**Low rates of postpartum glucose screening among Indigenous and non-Indigenous women in Australia with gestational diabetes**

**Abstract**

*Objectives:*

Women with gestational diabetes have a high risk of type 2 diabetes postpartum, with Indigenous women particularly affected. This study reports postpartum diabetes screening rates among Indigenous and non-Indigenous women with gestational diabetes, in Far North Queensland, Australia.

*Methods:*

Retrospective study including 1012 women with gestational diabetes giving birth at a regional hospital from 1/1/2004 to 31/12/2010. Data were linked between hospital records, midwives perinatal data, and laboratory results, then analysed using survival analysis and logistic regression.

*Results:*

Indigenous women had significantly longer times to first oral glucose tolerance test (OGTT) (HR 0.62, 95% CI 0.48-0.79, p<0.0001) and ‘any’ postpartum glucose test (HR 0.81, 95% CI 0.67-0.98, p=0.03), compared to non-Indigenous women. Postpartum screening rates among all women were low. However, early OGTT screening rates (<6 months) were significantly lower among Indigenous women (13.6% versus 28.3%, p<0.0001), leading to a persistent gap in cumulative postpartum screening rates. By three years postpartum, cumulative rates of receiving an OGTT, were 24.6% (95% CI 19.9-30.2%) and 34.1% (95% CI 30.6-38.0%) among Indigenous and non-Indigenous women, respectively. Excluding OGTTs in previous periods, few women received OGTTs at 6-24 months (7.8% versus 6.7%) or 2-4 years (5.2% versus 6.5%), among Indigenous and non-Indigenous women, respectively.

*Conclusions:*

Low rates of postpartum diabetes screening demonstrate that essential ‘ongoing management’ and ‘equity’ criteria for population-based screening for gestational diabetes are not being met; particularly among Indigenous women, for whom recent guideline changes have specific implications. Strategies to improve postpartum screening after gestational diabetes are urgently needed.

**Introduction**

Gestational diabetes mellitus (gestational diabetes), defined as diabetes diagnosed during pregnancy ([1](#_ENREF_1), [2](#_ENREF_2)), is increasing in prevalence ([3](#_ENREF_3), [4](#_ENREF_4)). Indigenous women experience particularly high rates of gestational diabetes ([4-6](#_ENREF_4)), with Indigenous Australian women experiencing approximately twice the age-adjusted risk of gestational diabetes than other Australian women ([4](#_ENREF_4), [7](#_ENREF_7)). Gestational diabetes causes serious complications in pregnancy, birth ([8](#_ENREF_8)) and the longer term ([9](#_ENREF_9)) for both women and their infants. Women diagnosed with gestational diabetes have a very high risk of developing Type 2 Diabetes Mellitus (type 2 diabetes) postpartum (approximately 25% within 15 years) ([10](#_ENREF_10)), more than seven-times the risk among women without gestational diabetes ([11](#_ENREF_11)), with Indigenous women having the highest risk ([5](#_ENREF_5), [12](#_ENREF_12)). This emergence of diabetes among young child-bearing women represents an ominous stage in the diabetes epidemic, as exposure to diabetes in-utero compounds the risk for the next generation ([13](#_ENREF_13), [14](#_ENREF_14)), and gestational diabetes becomes an additional driver for type 2 diabetes ([14](#_ENREF_14), [15](#_ENREF_15)).

Strong evidence about the risks associated with diabetes in pregnancy ([8](#_ENREF_8)) has led to changes to international ([2](#_ENREF_2)) and national ([16](#_ENREF_16)) screening guidelines for gestational diabetes . The changes include: offering screening in early pregnancy for women at high risk of type 2 diabetes, in addition to 24-28 weeks as is currently recommended; separating ‘probable’ undiagnosed type 2 diabetes from gestational diabetes; and changing the diagnostic thresholds. These changes are likely to significantly increase the prevalence of gestational diabetes ([17](#_ENREF_17)), and have particular implications for Indigenous women, who are categorised as having a high risk of type 2 diabetes, and therefore advised to have additional screening in early pregnancy. Essential criteria when introducing population-based screening include ensuring that adequate and acceptable treatment, prevention and ‘ongoing management’ postpartum are provided, and that ‘equity and access is provided’ ([18](#_ENREF_18), [19](#_ENREF_19)). There currently is limited evidence that these criteria are met ([20](#_ENREF_20)), particularly for Indigenous women ([21](#_ENREF_21)).

Despite the clear evidence of an increased risk of developing type 2 diabetes ([5](#_ENREF_5), [12](#_ENREF_12), [22](#_ENREF_22)), few studies have investigated rates of postpartum glucose screening for Indigenous women with gestational diabetes ([21](#_ENREF_21)), which has been identified as a ‘high priority research need for gestational diabetes’ ([23](#_ENREF_23)). In Far North Queensland, Australia, there have been a number of initiatives introduced to improve care for women with gestational diabetes ([24](#_ENREF_24)), including protocols ([25-27](#_ENREF_25)) which recommend all women with gestational diabetes are offered postpartum glucose testing. While there is some variation in the recommendations during the study period from 2004 to 2010, the local guidelines are broadly based on the previous national guidelines ([28](#_ENREF_28)), which advise an early oral glucose tolerance test (OGTT) at six to eight weeks postpartum, and then one to three yearly, dependent on assessment of risk and likelihood of pregnancy. This study describes rates of postpartum diabetes screening among Indigenous and non-Indigenous women with gestational diabetes in Far North Queensland from 1/1/2004 to 31/12/2010. Low rates of postpartum screening have been reported among non-Indigenous women in Australia ([29](#_ENREF_29)) and internationally ([30](#_ENREF_30)); with particularly low rates reported among Indigenous women in similar high income countries, including Canada ([31](#_ENREF_31)), and New Zealand ([32](#_ENREF_32), [33](#_ENREF_33)). One small study recently reported low rates of postpartum screening among Indigenous women in Far North Queensland ([34](#_ENREF_34)). This study is timely with recent changes to national diabetes screening guidelines ([16](#_ENREF_16)), which have particular implications for Indigenous women. To our knowledge, this is the first study to compare rates of postpartum glucose screening among Indigenous and non-Indigenous women diagnosed with gestational diabetes. Comparison is important to understand whether current strategies are similarly effective for all women, or whether targeted strategies for Indigenous women may be warranted.

**Methods**

*Study setting and sample*

The study setting and design details are reported elsewhere ([35](#_ENREF_35)). The study includes all women coded as giving birth at Cairns Hospital (CH) from 1/1/2004 to 31/12/2010 and having gestational diabetes in the CHCCS. CH is the regional hospital for Far North Queensland, a vast region covering almost 300,000 square kilometres. More than 80% of women in the region give birth at CH, which includes almost all women with gestational diabetes as this is the only secondary referral hospital (resourced to provide care for most complicated pregnancies) in Far North Queensland. Gestational diabetes screening procedures and diagnostic criteria used during the study period are detailed elsewhere ([36](#_ENREF_36)).

The current study used linked electronic data with a sample validated by medical record reviews (MRR). The following data sources were linked: (1) Cairns Hospital Clinical Coding system (CHCCS ) for all women who gave birth 1/1/2004 to 31/12/2010, with gestational diabetes diagnoses based on International Classification of Diseases (ICD) coding (024.41, 024.42, 024.42, 0.24.43, 0.24.44), were included in this study. ); (2) pregnancy and birth details from the Midwives Perinatal Data Collection (MPDC); (3) postpartum glucose screening test details for included women from the three local laboratories **from 1/1/2004 to 31/11/2011**. Additionally, review of medical records for all Indigenous births (n=578) and a random sample of non-Indigenous births (n=332) enabled validation of accuracy of gestational diabetes coding, identification of antenatal and postnatal care providers, and calculation of Body Mass Index (BMI) where weight and height data were recorded.

