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AN ASSESSMENT OF PRENATAL CARE RECEIVED BY MOTHERS WITH DIABETES MELLITUS USING OUTCOME MEASURES: A RETROSPECTIVE STUDY IN SOUTH EAST IDAHO

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Abstract: The most commonly used standard for measuring prenatal care (PNC) adequacy is the "Kessner Index" which prescribes PNC for normal pregnancies in terms of the month of pregnancy care started, number of visits, and length of gestation. This index was adopted in this study to assess the effect intensity of PNC on the course of pregnancy and labor, as well as the ultimate delivery effect on mothers with pregestational diabetes mellitus (DM) whether type 1 or type 2 and gestational diabetes mellitus (GDM)). The study covered females who gave a singleton live birth at four major hospitals in Southeast Idaho (1996-1999). Maternal (n=110) retrospective information were analyzed. GDM is substantially more prevalent than prepregnancy DM. Subjects were classified according to "Kessner Index"; the majority of pregnant females received adequate care. The Mann-Whitney test revealed statistically significant differences in the Apgar scores due to PNC. Similar results were found in the number of newborn complications. The relationship between PNC and a reduction in maternal labor complications was inconclusive. Since a substantial proportion of pregnant women may not be aware of their diabetes or at risk for diabetes, early screening for all pregnant women, particularly women at their reproductive age is warranted.

Keywords: Prenatal care, Diabetes, Birth outcome

INTRODUCTION

With the increase in obesity and sedentary lifestyles, the prevalence of diabetes mellitus (DM) among reproductive aged women is rising both in the United States (Ferrara et Al., 2004) and globally (Feig and Palda, 2002). Gestational diabetes mellitus (GDM), which usually reflects type 2 DM in the underlying population (King, 1998) [3], would also be seen more frequently (Metzger, 2006). The prevalence of diabetes in pregnancy, either GDM or preexisting, was 25.3/1,000 births in the U.S. for the period 1993–1995 (CDC, 1998). Based on projected changes in the U.S. and

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worldwide demographics, it is estimated that the total number of cases of GDM would rise to 120% by 2025) (King, 1998).

Available data from the first report on maternal and infant health information, exclusive to the 2003 revision of the U.S. Standard Certificate of Live Birth, indicate that there were 571,858 births to residents of Idaho, Kentucky, New York (excluding New York City), Pennsylvania, South Carolina, Tennessee, and Washington in 2004 (14% of all U.S. births) and GDM is substantially more prevalent than prepregnancy DM 44.0 per 1,000 (or 4.4%) compared with 7.2 per 1,000, (or 0.7%), respectively, while the prevalence of both types increased steadily by age (Martin and Menacker, 2007). There are strong debates illustrating that intrauterine disclosure to either type of DM during pregnancy predisposes offspring to develop obesity and abnormal glucose tolerance later in life independently from genetic transmission (ADA, 2003; Clausen, et al., 2008; Hillier, et al., 2007; Waterland and Garza, 1999). Therefore, the public health aspects of increasing GDM need more attention to decrease the prevalence of type 2 DM in future generations.

Studies have suggested that to avoid early pregnancy loss and costly congenital malformations in the newborn of women with DM, standard medical care and patient counseling and training must start early in pregnancy, if not before Tolstoi and Josimovich, 1999; Fiscella, 1995; Zenk, 1999; UDHHS, 1991). This is because prenatal care in early pregnancy allows health care professionals to monitor fetal growth and maternal health, and to determine the best course of action to improve birth outcomes. A recent study (Bachelard, Santos, and Paccaud, 1996) in community settings examined retrospectively the data of 854 pregnancies delivered in the Vaued Canton in Switzerland. Using the "Kessner Index" (Kessner, et al., 1973) classification to assess the level of prenatal care, the study found that the prevalence of preterm birth was more frequent among women classified as having intermediate or inadequate prenatal care than among women with adequate prenatal care.

The purpose of this pilot study was to assess the impact of PNC utilization on maternal and neonatal outcomes of mothers with pregestational DM (whether type 1 or type 2), and GDM in Southeast Idaho from 1996 to 1999. The hypothesis set forward was that a pregnant woman with pre- and gestational DM who uses adequately prenatal care services will have better maternal and neonatal birth outcomes than a woman who uses prenatal care services inadequately. To my knowledge, at the time of conducting the current research, this hypothesis had not been investigated in Idaho.

METHODS

Design

A cross-sectional retrospective design that involved explanatory (three levels of prenatal care use) and response variables (maternal and neonatal outcomes) of all women in four major hospitals in Southeast Idaho with pre-gestational DM (type 1 and type 2), and GDM who delivered a live birth infant between 1st January 1996 and 31st December 1999, were included in the analysis.

