

Improving Postpartum Healthcare and Health Outcomes of Women with a History of Gestational Diabetes Mellitus

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Abstract

Background

Women who have had gestational diabetes mellitus (GDM) are at increased risk of type 2 diabetes (T2DM), and are recommended to have T2DM screening in the postpartum period, although this screening is often not undertaken. This thesis examines how postpartum care for women with GDM may be improved.

Methods

Two systematic reviews of qualitative/survey studies examine:

- (1) Clinicians' views and knowledge relating to provision of healthcare in the postpartum period for GDM.
- (2) Women's views and knowledge relating to healthcare seeking after GDM.

A randomised controlled trial and two nested studies assess:

- (1) Postpartum SMS reminders to women who have experienced GDM to test for T2DM:
The DIAMIND Trial
- (2) Predictors of postpartum diabetes screening in the DIAMIND Trial
- (3) Barriers and facilitators to postpartum diabetes testing.

Results

The systematic review on clinician's views included 13 studies (4435 clinicians). Key themes included adequacy of knowledge of risk of T2DM, and differing perceptions of the value of postpartum screening. Women faced obstacles to accessing healthcare, and a need for improved GDM education. Studies reported shortfalls in systems to ensure communication of the GDM diagnosis and postpartum screening.

The systematic review on women's views included 42 studies (7949 women). Non-judgemental, well-coordinated care was preferable. Perception of T2DM risk increased with time from their GDM diagnosis, family history of T2DM and other risk factors for GDM. Children's needs took priority over their own healthcare. A need for a more pro-active approach to postpartum care was identified.

The DIAMIND Trial found that SMS reminders did not increase attendance for an oral glucose tolerance test (OGTT) within six months postpartum, with 104 (77.6% of 134) women attending in the six week group and 103 (76.8% of 134) women attending in the control group (RR 1.01, 95% CI 0.89-1.15).

Women were more likely to complete OGTTs if they were of Asian ethnicity (P = 0.007), had a bachelor's degree (P = 0.036), and if they did not smoke prior to pregnancy (P = 0.045).

Women were less likely to attend if they had gained excessive weight during their pregnancy (P = 0.004) or were Caucasian (P = 0.001).

208 women (75%) returned their questionnaires. Preferred reminder types were *SMS* (67%), *email* (17%), *postal* (12%) and *voice call* (1%). Common barriers to postpartum glucose testing included: *not having enough time* (73%), *inadequate or non-availability of childcare* (30%), and *a need to focus on the health of the baby* (30%). The most common facilitator for postpartum testing was *having a shorter test* (33%).

Conclusions

Postpartum care for women with GDM could be improved through systematic communication of the diagnosis, clear responsibilities for postpartum care, better GDM education and minimisation of healthcare cost barriers. Non-judgemental, holistic and pro-active care is preferable.

An OGTT postpartum attendance “ceiling effect” may explain the non-increase in attendance in the six week SMS reminder group. Lack of time and caring responsibilities were barriers to OGTT completion. Further research is needed on reasons for postpartum non-attendance to facilitate diabetes detection and prevention.

Thesis Declaration

I certify that this work contains no material which has been accepted for the award of any other degree or diploma in my name, in any university or other tertiary institution and, to the best of my knowledge and belief, contains no material previously published or written by another person, except where due reference has been made in the text. In addition, I certify that no part of this work will, in the future, be used in a submission in my name, for any other degree or diploma in any university or other tertiary institution without the prior approval of the University of Adelaide and where applicable, any partner institution responsible for the joint-award of this degree. I give consent to this copy of my thesis when deposited in the University Library, being made available for loan and photocopying, subject to the provisions of the Copyright Act 1968.

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Literature Review

Gestational diabetes mellitus (GDM) is a form of diabetes, or carbohydrate intolerance, which is first diagnosed during pregnancy (World Health Organization 2013). Women who have had GDM are at higher risk of type 2 diabetes mellitus (T2DM) in the future; they are also at risk of GDM in future pregnancies (Kim et al 2007; Kim et al 2002; Lee et al 2007). Due to this increased risk of T2DM, clinical practice guidelines recommend screening for T2DM in the postpartum period (American Diabetes Association 2014; Nankervis et al 2014; South Australian Perinatal Practice Guidelines 2012; The American College of Obstetricians and Gynecologists 2013; Thompson et al 2013; Walker 2008). However, screening rates are moderately low, and vary considerably between settings (Tovar et al 2011). It is therefore important to investigate both the causes of these low rates, as well as possible solutions.

