DME 2015-000249 R2

Does First Nations Ancestry Modify the Association between Gestational Diabetes and Subsequent Diabetes: A Historical Prospective Cohort Study Among Women in Manitoba, Canada

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Abstract word count: 249
Manuscript word count: 3,118

Bulleted novelty statement:
This historical cohort study examined the impact of gestational diabetes mellitus (GDM) after excluding pre-existing diabetes in mothers who delivered from 1981-2011 in Manitoba, Canada. First Nations (FN) women had 2-times more GDM and were 3-times more likely to develop postpartum diabetes than non-FN women. Postpartum diabetes in both FN and non-FN mothers was affected by GDM, lower family income and rural residence. The relative risk of developing postpartum diabetes in non-FN women was higher than FN women. The findings suggest that the reduction of GDM and socioeconomic inequities are required for preventing postpartum diabetes in FN and non-FN women.

Running title: GDM and subsequent diabetes in mothers

Abstract

Background: Over the past 30 years, the prevalence of diabetes has steadily increased among Canadians, which is particularly evident among First Nations (FN) women. The interplay between FN ancestry, gestational diabetes mellitus (GDM) and the development of subsequent diabetes among mothers remains unclear.

Methods: After excluding known pre-existing diabetes, we explored whether FN ancestry may modify the association between GDM and postpartum diabetes among women in Manitoba (1981-2011) via a historical prospective cohort database study. We analyzed administrative data in the Population Health Research Data Repository with Kaplan-Meier survival analysis and Cox proportional hazards regression.

Results: GDM was diagnosed in 11,906/404,736 deliveries (2.9%), 6.7% of FN and 2.2% of non-FN pregnant women ($p<0.0001$). Postpartum diabetes during ≤30 years follow-up was >3 times higher among FN women than among non-FN women ($p<0.0001$). Diabetes developed in 76.0% of FN and 56.2% of non-FN women with GDM within the follow-up period. The hazard ratio of GDM for postpartum diabetes was 10.6 among non-FN women and 5.4 among FN women. Other factors associated with a higher risk of diabetes included lower family income among FN and non-FN women and rural/remote residences among FN women. Among non-FN women, urban residence was associated with a higher risk of diabetes.

Interpretation: GDM increases postpartum diabetes in FN and non-FN women. FN women had substantially more GDM or postpartum diabetes than non-FN women, partially due to socioeconomic and environmental barriers. Reduction in GDM and socioeconomic inequalities are required to prevent diabetes in women, particularly in FN population.

Introduction

Type 2 diabetes mellitus (T2DM) is one of the fastest growing chronic diseases and causes serious health and economic concerns world-wide[1]. Indigenous people across the world are disproportionally affected by T2DM[2]. First Nations (FN) people are the largest Indigenous group in Manitoba[3]. FN women have a higher prevalence of both diabetes and obesity than FN men in rural/remote communities in Manitoba[4].

Gestational diabetes mellitus (GDM) is a condition in which pregnant women without previous diabetes exhibit glucose intolerance during late pregnancy[5, 6]. The prevalence of GDM varies among groups of Indigenous North Americans. Native Americans and Canadian FN women have both been identified as having higher rates of GDM[7-10]. Results from previous prospective[11, 12] and retrospective[13, 14] cohorts suggest that GDM increases the risk for subsequent development of diabetes in mothers. A meta-analysis in 2009 that summarized 20 qualified studies indicated that GDM may increase the risk of T2DM by up to 7-folds compared to those without GDM after an average of 8.3 years of follow-up[15]. However, GDM is not easy to distinguish from pre-existing diabetes in population-based database studies. Glucose intolerance detected during early pregnancy may result from pre-existing diabetes. The degree to which FN ancestry may modify the association between GDM and postpartum diabetes has not been studied in Canada.

To address these knowledge gaps, we conducted a large population-based historical prospective cohort database study using an administrative database that included all pregnancies delivered in hospitals within the province of Manitoba between 1981 and 2011 to explore the impact of GDM on the development of diabetes after excluding pre-existing diabetes in FN and non-FN women during up to 30 years of follow-up.

Methods

Study design and databases

Since 1970, Manitoba Health has collected a complete standardized obstetric hospital abstract form from all women who give birth in hospitals in the province. Information from the abstracts was incorporated into the Population Health Research Data Repository (Repository) at the Manitoba Centre for Health Policy (MCHP) in the University of Manitoba. The Repository contains linkable administrative databases, including physician claims, hospital discharge abstracts, vital statistics and pharmaceutical prescriptions of all registered residents in the province using scrambled personal health identification numbers.

