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Effects of Prenatal Gestational Diabetes Nutrition Education Class and Individual Follow-Up on Maternal and Infant Outcomes

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Effects of Prenatal Gestational Diabetes Nutrition Education Class and Individual Follow-Up on Maternal and Infant Outcomes

By

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DEDICATION

I would like to dedicate this work to my sister, Gena, who is no longer with us on earth, but instead, resides in heaven and within the hearts of those who knew, and therefore, loved her. Sister, not only did you inspire me in your 35 years of life, but the memories I have of you continue to motivate me to strive for excellence, kindness, and compassion in all that I do as well as accept life's challenges with a grateful and perseverant heart. We love you and miss you, dear sister - forever and always.

"Unless someone like you cares a whole awful lot, nothing is going to get better. Its not."
Dr. Seuss – The Lorax

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I would like to thank my committee members who never cease to amaze me with their kindness, knowledge, skill, and ongoing support. I could not have done this without each of you. Thank you so much, Corri, Ann, and Meghan!

Additionally, I would like to acknowledge my loving parents, Joe and Tami, my encouraging siblings, Gena, Tad, Meghan, Melissa, Nick, and Kayla, and my best friend, Anna, for their never-ending faith in me and for helping me "keep it together" in times of chaos. I am fortunate to live in the shelter of your love.

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ADA:	American Diabetes Association
AGA:	Appropriate for Gestational Age
BG:	Blood Glucose
BMI:	Body Mass Index
CDE:	Certified Diabetes Educator
IV:	Intravenous
GA:	Gestational Age
DM:	Diabetes Mellitus
GDM:	Gestational Diabetes Mellitus
IADPSG:	International Association of Diabetes and Pregnancy Study Groups
LGA:	Large for Gestational Age
RD:	Registered Dietitian
OGTT:	Oral Glucose Tolerance Test
EGP:	Endogenous Glucose Production

EFFECTS OF PRENATAL GESTATIONAL DIABETES NUTRITION EDUCATION CLASS AND INDIVIDUAL FOLLOW-UP ON MATERNAL AND INFANT OUTCOMES

Samantha List, RD, LMNT

The University of Nebraska Medical Center, 2016

ABSTRACT

BACKGROUND: Gestational Diabetes Mellitus (GDM) is defined by glucose intolerance detected with the onset of pregnancy, and if gone undetected and untreated, can lead to morbidities for the mother and baby. Implementation of nutrition counseling can work to reduce the risk of complications through dietary modification promoted and adopted during pregnancy. Follow-up is important, as individual assessment is used to modify recommendations. GDM class and follow-up provided through the Diabetes Center of Nebraska Medicine covers and promotes proper management of blood glucose (BG) during pregnancy for women with GDM.

PURPOSE: The purpose of this study was to assess the impact of GDM class and follow-up with a Certified Diabetes Educator (CDE) on maternal and infant outcomes in women diagnosed with gestational diabetes as well as to establish rate of individual follow-up after GDM class attendance.

METHODS: A retrospective medical record review was conducted on women with GDM who attended GDM class between the dates of July 2014-January 2015. The primary maternal outcome was pregnancy weight gain and primary infant outcome was lowest blood glucose. Secondary outcomes include mode of delivery, birth weight, weight appropriateness for age, incidence of shoulder dystocia, involvement of NICU

staff, and need for IV, heart, and respiratory support. An analysis of proportions and means, via Fischer's Exact Test and Mann-Whitney U Test, was preformed, as appropriate, on variables between groups: mothers who attended class and follow-up verse those who only attended class. Rate of follow-up with a CDE post GDM class was also calculated.

RESULTS: Follow-up rate with a CDE after group class was 67.3%, leaving 32.7% without follow-up, which may be linked to increased gravidity of those in the non-follow-up group (1.3 vs. 2.81, p=0.004). No significant differences in maternal and fetal outcomes were identified between groups.

CONCLUSION: Findings indicate that group GDM class held at Nebraska Medicine's Diabetes Center, on its own, successfully communicates information to women with GDM to aid in BG management and favorable outcomes.

INTRODUCTION

Diabetes Mellitus (DM) is a group of metabolic diseases characterized by defects in insulin secretion, action, or both resulting in hyperglycemia. One of these diseases, Gestational Diabetes Mellitus (GDM), is defined by glucose intolerance detected with the onset of pregnancy[1]. If gone undetected and untreated, GDM can lead to significant morbidities for the mother and baby, during pregnancy and for the long term[2]. Consequences include higher rates of stillbirth, polyhydramios, gestational hypertension, macrosomia (birth weight >4000 grams), and caesarean delivery[3]; however, GDM risk factors can be reduced with healthy dietary patterns promoted and adopted during pregnancy through the implementation of nutrition counseling[4].

Medical Nutrition Therapy (MNT) is the initial treatment for gestational diabetes, generally characterized by a division of calories and carbohydrate over three meals and two to four snacks, however, the diet is individualized to the person throughout follow-up[5]. Goals of MNT in gestational diabetes include achievement and maintenance of normoglycemia, prevention of ketosis, and promotion of appropriate weight gain based on maternal pre-pregnancy BMI[6] as well as fetal wellbeing through adequate nutrition[7], as appropriate pregnancy weight gain has been associated with improved outcomes[8].

Close follow-up is necessary to ensure nutritional adequacy, since individual assessment of diet, weight changes, and blood glucose monitoring data is used to modify nutrition recommendations. In fact, it is recommended that those with GDM visit a registered dietitian (RD) a minimum of three times[9], as nutrition counseling in this population has resulted in reduced saturated fat and caloric intake[10], decreased pregnancy weight gain in obese women[11], as well as decreased maternal fasting serum glucose levels[12]. Despite the benefits of and recommendations for nutritional counseling, however, it has been shown that nutrition counseling rarely takes place at the recommended frequency stated above[13].