**CHCCS coding was performed by administrative staff, based on what was documented in the medical records by clinical staff for each inpatient episode, and included approximately 80% of women with gestational diabetes identified in the MPDC (**[**36**](#_ENREF_36)**). For women identified with gestational diabetes in the CHCCS, data on all pregnancies during the study period were collected, to enable censoring during subsequent pregnancies, or following type 2 diabetes diagnosis.**

**The primary outcomes were: Time from gestational diabetes confinement date to the first OGTT or ‘any’ laboratory-based glucose test, including OGTT, glycosated haemoglobin (HbA1C), fasting plasma glucose (FPG), or random plasma glucose (RPG); and proportions of Indigenous and non-Indigenous women who had received a glucose test (OGTT or ‘any’) within three time windows which include recommended screening timepoints common to most screening guidelines; 6 weeks (0-6 months), 1 year (6-24 months), 3 years (2-4 years) postpartum. Point-of-care postpartum glucose tests (HbA1C, FPG, RPG) conducted at community-based healthcare services are not included. As an ethical requirement, where recommended postpartum glucose screening tests were due, letters were sent to the local medical practitioner to suggest that they check their records and assess the need to contact the woman and offer her a postpartum OGTT.**

***Indigenous status***

**Indigenous status is a measure of whether a person identifies as being of Aboriginal or Torres Strait Islander origin. Classification as Indigenous includes: Aboriginal but not Torres Strait Islander origin; Torres Strait Islander but not Aboriginal origin; or both Aboriginal and Torres Strait Islander origin. People classified as non-Indigenous were not of Aboriginal or Torres Strait Islander origin.**

**The sample size was assessed as adequate to test the estimated 10% difference in postpartum screening between Indigenous (20%) and non-Indigenous women (30%).**

*Data analysis*

De-identified data were analysed in Stata 11.0 statistical package (Stata Corporation, College Station, TX). Time to first glucose screening test from confinement date, among pregnancies coded as GDM, was summarised using Kaplan-Meier survival curves and analysed using Cox proportional hazards regression models. Separate models were fitted for time to OGTT and time to ‘any’ screening. Women were censored from the analysis if they became pregnant or were diagnosed with T2DM as they would then not be advised to have T2DM screening. Timing of pregnancy censoring events were from: time of onset of subsequent pregnancy, calculated as 273 days prior to subsequent confinement; or 20 weeks prior to date of a postpartum test if that test was coded as ‘during pregnancy’ yet no pregnancy was recorded, including all tests after 1/3/2010 to account for women who may be pregnant during the study period but give birth after the study period (31/12/2010). Timing of T2DM censoring events were from the date of T2DM diagnosis from any data source (e.g. medical records, MPDC data, laboratory tests) that indicated the woman had developed T2DM. The proportions of women screened by each of the recommended time points were assessed by calculating the proportion of eligible women who received an OGTT or ‘any’ laboratory- based screening test at the postpartum periods (0 to <6 months, 6 to <24 months, 24-48 months), excluding tests performed in the previous period. Tests were two tailed and p<0.05 was considered statistically significant.

*Ethics*Ethical approval was granted for this project by the Cairns Hospital and Hinterland Research Ethics Committee, the Monash University Human Research and Ethics Committee, and the Queensland Health Research Ethics and Governance Unit (no. 201101190).

**Results**

From 1/1/2004 to 31/12/2010, 1012 women were identified in the CHCCS as giving birth at CH and having gestational diabetes, from a total of 16,765 births during the same period; including 352 Indigenous and 660 non-Indigenous women. Two women who died in the early postpartum period were excluded from analyses.

1010 women included in this study had 1503 births during the study period and 1083 births were coded as gestational diabetes after linkage with MPDC data and medical record review of 912 pregnancies, among 702 women. Overall, 6.2% pregnancies were reclassified as gestational diabetes, from 65.4% (596/912) before MRR to 71.6% (653/912) after MRR using the MPDC coding (see figure 1). If a 6.2% increase were extrapolated to the remaining 593 pregnancy records which were not reviewed, we would expect to have reclassified an additional 37 pregnancies as gestational diabetes.

**<insert Figure 1 about here>**

The mean maternal age was 30.5 years (Standard Deviation (SD) 6.8) among Indigenous mothers and 33.2 (SD 5.6) among non-Indigenous mothers, while the mean Body Mass Index (BMI) was 30.9 (SD 7.0) among Indigenous mothers and 29.1 (SD 6.7) among non-Indigenous mothers. Among the women who had a MRR, about half of Indigenous mothers had discharge referrals for their postpartum care to government health clinics (52%), with substantial fractions to private medical practitioners (25%), and community controlled health services (18%). The majority of non-Indigenous mothers had discharge referrals to private medical practitioners (84%), with small proportion at government health clinics (9%). Selected characteristics of mothers and their pregnancies are outlined in Table 1 and Table 2.

**<<insert Table 1: Maternal characteristics about here>>**

**<<insert Table 2: Pregnancy characteristics about here>>**

Laboratories identified 1625 glucose tests provided between 1/1/2004 and 31/11/2011 for the women included in this study;1067 (66%) were follow-up screening tests and the remainder were during pregnancy or prior to a diagnosis of gestational diabetes. 342/1067 (32%) were provided for Indigenous women and 725/1067 (68%) were provided for non-Indigenous women.

*Time to first OGTT*

Significantly longer times to first OGTT were seen among Indigenous women, compared to non-Indigenous women (Hazards Ratio (HR) 0.62, 95% CI 0.48-0.79; p<0.0001, figure 2.1 and table 3). At two months postpartum, we estimated 7.9% (95% CI 5.6-11.1%) Indigenous women and 16.8% (95% CI 14.2-19.8%) non-Indigenous women had an OGTT recorded (table 4). The discrepancy in early screening rates led to a persistent gap between Indigenous and non-Indigenous women, for example by three years the cumulative rates of having received an OGTT postpartum, were 24.6% (95% CI 19.9-30.2%) and 34.1% (95% CI 30.6-38.0%) respectively (table 4).

*Time to first laboratory-based glucose screening test*

We found a significantly longer time to ‘any’ laboratory-based postpartum glucose screen for Indigenous women, compared to non-Indigenous women (HR 0.81, 95% CI 0.67-0.98%, p=0.03, figure 2.2 and table 3). At two months postpartum, we estimated 9.0% (95% CI 6.5-12.3%) of Indigenous women and 19.2% (95% CI 16.4-22.3%) of non-Indigenous women had a postpartum glucose screen (table 4). By 36 months (3 years) postpartum, the cumulative rate of a first glucose screening test was starting to converge for the two populations, with 44.4% (95% CI 38.7-50.6%) among Indigenous women, and 49.1% (95% CI 45.1-53.2%) among non-Indigenous women (see figure 2.2 and table 4).

**<<Insert Figure 2 about here>>**

**<<Insert Table 3 about here>>**

**<<Insert Table 4 about here>>**

*Probability of OGTT testing at 0-<6 months; 6-<24 months; and 2-4 years*

A significantly lower proportion of Indigenous women received an early postpartum OGTT within six months postpartum (HR 0.62, 95% CI 0.48-0.79, p<0.0001, figure 3.1 and table 3). By six months postpartum, only 13.6% (95% CI 10.5-17.5%) Indigenous women, compared to 28.3% (95% CI 25.1-31.9%) non-Indigenous women received an OGTT (figure 3.1, table 5).