GDM: A brief history

Prior to development of the term GDM, and diagnostic and screening recommendations, it was observed that women with poor obstetric histories (e.g. a large baby or fetal loss) were more likely to have high blood glucose during a later pregnancy and to go on to develop T2DM and that treatment of the high blood glucose improved obstetric outcomes; thus research was conducted into methods of detection of diabetes during pregnancy (Carrington et al 1957). The O'Sullivan and Mahan criteria was subsequently published in 1964; this criteria for diagnosing diabetes in pregnancy was based on results from 100 gram oral glucose tolerance tests (OGTTs) performed in 752 mainly second- and third-trimester pregnant women. Four venous glucose values were measured (fasting, one hour, two hours and three hours); the results were normally distributed, and the predictive value for future diabetes was validated by applying them to a second population of 1013 non-pregnant women who had been tested during a previous pregnancy and followed up for up to eight years. O'Sullivan and Mahan concluded from their results that the mean values plus two standard deviations

(rounded to the nearest 5mg/dL) were the most appropriate limits for diagnosing diabetes in pregnancy (O'Sullivan and Mahan 1964).

In 1979, the National Diabetes Data Group in the United States recommended that GDM be recognised as a condition with its own diagnostic criteria, and that high risk pregnant women be screened (many risk factors were specified by the group and included family history of diabetes in a first degree relative, history of stillbirth and maternal obesity) (National Diabetes Data Group 1979). Then in 1980, the American Diabetes Association recommended that all pregnant women be screened between the 24th and 28th weeks of pregnancy, using a 50 gram oral glucose challenge test (OGCT), followed by a 100 gram oral glucose tolerance test (OGTT). Women would be diagnosed with GDM if both tests had abnormal results (Freinkel and Josimovich 1980). Many countries developed their own diagnostic criteria, primarily based on expert opinion (Cundy et al 2014). In 2005 and 2009, two randomised controlled trials were published which demonstrated benefits of treatment of GDM (Crowther et al 2005;Landon et al 2009). Then, in 2008, the Hyperglycemia and Adverse Pregnancy Outcome (HAPO) study was published, and the findings of this study led to new diagnostic recommendations (Hapo Study Cooperative Research Group et al 2008;International Association of Diabetes Pregnancy Study Groups Consensus Panel et al 2010). There is currently ongoing debate around the diagnostic criteria for GDM, as briefly described in the following paragraphs.

GDM diagnostic criteria: Arguments for changing the diagnostic threshold

The HAPO study, a prospective, multicentre cohort study, with 23,216 pregnant women, found that there was a continuous relationship between maternal glycaemia at 24 to 28 weeks, and adverse outcomes for mothers and babies. The results of the study remained significant after adjusting for possible confounders such as maternal obesity. The results of the HAPO study, and results from other studies on the same topic (Hillier et al 2007;Jensen et al 2001;Jensen et al 2008;Pettitt and Knowler 1998;Pettitt et al 1980;Sacks et al 1995;Sermer et

al 1995), including two randomised controlled trials (Crowther et al 2005;Landon et al 2009) were considered by the International Association of Diabetes and Pregnancy Study Groups (IADPSG) (International Association of Diabetes Pregnancy Study Groups Consensus Panel et al 2010), and led to recommendations of new diagnostic criteria. The key differences in the IADPSG recommendations compared with previous criteria were use of a one-step (OGTT only) rather than two-step approach to diagnosis, and adjustment of the glucose thresholds for diagnosis to levels associated with 1.75-fold increase in risk above the mean (from HAPO study results) for birth weight, cord C peptide concentration, and percentage body fat > 90th centile. Only one abnormal value would then be needed for diagnosis of GDM (Table 1).

Table 1: IADPSG Recommended GDM Diagnostic Criteria

Organisation	Target group	Method of screening	Diagnostic thresholds
IADPSG	All women	75 g OGTT (one-step)	Fasting \geq 5.1mmol/L 1 hour \geq 10.0mmol/L 2 hours \geq 8.5mmol/L

The new diagnostic criteria were endorsed by the Australasian Diabetes in Pregnancy Society (ADIPS) and the American Diabetes Association (American Diabetes Association 2014), as well as associations in France and China (Cundy et al 2014;Nankervis et al 2013;Nankervis and Conn 2013). The World Health Organisation (WHO) also endorsed the recommendations, but rated the quality of the evidence as very low, and rated the strength of their recommendation as weak (World Health Organization 2013).

