://www.cdph.ca.gov/programs/cdapp/Pages/SweetSuccessMaterials.aspx

- **National Diabetes Fact Sheet, 2011**

http://www.cdph.ca.gov/programs/cdapp/Documents/MO-CDAPP-CDC-DiabetesFactSheet.pdf

- **Preconception Care**

http://www.cdc.gov/ncbddd/preconception/QandA.htm

- **Glycemic Index for 100+ Foods**

http://www.health.harvard.edu/newsweek/Glycemic_index_and_glycemic_load_for_100_foods.htm

- **Gestational Diabetes Fact Sheet**

http://diabetes.niddk.nih.gov/dm/pubs/gestational/

A Woman's Guide to Understanding, Preventing, and Treating

Gestational Diabetes Mellitus

Stephanie Zankman
University of Arizona
Department of Physiology,
Honors College

Collaborators:
William Richardson, M.D.
Randi Weinstein, Ph.D.
Frances Catinella, RD

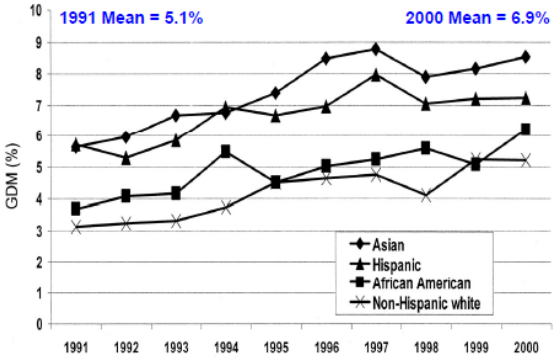
Tel: 555 555 5555

What is Gestational Diabetes?

Gestational diabetes mellitus (GDM) is a form of diabetes that develops during pregnancy, and is generally resolved after the birth of the child. It develops during the second half of pregnancy, and often recurs in future pregnancies. GDM affects 2-10% of all U.S. pregnancies each year, and about 50% of the women diagnosed with GDM will develop Type II Diabetes within 5 years of giving birth.

Risk Factors for Development of GDM

Women of Hispanic, Native American, African American, Asian-American, and Pacific Islander descent are at highest risk of developing GDM. The frequency of GDM cases among these ethnic groups increased steadily from 1991 to 2000 and this trend is likely to continue.



Ferrara A. Diabetes Care. 2007. 30(Supplement 2): S141-S146.

Other risk factors for the development of GDM include:

- Being overweight prior to pregnancy
- Having a 1st degree relative with diabetes, or personal history of GDM
- Previous stillbirth
- Birth of a baby 9+ lbs (average newborn weight between 6 lbs, 2oz and 9 lbs, 2oz)
- Advanced maternal age
- Smoking, physical inactivity, high saturated fat diet

How does GDM affect your baby?

During GDM, the expectant mother is unable to secrete the extra insulin necessary to keep blood sugar levels within normal range. The expectant mother develops a condition called hyperglycemia, or high blood glucose (sugar) levels. Extra glucose in the blood is able to cross the placenta into the baby's bloodstream. High blood glucose levels are associated with **increased risk of stillbirths in the final 8 weeks of pregnancy**. In order to balance the surplus of glucose, the fetus secretes excess insulin. This extra insulin, acts as a fetal growth hormone, **causing the baby to grow to an abnormally large size.** A larger baby is more prone to **injuries** as it exits the birth canal. Also, the expectant mother's diabetes can cause the baby's lungs to develop at a slower rate, increasing the **risk of respiratory distress syndrome,** making breathing difficult for the newborn.

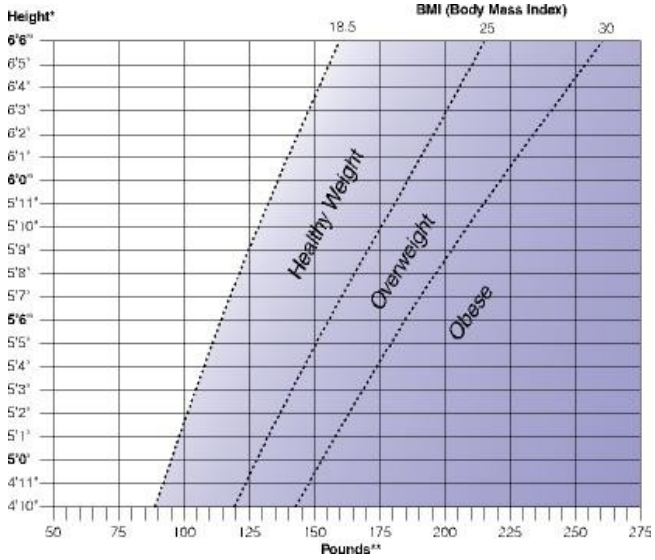
Of additional concern is the possibility that the baby's excess glucose and insulin levels, resulting from the mother's GDM, may "metabolically imprint" that child for life, **making the child more likely to be obese and develop Type II Diabetes at a young age.**

Ford-Martin, Paula, and Ian Blumer. "Gestational Diabetes." *The Everything Diabetes Book: from Diagnosis and Diet to Insulin and Exercis, All You Need to Live a Healthy, Active Life*. Avon, MA: Adams Media, 2004. Print.