Gestational Diabetes class and follow-up provided through the Diabetes Center of Nebraska Medicine is meant to cover and promote proper management of blood glucose during pregnancy in mothers with gestational diabetes. Classes are led by registered dietitians who are also certified diabetes educators (CDE), and follow-up appointments are administered by either an RD, nurse, or exercise physiologist, who are all certified in diabetes education. Education includes an overview of gestational diabetes, blood glucose monitoring and goals, nutritional intervention and guidance, benefits and impact of exercise, medication management, as applicable, and problem solving. Women who attend individual follow-up are then provided with feedback based on blood glucose and diet records upon which adjustments are made. In addition, these women are given more information on breastfeeding and diabetes screening recommendations post-delivery. The results of this study established the previously unknown rate of gestational follow-up education at the Nebraska Medicine Diabetes Center, and will be used to evaluate the existing gestational diabetes education program as well as directly influence program alterations to improve overall patient care.

Review of Literature

GDM – Definition, Diagnostic Criteria, and Prevalence

Gestational Diabetes Mellitus (GDM), is defined as glucose intolerance detected with the onset of pregnancy[1]. Historically, the diagnosis of GDM across countries, based on prevention of future onset DM in mothers, was highly variable, causing problems in international discussion. Due to this, the International Association of Diabetes and Pregnancy Study Groups (IADPSG) announced uniform diagnostic criteria to be used worldwide[1] based on the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study[15], conducted in 25,505 women in nine different countries to evaluate maternal and fetal outcomes.

The HAPO study found that with increasing blood glucose (BG) levels following the 75-gram oral glucose tolerance test (OGTT) between 24-32 weeks of gestation, frequency of birth weight >90th percentile, caesarian section, and neonatal hypoglycemia increased[15]. When comparing the highest 1-hour plasma glucose category to the lowest, infants were more likely to be born at weights greater than the 90th percentile, (OR 4.49, 95% CI 3.16-6.39), women were more likely to have caesarian deliveries, (OR 1.86, 95% CI 1.35-2.57) and infants were at more likely to experience hypoglycemia (OR 1.29, 95% CI 0.51-3.31). Results from this study revealed that with elevated blood glucose exposure to the fetus during pregnancy, the odds of maternal and fetal outcomes, described above, also increased. Since no clear blood glucose level demonstrated an increase in primary outcomes[15], in 2008-2009, the IADPSG revised GDM diagnostic criteria and recommend that all women without known diabetes undergo a 75-gram OGTT between 24-28 weeks of gestation. Fasting, 1-hour, and 2-hour plasma glucose levels with an odds ratio 1.75

times higher than the lowest category for fasting, 1-hour, and 2-hour plasma blood glucose levels, was established for diagnosis. Please see Table 1 below for gestational diabetes diagnostic criteria[1].

Table 1. Screening and Diagnostic Criteria for Gestational Diabetes Mellitus[1]

Time Frame	Diagnostic Criteria
Fasting Plasma Glucose	>92 mg/dL
1-Hour Plasma Glucose	>180 mg/dL
2-Hour Plasma Glucose	>153 mg/dL

Patients are recommended to fast for a minimum of 8 hours prior to 75-gram OGTT, which is to be administered between 24-28 weeks of gestation. To be diagnosed with GDM, only one of the three above values must be exceeded[1].

In a recent study involving 2,448 Italian pregnant women, the new IADPSG diagnostic criteria (Table 1) were utilized in place of previous screening protocol. As a result, 538 more women were screened, 31.8% of which were diagnosed with GDM. This new diagnostic criteria required more GDM screening; however, it also identified 171 women with GDM who would have never been screened if previous protocol was left in place[21].

Although the ADA has now adopted this new criterion, the Committee on Obstetric Practice continues to recommend a two-step approach to screening and diagnosis. This process is different, as they recommend pregnant women to first be screened with a 50-gram, 1-hour OGTT at 24-28 weeks of gestation and if failed, are diagnosed based on the result of a 100-gram, 3-hour OGTT[17]. Although universal diagnostic criterion is available, protocols continue to remain variable at this time.

According to the ADA (2013), about 7% of pregnancies are complicated by gestational diabetes, ranging from 1 to 14% depending on diagnostic criteria used and population studied. Based on these estimations, this amounts to approximately 200,000 cases of gestational diabetes each year[1]. DeSisto et al. (2014) aimed to provide current data on the prevalence of GDM based on birth certificates and the Pregnancy Risk Assessment Monitoring System and found that in 2010, prevalence of GDM was as high as 9.2% in the United States. This study included records from 23,479 women in 15 states and New York City. Additionally, this study group found that prevalence increased with maternal age, number of children, and use of WIC, and decreased with higher education ($p<0.05$)[16].

Pathophysiology of GDM

During the first trimester of pregnancy, insulin sensitivity tends to be normal and in some cases, greater than normal[18]. As pregnancy proceeds, however, insulin resistance becomes more pronounced[19], and according to Buchanan and colleges (1990), insulin sensitivity can be reduced up to 60-80%[20]. Although this phenomenon is multifactorial, it can be explained, in part, by increased secretion of progesterone, which decreases glucose transport and insulin binding, and hormone placental lactogen, known to reduce insulin sensitivity[21]. Additionally, plasma concentration of cortisol doubles during pregnancy, which can induce insulin resistance when in excess[22]. In order to meet elevated energy needs, endogenous glucose production (EGP) increases by 16-30%[18]. As a result of impaired insulin sensitivity, glucose utilization, and EGP suppression, plasma glucose levels after meals are higher and last longer in pregnancy. Though these changes and mechanisms do occur in normal pregnancies, in cases of gestational diabetes, the degree of insulin resistance is much more severe[23].

As a compensatory response, in both normal pregnancies and those complicated by GDM, insulin secretion increases starting in the first trimester and is maximized by the third[24]. To accommodate, the β-cells of the pancreas undergo both functional and structural changes[25] such as growth, proliferation[26], and increased insulin secretion[27]. When these actions are insufficient, abnormal glucose tolerance is observed. In fact, Xiang and colleges (1999) estimate a 67% reduction in β-cell compensation in women with GDM when compared to those with normal pregnancies[28].

Risk Factors and Complications of GDM

In a study conducted by Griffin et al. (2000), subjects diagnosed with GDM were significantly older (31 vs. 27 years, $p<0.05$) and weighed more (80 vs. 73.8 kg, $p<0.05$) than those not diagnosed although parity was not significantly different[29]. In addition to weight and age, the American Diabetes Association identifies high blood glucose, abnormal cholesterol, smoking, inactivity, high blood pressure, and poor diet quality as risk factors[30]. The CDC also includes family history of diabetes, having a multiple pregnancy, and having GDM in a previous pregnancy as potential causes[31]. In a study encompassing over 65,000 pregnancies, those with gestational diabetes in one pregnancy had a 41% risk of developing GDM in a second, compared to a 4% risk in those who did not have GDM previously[14].