Ethics

The Research Ethics Board at the University of Manitoba and the provincial Health Information Privacy Committee approved the study protocol. Permission was obtained from the Health Information Research Governance Committee of the Assembly of Manitoba Chiefs and the Department of Aboriginal and Northern Affairs Canada's National Indian Registry System (IRS) to link the FN identifier in the Status Verification System in the Repository to identify FN women.

Exposures of interest

The primary exposure of interest was GDM. To avoid confounding the effects of GDM and pre-existing diabetes on the outcome of incident diabetes after pregnancy, GDM was defined as a diagnosis of diabetes (through hospital abstract) at ≥21 weeks of gestation or any first-time incident diagnosis of diabetes (through hospital or physician claims data) at ≥21 weeks of gestation[16]. Women

with a diagnosis of GDM or any type of diabetes at ≤20 weeks of gestation were excluded from the study with pre-existing diabetes.

FN status was verified in the database through an approved linkage with the IRS database (99% reliability) for FN people living in Manitoba between 1984 and 2011[17], and municipal codes (70% reliability) were used for those before 1984[10]. However, non-status FN and Métis people (representing approximately 30% of total "Aboriginal" people in the province)[3] were not identified in the linked file

Outcomes of Interest

Incident diabetes among women was defined as one hospitalization or two physicians' diagnoses of diabetes within a 3-year period[18] following pregnancy. We used the International Classification of Diseases codes (ICD)-10-CA codes after April 1, 2004 or ICD-9-CM code prior to that date on all outpatient physician claims to define GDM. Outpatient claims are only available at the 3-digit level in the Repository. The dataset was unable to differentiate type 1 (T1DM) from T2DM in women. In an effort to control for the potential confounding effect of T1DM, women diagnosed with diabetes prior to pregnancy were excluded from analyses. Women who were not diagnosed with diabetes after pregnancy were censored on the date they left the province, died, conceived a new pregnancy, or the end of the study period, whichever came first.

Secondary factors controlled for in analysis

Hypertension in pregnancy was defined as 1) any hospitalization or physician visit for essential hypertension in the year prior to birth; or 2) any hospitalization or physician visit for gestational

hypertension (including hypertension complicating pregnancy, pre-eclampsia and eclampsia) in the gestation period.

Socioeconomic status is available in the Repository at a small-area aggregate level using the Canada Census, and attributed through postal code and municipal code to individuals living within the small areas. Income quintiles (five groupings of 20% of the population each) were defined as described previously[18]. Rural or urban residence was identified from postal codes.

Statistical methods

Differences in the proportion of pregnancies with a GDM diagnosis were determined using Fisher exact tests. Kaplan-Meier (KM) survival analysis was used to calculate the cumulative incidence rate for diabetes after delivery. Risk factors associated with diabetes after delivery were assessed using a Cox proportional hazards regression model. Multiple deliveries per woman were accounted for with a frailty parameter. All analyses were performed using SAS© version 9.3.

Results

Descriptive Background

We identified 404,736 deliveries with a live birth from 214,028 women who delivered in hospitals in Manitoba between April 1, 1981 and March 31, 2011 (Fig.1). Among FN women, nearly 3/4 of the deliveries (70.5%) of them resided in rural or remote communities (Table 1). FN women were 2.3-times more likely than non-FN women to be from families in the lowest income quintile in the province (60.0% versus 17.9%). FN women were 3-times more likely to develop diabetes during up to 30 years of follow-up after delivery than non-FN women (14.2% versus 3.5%). A total of 2.9% of pregnancies (n=11,906) were complicated with GDM, which did not include the 6,141 deliveries

from women with pre-existing diabetes. FN women had 2-times more GDM than non-FN women (6.7% versus 2.2%, Table 1). Women with pre-existing diabetes were excluded from the study.

Descriptive Background by GDM Diagnosis

A pregnancy complicated by GDM was nearly 0.63-times and 0.79-times more likely to have cesarean section among FN or non-FN women respectively compared to those without GDM (Table 2). Women with GDM were more likely to be in the lowest income quintile compared to those without GDM (65.5% versus 59.9% in FN, 21.9% versus 17.8% in non-FN, $p<0.0001$). Although FN women had more GDM than non-FN women, the relative increase in diabetes subsequent to delivery (GDM versus non-GDM) in non-FN women (27.6% versus 3.0%) was 2.35-times of that in FN women (45.5% versus 11.9%, $p<0.0001$).