GDM diagnostic criteria: Arguments against decreasing diagnostic threshold

Not all clinicians, researchers and associations with an interest in GDM agree with the proposed changes to the GDM diagnostic criteria (Cundy et al 2014;Langer et al 2013). For example, the US College of Obstetricians and Gynaecologists has not endorsed the change (Cundy et al 2014;The American College of Obstetricians and Gynecologists 2013), and the 2013, Eunice Kennedy Shriver National Institute of Child Health and Human Development Consensus Development Conference on diagnosing GDM recommended that clinicians

continue to use a two-step approach to screen for and diagnose GDM because there would be a certain rise in health care costs despite insufficient evidence for clinically significant improvements in outcomes (Vandorsten et al 2013). The Canadian Diabetes Association (CDA) has also recommended retaining a two-step approach as their preferred option for GDM diagnosis (Thompson et al 2013).

Numerous arguments for and against adopting the new criteria have been made (Cundy et al 2014;d'Emden 2014;International Association of Diabetes Pregnancy Study Groups Consensus Panel et al 2010;Kevat et al 2014;Langer et al 2013). The new criteria, where adopted, may significantly increase the number of women being diagnosed with GDM. It is important that costs and benefits of the proposed criteria are further explored through well-designed research, particularly randomised controlled trials.

GDM Diagnosis and Prevalence

In 2010, the Australian Institute of Health and Welfare (AIHW) released the first national report on the impact of diabetes in pregnancy on Australian women and their babies (Australian Institute of Health and Welfare 2010). This report examined maternal characteristics in comparison with perinatal interventions and outcomes, using data from both the National Hospital Morbidity Database and the National Perinatal Data Collection database. The AIHW report found that the overall population prevalence of GDM in Australia (using ADIPS 1998 criteria (Hoffman et al 1998)) was 5%.

The prevalence of GDM is not only influenced by diagnostic criteria, but also by the presence of individual risk factors of the women becoming pregnant in a particular setting. The risk factors for GDM overlap with those for T2DM, and include overweight and obesity, use of medications such as corticosteroids, increased age, previous GDM, previous macrosomic babies, polycystic ovarian syndrome and certain ethnicities including Asian, Indian subcontinent, Aboriginal, Torres Strait Islander, Pacific Islander, Maori, Middle Eastern and

non-white African (Nankervis et al 2013;Teh et al 2011). The prevalence of GDM in Australia is likely to grow with increases in maternal obesity and age, migration and use of altered GDM diagnostic criteria (Nankervis and Conn 2013;Scheil et al 2013).

Women who have had GDM are at greatly increased risk of T2DM

Women who have had GDM are at higher risk of development of T2DM in the future (Bellamy et al 2009). A systematic review and meta-analysis published in 2009 found that women who have had GDM (diagnosed prior to IADPSG criteria) are at least seven times as likely as those who had a normoglycaemic pregnancy to develop T2DM (RR 7.43, 95% CI 4.79-11.51) (Bellamy et al 2009). This systematic review included retrospective and prospective cohort studies from 1960 to 2009, with data from women who had GDM as well as from women who had normoglycaemic pregnancies. The length of follow-up in the included studies ranged from 16 weeks to 28 years (Bellamy et al 2009).

The methodological quality of the systematic review described above may be assessed using the AMSTAR tool, which is validated, has 11 criteria, and was developed based on previous research into assessment of the methodological quality of systematic reviews (Shea et al 2009). The review was generally well designed and reported, with a score of 9/11 (high quality), according to AMSTAR criteria; the review had an “a priori” design (established research question and inclusion criteria prior to conduct). Methods included duplicate study selection and data extraction, and a comprehensive literature search was performed. Other aspects, such as the likelihood of publication bias, were addressed. There was significant unexplained heterogeneity in the meta-analysis, and studies were included regardless of their rate of follow-up, which may have resulted in a biased effect estimate (Kristman et al 2004), but the increased risk of T2DM was unequivocally demonstrated.

Why postpartum follow-up of GDM is important

Postpartum follow-up of women who have experienced GDM allows early detection of T2DM, as well as an opportunity for prevention of T2DM in women who are known to be at higher risk.