GDM has been linked to several adverse maternal and fetal outcomes. As described earlier, the HAPO study found that women with GDM are at higher risk of caesarian section, and their infants are born at birth weights >90th percentile and experience neonatal hypoglycemia in greater frequency[15]. Langer and Mazze (1988) also found a relationship between GDM and infant birth weight, demonstrating that as mean BG levels and instability of glycemic control increased, incidence of large for gestational age (LGA) and macrosomatic infants also increased[32]. Another study focusing on pregnant women less than 35 years of age with no previous GDM risk factors, rate of caesarian section was significantly more common in women with gestational diabetes when compared to those without (OR 2.36, 95% CI 1.53-3.64, $p<0.001$) and remained significant after controlling for age, pre-pregnancy BMI, and parity (OR 1.92, 95% CI 1.21-3.06, $p=0.006$). Additionally, more newborns of GDM mothers were born large-for-gestational-age (OR 3.53, 95% CI 1.34-9.34, $p=0.011$) and had significantly higher birth weights ($p<0.001$) even after controlling for maternal age, pre-pregnancy BMI, and gestational age at birth. Polyhydramnios, the excessive accumulation of amniotic fluid, was also associated with GDM (OR 4.48, 95% CI 1.20-16.73, $p=0.025$) in addition to admission to the NICU (OR 4.39, 95% CI 1.44-13.37, $p=0.009$)[33].

GDM - Nutrition Therapy and Patient Outcomes

Medical Nutrition Therapy (MNT) is the initial treatment for gestational diabetes, generally characterized by a division of calories and carbohydrate over three meals and two to four snacks; however, specific recommendations should be tailored to the patient throughout follow-up[5,38]. Goals of MNT in gestational diabetes include achievement and maintenance of normoglycemia, prevention of ketosis, promotion of appropriate pregnancy weight gain, based on maternal pre-pregnancy BMI[6,35], and to support fetal growth and wellbeing through adequate nutrition[7]. It is the position of the ADA that all women with the diagnosis of GDM should receive nutritional counseling by a Registered Dietitian when possible, and individualized MNT is recommended and should include counseling on adequate calorie provision, appropriate macronutrient distribution, and breastfeeding after delivery[34]. However, despite recommendations, a 2013 cross-sectional study found that 22% of women with gestational diabetes stated they never received nutrition counseling from a registered dietitian and 65% visited an RD just once or twice throughout their pregnancy[13].

Supporting adequate weight gain during pregnancy has been shown to improve infant and maternal outcomes. In a retrospective study involving 31,074 women during the years of 2001-2004, appropriate weight gain throughout pregnancy, per Institute of Medicine recommendations[7], resulted in optimal outcomes while excessive weight gain was associated with an increased odds of LGA infants (OR 1.72, 95% CI 1.53-1.93), early delivery (OR 1.30, 95% CI 1.14-1.48), and cesarean delivery (OR 1.52, 95% CI 1.26-1.83). Additionally, those with suboptimal weight gain had greater odds of having small-for-gestational age (SGA) infants (OR 1.39, 95% CI 1.01-1.90), but lower odds of having LGA infants (OR 0.60, 95% CI 0.52-0.67)[8]. Please see Table 2 below for the Institute of Medicine's most recent weight gain recommendations based on pre-pregnancy Body Mass Index (BMI)[35].

Table 2. Institute of Medicine Gestational Weight Gain Recommendations[35]

BMI Category	Pre-Pregnancy BMI	Total Weight Gain Recommendation
Underweight	<18.5 kg/m^2	28-40 lbs
Normal Weight	18.5-24.9 kg/m^2	25-35 lbs
Overweight	25-29.9 kg/m^2	15-25 lbs
Obese	>30 kg/m^2	11-20 lbs

Regulating calorie and macronutrient provision also aids in blood glucose management. In women with GDM who had BMIs greater than 30 kg/m^2, a 30-33% calorie reduction (~1,600-1,800 calories per day) was effective in minimizing hyperglycemia and plasma triglycerides without inducing ketonuria, while diets with 50% reduction in calories (~1,200 calories per day) also minimized hyperglycemia, but were associated with an increase in ketonuria[36]. Limiting carbohydrates to 35-40% of total daily calories has been shown to reduce maternal BG and improve maternal and infant outcomes. In a study conducted on women with diet-controlled GDM, a diet low in carbohydrate, composed of less than 42% total calories from carbohydrate, was compared to a high carbohydrate diet, with energy from carbohydrates exceeding 45% of total calories. While the groups were demographically similar, postprandial BG levels were significantly reduced in the low-carbohydrate group ($p<0.04$) and fewer participants in this group required the addition of insulin therapy ($p<0.047$, RR 0.22; 95% CI 0.02, 1.00) when compared to those consuming a high carbohydrate diet. In addition, incidence of LGA infants was significantly lower in the low carbohydrate group when compared the high-carbohydrate group ($p< 0.035$, RR 0.22, 95% CI 0.05, 0.91) and required fewer caesarian sections ($p< 0.037$; RR 0.15; 95% CI 0.04, 0.94)[37].

Physical Activity and Pharmacological Therapy for GDM

In addition to diet modification, regular aerobic exercise has also been shown to lower fasting and post-meal BG and may be used in addition to nutritional therapy to improve maternal BG control. Although the optimal frequency and intensity of exercise for lowering maternal BG have not been established, it appears that at least three exercise sessions weekly, greater than fifteen minutes each, are necessary to impact maternal BG levels. In some cases, two to four weeks of regular exercise may be needed in order to see an effect[38,39].

When nutritional intervention alone is not enough to achieve normoglycemia, insulin therapy has been shown to reduce fetal complications most consistently[34]. If insulin therapy is added to nutrition therapy, it is necessary to maintain consistent carbohydrate distribution at meals and snacks to facilitate insulin adjustments[39]. Oral glucose agents, such as glyburide, are not currently FDA approved for this population or recommended as a method to lower BG in women with GDM; however, one non-blinded clinical trial comparing glyburide to insulin therapy yielded similar perinatal outcomes[40]. Although promising, more research needs to be conducted in this area to ensure its safety[34].