Associations between GDM, FN status, and T2DM

In pooled Cox proportional hazards analysis (data not shown), we found that the HR of GDM for the development of subsequent diabetes was 7.97 (95% CI 7.58-8.38), while the HR of FN status was 3.51 (95% CI 3.34-3.70). When exploring the impact of GDM and FN status on T2DM among women, significant interactions between GDM and FN were detected ($p<0.0001$) using the Cox proportional hazards model. This indicates that the association between GDM and subsequent T2DM may differ, depending on whether the woman is of FN ancestry or not. We therefore stratified our survival analysis and Cox proportional hazards model by FN status (Fig.2, Table 3). The percent of accumulated incidence of diabetes in non-FN women with GDM was 16.5% at 5 years after delivery compared to 0.4% among those without GDM ($p<0.0001$). Among FN women, 22.2% with GDM had developed diabetes by 5 years after delivery compared to 1.5% among those without GDM ($p<0.0001$). At 10 years after delivery, the incidence of diabetes among FN women with GDM was

47.2% compared to 5.5% among those without GDM ($p<0.0001$). The trend for the increased incidence of diabetes among women with GDM was sustained and remained significant at 10-25 years following their first pregnancy in the cohort. Diabetes was estimated to develop in 76.0% of FN and 56.2% of non-FN women who had GDM within 25 years after pregnancy ($p<0.0001$), which were 1.47- and 5.49-times higher than the risk of diabetes among FN or non-FN women without GDM (30.9% and 8.7%). Regardless of GDM status, the cumulative incidence of diabetes among FN women was higher than that among non-FN women at all time points (Fig.2). The patterns of the survival curves for the development of diabetes after the second, third and fourth pregnancies were similar to that after the first pregnancy (data not shown).

In multivariate survival analyses (Cox proportional hazards model, Table 3), the association between GDM and subsequent diabetes was stronger among non-FN women (HR 10.61) than among FN women (HR 5.36) ($p<0.0001$, assessed through model with interaction). In multivariate analyses, we controlled for factors other than our primary inputs (FN and GDM) of interest. For example, the strength of the association between hypertension during pregnancy on subsequent diabetes among non-FN women (HR 1.89, $p<0.0001$) was moderately greater than that among FN women (HR 1.64, $p<0.0001$). Each additional year of age was associated with a 1.021 times higher risk over time of diabetes among FN women and 1.024 times higher risk among non-FN women, $p<0.0001$). For example, the HR of subsequent diabetes after delivery for a FN woman who is 15 years older than another is 1.37 ($1.021^{15}=1.37$). Lower income was associated with an increased risk of developing diabetes among both FN (HR 1.28, $p=0.0014$) and non-FN women (HR 1.87, $p<0.0001$). Rural residence was also associated with an increased risk of developing diabetes among FN women (HR 1.16, $p=0.0001$), but a decreased risk among non-FN women (HR 0.76, $p<0.0001$) (Table 3).

Interpretation

In this large scale, population-based cohort database study, we explored the possible impact that GDM may have on the subsequent risk of developing diabetes among women in Manitoba over a 30-year period. We specifically evaluated the role that FN ancestry may have on modifying the GDM/T2DM association. The unique linkage of large population-based administrative and clinical datasets as well as the careful epidemiological definition of GDM in the present study allowed us to estimate the association between GDM and the development of subsequent diabetes among women after excluding known pre-existing diabetes. The results suggest that GDM alone is a strong and independent risk factor for developing diabetes after pregnancy. Over 3/4 of FN women and over 1/2 of non-FN women with GDM were estimated to develop diabetes within 30 years after index delivery in Manitoba.