However, no significant difference was seen in the proportions of Indigenous and non-Indigenous women who received an OGTT at 12 months (6-24 months) and three years (24-48 months) postpartum, which encompasses the recommendations in most guidelines (table 3). Excluding OGTTs performed prior to six months postpartum; by two years postpartum 7.8% (95% CI 5.2-11.5%) Indigenous women and 6.7% (95% CI 4.9-9.0%) non-Indigenous women received an OGTT (figure 3.2, table 5). Excluding OGTTs performed prior to 24 months (two years) postpartum; only 5.2% (95% CI 2.5-10.7%) Indigenous women and 6.5% (95% CI 4.3-9.8%) non-Indigenous women received an OGTT by four years postpartum (figure 3.3, table 5).

*Probability of ‘Any’ laboratory-based glucose test at 0-<6 months; 6-<24 months; and 2-4 years*

A significantly lower proportion of Indigenous women received *any* laboratory-based postpartum glucose screen within the first six months postpartum (HR 0.81, 95% CI 0.67-0.98, p=0.03, figure 3.4 and table 3), with only 17.3% (95% CI 13.9-21.6%) receiving any glucose screen by six months postpartum, compared to 32.8% (95% CI 29.4-36.4%) non-Indigenous women (figure 3.4 and table 5). However, when excluding glucose screening tests from the previous period, no significant differences were observed in the proportion of Indigenous and non-Indigenous women who received any laboratory-based postpartum glucose screen between six to 24 months or two to four years (table 3). Excluding tests performed prior to six months; by two years postpartum, 21.7% (95% CI 17.4-27.0%) Indigenous women and 22.4% (95% CI 19.1-26.0%) non-Indigenous women had received a postpartum glucose screen (figure 3.5, table 5). Excluding tests performed prior to two years postpartum; by four years postpartum 23.0% (95% CI 16.7-31.1%) Indigenous women and 21.5% (95% CI 17.4-26.3%) non-Indigenous women received any laboratory-based postpartum glucose test (figure 3.6, table 5).

Sensitivity analyses conducted with data restricted only to records which had a MRR (n=910) were very similar to the results reported on the whole sample, with the exception of a wider confidence interval in the HR for any postpartum test at 6 months possibly leading to a different conclusion (HR 0.82, 95% CI 0.65-1.03, p=0.08).

 **<<Insert Figure 3 about here>>**

**<<Insert Table 5 about here>>**

**Discussion**

We found that postpartum glucose screening rates were low among all women with gestational diabetes. These findings demonstrate that essential ‘ongoing management’ criteria for gestational diabetes screening are not being met. Further, significantly longer times were observed to first OGTT (HR 0.62) and ‘any’ (HR 0.81) postpartum glucose screen among Indigenous women, compared to non-Indigenous women. Early postpartum OGTT screening rates (<6 months) were significantly lower among Indigenous women (14% versus 28%), which led to a persistent gap in the cumulative rates of postpartum OGTT screening, demonstrating ‘equitable access’ to postpartum screening is also not being provided for Indigenous women, who are the subject of recent guideline recommendations ([2](#_ENREF_2), [37](#_ENREF_37)).

A limitation of this study includes the absence of ‘point of care’ tests provided by primary health care professionals, such as HbA1C, RPGs, and FPGs. Therefore the ‘any laboratory-based test’ estimates in this study are likely to be lower than the true glucose screening rates. Nevertheless, OGTTs are not performed outside a laboratory setting and therefore we conclude the rates of postpartum OGTT screening are accurate. Another limitation is that the medical record review suggested the identification of gestational diabetes is likely to be underestimated in these routinely collected data by approximately 37 pregnancies. Therefore **our** estimates are likely be conservative and err towards overestimation of screening rates, with more pregnancies censored as ‘not gestational diabetes’.

Low rates of postpartum screening for type 2 diabetes have been reported for non-Indigenous women in Australia ([29](#_ENREF_29)) and internationally ([38](#_ENREF_38), [39](#_ENREF_39)), and similarly reported significant variations by ethnicity ([40](#_ENREF_40)). However, the rates of 14% postpartum screening among Indigenous women by six months postpartum observed in our study, were significantly lower than the rates of 38% by six weeks postpartum reported in Canada in 1998 ([31](#_ENREF_31)), and 37% reported among Maori and non-Maori women more recently in New Zealand ([32](#_ENREF_32)). The only other study to date to report postpartum diabetes screening among Indigenous women in Australia, also in Far North Queensland during the same study period, noted that OGTTs were performed in 1/6 (16.6%) Indigenous women diagnosed with gestational diabetes in 2006, and 6/19 (31.6%) Indigenous women diagnosed with gestational diabetes in 2008 ([34](#_ENREF_34)). The variation from our study is likely due to small numbers.

The particularly low rates of early postpartum screening among Indigenous women, is a concern for a number of reasons. Indigenous women generally have higher parity than non-Indigenous women ([41](#_ENREF_41)), with shorter pregnancy intervals, therefore delays in postpartum screening may have greater consequences. Studies overseas suggest Indigenous women at highest risk of glucose intolerance may be less likely to return for postpartum diabetes screening ([42](#_ENREF_42)). Delayed diagnosis and treatment of type 2 diabetes also pose serious risks to subsequent pregnancies in the short term for both Indigenous and non-Indigenous women, including congenital abnormalities ([43](#_ENREF_43), [44](#_ENREF_44)), shoulder dystocia, macrosomia ([13](#_ENREF_13), [45](#_ENREF_45)), neonatal intensive care admissions, and hypoglycaemia ([46-48](#_ENREF_46)); and increased risks for the infant in the longer term of obesity, hyperglycaemia, type 2 diabetes and renal disease ([14](#_ENREF_14), [49-54](#_ENREF_49)). Undiagnosed and untreated diabetes also poses serious risks for the mother, including caesarean section ([55](#_ENREF_55)), heart disease, stroke, renal disease, kidney failure, limb amputations and blindness ([56](#_ENREF_56)).

The reasons for low rates of postpartum screening among Indigenous women are not yet well-understood, and research is required to improve our understanding to systematically develop strategies to improve postpartum screening. Surveys of non-Indigenous women and providers elsewhere have reported a number of barriers to postpartum screening ([29](#_ENREF_29), [57](#_ENREF_57), [58](#_ENREF_58)). Reported barriers include factors such as: lack of awareness and forgetting about the need for a test, test inconvenience, the unpleasant nature of the test and the fear of results ([58](#_ENREF_58)), poor communication, time pressures, costs, inconsistent guidelines, and lack of GDM documentation ([40](#_ENREF_40)). While little is known about barriers for Indigenous women, one study suggests low health literacy among Indigenous people in Far North Queensland in relation to diabetes ([59](#_ENREF_59)), which is likely to impede the decision-making capacity of women with gestational diabetes. There is evidence of disparities in access to treatment for the complications of diabetes ([60-65](#_ENREF_60)), including diabetes in pregnancy ([66](#_ENREF_66)), which may be helpful for understanding some of the barriers to postpartum glucose screening among Indigenous women with gestational diabetes. Women in Far North Queensland also experience additional challenges, including long distances to travel to receive an OGTT, real or perceived costs associated with tests from limited private laboratory services, high staff turnover, and high population mobility. Another challenge is the number of guidelines which address cardio-metabolic risk screening among Indigenous people, who may fall under several ‘risk’ categories ([67-72](#_ENREF_67)). Most guidelines recommend regular glucose screening, however only gestational diabetes guidelines advise an OGTT be used as a screening test, rather than a diagnostic test; as both FPG and HbA1C have lower sensitivity and may not detect impaired glucose tolerance ([73-75](#_ENREF_73)). Even during the short period of this study, local guidelines changed three times ([25-27](#_ENREF_25)), with some variation from national guidelines ([28](#_ENREF_28)), and have subsequently been revised twice ([76](#_ENREF_76)), broadly in line with revised national guidelines ([37](#_ENREF_37)).