METHODS

Participants

The institutional review board at the University of Nebraska Medical Center (Omaha, NE) approved this study. This is a retrospective medical record review conducted on mothers diagnosed with GDM who attended gestational diabetes class at the Nebraska Medicine Diabetes Center from July 2014-January 2015 and their infants. Classes are led by registered dietitians who are also certified diabetes educators (CDE), and follow-up appointments are administered by a registered dietitian, nurse, or exercise physiologist, who are all certified in diabetes education. Education includes an overview of gestational diabetes, blood glucose monitoring and goals, nutritional intervention and guidance, benefits and impact of exercise, problem solving, and medication management, as applicable. Women who attend individual follow-up are then provided with feedback based on blood glucose and diet records upon which adjustments are made. In addition, these women are given more information on breastfeeding and diabetes screening recommendations post-delivery.

This time period was chosen for the consistency of care provided, as there was minimal staff turnover, and allowed enough time to pass for mothers who attended class to reach delivery. GDM mothers less than 19 years of age, expecting a multiple pregnancy, and those scheduled for group class but did not attend were excluded. After extensive chart review, 49 mothers and 42 infants were eligible for this study. This sample was then split further into follow-up (Group 1) and non-follow-up (Group 2) groups, where those who attended GDM class and an individual follow-up appointment were placed in Group 1, and those who only attended class were placed in Group 2.

Data Collection

Clinical outcomes collected via retrospective chart review include: lowest infant blood glucose, presence of infant hypoglycemia, infant birth weight, gestational age, involvement of neonatal intensive care unit (NICU) staff, maternal pre-pregnancy BMI, maternal weight gain, maternal weight gain according to recommended ranges, mode of delivery (vaginal vs. caesarian section), average maternal blood glucose, and hemoglobin A1c, as available. Other variables collected include: age, ethnicity, race, insurance, and zip code, additional complications, serum calcium, method of feeding (formula vs. breastfeeding), IV support, and APGAR score of the infants at birth. Presence of infant hypoglycemia was defined by blood glucose less than 30 mg/dL and weight gain recommendations were based on the Institute of Medicine parameters (see Table 2). Health insurance was divided into two groups: public (Medicaid) and private (others).

Analysis

Women were separated into two groups: those who attended class in addition to one or more follow-up appointments and those who attended GDM group class but did not participate in a follow-up appointment. Those who were scheduled for group class but did not attend were excluded. Rate of follow-up with a CDE post gestational diabetes class was established by calculating proportion. Additionally, an analysis of proportions and means, via Fischer’s Exact Test and Mann-Whitney U Test, was preformed, as appropriate, on maternal and fetal outcomes between the two groups. Results with a p-value <0.05 were deemed significant. In order to accept the two hypotheses, results must demonstrate significantly improved fetal and maternal outcomes in the follow-up group verse the group who attended group class with no follow-up.

RESULTS

There were 33 mothers and 28 infants in Group 1, the follow-up group, and 16 mothers and 14 infants in Group 2, the group with no individual follow-up after group class. There were no significant differences found in maternal baseline characteristics, with the exception of gravidity, in which women in Group 2 had significantly more previous pregnancies than women in Group 1. Results are displayed below in Table 1.

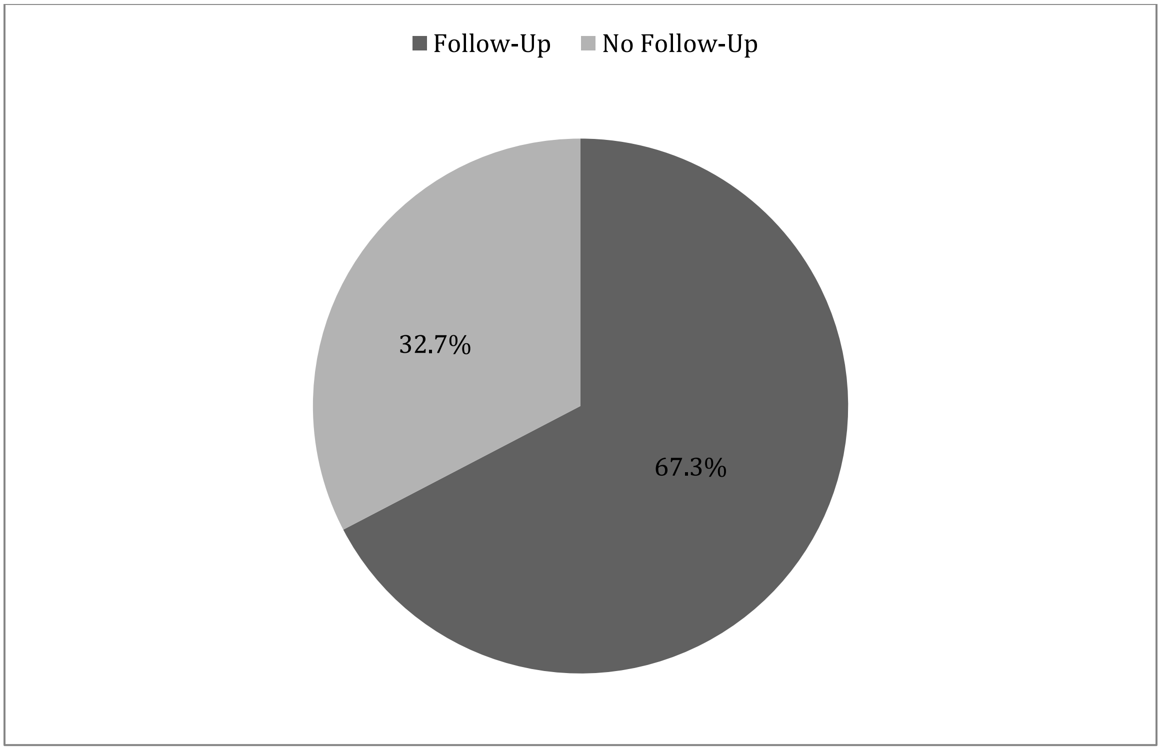
Table 3. Maternal Baseline Characteristics