Importantly, we found that GDM may be a relatively stronger risk factor for the development of diabetes after pregnancy among non-FN women than among FN women. Although FN women have a higher rate of diabetes than non-FN women, the HR of GDM on subsequent diabetes among non-FN women was almost double compared to that among FN women. This is possibly due to the lower proportion of non-FN women without GDM who developed subsequent diabetes (2.96%) compared with FN women without GDM who developed subsequent diabetes (11.94%, Table 2). Our study suggests that lower family income increases the risk of diabetes after pregnancy among FN and non-FN women. Rural/remote residence was associated with an increased risk of diabetes among FN women in the present study. Approximately 60% of FN people in Manitoba live in rural communities and the majority of families in rural FN communities have annual incomes that are lower than the national average[19]. Many FN women live in inadequate housing conditions, and are dealing with present, chronic and historical stress[20]. Although the HR for income or rural residence among FN

women in the present study are moderate (1.28, 1.16) compared to that of GDM (5.36), the combination of the impact of the socioeconomic disparities and geographic barriers may play a substantial role in the increased risk of diabetes after pregnancy among FN women in rural communities. The health and social disparities between FN and the general Canadian population are well known[20]. This reality is reflected in current guidelines of the Society of Obstetricians and Gynecologists of Canada, which recognized the social determinants of health and historical factors as a root cause of poorer health outcomes in Indigenous women[21]. The contextual realities, including geographical isolation, lack of regular prenatal/postnatal health care providers and language barriers to communicate with health professionals, in rural and remote FN communities in Manitoba resulting from detrimental colonial policies, and the influence of the social determinants of health on wellbeing must be considered when assessing potential mechanisms for the development and the prevention of common chronic diseases, such as diabetes.

Our findings of high prevalence of GDM and incidence of diabetes among Canadian FN women are consistent with previous studies by our or other groups[10, 13]. Both genetic and environmental factors may contribute to the susceptibility of FN women to both GDM and T2DM[22, 23]. A recent qualitative study demonstrated that GDM care among Indigenous women including FN women living in urban or rural communities in Manitoba is influenced by access to healthcare system, culture, attitude and messages from healthcare providers, and trust between care providers and patients[24]. Randomized controlled trials from our group and others suggested that lifestyle interventions decreased the rate of excessive gestational weight gain in pregnant women[25, 26], which reduced the risk for GDM and postpartum diabetes. Our recent studies suggested that pregnant women living in FN rural communities tend to have less access to healthy diets and lower physical activity compared to non-FN women in urban communities, but the pre-pregnancy body mass indexes (BMI) between groups

were not significantly different[27]. Socioeconomic factors and lower utilization of prenatal/postnatal care may contribute to the increased risk of GDM and subsequent diabetes among rural-living FN women. The lower risk of diabetes after pregnancy by rural residence among non-FM women may be partially related to the lower prevalence of GDM among rural-living non-FN women compared to FN women as previously described[10]. Our current findings provide additional evidence that socioeconomic and geographical factors contribute to the development of incident diabetes among FN and non-FN women.

Any type of hypertension is more frequent in diabetic pregnancies[28]. The present study suggested that hypertension during pregnancy may significantly increase the hazard of subsequent diabetes in women with a 60% increase in the risk of subsequent diabetes (HR 1.64) among FN women and 90% increase of the risk among non-FN women (HR 1.89). This finding reflects an association between hypertension and postpartum diabetes, which is consistent with the results from previous prospective or population-based cohort where preeclampsia or hypertensive disorder during pregnancy may increase the risk of diabetes after pregnancy[29]. The underlying mechanism for the relatively higher risk of diabetes in non-FN women with gestational hypertension remains to be investigated.

Limitations

The present study has several limitations. First, the Repository does not contain information on maternal height or pre-pregnancy weight or maternal weight gain during pregnancy. Obesity is a known risk factor for both GDM and T2DM. However, we were unable to assess the impact of pre-pregnancy BMI or gestational weight gain on postpartum diabetes in mothers. Second, coding of outpatient data for postpartum diabetes in women did not distinguish T2DM and T1DM, although the vast majority is T2DM as expected[1]. Third, non-status FN and Métis people (this may account for

over 30% of total Indigenous people)[3] are not registered as FN people in the administrative databases in Manitoba. Therefore, the results of the present study may somewhat underestimate the impact of factors associated with FN ancestry. Fourth, although 6,141 deliveries or 3,948 pregnant women (1,488 FN and 2,460 non-FN women) with known pre-existing diabetes were excluded from the analysis in the present study, we cannot be certain that all other women with GDM in the database did not have pre-existing diabetes. Some of them may never have been screened for diabetes before late pregnancy. This may somewhat overestimate the impact of GDM.