Recent studies show that comparatively simple ‘interventions’ can improve postpartum glucose screening rates ([77](#_ENREF_77)), including physician reminders ([78](#_ENREF_78)), system changes ([31](#_ENREF_31), [73](#_ENREF_73), [79](#_ENREF_79)), proactive postpartum care plans ([80](#_ENREF_80)), antenatal education ([81](#_ENREF_81)), registers ([82](#_ENREF_82)), clinical protocols, electronic records and patient reminders ([83](#_ENREF_83)). One study in the United States showed stark comparisons between high rates of early postpartum Papanicolaou (Pap) testing for cervical cancer (94%), and concurrent low rates of postpartum glucose screening among women with GDM (37%) ([84](#_ENREF_84)). Successful strategies to improve cervical cancer screening among Indigenous women ([85](#_ENREF_85)) , which includes a national register and reminder system, may provide lessons to improve postpartum screening.

Importantly, gestational diabetes can be treated ([86-88](#_ENREF_86)) and the rate of progression to type 2 diabetes reduced ([89](#_ENREF_89)); therefore a gestational diabetes diagnosis offers an important ‘window of opportunity’ ([90](#_ENREF_90)) for prevention, and strategies to improve postpartum glucose screening must also include supporting women to reduce and manage their risks. Recent studies suggest the ‘pre-diabetes’ stage presents a critical opportunity for prevention of type 2 diabetes ([91](#_ENREF_91)). While the evidence for effective strategies for preventing type 2 diabetes among Indigenous peoples’ is scarce ([92](#_ENREF_92)), studies among non-Indigenous women suggest postpartum weight loss is achievable, and the postpartum period offers unique preventive opportunities for women ([93](#_ENREF_93), [94](#_ENREF_94)) and their infant ([95](#_ENREF_95), [96](#_ENREF_96)) by breastfeeding; and through strategies involving diet and exercise ([97-101](#_ENREF_97)). Women with gestational diabetes, and their infants, are more likely to experience interventions and complications during pregnancy and birth which may inhibit breastfeeding, such as caesarean section and neonatal hypoglycaemia, and therefore are likely to require additional support postpartum. Further, Indigenous women are more likely to be categorised as having as having ‘low socio-economic status’, which is associated with a lower confidence with breastfeeding ([102](#_ENREF_102)) and postpartum weight loss ([103](#_ENREF_103)), suggesting positive encouragement and support may be helpful.

These findings support calls for targeted programs to address the needs of women in specific cultural groups ([40](#_ENREF_40)) to ensure all women with gestational diabetes receive postpartum glucose screening. Further research is needed to investigate factors associated with postpartum glucose screening, to identify practical collaborative solutions with communities to overcome barriers. Tailoring support in response to local needs will require qualitative formative and/or participatory action research, and careful evaluation, to ensure the benefits of recent changes to international gestational diabetes screening recommendations are realised and outweigh the risks and inconvenience.

 **Conclusions**

While postpartum glucose screening rates are low for all women in Far North Queensland, the early postpartum glucose screening rates are particularly low among Indigenous women. Essential population-based screening criteria to ensure ‘ongoing management’ and ‘equitable access’ for recently introduced guidelines, which have particular implications for Indigenous women, are not being met. This issue is particularly serious for Indigenous women, who already have a much higher risk of type 2 diabetes compared to non-Indigenous women.

**List of abbreviations**

CH Cairns Hospital

CHCCS Cairns Hospital Clinical Coding System

CI Confidence interval

FPG Fasting Plasma Glucose

HbA1C Glycosated Haemoglobin

HR Hazards ratio

IADPSG International Association for Diabetes in Pregnancy Study Group

ICD International Classification of Disease

MPDC Midwives Perinatal Data Collection

MRR Medical record review

OGTT Oral Glucose Tolerance Test

RPG Random Plasma Glucose

SD Standard deviation

**References**

**1. International Association of Diabetes and Pregnancy Study Groups. International Association of Diabetes and Pregnancy Study Groups recommendations on the diagnosis and classification of hyperglycaemia in pregnancy. Diabetes Care. 2010; 33(3):676-82.**

**2. World Health Organization. Diagnostic Criteria and Classification of Hyperglycaemia First Detected in Pregnancy. Geneva: WHO2013.**

**3. Sicree R, Shaw J, Zimmet P. The Global Burden Diabetes and Impaired Glucose Tolerance. Diabetes. 2009; 27:1-105.**

**4. Australian Institute of Health and Welfare. Diabetes in pregnancy: its impact on Australian women and their babies. Canberra: AIHW2010 Contract No.: Cat. no. CVD 52.**

**5. Yue DK, Molyneaux LM, Ross GP, et al. Why does ethnicity affect prevalence of gestational diabetes? The underwater volcano theory. Diabet. Med. 1996; 13(8):748-52.**

**6. Benjamin E, Winters D, Mayfield J, et al. Diabetes in pregnancy in Zuni Indian women: Prevalence and subsequent development of clinical diabetes after gestational diabetes. Diabetes Care. 1993; 16(9):1231-5.**

**7. Chamberlain C, Banks E, Joshy G, et al. Prevalence of gestational diabetes mellitus (GDM) among Indigenous women and comparison with non-Indigenous Australian women: 1990-2009. Aust. N. Z. J. Obstet. Gynaecol. 2014; In Press(Accepted 28/3/2014).**

**8. HAPO Study Cooperative Research Group. Hyperglycaemia and Adverse Pregnancy Outcomes. N. Engl. J. Med. 2008; 358(19):1991-2002.**

**9. Dyck R, Osgood N, Lin TH, et al. Epidemiology of diabetes mellitus among First Nations and non-First Nations adults. CMAJ Canadian Medical Association Journal. 2010; 182(3):249-56.**

**10. Lee AJ, Hiscock RJ, Wein P, et al. Gestational Diabetes Mellitus: Clinical Predictors and Long-Term Risk of Developing Type 2 Diabetes: A retrospective cohort study using survival analysis. Diabetes Care. 2007; 30(4):878-83. doi:10.2337/dc06-1816**

**11. Bellamy L, Casas J-P, Hingorani AD, et al. Type 2 diabetes mellitus after gestational diabetes: a systematic review and meta-analysis. The Lancet. 2009; 373(9677):1773-9. doi:10.1016/s0140-6736(09)60731-5**

**12. Kim C. Gestational diabetes and the incidence of type 2 diabetes: a systematic review. Diabetes Care. 2002; 25(10):1862-8.**

**13. Dyck R, Osgood N, Lin TH, et al. Epidemiology of diabetes mellitus among First Nations and non-First Nations adults. Can. Med. Assoc. J. 2010; 182(3):249-56.**

**14. Osgood ND, Dyck RF, Grassmann WK. The inter- and intragenerational impact of gestational diabetes on the epidemic of type 2 diabetes. Am. J. Public Health. 2011; 101(1):173-9.**

**15. Bhattarai MD. Three patterns of rising type 2 diabetes prevalence in the world: Need to widen the concept of prevention in individuals into control in the community. Journal of the Nepal Medical Association. 2009; 48 (174):173-9.**

**16. Nankervis A, McIntyre HD, Moses RG, et al. Testing for Gestational Diabetes Mellitus in Australia. Diabetes Care. 2013; 36(5):e64. doi:10.2337/dc12-2345**

**17. Moses R, Morris G, Petocz P, et al. The impact of potential new diagnostic criteria on the prevalence of gestational diabetes mellitus in Australia. Med. J. Aust. 2011; 194(7):338-40.**

**18. Wilson J, Jungner G. Principles and practice of screening for disease. Public Health Paper Number 34. Geneva: WHO; 1968.**