GDM Prevention

The likelihood of acquiring GDM can often either be reduced or prevented by simple lifestyle modifications. For example, if you are overweight, losing weight prior to pregnancy will greatly reduce your chances of having GDM. Similarly, you can modify other lifestyle factors, such as the cessation of smoking, or increasing your level of physical activity.

The BMI, or Body Mass Index, is a useful tool for approximating whether or not your current weight falls in a healthy range. The BMI is a measurement of an individual's degree of body fat, based on their height and weight.



Based on your BMI prior to pregnancy, you can estimate the recommended, healthy amount of weight that can be gained during pregnancy. If you exceed this suggested weight gain, you may be putting yourself at risk for the development of GDM.

Pre-pregnancy weight	Recommended weight gain
Underweight (BMI less than 18.5)	28 to 40 pounds
Normal weight (BMI 18.5 to 24.9)	25 to 35 pounds
Overweight (BMI 25 to 29.9)	15 to 25 pounds
Obese (BMI 30 or greater)	11 to 20 pounds

"Pregnancy Weight Gain: What's Healthy?" *Pregnancy Week by Week*. Mayo Clinic. Web. 28 Apr. 2011.

GDM Treatment—Diet

To regulate your blood glucose levels while you have GDM, it is important to establish a strict dietary plan with your dietician or health care provider. Here are some general guidelines:

General Dietary Tips:

- Researchers recommend 3 small-to-medium sized meals and 2-4 snacks every day
- Eat less carbohydrate at breakfast than at other meals because this is when insulin resistance is the greatest (also avoid milk at breakfast)
- Add a light nighttime snack (fruit, a handful of pretzels, or crackers) to keep your blood sugar at a healthy level overnight.

Glycemic Index:

The Glycemix Index (GI) value for any given food is a measurement of how rapidly that food will be converted to glucose in the blood.

Use the Glycemic Index as a guide for foods to avoid or enjoy. Choose foods with a lower GI, because these are converted into glucose more slowly and will minimize your insulin response.

Better Choice (Lower GI)	Worse Choice (Higher GI)
Sweet Potato (54)	Baked Potato (85)
Grapefruit (25)	Pineapple (66)
Peanuts (14)	Potato Chips (54)
Whole Wheat Bread (49)	White Bread (71)
Whole Wheat Tortilla (30)	Corn Tortilla (52)

"Glycemic Index and Glycemic Load for 100 Foods." *Harvard Health Publications*. Harvard Medical School. Web. 26 Apr. 2011. <http://www.health.harvard.edu/newsweek/Glycemic_index_and_glycemic_load_for_100_foods.htm>.

Portion Control—The Plate Method

Controlling your portion sizes, whether for a whole meal or for individual foods, is critical to any nutritional plan. Monitoring portions can help you restrict calories and ultimately maintain a healthy weight.

Below is an example of portion control in the form of the "Plate Method," where half of an average 9inch plate is dedicated to non-starchy vegetables, one quarter of the plate to lean protein, and the last quarter to starchy foods. The plate method is not as efficient as carbohydrate counting, but it is a useful tool for understanding the basic principles of portion control, especially when one eats at a restaurant.

- 1/2 Non-starchy vegetables: Spinach, broccoli, onions, peppers, carrots, tomatoes, etc
- 1/4 Lean Protein: 3oz lean beef, pork, chicken, fish, or tofu, eggs, cottage cheese, etc
- 1/4 Starchy Foods: Bread, potatoes, corn, beans, rice, tortilla, etc

For breakfast, use the two quarters of the plate only. For lunch and dinner, use the whole plate.

"My Plate Planner." *My Plate Planner*. AARP. Web. 26 Apr. 2011. <http://videos.med.wisc.edu/files/plate_planner.pdf>.

Other tips for estimating serving sizes:

1 cup of fruit = a clenched fist

3 ounces of fish/meat = palm of your hand/a deck of cards

1 teaspoon of butter/dressing = the head of a toothbrush

Carbohydrate Counting

Carbohydrates consumed from your diet can contribute to high blood glucose levels. Carbohydrate counting is a nutritional plan that allows you to restrict the amount of carbohydrate you eat throughout the day.

When counting carbohydrates, it is important to pay attention to the amount of carbohydrates, measured in grams (g) that is actually in your food. You may find this information on the nutritional label of the food you consume:

Here is an example of a meal plan that employs carbohydrate counting:

Nutrition Facts

Serving Size: About (20g)
Servings Per Container: 16

	Amount Per Serving	% Daily Value*
Total Calories	60	
Calories From Fat	15	
Total Fat	2 g	3%
Saturated Fat	1 g	4%
Trans Fat	0 g	
Cholesterol	0 mg	0%
Sodium	45 mg	2%
Total Carbohydrates	15 g	5%
Dietary Fiber	4 g	17%
Sugars	4 g	

First meal: **30g of carbohydrate**
Snack: **15 - 30g of carbohydrate**
Second meal: **45g of carbohydrate**
Snack: **15-30g of carbohydrate**
Third meal: **45g of carbohydrate**
Snack: **15-30g of carbohydrate**

Each food choice below represents **15g carbohydrate**, except for non-starchy vegetables which only represent 5g.:

- **Dairy**: 8oz milk, 8oz plain yogurt, 1/2cup ice cream
- **Starch**: 1/3 cup cooked pasta, 1 slice bread, 1 small tortilla (flour or corn)
- **Fruit**: 1 small banana, 15 grapes, 3/4 cup raspberries/blueberries
- **Non-starchy veggies** (1/2 cup cooked): mushrooms, spinach, onions, carrots
- **Sauces, jellys, sweets**: 1 Tbsp white/brown sugar, 1/2 glazed donut, 4oz regular sugar

Catenilla, Frances. *Living with Diabetes in Pregnancy*. Tucson: Tucson Medican Center. Print.