	Group 1 **Follow-Up**			Group 2 **No Follow-Up**			
	No.	Mean	SD	No.	Mean	SD	P-value
Age (years)	33	28.36	4.676	16	29.19	6.123	0.474
Gravidity	30	1.3	1.236	16	2.81	1.721	0.004*
Pre-Pregnancy BMI (kg/m^2)	33	31.23	7.55	15	37.12	12.84	0.161
Week of Gestation	32	27.25	6.825	16	30.88	3.704	0.123
1-Hour GTT (mg/dL)	28	184.86	25.2	11	168.45	34.9	0.318
3-Hour GTT (mg/dL)	24	127.54	31.12	7	121	31.9	0.620
HbA1c (%)	8	5.41	0.75	5	5.12	0.58	0.418
	No.	Proportion	%	No.	Proportion	%	P-value
Ethnicity	31			15			0.193
Hispanic	3	0.0968	9.68	4	0.2667	26.67	
Non-Hispanic	28	0.9032	90.32	11	0.7333	73.33	
Race	31			15			1.000
White	23	0.7419	74.19	11	0.7333	73.33	
Non-White	8	0.2581	25.81	4	0.2667	26.67	
Health Insurance	31			16			0.131
Public	10	0.3226	32.26	9	0.3750	37.50	
Private	21	0.6774	67.74	7	0.4375	43.75	

** Significant p-value (p<0.05)*
Gravidity = Number of previous pregnancies
GA = Gestational Age
BMI = Body Mass Index
GTT = Glucose Tolerance Test
HbA1c = Hemoglobin A1c

From July 2014-January 2015 at the Nebraska Medicine Diabetes Center, 67.3% of women who attended GDM group class also came back for follow-up, leaving 32.6% of this sample without individual follow-up with a Certified Diabetes Educator after group class (Figure 1).

Figure 1: Proportion of GDM Class Follow-Up vs. No Follow-Up



Results regarding maternal outcomes are displayed in Table 4, and visual displays of maternal blood glucose levels and mode of delivery proportions, between groups, can be viewed in Figures 2 and 3, respectively.

Table 4. Maternal Outcomes

	Group 1 **Follow-Up**			Group 2 **No Follow-Up**			
	No.	Mean	SD	No.	Mean	SD	P-value
Average Maternal BG (mg/dL)	32	102	10.5	9	100	10.2	0.670
Maternal Weight Gain (lbs)	26	20.2	17	12	21.5	16.7	0.888
	No.	Proportion	%		Proportion	%	P-value
Weight Gain within Recommended Range	26			12			0.453
Yes	18	0.6923	69.23	2	0.1667	16.67	
No	8	0.3077	30.77	10	0.8333	83.33	
Mode of Delivery	27			14			0.165
Vaginal	17	0.6296	62.96	12	0.8571	85.71	
C-Section	10	0.3703	37.03	2	0.1429	14.29	

Recommended Weight Gain Based on Institute of Medicine Recommendations[35]

No statistical significance was found in average maternal blood glucose between groups (p=0.670) and mean maternal weight gain was similar between groups, at 20.2 lbs for those with follow-up and 21.5 lbs for those without follow-up (p=0.888). Although not statistically significant, 69.23% of women in Group 1 (Follow-Up) experienced weight gain within the recommended range per pre-pregnancy BMI, while only 16.67% of women in Group 2 (No Follow-Up) gained weight within recommended ranges (p=0.453). No significant difference was found in mode of delivery between groups (p = 0.165); however, it is worth noting that nearly 40% of those in the follow-up group underwent caesarian sections compared to just 14.3% of women in Group 2.

Figure 2. Average Maternal Blood Glucose between Groups

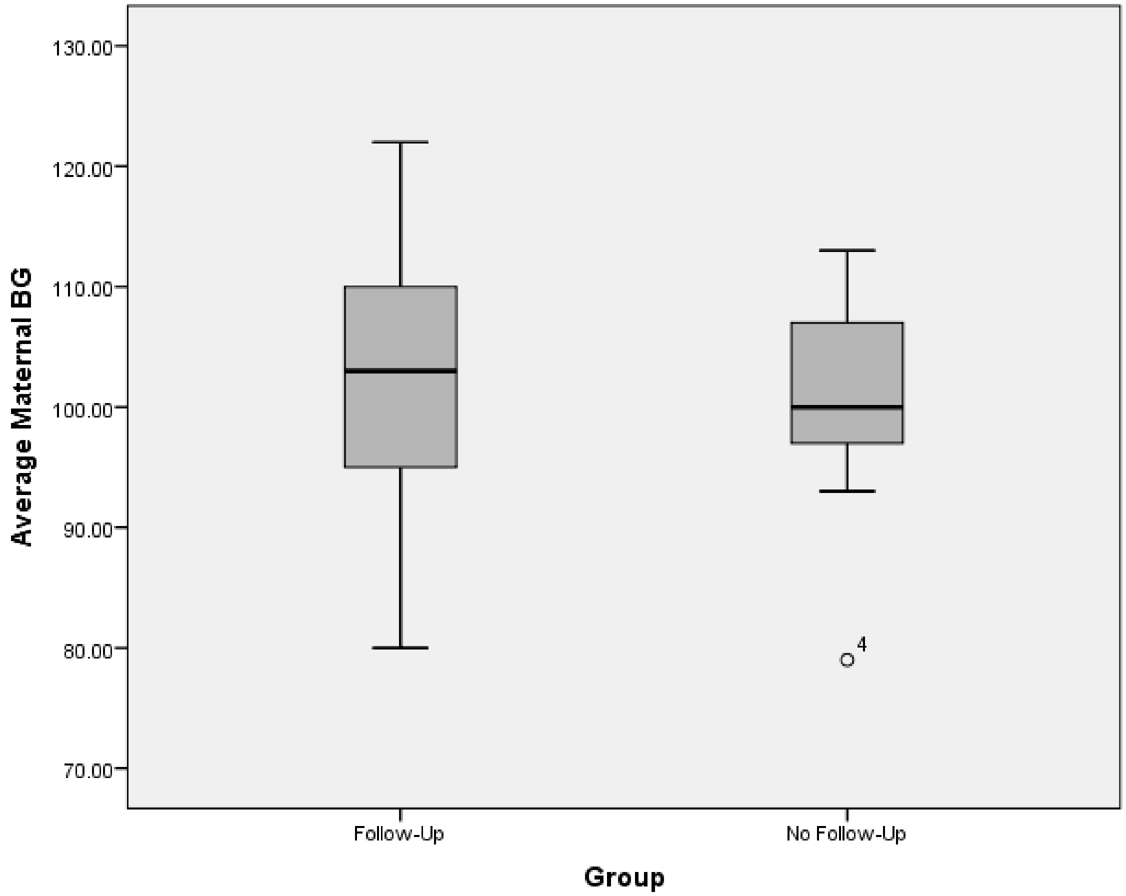
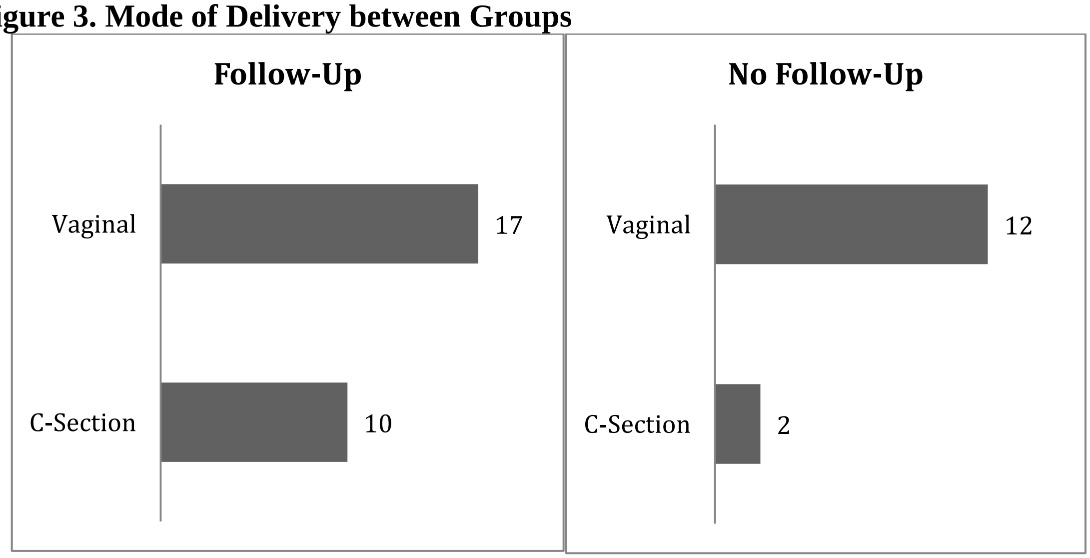