**19. Australian Health Ministers' Advisory Council. Population Based Screening Framework. Commonwealth of Australia, Barton. 2008.** [**http://www.cancerscreening.gov.au/internet/screening/publishing.nsf/Content/pop-based-screening-fwork/$File/screening-framework.pdf**](http://www.cancerscreening.gov.au/internet/screening/publishing.nsf/Content/pop-based-screening-fwork/%24File/screening-framework.pdf)**. Accessed 29/8/2013.**

**20. Waugh N, Pearson D, Royle P. Screening for hyperglycaemia in pregnancy: Consensus and controversy. Best Practice & Research Clinical Endocrinology & Metabolism. 2010; 24(4):553-71.**

**21. Chamberlain C, McNamara B, Williams ED, et al. Diabetes in pregnancy among indigenous women in Australia, Canada, New Zealand and the United States: A systematic review of the evidence for screening in early pregnancy. Diabetes Metab. Res. Rev. 2013; 29(4):241–56. doi:10.1002/dmrr.2389**

**22. Steinhart JR, Sugarman JR, Connell FA. Gestational diabetes is a herald of NIDDM in Navajo women. High rate of abnormal glucose tolerance after GDM. Diabetes Care. 1997; 20(6):943-7.**

**23. Bennett WL, Robinson KA, Saldanha IJ, et al. High priority research needs for gestational diabetes mellitus. J. Womens Health. 2012; 21(9):925-32.**

**24. Davis B, Bond D, Howat P, et al. Maternal and neonatal outcomes following diabetes in pregnancy in Far North Queensland, Australia. Aust. N. Z. J. Obstet. Gynaecol. 2009; 49(4):393-9.**

**25. Queensland Health and Royal Flying Doctors Service (Queensland section). Primary Clinical Care Manual. 4th Edition Cairns: Queensland Health and Royal Flying Doctors Service; 2005.**

**26. Queensland Health and Royal Flying Doctors Service (Queensland section). Primary Clinical Care Manual. 5th Edition. Cairns: Queensland Health and Royal Flying Doctors Service; 2007.**

**27. Queensland Health and Royal Flying Doctors Service (Queensland Section). Primary Clinical Care Manual. 6th Edition. Cairns: Queensland Health and Royal Flying Doctors Service; 2009.**

**28. Hoffman L, Nolan C, Wilson DA, et al. Gestational diabetes mellitus - management guidelines. Med. J. Aust. 1998; 169(2):93-7.**

**29. Morrison MK, Collins CE, Lowe JM. Postnatal testing for diabetes in Australian women following gestational diabetes mellitus. Aust. N. Z. J. Obstet. Gynaecol. 2009; 49(5):494-8.**

**30. Ferrara A. Trends in postpartum diabetes screening and subsequent diabetes and impaired fasting glucose among women with histories of gestational diabetes mellitus: A report from the Translating Research Into Action for Diabetes (TRIAD) Study. Diabetes Care. 2009; 32(2):269-74.**

**31. Mohamed N, Dooley J. Gestational diabetes and subsequent development of NIDDM in aboriginal women of northwestern Ontario. Int. J. Circumpolar Health. 1998; 57 (Suppl 1):355-8.**

**32. McGrath NM, Baldwin A. Further post-partum follow-up of women with gestational diabetes mellitus from Northland, New Zealand. Diabet. Med. 2012; 29(3):415.**

**33. McGrath NM, Baldwin A. Further post-partum follow-up of women with gestational diabetes mellitus from Northland, New Zealand. Diabet. Med. 2012; 29(3):415. doi:10.1111/j.1464-5491.2011.03476.x**

**34. Davis B, McLean A, Sinha AK, et al. A threefold increase in gestational diabetes over two years: Review of screening practices and pregnancy outcomes in Indigenous women of Cape York, Australia. Aust. N. Z. J. Obstet. Gynaecol. 2013; 53(4):363–8. doi:10.1111/ajo.12042**

**35. Chamberlain C, Fredericks B, Davis B, et al. Postpartum care for Aboriginal and non-Aboriginal women with Gestational Diabetes Mellitus across urban, rural and remote locations: a protocol for a cohort linkage study SpringerPlus. 2013; 2(576):doi:10.1186/2193-1801-2-576.**

**36. Chamberlain C, Fredericks B, McLean A, et al. Gestational Diabetes Mellitus (GDM) case ascertainment in far north Queensland, Australia, 2004 to 2010: Midwives perinatal data most accurate routinely collected source. Aust. N. Z. J. Public Health. 2013; 37(6):556–61.**

**37. Nankervis A, McIntyre HD, Moses R, et al. Consensus guidelines for the testing and diagnosis of gestational diabetes in Australia. Australasian Diabetes in Pregnancy Society. 2013.** [**http://www.adips.org/downloads/ADIPSconsensusguidelinesGDM140213\_000.pdf**](http://www.adips.org/downloads/ADIPSconsensusguidelinesGDM140213_000.pdf) **Accessed Accessed 17/2/2013.**

**38. Russell MA. Rates of postpartum glucose testing after gestational diabetes mellitus. Obstet. Gynecol. 2006; 108(6):1456-62.**

**39. Pierce M, Modder J, Mortagy I, et al. Missed opportunities for diabetes prevention: Post-pregnancy follow-up of women with gestational diabetes mellitus in England. Br. J. Gen. Pract. 2011; 61(591):e611-e9.**

**40. Tovar A, Chasan-Taber L, Eggleston E, et al. Postpartum screening for diabetes among women with a history of gestational diabetes mellitus. Prev. Chronic. Dis. 2011; 8(6):A124.**

**41. DeCosta C, Child A. Pregnancy outcomes in urban Aboriginal women. Med. J. Aust. 1996; 164(9):523-6.**

**42. Hunt K, Conway D. Who returns for postpartum glucose screening following gestational diabetes mellitus? Am. J. Obstet. Gynecol. 2008; 198(4):e404.**

**43. Farrell T, Neale L, Cundy T. Congenital anomalies in the offspring of women with type 1, type 2 and gestational diabetes. Diabet. Med. 2002; 19(4):322-6.**

**44. Bower C, Stanley F, Connell AF, et al. Birth defects in the infants of aboriginal and non-aboriginal mothers with diabetes in Western Australia. Med. J. Aust. 1992; 156(8):520-4.**

**45. Cundy T, Gamble G, Manuel A, et al. Determinants of birth-weight in women with established and gestational diabetes. Aust. N. Z. J. Obstet. Gynaecol. 1993; 33(3):249-54.**

**46. Aljohani N, Rempel B, Ludwig S, et al. Impact of diabetes on maternal-fetal outcomes in Manitoba: Relationship with ethnic and environmental factors. Clin. Invest. Med. 2008; 31(6):E338-45.**

**47. Pettitt DJ, Knowler WC, Baird HR, et al. Gestational diabetes: infant and maternal complications of pregnancy in relation to third-trimester glucose tolerance in the Pima Indians. Diabetes Care. 1980; 3(3):458-64.**

**48. Claydon J, Mitton C, Sankaran K, et al. Ethnic differences in maternal risk factors and infant outcomes in Canadian high-risk births. Perinatology. 2007; 9(1):1-8.**

**49. Pettitt DJ, Knowler WC. Long-term effects of the intrauterine environment, birth weight, and breast-feeding in Pima Indians. Diabetes Care. 1998; 21(SUPPL.2):B138-B41.**

**50. Lindsay RS, Hanson RL, Bennett PH, et al. Secular trends in birth weight, BMI, and diabetes in the offspring of diabetic mothers. Diabetes Care. 2000; 23(9):1249-54.**