The benefits of early detection of T2DM

Glucose testing in the postpartum period allows those who have developed T2DM to be identified and treated early, with a view to reducing the risk of complications of pregestational diabetes (diabetes present before pregnancy) (Thompson et al 2013) and long term complications. Identification of T2DM before future pregnancies allows for optimised blood glucose control in the early stage of pregnancy (Thompson et al 2013). Maternal hyperglycaemia during early pregnancy increases the risk of several complications for the mother and her baby such as congenital malformations (e.g. abnormalities of the heart and central nervous system, which are increased three-fold), miscarriage, stillbirth, fetal macrosomia, requirement for induction of labour or caesarean section and birth trauma for mother and baby (Bell et al 2008;Feig et al 2006;Macintosh et al 2006;Thompson et al 2013).

For women, in the long term, treating T2DM using exercise, dietary and pharmacological methods helps to reduce morbidity, including macrovascular disease (atherosclerosis) and microvascular disease (retinopathy, nephropathy, and neuropathy) and mortality (Bailey et al 2005;Hordern et al 2012;McCulloch 2012).

The benefits of being able to prevent T2DM in women who are at high risk

All women who have had GDM are at increased risk of T2DM, so for women who have not yet developed T2DM, postpartum appointments present an opportunity for T2DM prevention. This may lead to numerous health and cost benefits. The overall financial cost of T2DM in Australia was estimated to be \$12.4 billion in 2008, and has been rising (Access Economics 2008). Direct medical costs increase greatly with progression from impaired glucose tolerance

to diabetes with complications (Herman 2011). Lifestyle and pharmacological interventions to prevent T2DM have been shown to be cost-effective (Herman 2011).

For example, both metformin and lifestyle modification were shown to reduce the development of T2DM in the Diabetes Prevention Program (DPP) trial. The DPP trial included 3234 people with increased risk of T2DM (i.e. elevated fasting and post-load plasma glucose concentrations), and was conducted in 27 centres in the United States (Knowler et al 2002); the primary goals of the DPP trial were to determine whether a lifestyle intervention or metformin would prevent or delay the onset of T2DM, whether the interventions differed in effectiveness, and also whether their efficacy differs according to age, sex, or ethnicity. Participants were followed-up for an average 2.8 years. The lifestyle intervention reduced the incidence of T2DM by 58 percent (95% CI 48 to 66) and metformin reduced it by 31 percent (95% CI 17 to 43); the incidence of diabetes was 11.0, 7.8, and 4.8 cases per 100 person-years in the placebo, metformin, and lifestyle groups, respectively (Table 2)

Table 2: Overall Incidence and Reduction of Incidence of T2DM in the DPP Trial (Knowler et al 2002)

Participants	Overall Incidence (cases/100 person-years)			Reduction in Incidence Percent (95% CI)		
	Placebo	Metformin	Lifestyle vs Placebo	Lifestyle vs Placebo	Metformin vs Placebo	Lifestyle vs Metformin
3234	11.0	7.8	4.8	58 (48 to 66)	31 (17 to 43)	39 (24 to 51)

The DPP lifestyle intervention goal was for participants to achieve and maintain a 7% initial body weight reduction through low-fat diet and physical activity. The participants were taught by case managers individually for the first 24 weeks after enrolment about diet, exercise and behaviour modification, with subsequent individual sessions (usually monthly) and group sessions with the case managers to reinforce the behavioural changes.

In 2008, a sub-group analysis of the DPP trial was published in which the results from women with a history of GDM (hGDM) were compared with results from women without hGDM (Ratner et al 2008). The findings were that women with hGDM were more likely to develop

T2DM overall (71% higher incidence), and that both intensive lifestyle and metformin therapy reduced the incidence of T2DM in women with hGDM by approximately 50% compared with the placebo group.