Figure 3. Mode of Delivery between Groups



Infant outcome results are exhibited in Table 5. In addition, a box plot of lowest infant blood glucose levels and a bar graph demonstrating presence of hypoglycemia (BG <30 mg/dL), between groups, can be viewed in Figures 4 and 5.

Table 5. Infant Outcomes

	Group 1 **Follow-Up**			Group 2 **No Follow-Up**			
	No.	Mean	SD	No.	Mean	SD	P-value
Gestational Age (weeks)	27	38.8	1.4	14	38.6	1.3	0.349
Birth Weight (grams)	27	3523	471.1	14	3315	277.5	0.187
Lowest BG (mg/dL)	26	42.8	14.5	12	49.4	17.1	0.131
APGAR Score (60 second)	27	7.3	2.2	12	8.1	1.2	0.208
APGAR Score (10 minute)	27	8.3	1.9	12	8.8	0.8	0.723
	No.	Proportion	%	No.	Proportion	%	P-value
Presence of Hypoglycemia	26			12			0.643
Yes	5	0.1923	19.23	1	0.0833	8.33	
No	21	0.8077	80.77	11	0.9167	91.67	
Weight Appropriate for Age	27			14			0.539
Yes	24	0.8889	88.89	14	1.000	100.0	
No	3	0.1111	11.11	0	0.000	00.00	
Shoulder Dystocia	26			12			1.000
Yes	1	0.040	4.00	0	0.000	00.00	
No	25	0.9615	96.15	12	1.000	100.0	
NICU Staff Present	26			13			0.740
Yes	14	0.5385	53.85	8	0.5333	53.33	
No	12	0.4615	46.15	5	0.4167	41.67	
Intravenous Support	26			12			1.000
Yes	8	0.3077	30.77	4	0.3333	33.33	
No	18	0.6923	69.23	8	0.6667	66.67	
Respiratory Support	26			12			1.000
Yes	4	0.1538	15.38	2	0.2000	20.00	
No	22	0.8462	84.62	10	0.8333	83.33	
Heart Support	26			12			1.000
Yes	0	0.000	0.000	0	0.000	00.00	
No	26	1.000	100.0	12	1.000	100.0	

Hypoglycemia defined as BG <30 mg/dL

Mean gestational age (GA) was similar between groups, at 38.8 weeks for those in Group 1 and 38.6 weeks for infants in Group 2 (p=0.349). Mean birth weight between groups was also similar, with averages of 3,523 grams for infants in Group 1 and 3,315 grams for infants in Group 2 (p=0.187). Although not statistically significant, 100% of infants in Group 2 had birth weights appropriate for their age, while this was only true for 88.9% of infants in Group 1 (p=0.539).

When looking at average lowest blood glucose (Figure 4), differences were not significant between groups (p=0.131), but there were 4 occurrences of infant hypoglycemia (BG <30 mg/dL) in Group 1 (15.4%) and 1 incidence (8.3%) in Group 2. Need for intravenous, respiratory, and heart support was similar between groups (p=1.00) and aid of NICU staff was indicated in ~53% of births in both groups (p=0.740).