Protein

- protein/meat should be included with every meal (1 palm of hand = 3oz)
- No carbs from fish, poultry, pork, cottage cheese, cheese, eggs, tuna/chicken salad, soy products, peanut butter, nuts and seeds

Fat

- Fat choices should be low fat
- Choose low fat margarine, canola oil, salad dressing, cream cheese, sour cream, mayo, bacon, creamer

Free Foods

- No carbs in them! Eat as much of them as you like!
- Mustard, rice cakes, broth, salsa, sugar free gum, water, crystal light, low sugar jam, relish, pickles

Dietary Fiber

- Consume a healthy amount of dietary fiber – whole grains, dried beans and peas, citrus fruits, nuts, and vegetables (fiber normalizes blood glucose levels)
- Consume at least 2 liters, or around 8 glasses, of water daily to help digest this fiber.

Diabetes Superfoods

- **Drained beans**: good source of fiber, protein, magnesium, and potassium
- **Dark Green Leafy Vegetables** (spinach, collards, kale): very low in calories and carbs
- **Sweet Potatoes** (as a lower GI replacement for baked potatoes): high in vitamin A and fiber
- **Fish high in Omega-3 Fatty Acids** (Salmon)
- **Nuts:** healthy source of fat, magnesium, and fiber

Avoid Fast Food

- Fast food is high in sugar, calories, fat, cholesterol, and sodium, and has been shown to induce weight gain, be linked with Type 2 Diabetes, and contribute to a variety of health complications, such as heart disease.

Catenilla, Frances. *Living with Diabetes in Pregnancy*. Tucson: Tucson Medican Center. Print.

Nutritional Label

Nutritional Label Interpretation

- The amount of daily calories recommended varies dependent on an individual's age, height, weight, and activity.
- For a 140 pound, active (moderate exercise almost every day) 5 feet 6 inches, 30 year old woman, the recommended daily intake is 2050 calories. For this same woman, if she were inactive (rarely exercised), her suggested daily intake would be 1700 calories.
- When examining **% Daily Value** calculations, consider anything 5% or less as a low value, and anything 20% or more as high.
- Health experts recommend that you keep the amount of **total fat, saturated fat, trans fat, cholesterol, and sodium to a minimum**.
- Getting enough **calcium** may reduce the risk of osteoporosis.
- Eating a lot of **dietary fiber** promotes healthy bowel function.
- Diet rich in fruits, vegetables, and grain products that contain dietary fiber, and low in saturated fat and cholesterol may reduce the risk of heart disease.

How to Understand and Use the Nutrition Facts Label. FDA, 11 Mar. 2011. Web. 26 Apr. 2011. <http://www.fda.gov/food/labelingnutrition/consumerinformation/ucm078889.htm>.

GDM Treatment—Exercise

It is important to exercise regularly during your pregnancy, as regular exercise can help promote normal blood glucose levels. Also, exercise can decrease your appetite, helping prevent excessive weight gain during your pregnancy.

While exercise is necessary, try to keep your intensity levels similar to how they were prior to your pregnancy.

- If you were physically inactive before, try moderate exercise (walking 30 mins a day or yoga) and low resistance weight lifting.
- If you were moderately - intensely active previously, continue your same exercise habits.

****The key is to not make any drastic changes to your exercise routine during your pregnancy**

If you are curious how many calories you might burn in 30 minutes of exercise, here are some examples:

For a 140 pound person:

- Moderate walking: 80 calories
- Low resistance weight lifting: 95 calories
- Low impact aerobics: 160 calories

For a 180 pound person:

- Moderate walking: 102 calories
- Low resistance weight lifting: 123 calories
- Low impact aerobics: 205 calories

Other Factors that could affect your blood glucose levels:

- Stress can increase your blood glucose levels
- Try to reduce your stresses by taking time for yourself every day and avoiding aggravating situations
- Vomiting and diarrhea can alter your glucose levels, and if your glucometer readings are off target two or more times in a row, contact your physician
- **Breastfeeding leads to reduced blood glucose levels postpartum (after your pregnancy) and may help reduce the mother's risk of developing Type 2 Diabetes. The baby also greatly benefits from the calcium and other nutrients it receives from the mother's milk.**

Catenilla, Frances. *Living with Diabetes in Pregnancy*. Tucson: Tucson Medican Center. Print.

Vigilar los niveles de glucemia

Un dispositivo llamado glucómetro es utilizado para personas con diabetes para medir los niveles de glucosa en sangre.