Further research studies examining lifestyle interventions, specifically for women who have had GDM, are necessary (Bentley-Lewis et al 2008;Pan et al 1997;Tuomilehto et al 2001). One such study is the Mothers After Gestational Diabetes in Australia Diabetes Prevention Program (MAGDA-DPP; Shih et al 2013), which is a randomised controlled trial for assessment of a structured diabetes prevention program for post-GDM women (compared with usual care). The diabetes prevention program in the MAGDA study aims to encourage participants to achieve goals of: (1) reducing fat intake (no more than 30% of energy from fat); (2) decreasing saturated fat intake (no more than 10% of energy from saturated fat); (3) increasing fibre intake (at least 15 gram per 1000 kcal); (4) increasing physical activity (at least 30 minutes of moderate exercise per day); and (5) reducing body weight (at least 5% of body weight reduction within 12 months). Another Diabetes Prevention Program trial specifically for women who have experienced GDM is currently being conducted in Northern California, The GEM (Gestational Diabetes' Effects on Moms) study. The GEM study follows on from a feasibility study conducted by the same research group of a pregnancy and postpartum print and telephone lifestyle intervention based on the DPP curriculum (Ferrara et al 2011). The GEM study is a cluster randomised trial of a DPP-derived lifestyle intervention (delivered via telephone) versus usual care (Ferrara et al 2014). The results of these trials are not yet available.

Breastfeeding may also decrease the risk of development of T2DM in women who have had GDM (Feig 2012). Two large cohort studies have shown decreased rates of T2DM in women who breastfed their babies compared with those who did not (Stuebe et al 2005;Liu et al 2010). Another trial has found that longer duration of breastfeeding was associated with lower incidence of metabolic syndrome in women with a history of GDM (after controlling for BMI and sociodemographic and lifestyle traits) (Gunderson et al 2010).

Guidelines relating to follow-up of GDM in the postpartum period

Due to the increased likelihood of T2DM, many guidelines, including those listed in the table below, recommend postpartum diabetes screening for women who have had GDM.

Table 3: Postpartum glucose testing guideline recommendations

Guideline	Screening Recommendations	Comments
Australasian Diabetes in Pregnancy Society (Nankervis et al 2014)	<p>Early screening: 75g 2-hr OGTT, preferably at 6-12 weeks post-partum, with classification according to the WHO criteria.</p> <p>Longer term: If contemplating another pregnancy: OGTT annually. If not, then depending on the clinical circumstances either an OGTT, HbA1c or FPG at 1-3 years.</p>	This guideline is based on evidence and consensus opinion of Council members of the ADIPS. These guidelines have been endorsed by the Royal Australian and New Zealand College of Obstetricians and Gynaecologists (RANZCOG).
South Australian Perinatal Practice Guidelines 2012	<p>Early screening: 75 gram OGTT at 6-12 weeks post-partum.</p> <p>Longer term: 1-2 yearly OGTT.</p>	These guidelines are based on systematic review of evidence, and have been approved by the South Australian Department of Health.
American Diabetes Association 2014	<p>Early screening: Screen women with GDM for persistent diabetes at 6–12 weeks postpartum, using a test other than A1C.</p> <p>Longer term: 3 yearly testing using OGTT.</p>	This guideline is evidence based. It is annually revised by the ADA's multidisciplinary Professional Practice Committee. This guideline was approved by the Executive Committee of ADA's Board of Directors, which includes health care professionals, scientists, and lay people. Feedback from the larger clinical community was also incorporated. No industry support was used to fund the development of the guideline.
The American College of Obstetricians and Gynecologists 2013	<p>Early screening: 75 gram OGTT or FPG 6-12 weeks postpartum.</p> <p>Longer term: 3 yearly testing using OGTT</p>	This guideline represents an assessment on the issue by the American College of Obstetricians and Gynaecologists' Committee on Obstetric Practice.
Canadian Diabetes Association (Thompson et al 2013)	<p>Early screening: 75 gram OGTT at 6 weeks to 6 months postpartum</p>	These guidelines are evidence based and developed by the Clinical & Scientific Section of the Canadian

	Longer term: <i>No recommendation</i>	Diabetes Association, a multidisciplinary team of experts working as volunteers to develop the guideline. Financial assistance for guideline was provided by industry sponsors in the form of unrestricted educational grants
The UK National Institute for Health and Clinical Excellence (NICE) guideline (Walker 2008)	Early screening: FPG (not an OGTT) should be performed at 6 weeks. Longer term: FPG annually.	NICE guidelines aim to be evidence based. They are developed by an independent committee of experts including clinicians, women, carers and health economists, with UK National Health Service funding. The committee also consult with an associated public citizen's council.
New Zealand Ministry of Health 2014	Early screening: Primary care provider should offer screening for T2DM at three months after birth using HbA1c. Longer term: Repeat the HbA1c test in one year.	The guideline has been commissioned and funded by the Ministry of Health. It was developed by a multidisciplinary Guideline development team, and was evidence based.