In conclusion, our results suggest that GDM, after excluding known pre-existing diabetes, increases the risk of diabetes after delivery among both non-FN and FN women in Manitoba. FN women have a higher prevalence of GDM and subsequent development of diabetes. In Manitoba, 70% of FN pregnant women live in rural areas (Table 1). Rural or remote residency and socioeconomic inequalities contribute to the development of diabetes after GDM among FN women living in rural or remote communities. Socioeconomic inequalities, such as poverty and difficulty accessing health care and other social services may also contribute to postpartum diabetes for off-reserve FN women due to in part to low employment rates as well as more difficult access to health care and other social services. The present study for the first time demonstrates that GDM is a stronger relative risk factor for subsequent diabetes among non-FN women than that among FN women. Lower family income appears to be associated with diabetes among both FN and non-FN women. In addition, our results indicate that rural residence may be associated with an increased risk of diabetes after delivery among FN women, but a decreased risk of diabetes among non-FN women. The findings of the present study may help to develop population-specific strategies for preventing diabetes after pregnancy and improving the long-term health of FN and non-FN women. The results also suggest the importance of prevention and management of GDM, screening for diabetes in women with a

history of GDM, and postpartum care of women with a history of GDM. A recent review suggested that lifestyle intervention and breastfeeding (≥3 months) reduced the risk of diabetes in women with GDM[30]. For FN and non-FN women recently diagnosed with GDM, health professionals should inform patients about the risk of postpartum diabetes to women and potential risk to offspring, and educate women on the importance of postpartum screening for diabetes, healthy eating, physical activity and breastfeeding for at least 3 months. Implementing policies to reduce socioeconomic inequalities and strategies to reduce geographic barriers for access to prenatal/postnatal care are required for improving the outcomes of GDM patients in terms of subsequent diabetes at population level, particularly in FN women living in rural or urban areas. Although the study was conducted in Manitoba, we believe that the results are generalizable to other provinces in Canada in a public health care system, and may have international implications.

Acknowledgements: The authors thank Dr. Phillip Gardiner and Dr. Gustaaf Sevenhuysen for advice on project design, and Dr. Amy Hui for project coordination. The authors gratefully acknowledge grant support from the Canadian Institutes for Health Research (CIHR, SEC117115), support for the Applied Public Health Chair for Dr. Patricia Martens from CIHR/Public Health Agency of Canada, and support for the Gender and Health Chair for Dr. Maureen Heaman from CIHR.

Legend of Figures

Figure 1 Cohort chart. FN: First Nations; GDM: gestational diabetes mellitus.

Figure 2 Accumulated incidence of postpartum diabetes in mothers analyzed using Kaplan-Meier survival analysis. Solid black line: First Nations (FN) women with gestational diabetes mellitus (GDM; solid grey line: Non-FN with GDM; dashed black line: FN without GDM (non-GDM); dashed grey line: non-FN and non-GDM.

This is the accepted version of the following article: Does First Nations Ancestry Modify the Association between Gestational Diabetes and Subsequent Diabetes: A Historical Prospective Cohort Study Among Women in Manitoba, Canada, which has been published in final form at Diabetic Medicine at Wiley's website.