Una lanceta pincha el dedo para extraer una muestra pequeña de sangre. De esa muestra, el glucómetro puede calcular la cantidad de glucosa que atraviesa el torrente sanguíneo en ese momento.

Se recomienda que realice al menos cuatro pruebas de un día: antes del desayuno, una hora después de cada comida, y en cualquier momento que el plan dietetico sea interrumpido

Éstos son los valores saludables para los niveles de glucosa en la sangre que usted debe tratar de lograr:

- Glucosa en sangre en ayunas: 60-90 mg/dl
- 1HR después de las comidas: < 140mg/dl
- 2 Hr después de las comidas: < 120mg/dl

Insulinoterapia

La insulinoterapia es necesaria aproximadamente en el 15% de los casos de DMG donde los niveles de glucosa son tan altos que no pueden ser controlados. En estos casos, las inyecciones de insulina son necesarias para que los niveles de glucosa en sangre en el rango normal.

Ford-Martin, Paula, and Ian Blumer. "Gestational Diabetes." *The Everything Diabetes Book: from Diagnosis and Diet to Insulin and Exercis, All You Need to Live a Healthy, Active Life*. Avon, MA: Adams Media, 2004. Print.

Sitios web útiles

Para obtener más información sobre diabetes mellitus gestacional, consulte cualquiera de las siguientes páginas web:

- **Diabetes gestacional: Una guía para mujeres embarazadas**

http://effectivehealthcare.ahrq.gov/ehc/products/107/162/2009_0804DMG_Cons_singlpgs.pdf

- **Dulce éxito: Programa de Prevención de la Diabetes**

http://www.cdph.ca.gov/programs/cdapp/Pages/SweetSuccessMaterials.aspx

- **Hoja de Datos de diabetes nacional de 2011**

http://www.cdph.ca.gov/programs/cdapp/Documents/MO-CDAPP-CDC-DiabetesFactSheet.pdf

- **Cuidado antes de la concepción**

http://www.cdc.gov/ncbddd/preconception/QandA.htm

- **Índice glucémico de los alimentos**

http://www.health.harvard.edu/newsweek/Glycemic_index_and_glycemic_load_for_100_foods.htm

- **Gestational Diabetes Fact Sheet**

http://diabetes.niddk.nih.gov/dm/pubs/gestational/

Guía de una mujer a la comprensión, prevención y tratamiento de la

diabetes mellitus gestacional

Stephanie Zankman
Universidad de Arizona
Departamento de Fisiología,
Colegio de honra

Colabaradores:
William Richardson, M.D.
Randi Weinstein, Ph.D.
Frances Catinella, RD

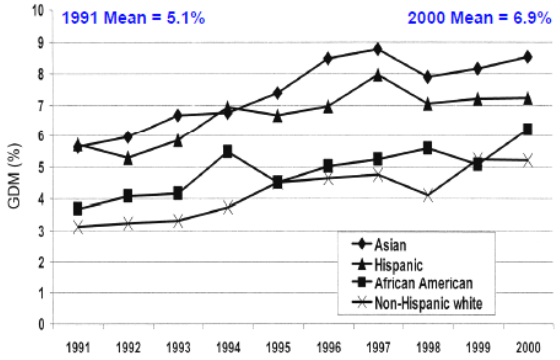
Tel: 555 555 5555

¿Qué es la diabetes gestacional?

La diabetes mellitus gestacional (DMG) es una forma de diabetes que se desarrolla durante el embarazo, y generalmente se resuelven después del nacimiento del niño. Se desarrolla durante la segunda mitad del embarazo, y con frecuencia se repite en embarazos futuros. DMG afecta a un 2-10% de todos los embarazos EE.UU. cada año, y alrededor del 50% de las mujeres con diagnóstico de DMG se desarrollan diabetes tipo II dentro de los 5 años de dar a luz.

Factores de Riesgo de adquisición de DMG

Las mujeres de los hispanos, nativos americanos, afroamericanos, asiático-americanos, y la ascendencia islas del Pacífico están en mayor riesgo de desarrollar DMG. La frecuencia de los casos de DMG entre estos grupos étnicos aumentó constantemente desde 1991 hasta 2000 y esta tendencia probablemente continuará



Ferrara A. Diabetes Care. 2007. 30(Supplement 2): S141-S146.

Otros factores de riesgo para el desarrollo de DMG incluyen:

- El exceso de peso antes del embarazo
- Tener un familiar de 1er grado con diabetes, o antecedentes personales de DMG
- mortinato anterior
- Nacimiento de un bebé de 9 + libras (peso del recién nacido promedio de 6 libras, 2 oz y 9 libras, 2 onzas)
- Edad avanzada de la madre
- Fumar, la inactividad física, la dieta rica en grasas saturadas

¿Cómo DMG afectar a su bebé?