Data source

The researcher abstracted the birth certificates and medical charts of both the mothers and their infants. The study population was restricted to mothers diagnosed with DM prior to or during pregnancy and having a full term singleton live births. Exclusion criteria included any cases with undocumented information on birth weight, gestational age, timing of prenatal care initiation, and number of prenatal care visits. The approval to conduct this study was obtained from both the Human Subjects Committee of Idaho State University and the Committee in charge for each hospital in Southeast Idaho.

The independent variables included date of first visit to PNC service, number of PNC visits, parents' age, marital status, and race. Maternal outcome measures are incidence of pregnancy induced hypertension (PIH), route of delivery (vaginal or caesarean), and the number of labor complications[1]. Neonatal outcome measures are birth weight (g), gestational age (weeks), birth-weight-related gestational age [large-for-gestational-age (LGA), adequate-for-gestational-age (AGA), small-for-gestational-age (SGA)] (Battagalia and Lubchenco, 1967), Apgar scores at 1 and 5 minutes, number of newborn complications,[2] and number of infant congenital abnormalities (defined here as malformation discovered during the birth hospitalization).

Assessment of adequacy of PNC services:

The established method of measuring the adequacy of PNC services called the "Kessner Index" was adopted in this study (Kessner, et al., 1973). It combines the timing (which trimester) of the first PNC visit, the number of visits, and length of gestation (i.e., gestational age) at time of birth. The last factor corrects for shorter pregnancies. The "Kessner Index" categorize the quantity of PNC into three levels: "adequate" if care begins in the first trimester with 9 or more visits over a 36-week or more pregnancy; or "intermediate" which includes 5-8 visits for a 36-week pregnancy; or inadequate if it begins in the 3rd trimester, or includes 4 or fewer visits for a pregnancy of 34 or more weeks. Each subject examined in this study was classified into one of the three "Kessner Index" categories. Because there was only one case that fell into the inadequate PNC category, the three "Kessner Index" categories of adequate, intermediate, and inadequate were modified to only two levels, adequate vs. less than adequate.

Statistical analysis

Using SPSS for Windows release 10.0, the appropriate statistical tests were applied to test the relationship between the level of PNC and several selected outcome measures indicating the health conditions for both the mothers and their infants. A one-way analysis of covariance (ANCOVA) was used to test the impact of PNC levels on infant weight at birth. The factor of interest was level of PNC (adequate vs. less than adequate), with gestational age as a covariate. The T-test was used to compare the average gestational age (as a continuous variable) between the adequate and less than adequate PNC groups. Most of the adopted criteria, such as Apgar scores, number of labor complications, number of newborn complications and number of congenital abnormalities did not meet the assumptions necessary for parametric tests, so the non-parametric (Mann-Whitney) test was employed to compare the level of the response variables between the adequate and less than adequate PNC groups. Because the Apgar score is of an ordinal nature and skewed, while the distribution is enormously skewed for the number of labor complications, the number of newborn complications and the number of congenital abnormalities, the non-parametric Mann-Whitney test was used to compare the level of the response variables between the adequate and less than adequate PNC groups. A Chi-Square test was used

Table 1 Means and standard deviations of quantitative variables

Variable	*Mean ±SD*
Years of education	
Mother	12.3 ±2.9
Father	12.4 ±3.2
Age	
Mother	30.0 ±6.3
Father	32.7 ±6.9
Birth weight (g)	3,513 ±605.5
Apgar score at 1 minute	
Adequate PNC	7.62 ±1.54
Less than adequate PNC	7.27 ±1.36
Apgar score at 5 minutes	
Adequate PNC	8.88 ±0.76
Less than adequate PNC	8.69 ±0.75
Gestational age (weeks)	38.2 ±1.9

Table 2 Frequencies of Qualitative Variables

Variable	*Case*		*Frequency*	*%*
Race	Mothers	White	75	68.2
		Non-White	35	31.8
	Fathers	White	73	66.4
		Non-White	37	33.6
Mother Marital Status	Married		96	87.3
	Unmarried		14	12.7
Incidence of Diabetes Mellitus	Pre-gestational DM		21	19.1
	Gestational DM		89	80.9
Labor Complications	None		41	37.3
	1-2 Types		53	48.2
	>2 Types		16	14.9
Newborn Complications	None		79	71.9
	1-2 Types		20	18.1
	2-5 Types		11	10.0
Congenital Abnormalities	Absent		106	96.9
	Present		4	3.6
Prenatal Care Groups	Less than adequate		48	44.4
	Adequate		60	55.6

to evaluate the relationship between PNC groups and presence of PIH, delivery route, and birth-weight-related gestational age (dichotomous variable).