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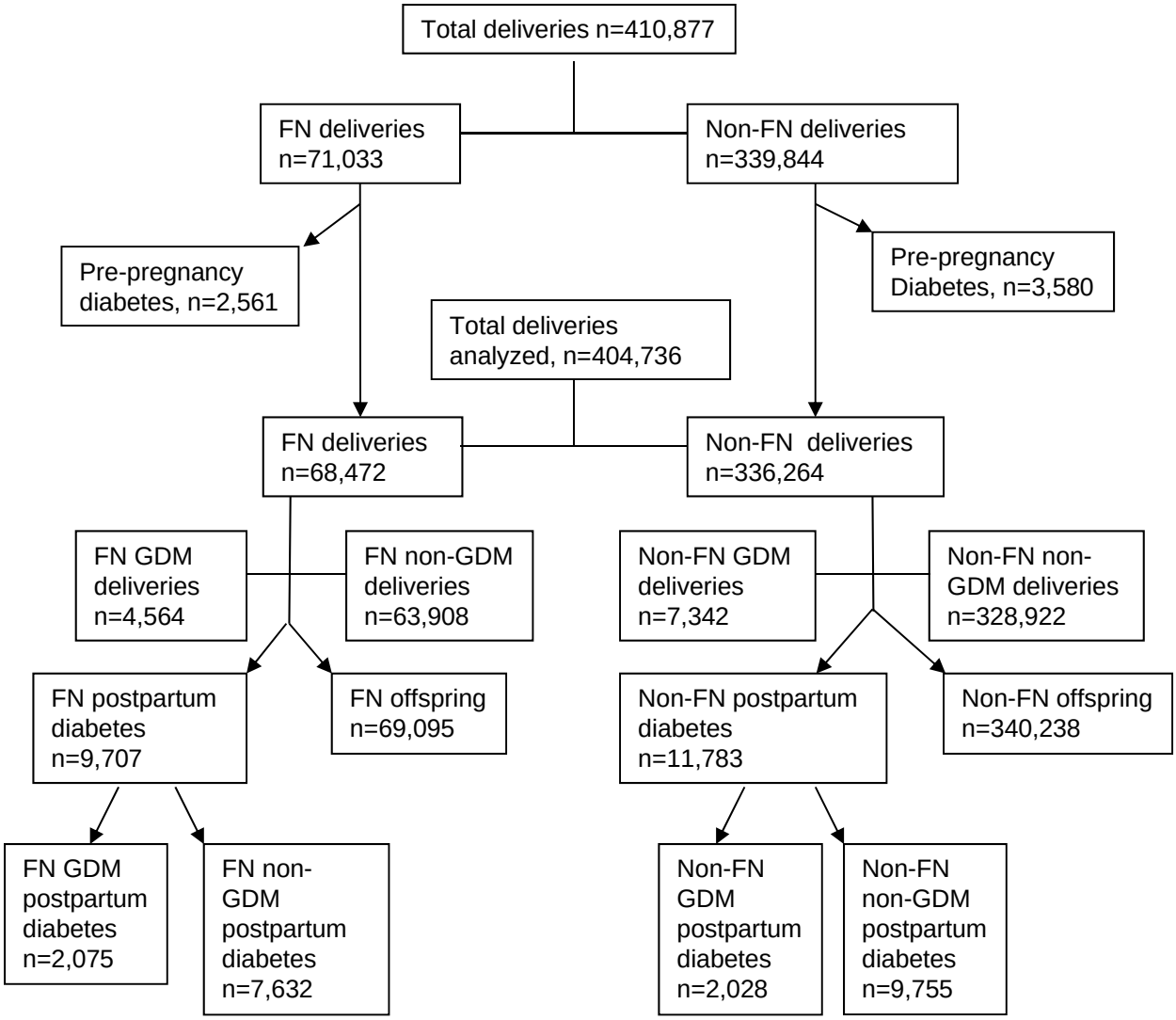
Figure 1


Total deliveries n=410,877
FN deliveries n=71,033
Non-FN deliveries n=339,844
Pre-pregnancy diabetes, n=2,561
Pre-pregnancy Diabetes, n=3,580
Total deliveries analyzed, n=404,736
FN deliveries n=68,472
Non-FN deliveries n=336,264
FN GDM deliveries n=4,564
FN non-GDM deliveries n=63,908
Non-FN GDM deliveries n=7,342
Non-FN non-GDM deliveries n=328,922
FN postpartum diabetes n=9,707
FN offspring n=69,095
Non-FN postpartum diabetes n=11,783
Non-FN offspring n=340,238
FN GDM postpartum diabetes n=2,075
FN non-GDM postpartum diabetes n=7,632
Non-FN GDM postpartum diabetes n=2,028
Non-FN non-GDM postpartum diabetes n=9,755