Durante DMG, la futura madre es incapaz de secretar la insulina adicional necesaria para mantener los niveles de azúcar en sangre dentro del rango normal. La futura madre se desarrolla una condición llamada hiperglucemia, o altos niveles de glucosa (azúcar). Exceso de glucosa en la sangre es capaz de atravesar la placenta hacia el torrente sanguíneo del bebé. Altos niveles de glucosa en sangre están asociados con un aumento del riesgo de las muertes fetales en las últimas 8 semanas de embarazo. Para equilibrar el exceso de glucosa, el feto segrega más insulina. Esta insulina adicional, actúa como una hormona del crecimiento fetal, causando el bebé a crecer a un tamaño anormalmente grande. Un bebé mayor es más propensa a las lesiones a la salida del canal de parto. Además, la diabetes de la futura madre puede causar los pulmones del bebé a desarrollar a un ritmo más lento, lo que aumenta el riesgo del síndrome de dificultad respiratoria, dificultando la respiración para el recién nacido.

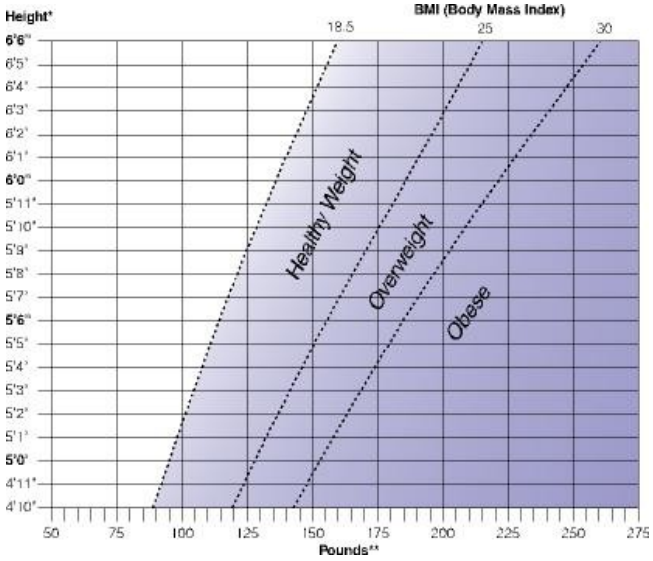
De preocupación adicional es la posibilidad de que el exceso de glucosa del bebé y los niveles de insulina, resultante de la madre de DMG, puede "metabólicamente huella" que niño de por vida, haciendo que el niño más probabilidades de ser obesos y desarrollar diabetes tipo II a una edad temprana.

Ford-Martin, Paula, and Ian Blumer. "Gestational Diabetes." *The Everything Diabetes Book: from Diagnosis and Diet to Insulin and Exercis, All You Need to Live a Healthy, Active Life*. Avon, MA: Adams Media, 2004. Print.

DMG Prevención

La probabilidad de adquirir DMG a menudo puede ser reducida o impedido por estilo de vida sencillo modificaciones. Por ejemplo, si usted tiene sobrepeso, perder peso antes del embarazo se reducirá en gran medida las posibilidades de padecer DMG. De igual manera, puede modificar otros factores del estilo, como el abandono del hábito de fumar, o aumentar su nivel de actividad física.

El IMC o Índice de Masa Corporal, es una herramienta útil para la aproximación si o no su peso actual cae en un rango saludable. El IMC es una medida del nivel de la grasa corporal de un individuo, basada en el peso y altura.



Basado en el índice de masa corporal antes del embarazo, se puede calcular el recomendado, buena cantidad de peso que puede ser adquirida durante el embarazo. Si supera este sugirió aumento de peso, puede ser ponerse en situación de riesgo para el desarrollo de DMG.

Peso antes del embarazo	Aumento de peso recomendado
Peso (IMC inferior a 18,5)	28 A 40 libras
Peso normal (IMC 18,5 a 24,9)	25 a 35 libras
Tener sobrepeso (IMC 25 a 29,9)	15 a 25 libras
Obesos (IMC 30 o mayor)	11 a 20 libras

"Pregnancy Weight Gain: What's Healthy?" *Pregnancy Week by Week*. Mayo Clinic. Web. 28 Apr. 2011. <http://www.mayoclinic.com/health/pregnancy-weight-gain/PR00111>.

Tratamiento de DMG - La Dieta

Para regular los niveles de glucosa en la sangre mientras tiene DMG, es importante establecer un plan estricto de alimentación con su nutricionista o médico. Aquí están algunas pautas generales:

Consejos general para la dieta:

- Los investigadores recomiendan 3 pequeñas a medianas comidas y 2 a 4 aperitivos cada día
- Comer menos cantidad de hidratos de carbono en el desayuno que en otras comidas porque es cuando la resistencia a la insulina es mayor (también evitar la leche en el desayuno)
- Agregar una pequena apertiva nocturna (frutas, un puñado de pretzels, o crackers) para mantener el azúcar en la sangre a un nivel saludable durante la noche.

Índice Glucémico:

El Glycemix Index (GI) valor de un alimento determinado es una medida de la rapidez con que los alimentos se convierte en glucosa en la sangre.

Utilice el índice glucémico como una guía para los alimentos para evitar o disfrutar. Escoger alimentos con un GI inferior, porque estos son convertidos en glucosa más lentamente y se minimiza la reacción de la insulina.

Mejor Elección (GI inferior)	Peor elección (GI Superior)
Batata (54)	patata al horno (85)
Toronja (25)	Piña (66)
Cacahuates (14)	Las Papas Fritas (54)
Whole Wheat Bread (49)	Pan blanco (71)
Whole Wheat Tortilla (30)	Tortilla de maíz (52)

"Glycemic Index and Glycemic Load for 100 Foods." *Harvard Health Publications*. Harvard Medical School. Web. 26 Apr. 2011. <http://www.health.harvard.edu/newsweek/Glycemic_index_and_glycemic_load_for_100_foods.htm>.