Figure 4. Lowest Infant Blood Glucose between Groups

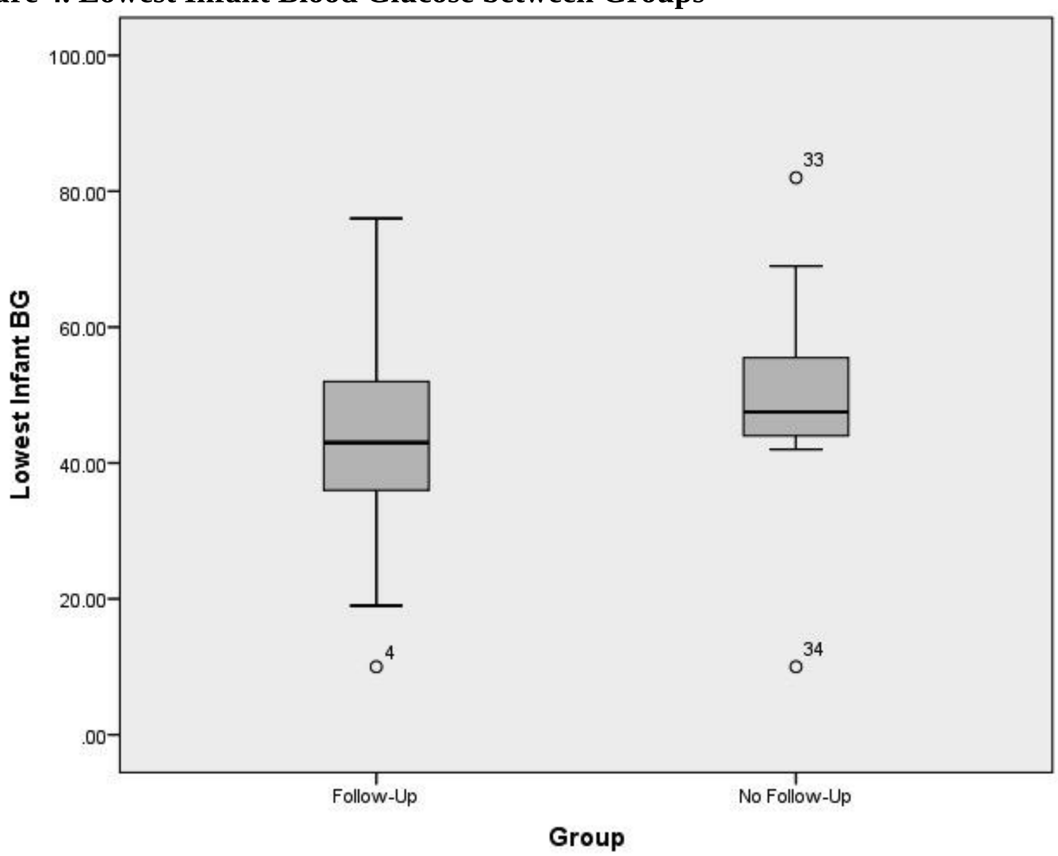


Figure 5. Presence of Infant Hypoglycemia between Groups

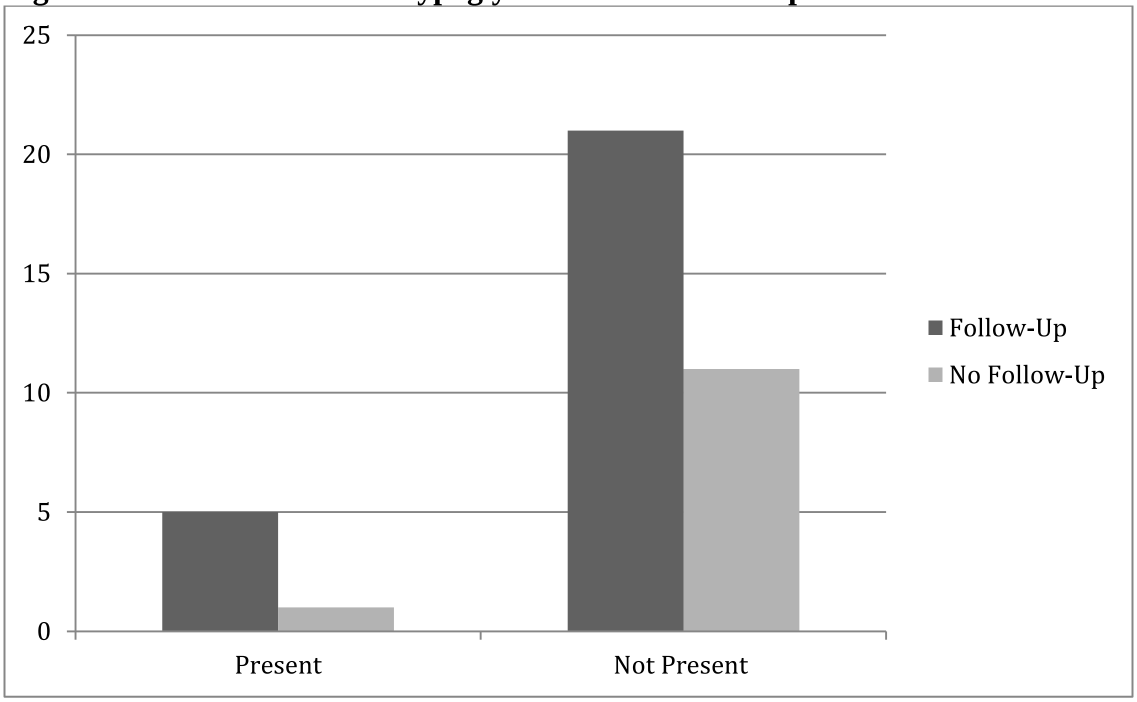
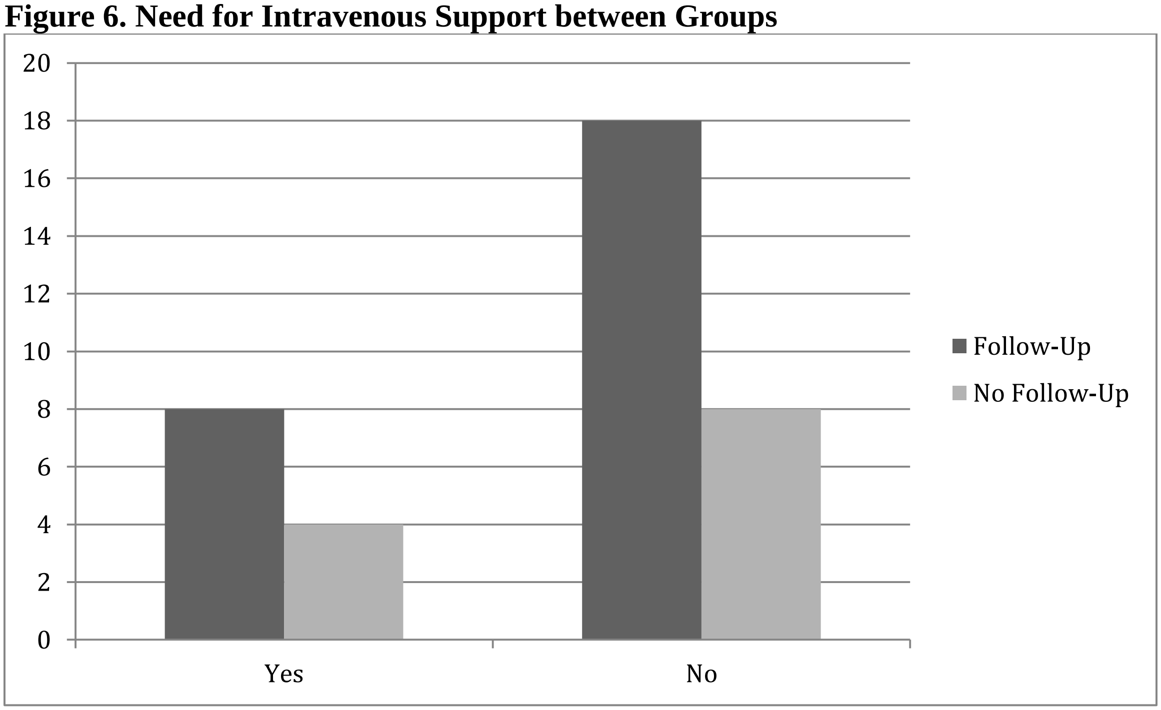