How often does postpartum follow-up of women with GDM occur?

There is evidence that rates of postpartum screening for T2DM are low-to-moderate (Tovar et al 2011). A systematic review by Tovar et al 2011 examining the rates of postpartum blood glucose screening reported in papers published between 2008 and 2010 (11 included studies, with 32,240 women) found that 34-73% of women with past GDM completed postpartum screening. The length of follow-up within studies varied, and all but one study had follow-up of greater than 12 weeks. The screening rate did not increase over time across studies. There were a few limitations of this review according to an AMSTAR assessment, although generally the review appeared methodologically sound. Limitations included: no list of excluded studies, unclear methods for assessment of quality in included studies, no exploration of publication bias and no exploration of conflict of interest. Most of the included studies were conducted in healthcare settings with interventions in place to try to increase the

rates of postpartum follow-up, so it is possible that other settings may have had lower rates (Tovar et al 2011).

Two Australian studies were included in the Tovar et al (2011) systematic review. These Australian studies reported relatively higher rates of postpartum screening compared with other included studies (Morrison et al 2009; Swan et al 2010). Morrison and colleagues (Morrison et al 2009) examined rates of postpartum glucose testing using a cross-sectional survey of 1372 women diagnosed with GDM between 2003 and 2005, sampled from the National Diabetes Services Scheme Database (NDSS) in Australia; they found that any form of postnatal glucose testing was completed at 6 to 8 weeks by 60.9% of respondents and within 6 months by 73.2% of respondents. However, only 27.3% had had an OGTT at 6-8 weeks. Furthermore, the overall survey response rate was 36%, and it is possible that there was response bias towards potentially more motivated women. In fact, the authors noted that, if none of the 14,521 women from the NDSS dataset who did not take part in the survey had returned for post-partum screening, the rate of any type of postnatal testing would actually be as low as 6.3%. This highlights the difficulty of accurately estimating the actual rate of uptake of testing, as well as the clear need to increase the rates of oral glucose tolerance testing in Australia. In the other Australian study, postal questionnaires were sent to 210 women in regional Victoria, and 61% of respondents had a postpartum OGTT (response rate was 40%) (Swan et al 2010). If all non-respondents did not have an OGTT, the actual rate may have been as low as 24%. Interestingly, this study found that a higher proportion of women living in smaller rural areas had a postpartum OGTT compared with women living in large rural areas (82.5% vs. 48.9%, $p < 0.05$). The authors speculated that this may have been due to the women in smaller rural areas seeing a family doctor who was more likely to be aware of the family diabetes risk.

Another systematic review, published in 2013, aimed to identify approaches associated with higher postpartum glucose testing rates. The authors categorised studies into either (1) “Usual Care” (data obtained via retrospective chart or database review) or (2) “Active Care”

(reporting results of studies with a proactive plan enacted to improve testing rates, such as calling or posting reminders to women or their physicians). This systematic review, with 54 included studies, found that the use of proactive contact programs increased postpartum testing rates (Carson et al 2013). With regards to AMSTAR assessment, the research aims and inclusion criteria were clearly stated. There was duplicated study selection and data extraction, and a comprehensive literature search (four databases) was performed. However, the review did not systematically assess the quality of the included studies, or assess the likelihood and implications of positive publication bias. There was also a lack of information on the types of active care within the included studies.

Patient/provider adherence to screening according to clinical practice guidelines: a theoretical framework

Examination of what is known about patient and clinician adherence to screening from previous research may form a useful theoretical framework upon which to base further exploration of the factors influencing screening for T2DM in the postpartum period.

One of the best studied areas of screening in relation to patient and physician adherence is in cancer detection (Subramanian et al 2004; Limmer et al 2014). Cancer screening adherence has the potential for reduction in morbidity and mortality with early detection, in conjunction with varied rates of uptake (Subramanian et al 2004; Limmer et al 2014).

Physician recommendation of the screening test has been frequently reported as an important predictor of patient adherence with breast and colorectal cancer screening recommendations, and less frequently with cervical cancer screening (Subramanian et al 2004; Limmer et al 2014). Physician recommendation of postpartum T2DM screening for women who have had GDM may be an important positive predictor of screening.