Control de porciones - El método de la placa

Controlar el tamaño de la porción, ya sea para una comida entera o para alimentos específicos, es fundamental para cualquier plan de dieta. Controlar las raciones puede ayudarle a restringir las calorías y en última instancia mantener un peso saludable.

A continuación se muestra un ejemplo del control de porciones en la forma del "método de la placa", donde la mitad de una placa promedio de nueve pulgadas está dedicada a las verduras sin almidón, una cuarta parte de la placa a proteínas magras, y la última cuarta de almidón. El método de la placa no es tan eficiente como contar de carbohidratos, pero es una herramienta útil para entender los principios básicos del control de porciones, especialmente cuando uno come en un restaurante.

- 1.2 verduras sin almidón: espinacas, brócoli, cebolla, pimientos, zanahorias, tomates, etc
- 1.4 Proteínas magras: 3 onzas de carne magra, cerdo, pollo, pescado o queso de soja, huevos, queso cottage, etc
- 1.4 alimentos almidónes: pan, patatas, maíz, frijoles, arroz, tortillas, etc

Para el desayuno, uso de las dos cuartas partes del plato solamente. Para el almuerzo y la cena, use todo el plato.

"My Plate Planner." *My Plate Planner*. AARP. Web. 26 Apr. 2011. <http://videos.med.wisc.edu/files/plate_planner.pdf>.

Otros consejos para la estimación de tamaños de las porciones:

1 taza de fruta = un puño cerrado

3 onzas de pescado o carne = palma de su mano / una baraja de cartas

1 cucharadita de mantequilla o vestirse = la cabeza de un cepillo de dientes

Contar de carbohidratos

Los hidratos de carbono consumidos de su dieta puede contribuir a los altos niveles de glucosa en la sangre. El conteo de carbohidratos es un plan nutricional que le permite restringir la cantidad de carbohidratos que usted come durante el día.

Al contar los hidratos de carbono, es importante prestar atención a la cantidad de hidratos de carbono, medida en gramos (g) que actualmente se encuentra en los alimentos. Usted puede encontrar esta información en la etiqueta nutricional de los alimentos que consumen:

Nutrition Facts

Serving Size: About (20g)
Servings Per Container: 16

	Amount Per Serving	% Daily Value*
Total Calories	60	
Calories From Fat	15	
Total Fat	2 g	3%
Saturated Fat	1 g	4%
Trans Fat	0 g	
Cholesterol	0 mg	0%
Sodium	45 mg	2%
Total Carbohydrates	15 g	5%
Dietary Fiber	4 g	17%
Sugars	4 g	

Aquí está un ejemplo de un plan de alimentación que emplea el conteo de carbohidratos:

La primera comida: **30 g de hidratos de carbono**

Apertivo: **15 - 30g de hidratos de carbono**

La segunda comida: **45g de hidratos de carbono**

Apertivo: **15-30g de hidratos de carbono**

La tercera comida: **45g de hidratos de carbono**

Apertivo: **15-30g de hidratos de carbono**

Cada elección de alimentos por debajo representa 15 g de hidratos de carbono, a excepción de las verduras sin almidón, que sólo representan 5g.:

- **Lácteos**: leche 8 oz, 8 oz de yogur natural, crema de hielo 1/2cup
- **Almidón**: 1 / 3 taza de pasta cocida, 1 rebanada de pan, 1 tortilla pequeña (harina o maíz)
- **Frutas:** 1 banana pequeña, 15 uvas, 3 / 4 taza de frambuesas / arándanos
- **Verduras sin almidón** (1 / 2 taza de verduras cocidas): champiñones, espinacas, cebollas, zanahorias
- **Salsas, jaleas, dulces:** 1 cucharada de blanco y el azúcar morena, 1 / 2 donut glaseado, azúcar regular 4 oz

Catenilla, Frances. *Living with Diabetes in Pregnancy*. Tucson: Tucson Medican Center. Print.

Proteína

- proteína / carne debe ser incluidas con cada comida (una palma de la mano = 3 oz)
- No hay carbohidratos en los peces, las aves de corral, carne de cerdo, queso cottage, queso, huevos, atún ensalada de pollo, productos de soya, mantequilla de maní, nueces y semillas

Grasa

- Opciones de grasa deben ser baja en grasa
- Elija margarina baja en grasa, el aceite de canola, aderezos para ensaladas, queso crema, crema agria, mayonesa, tocino, crema

Alimentos Libres

- No hay carbohidratos en estos! Comer tanto de ellos como quieras!
- Mostaza, pasteles de arroz, el caldo, la salsa, la goma sin azúcar, agua, luz cristal, jamón bajo en azúcar, condimentos, encurtidos

Fibra dietética

- Consuma una cantidad saludable de fibra dietética - los granos enteros, frijoles y guisantes secos, cítricos, nueces, y verduras (fibra normaliza los niveles de glucosa en la sangre)
- Consuma al menos 2 litros, o alrededor de 8 vasos de agua al día para ayudar a digerir la fibra.