**51. Bunt JC, Tataranni PA, Salbe AD, et al. Intrauterine exposure to diabetes is a determinant of hemoglobin A(1)c and systolic blood pressure in Pima Indian children. J. Clin. Endocrinol. Metab. 2005; 90(6):3225-9.**

**52. Dabelea D, Knowler WC, Pettitt DJ. Effect of diabetes in pregnancy on offspring: follow-up research in the Pima Indians. J. Matern. Fetal Med. 2000; 9(1):83-8.**

**53. Franks PW, Looker HC, Kobes S, et al. Gestational glucose tolerance and risk of type 2 diabetes in young Pima Indian offspring. Diabetes. 2006; 55(2):460-5.**

**54. Dyck RF. Tracking ancient pathways to a modern epidemic: diabetic end-stage renal disease in Saskatchewan aboriginal people. Kidney International - Supplement. 2005; (97):S53-7.**

**55. Schiff M, Rogers C. Factors predicting cesarean delivery for American Indian women in New Mexico. Birth (Berkeley, Calif.). 1999; 26(4):226-31.**

**56. Australian Institute of Health and Welfare. Australia's Health 2010. Canberra: AIHW2010 Contract No.: Cat. no. AUS 122.**

**57. Swan WE. Diabetes risk reduction behaviours of rural postpartum women with a recent history of gestational diabetes. Rural Remote Health. 2010; 10(4):1461.**

**58. Sterne VL, Logan T, Palmer MA. Factors affecting attendance at postpartum diabetes screening in women with gestational diabetes mellitus. Practical Diabetes International. 2011; 28(2):64-8.**

**59. Taylor S, McDermott R. What Do We Know about Health Literacy and Diabetes Care, and What Does This Mean for Aboriginal and Torres Strait Islander Peoples with Diabetes? Aboriginal and Islander Health Worker Journal. 2010; 34(6):28-30.**

**60. Yeates K, Tonelli M. Indigenous health: update on the impact of diabetes and chronic kidney disease. Curr. Opin. Nephrol. Hypertens. 2006; 15:588-92.**

**61. Yeates K, Schaubel D, Cass A, et al. Access to renal transplantation for minority patients with ESRD in Canada. Am. J. Kidney Dis. 2004; 44(6):1083-9.**

**62. Sequist T, Narva A, Stiles S, et al. Access to renal transplantation among American Indians and Hispanics. Am. J. Kidney Dis. 2004; 44(2):344-52.**

**63. Epstein A, Ayanian J, Keogh J, et al. Racial disparities in access to renal transplantation--clinically appropriate or due to underuse or overuse? N. Engl. J. Med. 2000; 343(21):1537-44.**

**64. McDonald SP, Russ GR. Current incidence, treatment patterns and outcome of end-stage renal disease among indigenous groups in Australia and New Zealand. Nephrology. 2003; 8(1):42-8.**

**65. Cass A, Cunningham J, Snelling P, et al. Renal transplantation for Indigenous Australians: identifying the barriers to equitable access. Ethn. Health. 2003; 8(2):111-9. doi:10.1080/13557850303562**

**66. Liu SL, Shah BR, Naqshbandi M, et al. Increased rates of adverse outcomes for gestational diabetes and pre-pregnancy diabetes in on-reserve First Nations Women in Ontario, Canada. Diabet. Med. 2012; 29(8):1464-5491.**

**67. Stewart JM, Sanson-Fisher RW, Eades S, et al. The risk status, screening history and health concerns of Aboriginal and Torres Strait Islander people attending an Aboriginal Community Controlled Health Service. Drug Alcohol Rev. 2012; 31(5):617-24.**

**68. Colagiuri S, Davies D, Girgis S, et al. National Evidence Based Guideline for Case Detection and Diagnosis of Type 2 Diabetes. Canberra: Diabetes Australia and the NHMRC2009.**

**69. National Aboriginal Community Controlled Health Organisation, Royal Australian College of General Practitioners. National guide to a preventive health assessment for Aboriginal and Torres Strait Islander people. 2nd edn. South Melbourne: RACGP2012.**

**70. Diabetes Australia, Royal Australian College of General Practitioners. Diabetes management in General Practice: Guidelines for Type 2 Diabetes. Seventeenth edition: RACGP.2011.**

**71. Central Australian Rural Practitioners Association. Standard Treatment Manual: 5th Edition. Alice Springs: Central Australian Rural Practitioners Association Inc.2009.**

**72. IDF Clinical Guidelines Task Force. Global guideline for Type 2 diabetes. Brussels: International Diabetes Federation2005.**

**73. Keely E. An opportunity not to be missed – how do we improve postpartum screening rates for women with gestational diabetes? Diabetes Metab. Res. Rev. 2012; 28(4):312-6. doi:10.1002/dmrr.2274**

**74. Picon MJ, Murri M, Munoz A, et al. Hemoglobin A1c versus oral glucose tolerance test in postpartum diabetes screening. Diabetes Care. 2012; 35(8):1648-53.**

**75. Kwong S, Mitchell R, Senior P, et al. Postpartum Diabetes Screening: Adherence rate and the performance of fasting plasma glucose versus oral glucose tolerance test. Diabetes Care. 2009; 32(12):2242–4.**

**76. Section) QHaRFDSQ. Primary Clinical Care Manual. Cairns2013.**

**77. Carson MP, Frank MI, Keely E. Postpartum testing rates among women with a history of gestational diabetes: Systematic review. Prim. Care Diabetes. 2013; 7(3):177-86.**

**78. Lega IC, McLaughlin H, Coroneos M, et al. A physician reminder to improve postpartum diabetes screening in women with gestational diabetes mellitus. Diabetes Res. Clin. Pract. 2012; 95(3):352-7.**

**79. Vesco KK, Dietz PM, Bulkley J, et al. A system-based intervention to improve postpartum diabetes screening among women with gestational diabetes. Am. J. Obstet. Gynecol. 2012; 207(4):16.**

**80. Gabbe SG, Landon MB, Warren-Boulton E, et al. Promoting health after gestational diabetes: A national diabetes education program call to action. Obstet. Gynecol. 2011; 119(1):171-6.**

**81. Stasenko M, Liddell J, Cheng YW, et al. Patient counseling increases postpartum follow-up in women with gestational diabetes mellitus. Am. J. Obstet. Gynecol. 2011; 24(6):522.e1-6.**

**82. Dannenbaum D, Verronneau M, Torrie J, et al. Comprehensive computerized diabetes registry. Serving the Cree of Eeyou Istchee (eastern James Bay). Canadian Family Physician. 1999; 45:364-70.**

**83. Ko JY, Dietz PM, Conrey EJ, et al. Strategies associated with higher postpartum glucose tolerance screening rates for gestational diabetes mellitus patients. J. Womens Health. 2013; 22(8):681-6.**

**84. Smirnakis KV. Postpartum diabetes screening in women with a history of gestational diabetes. Obstet. Gynecol. 2005; 106:1297-303.**

**85. Binns P, Condon J. Participation in cervical screening by Indigenous women in the Northern Territory: a longitudinal study. Med. J. Aust. 2006; 185 (9):490-4.**

**86. Crowther C, Hiller J, Moss J, et al. Australian carbohydrate intolerance study in pregnant women (ACHOIS) trial group: Effect of treatment of gestational diabetes mellitus on pregnancy outcomes. N. Engl. J. Med. 2005; 352(24):2477-86.**

**87. Landon M, Spong C, Thom E, et al. A multicenter, randomized trial of treatment for mild gestational diabetes. N. Engl. J. Med. 2009; 361(14):1339-48.**

**88. Oteng-Ntim E, Varma R, Croker H, et al. Lifestyle interventions for overweight and obese pregnant women to improve pregnancy outcome: systematic review and meta-analysis. BMC Med. 2012; 10(1):47.**