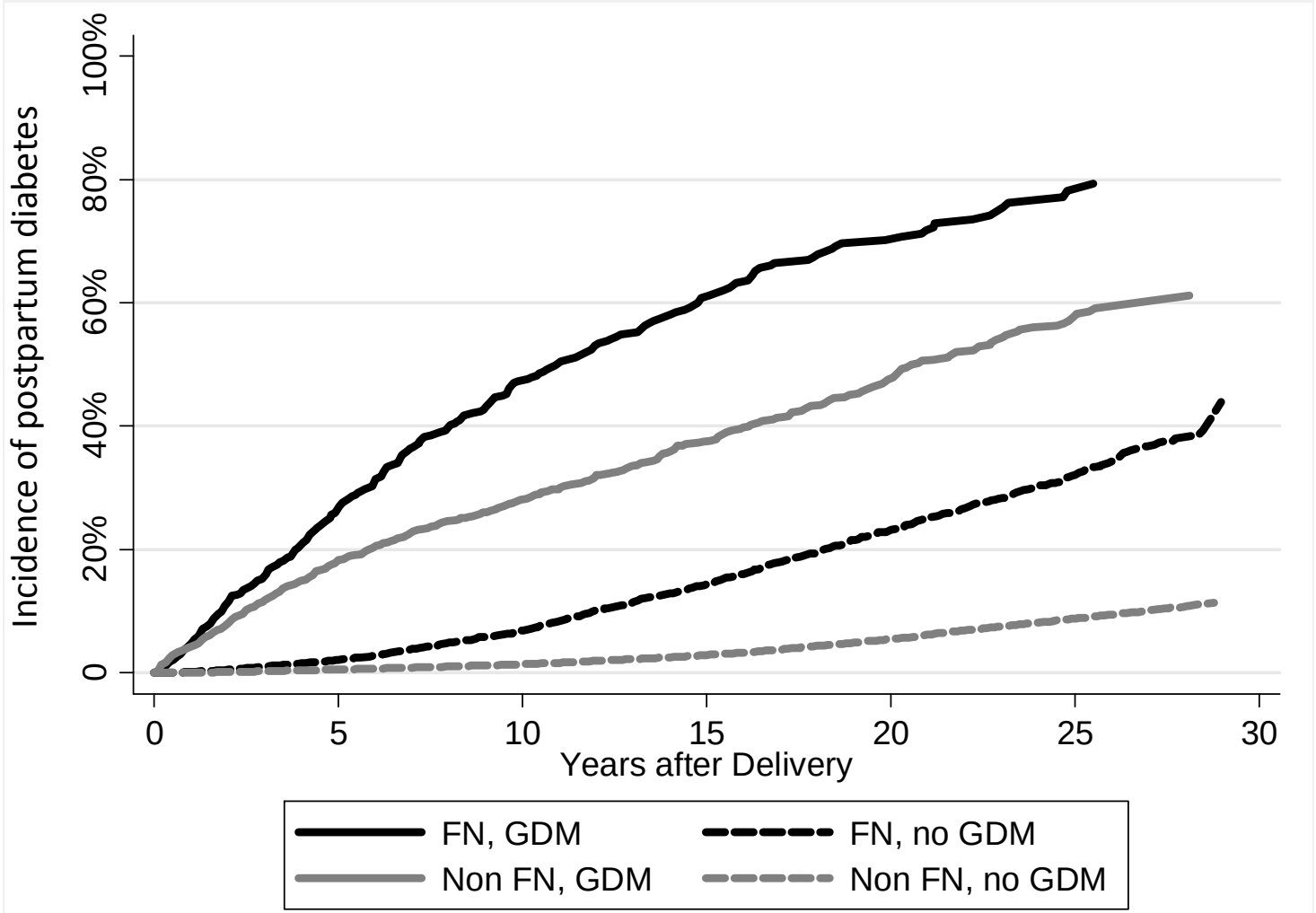

Incidence of postpartum diabetes
0
20%
40%
60%
80%
100%
0
5
10
15
20
25
30
Years after Delivery
FN, GDM
FN, no GDM
Non FN, GDM
Non FN, no GDM

Table 1 Demographic data for mothers at time of delivery[1]

Outcome/factor	Non-First Nations (n=336,264)	First Nations (n=68,472)
Age of mothers at birth (years, mean ± SD)	27.85 ± 5.34	23.71 ± 5.53*
Gestational weeks (weeks, mean ± SD	39.23 ± 1.97	39.05 ± 2.07
Parity*		
Parity 0 (%, no previous delivery)	137,396 (40.86)	19,702 (28.77)
Parity 1 (%)	118,587 (35.27)	16,487 (24.08)
Parity 2+ (%)	80,243 (23.86)	32,252 (47.10)
Missing data	38 (0.01)	31 (0.05)
Gestational diabetes	7,342 (2.18)	4,564 (6.67)*
Gestational hypertension	26,013 (7.74)	5,248 (7.66)
Cesarean section	59,091 (17.57)	8,910 (13.01)*
Diabetes (subsequent to delivery)	11,783 (3.50)	9,707 (14.18)*
Rural Residence	125,805 (37.41)	48,302 (70.54)*
Income quintile (based on 2006 Census)*		
Quintile 1 (%, lowest)	60,195 (17.90)	41,097 (60.02)
Quintile 2 (%)	68,884 (20.49)	13,799 (20.15)
Quintile 3 (%)	70,659 (21.01)	6,222 (9.09)
Quintile 4 (%)	72,008 (21.41)	3,937 (5.75)
Quintile 5 (%, highest, reference)	63,762 (18.96)	3,160 (4.62)

[1]Women with multiple deliveries during the study period are represented multiple times in the table.