La diabetes Superalimentos

- **Frijoles escurridos**: buena fuente de fibra, proteínas, magnesio y potasio
- **Las hortalizas de hoja verde oscuro** (espinaca, col, col rizada): muy baja en calorías y carbohidratos
- **Camotes** (como reemplazo de IG menor de papas al horno): alto contenido de vitamina A y fibra
- **Pescado con alto contenido en Omega-3 los ácidos grasos** (salmón)
- **Frutos secos:** fuente saludable de grasa de magnesio, y fibra

Evite la comida rápida

- La comida rápida es alta en azúcar, calorías, grasa, colesterol y sodio, y se ha demostrado que induce el aumento de peso, estar vinculada con la diabetes tipo 2, y contribuye a una variedad de complicaciones de salud, como enfermedades del corazón.

Catenilla, Frances. *Living with Diabetes in Pregnancy*. Tucson: Tucson Medican Center. Print.

Etiqueta Nutricional

Interpretación de la etiqueta nutricional

- La cantidad de calorías diaria recomendada cada dia varía en función de la edad de un individuo, altura, peso y actividad fisica.
- Para una mujer de 140 libras y 30 años de edad, que es activa (ejercicio moderado casi todos los días), y tiene 5 pies y 6 pulgadas de altura, la ingesta diaria recomendada es de 2.050 calorías. Para esta misma mujer, con un estado inactivo (rara vez se ejerce), la ingesta sugerida diaria sería 1.700 calorías .
- Al examinar los cálculos de % de valor diario, tenga en cuenta nada del 5% o menos como un valor bajo, y 20% o un valor mayor como un valoralto.
- Los expertos en salud recomiendan que usted mantenga la cantidad de **grasa total, grasa saturada, grasa trans, colesterol y sodio a un mínimo.**
- Consumir suficiente **calcio** puede reducir el riesgo de osteoporosis.
- Comer mucha **fibra dietética** promueve la función intestinal saludable.
- Dieta rica en frutas, verduras y productos de granos que contienen fibra dietética y baja en grasas saturadas y colesterol puede reducir el riesgo de enfermedades del corazón.

How to Understand and Use the Nutrition Facts Label. FDA, 11 Mar. 2011. Web. 26 Apr. 2011. <http://www.fda.gov/food/labelingnutrition/consumerinformation/ucm078889.htm>.

Tratamiento de DMG-Ejercicio

Es importante hacer ejercicio regularmente durante el embarazo, como el ejercicio regular puede ayudar a promover niveles normales de glucosa en la sangre. Además, el ejercicio puede disminuir el apetito, ayuda a prevenir el aumento excesivo de peso durante su embarazo.

Aunque el ejercicio es necesario, trate de mantener sus niveles de intensidad similar a la forma en que fueron antes de su embarazo.

- Si eran físicamente inactivos antes, trate de ejercicio moderado (caminar 30 minutos al día o yoga) y el levantamiento de peso de baja resistencia.
- Si fueron moderadamente - una intensa actividad con anterioridad, continúan sus mismos hábitos de ejercicio .

****La clave es no hacer cambios drásticos en su rutina de ejercicios durante el embarazo**

Si usted está curioso de cuántas calorías puede quemar en 30 minutos de ejercicio, he aquí algunos ejemplos:

Para una persona de 140 libras:

- Caminata moderada: 80 calorías
- Baja resistencia del levantamiento de pesas: 95 calorías
- Aeróbicos de bajo impacto: 160 calorías

Para una persona de 180 libras:

- Caminata moderada: 102 calorías
- Baja resistencia del levantamiento de pesas: 123 calorías
- Aeróbicos de bajo impacto: 205 calorías

Otros factores que podrían afectar sus niveles de glucosa en la sangre:

- El estrés puede aumentar sus niveles de glucosa en la sangre
- Trate de reducir su estrés tomando tiempo para usted todos los días y evitar situaciones agravantes
- Los vómitos y la diarrea puede alterar sus niveles de glucosa, y si las lecturas son glucómetro desviado dos o más veces en una fila, consulte a su médico
- **La lactancia materna puede reducir a las niveles de la glucosa en la sangre después del parto (después de su embarazo) y puede ayudar a reducir el riesgo de la madre de desarrollar diabetes tipo 2. El bebé también se beneficia enormemente del calcio y otros nutrientes que recibe de la leche de la madre.**

Catenilla, Frances. *Living with Diabetes in Pregnancy*. Tucson: Tucson Medican Center. Print.