**89. Case J, Willoughby D, Haley-Zitlin V, et al. Preventing Type 2 Diabetes After Gestational Diabetes. The Diabetes Educator. 2006; 32(6):877-86. doi:10.1177/0145721706294263**

**90. Kalra S, Malik S, John M. Gestational diabetes mellitus: A window of opportunity. Indian J Endocrinol Metab. 2011; 15(3):149-51.**

**91. Tabak AG, Herder C, Rathmann W, et al. Prediabetes: a high-risk state for diabetes development. Lancet. 2012; 379(9833):2279-90.**

**92. McNamara BJ, Sanson-Fisher R, D'Este C, et al. Type 2 diabetes in Indigenous populations: Quality of intervention research over 20 years. Prev. Med. 2011; 52(1):3-9.**

**93. Schwarz EB, Brown JS, Creasman JM, et al. Lactation and maternal risk of type 2 diabetes: a population-based study. Am. J. Med. 2010; 123(9):016.**

**94. Liu B, Jorm L, Banks E. Parity, breastfeeding, and the subsequent risk of maternal type 2 diabetes. Diabetes Care. 2010; 33(6):1239-41.**

**95. Owen CG, Martin RM, Whincup PH, et al. Does breastfeeding influence risk of type 2 diabetes in later life? A quantitative analysis of published evidence. Am. J. Clin. Nutr. 2006; 84(5):1043-54.**

**96. Pettitt DJ, Forman MR, Hanson RL, et al. Breastfeeding and incidence of non-insulin-dependent diabetes mellitus in Pima Indians. Lancet. 1997; 350(9072):166-8.**

**97. Amorim Adegboye A, Linne Y. Diet or exercise, or both, for weight reduction in women after childbirth. Cochrane Database Syst. Rev. 2013; (Issue 7):Art. No.: CD005627.**

**98. Tieu J, Crowther C, Middleton P. Dietary advice in pregnancy for preventing gestational diabetes mellitus. The Cochrane Database of Systematic Reviews. 2010; (7):Art. No.: CD007222.**

**99. Orozco LJ, Buchleitner AM, Gimenez-Perez G, et al. Exercise or exercise and diet for preventing type 2 diabetes mellitus. Cochrane Database Syst. Rev. 2012; (Issue 3):Art. No.: CD003054.**

**100. Han S, Middleton P, Crowther CA. Exercise for pregnant women for preventing gestational diabetes mellitus. Cochrane Database Syst. Rev. 2012; (Issue 7):Art. No.: CD009021.**

**101. van der Pligt P, Willcox J, Hesketh KD, et al. Systematic review of lifestyle interventions to limit postpartum weight retention: implications for future opportunities to prevent maternal overweight and obesity following childbirth. Obes. Rev. 2013; 14(10):792-805.**

**102. Demirtas B. Strategies to support breastfeeding: a review. Int. Nurs. Rev. 2012; 59(4):474-81.**

**103. Turner MJ, Layte R. Obesity levels in a national cohort of women 9 months after delivery. Am. J. Obstet. Gynecol. 2013; 209(2):10.**

**Figure 1: Flowchart of reclassification of GDM cases during medical record review of 912 births**

1505 births with one case of GDM recorded in CHCCS 1/1/2004-31/12/2010

Random sample selected for medical records review (n=912)

Unclear = 39

Not GDM = 277

GDM = 596/912 (65.4%)

**Medical Record Review reclassification ……………………………………………………………………………………**

GDM = 653/912 (71.6% = 6.2% increase)

Unclear = 8

Not GDM = 251

**Figure 2: Kaplan Meir estimates of time to first postpartum OGTT or ‘Any’ laboratory-based glucose screen for Indigenous and non-Indigenous
women with gestational diabetes**

**2.1 Average time to first postpartum OGTT 2.2 Average time to first postpartum laboratory-based glucose test
 (OGTT, HBA1C, FPG, RPG)**

 ** **

**Figure 3: Proportions Indigenous and non-Indigenous women with gestational diabetes who received an OGTT or ‘Any’ laboratory-based glucose screen at approximately 6 weeks, 12 months and 3 years postpartum**

**3.1 3.2 3.3**

 ** **

**3.4 3.5 3.6**

 ** **

**Table 1: Maternal characteristics of study population**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Indigenous |  | non-Indigenous |  |
| Maternal characteristics in all mothers | **n=352** | **%** | **n=660** | **%** |
| Births 2004-10 *1* | 178 | 29 | 442 | 71 |
| *2* | 116 | 38 | 190 | 62 |
| *3* | 47 | 63 | 28 | 37 |
| *4* | 11 | 100 | 0 | 0 |
| Country of Birth |   |   |   |   |
| *Australia* | 348 | 98.9 | 452 | 68.5 |
| *Middle East (Afghanistan, Iran, Kuwait)* |   0 |   0 | 3 | 0.5 |
| *Asia (Cambodia, China, Hong Kong, India, Japan, Korea, Malaysia, Laos, Phillipines, Sri Lanka, Thailiand, Vietnam)* |   0 |   0 | 86 | 13.0 |
| *Americas (Canada, Dominican Republic, South America, USA)* |   0 |   0 | 5 | 0.8 |
| *Pacific (Cook Islands, Fiji)* |   0 |   0 | 3 | 0.5 |
| *New Zealand* |   0 |   0 | 29 | 4.4 |
| *Europe (UK, Denmark, Finland, Macedonia, France, Germany, Netherlands, Romania, Serbia, Switzerland, Turkey)* |   0 |   0 | 44 | 6.7 |
| *Africa (Kenya, South Africa, Sierre Leone, Zimbabwe)* |   0  |   0 | 4 | 0.6 |
| *Papua New Guinea* | 1 | 0.28 | 24 | 3.6 |
| *Not stated* | 3 | 0.85 | 6 | 0.9 |
|  |  |  |  |   |
| Medical records reviewed |  343\* | 97 | 247 | 37 |
| Non-English speaking | 0 | 0 | 6 | 2 |
| Deceased (removed from analyses) |   1 |    |   1 |   |