Figure 6. Need for Intravenous Support between Groups



DISCUSSION

Follow-Up Rate

More women who attended group class also attended an individual follow-up appointment with a Certified Diabetes Educator than those who did not return for follow-up, 67.3% verse 32.7%, respectively. Reason for lack of follow up is unknown and likely multifactorial; however, gravidity was significantly different between groups, with Group 1 having an average of one previous pregnancy and those in Group 2 having an average of nearly three previous pregnancies (p=0.004). With this in mind, it may have been more difficult for women in Group 2 to schedule and attend an additional appointment, as they likely have more children to care for. Perception of risk may have also been compromised in this group resulting in less motivation to attend individual follow-up, since they have experienced a greater number of pregnancies in the past. Additionally, these women could have had GDM in past pregnancies and may have already received education in this area before. This could have contributed to higher confidence levels in blood glucose management during pregnancy and, thus, less motivation to return for follow-up.

Additional explanations for lack of follow-up may include late diagnosis of GDM, delivery prior to scheduled follow-up appointment, overall perception that their case of GDM is mild or low-risk, and lack of interest or desire to attend a follow-up appointment.

Maternal Outcomes

Mean maternal weight gain was similar between groups (p=0.888); however, 69.23% of women in Group 1 (Follow-Up) gained weight within recommended ranges per pre-pregnancy BMI, compared to just 16.67% of women in Group 2, those with no individual follow-up (p=0.453). Although not statistically significant, this could suggest that individual follow-up with a Certified Diabetes Educator after group GDM class may aid expecting mothers in the management of weight gain throughout pregnancy.

Mode of delivery between groups was not statistically significant (p=0.165); however, it is worth noting that nearly 40% of those in the follow-up group underwent caesarian sections compared to just 14.3% of women in Group 2. Reason for this is unknown; however, previous caesarian deliveries or increased severity of disease in the women who returned to individual follow-up may be influencing these results.

The American Diabetes Association recommends that women aim for blood glucose levels less than 140 mg/dL one hour after a meal and less than 120 mg/dL two hours after a meal[1]. In this sample, no statistical significance was found in average maternal blood glucose between groups (p=0.670), as mean BG levels were 102 and 100 for Group 1 and 2, respectively. Based on these results, it could be said that group gestational diabetes class alone helped this sample of women stay within recommended BG ranges; however, this information is limited to how well the patients monitored their blood glucose levels in between appointments. Additionally, for apparent ethical reasons, this study was designed without a true control group, as all women in this study received gestational diabetes education. It would be interesting to compare these outcomes to those of women with no specific gestational diabetes education at all.

Infant Outcomes

While mean gestational age (GA) and birth weight were similar between groups (p=0.349 and p=0.187, respectively), infants in Group 1 had two instances of macrosomia, defined as birth weight >4000 grams. When comparing percentage of infants born at weights appropriate for GA, 100% of infants in Group 2 were born at appropriate weights compared to 88.9% of infants in Group 1; this finding, however, was not statistically significant ($p=0.539$).

Between groups, no significant differences were found in average lowest blood glucose ($p=0.131$). Group 1 did have more instances of infant hypoglycemia, at 15.4% compared to 8.3% in Group 2, though not statistically significant ($p=0.643$). Need for intravenous, respiratory, and heart support was similar between groups ($p=1.00$) and aid of NICU staff was indicated in about 53% of births in both groups ($p=0.740$).

Reasons behind these findings are unclear, but one could postulate that women who return for individual follow-up may be followed more closely by their physician due to higher risk, and therefore, are more likely to return to follow-up with their CDE. Number of previous pregnancies could also influence these results. As discussed earlier, gravidity of women in Group 2 is significantly higher than the average gravidity of Group 1. Women who did not attend follow-up may have had GDM and education in previous pregnancies, making them more proficient in the management of their BG levels throughout pregnancy.

Limitations

Limitations of this study include its retrospective design, relatively small sample sizes, and lack of a true control group. The data obtained for this study was limited to what was documented in the electronic medical record and sample size was determined based on the number of women who attended group GDM class during the pre-determined, specified time period of this study (July 2014-January 2015). Since it is not ethical to withhold available information and treatment from patients, all women in this study received at least some gestational diabetes education, meaning this study had no true control group for comparison.

CONCLUSION

In conclusion, individual follow-up rate after group gestational diabetes class was 67.3%, leaving 32.7% without follow-up with a Certified Diabetes Educator at Nebraska Medicine's Diabetes Center. Lack of follow-up is likely related to number of previous pregnancies, as gravidity in the follow-up group was significantly lower when compared to the group without individual follow-up.

No significant differences in maternal and fetal outcomes were identified between groups, perhaps related to limited sample size. Overall, findings from this study indicate that group GDM class held at Nebraska Medicine's Diabetes Center, on its own, successfully communicates information to expecting mothers with gestational diabetes to aid in blood glucose management and favorable maternal and infant outcomes.

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