Characteristics of the study sample

Table 1 and 2 show the description of the studied mothers and their newborn infants with respect to the demographic variables, the explanatory variables (three levels of prenatal care use) and the response variables (maternal and neonatal outcomes).

Results

As shown in Tables 3-7, the Mann-Whitney test shows a statistically significant difference in Apgar scores at 1 minute and at 5 minutes due to prenatal care (P=0.016, P=0.035, respectively). Infants of mothers with adequate PNC shows statistically significant less number of newborn complications (P=0.033). A detailed analysis shows that infants of mothers with GDM had a more statistically significant (P=0.001) number of newborn complications than those of mothers with pregestational DM. As for labor complications the test result was inconclusive (P=0.051). No significant differences in congenital abnormalities due to PNC levels (P=0.112) were detected.

Differences in birth weights (adjusted for gestational age) at PNC levels were statistically not significant (ANCOVA F=1.427, P=0.235). Likewise, differences in average gestational age at PNC levels were statistically not significant (t=0.775, P=0.220). There was no association between birth weight-related- gestational age (LGA vs. AGA) and PNC levels ((χ^2=0.221, P = 0.319). There was no statistically significant association between PNC levels and delivery route (χ^2=2.752, P=0.253) or PIH (χ^2=0.608, P=0.219).

Table 3 Mann-Whitney tests for differences in Apgar scores due to prenatal care levels†.

Variables	*Test Statistics*		*P**
Apgar Score 1 min	M-W=1111	Z=-2.159	0.016
Apgar Score 5 min	M-W=1223	Z=-1.819	0.035

*Significance at P<0.05

Table 4 Mann-Whitney tests for differences in newborn complications, labor complications, and congenital abnormalities due to prenatal care levels.†

Variables	*Test Statistics*		*P*
Newborn Complications †	M–W=1202.5	Z=-1.84*	0.033
Labor Complications †	M–W=1188	Z=-1.633	0.051
Congenital Abnormalities	M–W=1375.5	Z=-1.219	0.112

* Significance at P<0.05

† adequate versus less than adequate.

DISCUSSION

The study results revealed a positive impact of prenatal care on avoiding some complications that either the mother or her newborn infant could meet (ACOG, 1994; ADA, 1998; ADA, 1998). The two areas in which it achieved significance, the newborn's Apgar scores and the number of complications the newborn experiences, under gird the importance of such care. The observed higher 1-minute and higher 5-minute Apgar scores for infants of mothers with adequate PNC is compatible with previous studies (Boss and Timbrook, 2001; *Sloan et al., 1996*; Eden, et al., 2005; Gunter, et al., 2007). On the contrary, other studies found no significant association between Apgar scores and a reduced level of prenatal care utilization (Shushan, Ezra, and Samueloff, 1997; Bienstock, et al. 1997; McDuffie, 1996;). Likewise, lower number of newborn complications was for infants from mothers with adequate PNC level are consistent with earlier studies (Tyson et al., 1990). Further analysis indicates that a significantly higher

Table 5 Mann-Whitney tests for differences in newborn complications, labor complications, and congenital abnormalities due to pregestational DM and GDM.

Variables	*Test Statistics*		*P*
Newborn Complications	M–W=566	Z=-3.54*	0.001
Labor Complications	M–W=841.5	Z=-0.740	0.230
Congenital Abnormalities	M–W=892.5	Z=-0.985	0.112

* Significance at P<0.05

Table 6 Tests for differences in birth weight and gestationalage due to prenatal care levels†.

Variables	*Test*	*Test Statistics*	*P*
Birth Weight	ANCOVA	$F_{(df=1)}=1.427$	0.235
Gestational Age	T-Test	$t_{(df=106)}=0.775$	0.220

* Significance at P<0.05

Table 7 Chi-square tests for association between prenatal care levels and delivery route, pregnancy induced hypertension, and gestational age.

Variables	*Test Statistics*	*P*
Delivery Route	2.752	0.253
Pregnancy Induced Hypertension	0.608	0.219
Gestational Age (LGA vs. AGA)	0.221	0.319

* Significance at P<0.05

† adequate versus less than adequate

number of newborn complications were for those infants of mothers with GDM than those of mothers with pregestational DM.