\*9 records missing

**Table 2: Pregnancy characteristics of study population**

|  |  |  |
| --- | --- | --- |
|  | Indigenous | non-Indigenous |
| Pregnancy characteristicsin all births  |  **n=592** | **%** | **n=913** | **%** |
| GDM | **388** | **66.4** | **695** | **76.3** |
| Accessibility/Remoteness Index of Australia (ARIA) |  |  |  |  |
| *Inner regional* | 1 | 0.2 | 2 | 0.2 |
| *Outer regional* | 379 | 64.0 | 879 | 96.3 |
| *Remote* | 35 | 5.9 | 4 | 0.4 |
| *Very remote* | 177 | 29.9 | 26 | 2.9 |
| *Interstate/overseas/unknown* | 0 |   | 2 | 0.2 |
| Married/defacto | **359** | **60.6** | **650** | **71.2** |
| Mean maternal age; years | **30.5 (SD 6.8)** |  | **33.2 (SD 5.6)** |  |
|  *<20* | 25 | 4.2 | 6 | 0.7 |
|  *20-24* | 113 | 19.1 | 72 | 7.9 |
|  *25-29* | 144 | 24.3 | 192 | 21.0 |
|  *30-34* | 153 | 25.8 | 278 | 30.5 |
|  *35-39* | 118 | 19.9 | 264 | 28.9 |
|  *40+* | 39 | 6.6 | 101 | 11.1 |
| Number antenatal visits |  |  |  |  |
|  *<2* | 7 | 1.2 | 1 | 0.1 |
|  *2 to 4* | 43 | 7.3 | 32 | 3.5 |
|  *5 to 7* | 157 | 26.5 | 138 | 15.1 |
|  *8+* | 380 | 64.2 | 724 | 79.3 |
|  *unclear/not stated* | 5 | 0.8 | 18 | 2.0 |
| Mean parity\* | **2.8 (SD 2.3)** | **591** | **1.2 (SD 1.5)** | **907** |
|  *0* | 104 | 17.6 | 345 | 38.1 |
|  *1 to 2* | 215 | 36.4 | 441 | 48.6 |
|  *3 to 4* | 135 | 22.8 | 84 | 9.3 |
|  *5+* | 137 | 23.2 | 37 | 4.1 |
| Smoking at 20 weeks gestation\* | **250** | **43.9** | **126** | **15.6** |
| Medical complications\*/\*\* | **289** | **48.9** | **234** | **25.6** |
| Induction | **168** | **28.4** | **337** | **36.9** |
| Mode of birth\* |  |  |  |  |
|  *vaginal* | 321 | 54.3 | 464 | 51.2 |
|  *caesarean* | 261 | 44.2 | 362 | 39.9 |
|  *other* | 9 | 1.5 | 81 | 8.9 |
| Pregnancy outcome |  |  |  |  |
|  *single livebirths* | 570 | 96.3 | 749 | 82.1 |
|  *multiple births (all liveborn)* | 11 | 1.9 | 26 | 2.9 |
|  *single stillbiirth* | 6 | 1.0 | 2 | 0.2 |
|  *multiple birth (one stillborn)* | 1 | 0.2 | 1 | 0.1 |
|  *unclear/not stated* | 4 | 0.7 | 135 | 14.8 |

**\* small amounts of missing data
\*\*medical complications are those diagnosed prior to pregnancy**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Pregnancy characteristics among women whose medical records were reviewed \*\*\*** | **Indigenous** **n=578** | **%** | **non-Indigenous****n=332** | **%** |
| **BMI (mean) kg/m2** | **30.9 (7.0)** |  | **29.1 (6.7)** |  |
|  *<18* | 5 | 0.9 | 0 |   |
|  *18-24* | 106 | 19.6 | 88 | 28.3 |
|  *25-29* | 143 | 26.4 | 93 | 29.9 |
|  *30-34* | 137 | 25.3 | 75 | 24.1 |
|  *35-39* | 86 | 15.9 | 37 | 11.9 |
|  *40+* | 65 | 12.0 | 18 | 5.8 |
|  |  |  |  |  |
| **Antenatal Care Location (Primary)** |  |  |  |  |
|  *None* | 1 | 0.2 | 0 |   |
|  *CH* | 43 | 7.5 | 20 | 6.3 |
|  *Private GP* | 126 | 22.0 | 261 | 81.6 |
|  *Government health clinic* | 317 | 55.3 | 33 | 10.3 |
|  *ACCHO* | 83 | 14.5 | 2 | 0.6 |
|  *Other* | 3 | 0.5 | 4 | 1.3 |
|  |  |  |  |  |
| **Antenatal Care Location (Secondary)** |  |  |  |  |
|  *None* | 29 | 5.7 | 20 | 6.6 |
|  *CH* | 471 | 91.8 | 281 | 92.7 |
|  *Private GP* | 3 | 0.6 | 0 | 0 |
|  *Government health clinic* | 4 | 0.8 | 2 | 0.7 |
|  *ACCHO* | 5 | 1.0 | 0 | 0 |
|  *Other* | 1 | 0.2 | 0 | 0 |
|  |  |  |  |  |
| **Postnatal Care Location\*\*\*\*** |  |  |  |  |
|  *None* | 9 | 1.6 | 1 | 0.3 |
|  *CH* | 3 | 0.5 | 1 | 0.3 |
|  *Private GP* | 143 | 24.7 | 281 | 84.4 |
|  *Government health clinic* | 300 | 51.8 | 29 | 8.7 |
|  *ACCHO* | 102 | 17.6 | 3 | 0.9 |
|  *Other* | 4 | 0.7 | 1 | 0.3 |

**\*\*\*Not all characteristics were recorded in all pregnancy records, so totals do not necessarily add up to total number of pregnancies
\*\*\*\*where discharge summaries were posted**

**Table 3: Comparison of average time to postpartum glucose screening during selected time windows (Indigenous vs non-Indigenous women)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Type of test | *Postpartum time window* | HR | 95% Confidence Interval | p-value |
| OGTT | ***0-5.9 months*** | **0.62** | **0.48-0.79** | **<0.0001** |
|  | *6-23.9 months* | 1.23 | 0.82-1.86 | 0.31 |
|  | *24-48 months* | 1.22 | 0.64-2.34 | 0.54 |
|  |  |  |  |  |
| Any test | ***0-5.9 months*** | **0.81** | **0.67-0.98** | **0.03** |
|  | *6-23.9 months* | 1.14 | 0.90-1.45 | 0.27 |
|  | *24-48 months* | 1.11 | 0.78-1.58 | 0.57 |

\*Any laboratory-based glucose test= OGTT, HbA1C, FPG, RPG

**Table 4: Estimated (Kaplan-Meier) probability of women receiving postpartum glucose screening by selected time-points**

|  |  |  |  |
| --- | --- | --- | --- |
|  |  | Indigenous | Non-Indigenous |
| Type of test | *Postpartum timepoint* | **%** | **95% Confidence Interval** | % | 95% Confidence Interval |
| OGTT | *0-2 months* | **7.9** | **5.6-11.1** | 16.8 | 14.2-19.8 |
|  | *0-1 year* | **16.5** | **13.1-20.7** | 30.4 | 27.1-34.0 |
|  | *0-3 years* | **24.6** | **19.9-30.2** | 34.1 | 30.6-38.0 |
|  |  |  |  |  |  |
| Any test\* | *0-2 months* | **9.0** | **6.5-12.3** | 19.2 | 16.4-22.3 |
|  | *0-1 year* | **23.6** | **19.6-28.3** | 37.8 | 34.2-41.6 |
|  | *0-3 years* | **44.4** | **38.7-50.6** | 49.1 | 45.1-53.2 |

**Table 5: Estimated (Kaplan-Meier) probability of women receiving a postpartum glucose screen during selected time-windows, excluding tests received in previous windows**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  |  |  | Indigenous | Non-Indigenous |
| Type of test | *Postpartum timepoint* | *Postpartum time window* | **%** | **95% Confidence Interval** | % | 95% Confidence Interval |
| OGTT | *6 months*  | *0-6 months* | **13.6** | **10.5-17.5** | 28.3 | 25.1-31.9 |
|  | *1 year*  | *6-24 months* | **2.9** | **1.6-5.4** | 2.5 | 1.5-4.0 |
|  | *2 years* |  | **7.8** | **5.2-11.5** | 6.7 | 4.9-9.0 |
|  | *3 years* | *24-48 months* | **4.2** | **1.9-9.1** | 4.9 | 3.1-7.5 |
|  | *4 years* |  | **5.2** | **2.5-10.7** | 6.5 | 4.3-9.8 |
|  |  |  |  |  |  |  |
| Any test | *6 months* | *0-6 months* | **17.3** | **13.9-21.6** | 32.8 | 29.4-36.4 |
|  | *1 year* | *6-24 months* | **7.0** | **4.7-10.2** | 7.8 | 5.9-10.1 |
|  | *2 years* |  | **21.7** | **17.4-27.0** | 22.4 | 19.1-26.0 |
|  | *3 years* | *24-48 months* | **11.9** | **7.8-17.9** | 14.3 | 11.2-18.1 |
|  | *4 years* |  | **23.0** | **16.7-31.1** | 21.5 | 17.4-26.3 |