*: $p<0.0001$ versus non-First Nations group.

Table 2 Comparison of outcomes and contributing factors for pregnant women with and without GDM

Outcome/factor	Non-First Nations		First Nations	
	GDM	No GDM	GDM	No GDM
	(n=7,337)	(n=328,732)	(n=4,558)	(n=63,752)
Age of mothers at birth (years, mean ± SD)	30.22 ± 5.64	27.80 ± 5.32*	26.62 ± 6.10	23.50 ± 5.42*
Parity*				
Parity 0 (no previous delivery) (%)	36.92	40.95	20.78	29.37
Parity 1 (%)	34.05	35.30	20.38	24.36
Parity 2+ (%)	29.03	23.74	58.84	46.22
Missing data (%)	0.00	0.01	0.00	0.05
Cesarean section (%)	28.34	17.33*	22.14	12.36*
Diabetes subsequent to delivery (%)[1]	27.61	2.96*	45.41	11.94*
Gestational hypertension (%)	19.26	7.48*	16.28	7.00 *
Rural residence (%)	31.44	7.55*	77.51	70.12*
Income quintile*				
Quintile 1 (%, lowest)	21.93	17.84	65.56	59.85
Quintile 2 (%)	21.69	20.51	17.58	20.42
Quintile 3 (%)	20.40	21.08	9.09	9.12
Quintile 4 (%)	20.12	21.50	4.20	5.89
Quintile 5 (%) (highest, reference)	15.86	19.08	3.57	4.72

GDM: gestational diabetes mellitus ; [1]: Cumulative Incidence ; * : p<0.0001 versus GDM.

Table 3 Risk factors for post-partum diabetes among women in Manitoba

Predictors	First Nations		Non-First Nations	
	HR (95% CI)	p value	HR (95% CI)	p value
Birth year 1982-1989 (reference):				
Birth year 1990-1994	1.03 (0.94-1.13)	0.5272	1.03 (0.96-1.10)	0.4073
Birth year 1995-1999	1.14 (1.04-1.26)	0.0080	1.22 (1.12-1.32)	<0.0001
Birth year 2000-2004	1.08 (0.96-1.21)	0.1897	1.34 (1.22-1.48)	<0.0001
Birth year 2005-2011	1.13 (0.99-1.30)	0.0792	1.41 (1.24-1.60)	<0.0001
Gestational diabetes mellitus (GDM)	5.36 (4.96-5.78)	<0.0001	10.61 (9.84-11.31)	<0.0001
Hypertension (gestational)	1.64 (1.51-1.79)	<0.0001	1.89 (1.77-2.02)	<0.0001
Cesarean section	1.38 (1.28-1.49)	<0.0001	1.44 (1.36-1.52)	<0.0001
Rural residence	1.16 (1.08-1.25)	0.0001	0.76 (0.72-0.80)	<0.0001
Income quintile:				
Income quintile 1 (lowest)	1.28 (1.10-1.50)	0.0014	1.87 (1.73-2.03)	<0.0001
Income quintile 2	1.06 (0.89-1.25)	0.5285	1.51 (1.39-1.63)	<0.0001
Income quintile 3	1.08 (0.90-1.30)	0.4055	1.34 (1.24-1.46)	<0.0001
Income quintile 4	1.11 (0.91-1.36)	0.2878	1.22 (1.12-1.32)	<0.0001
Income quintile 5 (highest, reference)				
History of GDM	2.11 (1.91-2.32)	<0.0001	2.27 (2.04-2.53)	<0.0001
Mother's age (each year)	1.021 (1.015-1.027)	<0.0001	1.024 (1.019-1.029)	<0.0001
Parity 0 (reference)				
Parity 1	1.01 (0.90-1.13)	0.9148	0.87 (0.91-0.93)	<0.0001
Parity 2+	1.18 (1.06-1.31)	0.0028	1.08 (1.01-1.16)	0.0245

HR: hazard ratio; CI: confidential interval; Parity 0: the first parity; Parity 1: the second parity; Parity 2+: parity 3 or more