References

1. Lawrence, Jean. "Trends in the Prevalence of Preexisting Diabetes and Gestational Diabetes Mellitus Among a Racially/Ethnically Diverse Population of Pregnant Women, 1999–2005." *Diabetes Care*. 31.5 (2008): 899-904. Web. 3 May 2011

2. Buchanan, Thomas. "What is Gestational Diabetes?." *Diabetes Care*. 30.Supplement 2 (2007): S105-S111. Web. 3 May 2011
3. Ferrara, Assiamira. "Increasing Prevalence of Gestational Diabetes Mellitus." *Diabetes Care* 30.Supplement 2 (2007): S141-146. Web. 3 May 2011.
4. Couston, Donald, and Lois Jovanovic. "Screening and diagnosis of diabetes mellitus during pregnancy." *UpToDate*. UpToDate, Inc., 8 Feb 2011. Web. 3 May 2011.
5. Ferrara, Assiamira. "Prevalence of Gestational Diabetes Mellitus Detected by the National Diabetes Data Group or the Carpenter and Coustan Plasma Glucose Thresholds." *Diabetes Care* 25.9 (2002): 1625-1630. Web. 3 May 2011.
6. Chu, Susan. "Maternal Obesity and Risk of Gestational Diabetes Mellitus." *Diabetes Care* 30.8 (2007): 2070-2076. Web. 3 May 2011.
7. Zhang, Cuilin. "Dietary Fiber Intake, Dietary Glycemic Load, and the Risk for Gestational Diabetes Mellitus." *Diabetes Care* 29.10 (2006): 2223-2230. Web. 3 May 2011.
8. Tobias, Deirdre. "Physical Activity Before and During Pregnancy and Risk of Gestational Diabetes Mellitus." *Diabetes Care* 34.1 (2011): 223-229. Web. 3 May 2011.
9. Dabelea, Dana. "The Predisposition to Obesity and Diabetes in Offspring of Diabetic Mothers." *Diabetes Care* 30.Supplement 2 (2007): S169-174. Web. 3 May 2011.

10. Lee, Anna. "Gestational Diabetes Mellitus: Clinical Predictors and Long-Term Risk of Developing Type 2 Diabetes." *Diabetes Care* 30.4 (2007): 878-883. Web. 3 May 2011.

11. Barbour, Linda. "Cellular Mechanisms for Insulin Resistance in Normal Pregnancy and Gestational Diabetes." *Diabetes Care* 30.Supplement 2 (2007): S112-119. Web. 3 May 2011.

12. Petraglia, Felice, and Donato D'Antona. "Maternal endocrine and metabolic adaptation to pregnancy." *UpToDate*. UpToDate, Inc., 1 Oct 2010. Web. 3 May 2011.
13. Desoye, Gernot. "The Human Placenta in Gestational Diabetes Mellitus." *Diabetes Care* 30.Supplement 2 (2007): S120-126. Web. 3 May 2011.
14. "Number (in Millions) of Civilian, Non-Institutionalized Persons with Diagnosed Diabetes, United States, 1980–2009." *Diabetes Data and Trends*. Center for Disease Control and Prevention, 29 March 2011. Web. 3 May 2011.
15. "National Diabetes Fact Sheet, 2011." Center for Disease Control and Prevention, n.d. Web. 3 May 2011.
16. "U.S. Obesity Trends." *Overweight and Obesity*. Center for Disease Control and Prevention, 3 March 2011. Web. 3 May 2011.
17. "California Diabetes and Pregnancy Program ." California Department of Public Health, 21 Apr 2011. Web. 3 May 2011.
18. Jovanovic, Lois. "Treatment and course of gestational diabetes mellitus." *UpToDate*. UpToDate, Inc., 8 Feb 2011. Web. 3 May 2011.

19. Landon, Mark. "A Multicenter, Randomized Trial of Treatment for Mild Gestational Diabetes." *New England Journal of Medicine* 361.14 (2009): 1339-1348. Web. 3 May 2011.
20. The HAPO Study Cooperative Research Group, . "Hyperglycemia and Adverse Pregnancy Outcomes." *New England Journal of Medicine* 358.19 (2008): 1991-2002. Web. 3 May 2011
21. Shepherd, Peter. "Glucose Transporters and Insulin Action — Implications for Insulin Resistance and Diabetes Mellitus." *New England Journal of Medicine* 341. (1999): 248-257. Web. 3 May 2011.
22. Mayer-Davis, Elizabeth. "Breast-Feeding and Risk for Childhood Obesity." *Diabetes Care* 29.10 (2006): 2231-2237. Web. 3 May 2011.
23. Gunderson, Erica. "Breastfeeding After Gestational Diabetes Pregnancy." *Diabetes Care*
30.Supplement 2 (2007): S161-168. Web. 3 May 2011.
24. Downs, Danielle. "Understanding Exercise Beliefs and Behaviors in Women With Gestational Diabetes Mellitus." *Diabetes Care* 29.2 (2006): 236-240. Web. 3 May 2011.
25. Kim, Catherine. "Racial and Ethnic Variation in Access to Health Care, Provision of Health Care Services, and Ratings of Health Among Women With Histories of Gestational Diabetes Mellitus." *Diabetes Care* 30.6 (2007): 1459-1465. Web. 3 May 2011.
26. Jovanovic, Lois. "Glycemic control in women with type 1 and type 2 diabetes mellitus during pregnancy." *UpToDate*. UpToDate, Inc., 30 Jan 2011. Web. 3 May 2011.
27. Cheung, N. Wah. "Population Health Significance of Gestaional Diabetes." *Diabetes Care* 26.7 (2003): 2005-2009. Web. 3 May 2011.
28. Kim, Catherine. "Risk Perception for Diabetes Among Women With Histories of Gestational Diabetes Mellitus." *Diabetes Care* 30.9 (2007): 2281-2287. Web. 4 May 2011.