This study supports earlier studies with regard to GDM increased incidence than prepregnancy diabetes. The current recommendation for screening test for GDM between 24 and 28 weeks of gestation may fail to detect pregnant women who develop GDM in the earlier weeks of pregnancy (Meyer, 1996; Super, 1991; Nahum, Wilson and Stanislaw, 2002). Further, identified women with GDM in the early weeks of pregnancy may indicates true GDM or may represent undiagnosed type 2 diabetes detected during screening (Seshiah, et al., 2007). This may suggest that early diagnosis (Bartha, Martinez-Del-Fresno and Comino-Delgado, 2000) and care should permit evaluation of intervention strategies, which may result in improved perinatal outcomes (Kogan, et al., 1981; Bartha, et al., 2003; Crowther, et al., 2005)

The observed finding with respect to absence of any significant relationship between fetal growth at birth (after adjusting birth weight for gestational age) and levels of PNC was inagreement with several previous studies (Alexander and Korenbrot, 1995; Early, 2000; Bienstock, et al., 1997; McDuffie, et al., 1996; Abramowicz and Kass, 1996) inconsistent with earlier studies (Diaz, Dinsmoor and Lin, 2001; Gold, 1998; Kotelchuck, 1994; Kogan, et al., 1994; Mustard and Roos, 1994). A possible explanation for such discrepancies could be attributed to the variation in measurement error of gestational age estimation (Alexander and Kotelchuck, 2001). In addition to the unaccounted for or unknown factors such as variation in race, genetics, class, psychosocial stress, prepregnancy BMI, bacterial infections of the genitourinary tract, and environmental factors, all of which could obscure the effect of adequate PNC on birth weight) (Langer, et al., 2005; Curry, 1989; Barfield, et al., 1996; Delgado, Bueno and Galvez, 1997). This study was logically expected to reveal a non-significant influence for adequate PNC on incidences of congenital abnormalities among newborns. This may be because GDM generally develops later in pregnancy, and therefore adversely impacts fewer developmental processes (ADA, 1999.).

The current study found no significant effect of PNC levels on either route of delivery or PIH. These findings are in agreement with other studies (Bienstock, et al., 1997; McDuffie, et al., 1996; Coustan and Lewis, 1978; Garner, et al., 1997). Nevertheless, other studies reached different conclusions, as a probable outcome to differences in methods of analysis (Mustard and Roos, 1994); Thomas, Golding and Peters,1991; Shushan, Ezra, and Samueloff, 1997; Alexander and Kotlechuck,, 1996). What this study did not establish, but may be inferred, is that there may be a connection between PNC level and reduced labor complications (Mustard and Roos, 1994). This connection may be obscured by the design limitations of this study such as the small size of the sample, limited geographic area of the study, the retrospective nature of data, and lack of randomization causal inference.

Furthermore, studies that use time of commencing and number of prenatal visits to evaluate adequacy of PNC use have important drawbacks. For example, using the "Kessner Index" as a proxy of prenatal care has been subject to intensive criticism for its alleged bias toward adequate care, inaccurate characterization of adequate care for women with more than 36 weeks gestation, and failure to distinguish inadequate care due to insufficient number of visits (Alexander and Kotlechuck, 1996; Kotelchuck, 1994; Alexander and Cornely, 1987). Further, the number of visits conveys information regarding the extension of care but does not inform about its continuity or quality. The indices of adequacy of PNC use do not establish any recommendation of a standard number of visits for high-risk pregnancy and birth. Nevertheless, even with these limitations in mind, the current indices available for assessing the adequacy of PNC use provide some useful information.

CONCLUSION

Despite some limitations, this study demonstrated the connection between newborn's Apgar scores, complications and adequacy of PNC and is of high-priority for the health and wellbeing of the infant of a diabetic mother. These findings are significant because to my knowledge, no literature exists that investigates such relationship in high-risk pregnancies complicated with DM in Idaho. This study was in agreement with other similar study findings. But since this study was confined to high-risk mothers suffering DM during the course of full term pregnancy, other studies may demonstrate contradictive results because their sample may have included different variables (e.g., health profiles or demographics).

Given the growing incidence of GDM in the entire U. S. A., this study suggests that future research should focus on refining criteria for measurement of effective prenatal care use for high-risk pregnancy complicated with diabetes, e.g., by recommending a standard number of PNC visits. It has been demonstrated that controlling maternal glycemia with medical nutrition therapy, close monitoring of blood glucose levels, and treatment with insulin when euglycemia is not achieved by diet alone can reduce maternal and fetal complications in diabetes (Menato, et al., 2008; Metzger and Coustan, 1998; ACOG, 2001; ADA, 2004; Major, et al., 1998). Thus, an overall reduction in the cost (Schmitt, Sneed and Phibbs, 2006; ADA, 2008) [63, 64] of providing critical health care can be realized by early detection (Seshiah, et al., 2008) [65] and treatment (González-Quintero, 2007) of mothers with DM or at risk for developing GDM. It is therefore imperative that due consideration in addressing provision of PNC services be given, particularly for high- risk pregnancy and birth.

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BIOGRAPHY

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