Other factors identified as positively impacting on patient adherence to cancer screening include secure financial status, having health insurance, being married, tertiary education

attainment, family history of cancer or presence of known risk factors for cancer, good psychological health and positive perception of health care system interactions and treatment efficacy (Subramanian et al 2004; Limmer et al 2014).

According to research into cancer screening, several factors influence the likelihood that physicians will recommend screening tests, including their past experience of patient adherence, patient demographics, their perception of test efficacy, their training, knowledge and agreement with screening guidelines and barriers to provision of care such as lack of equipment or poor reimbursement (Subramanian et al 2004).

What is known to influence postpartum screening rates?

It is likely that there would be some overlap in the above factors influencing attendance for postpartum diabetes screening, particularly physician recommendation, financial and sociodemographic factors and the presence of known risk factors, such as family history.

The influence of sociodemographic factors on postpartum follow-up

There have been somewhat conflicting results as to if and how age, ethnicity, marital status, parity and education influence the likelihood of postpartum glucose testing testing (Keely 2012;Tovar et al 2011). However, there is some evidence that predictors of higher postpartum screening attendance may be older age, nulliparity, higher income, higher education, Asian ethnicity, being a recipient of prenatal care, and antenatal treatment with insulin (Tovar et al 2011).

Women's views relating to postpartum follow-up of GDM

Many studies have sought insight into barriers and enablers to postpartum follow-up from the perspective of women, through interviews, focus groups and surveys. Given the number of studies and the importance of the topic, synthesis of their results is likely to be very valuable for improving postpartum care; such a systematic review has been conducted as part of this

thesis. Some examples of the included studies follow. Keely and colleagues (2010) asked 36 women why they did not complete oral glucose tolerance testing in a follow-up survey relating to their randomised controlled trial of postnatal postal reminders (Clark et al 2009). The most common reason for non-completion was time pressure (20 women, 55%), followed by lost lab requisition forms (7 women, 19%). In another study ($n = 88$), the most commonly reported barrier was test inconvenience (36%), followed by not knowing a follow-up test was required (28%) (Sterne et al 2011). In the same study, women said that reminders (39%) and raised awareness (31%) were likely to act as facilitators to screening. Bennett and colleagues ($n = 22$) found recent birth experiences, baby's health issues, adjustment to a new baby, emotional stress, postpartum mood symptoms and lack of time for self-care all contributed to low attendance for postpartum care. Other barriers included negative experiences with medical services such as long waiting periods and receiving care from multiple providers. Facilitators included availability of child care at the time of the appointment, a positive connection with clinical and office staff as well as a desire to have an appointment for either a check-up, to discuss family planning and/or obtain clearance for return to work. At a local level, barriers to completion of postpartum glucose testing identified in previous studies, were assessed in a follow-up survey for the women who participated in the DIAMIND Study (Heatley et al 2013).

Perception of increased risk of T2DM may be an important factor influencing motivation to undertake postpartum glucose testing (Keely 2012). Research has shown that some women with GDM do not perceive themselves as being at high risk for T2DM (Malcolm et al 2009; Morrison et al 2010). Therefore, changing perception of risk and providing further education to women regarding postpartum follow-up may result in increased attendance. A recent retrospective study examined the efficacy of an educational intervention for women to improve postpartum follow-up (Stasenko et al 2011). This study provided education about the importance of postpartum follow-up, delivered by a trained diabetes educator (registered nurse). The women were informed about their increased risk of T2DM, and provided with a

handout containing follow-up information and instructions on how to obtain an OGTT prior to their postpartum visit. This education resulted in an increase in postpartum blood glucose testing (with either fasting blood glucose or an OGTT) from 33% in the 2002 to 2006 cohort before the educational intervention began, to 53% in 2007 to 2009 ($p < 0.001$) when the intervention was in place.

Healthcare factors: Providers and the health care system

Numerous studies have examined the factors influencing provision of healthcare for women with GDM through surveying or interviewing clinicians (Baker et al 2009; Divakar and Manyonda 2011; Doran and Davis 2010; Gabbe et al 1998; Hunsberger et al 2012; Keely et al 2010; Ko et al 2013; Oza-Frank 2012; Persson et al 2011; Pierce et al 2011; Power et al 2013; Stuebe et al 2010; Weaver 2004). It is important that the results of these studies are applied to improving postpartum care, and given that the results have not been previously synthesised, a systematic review of these studies was conducted as part of this thesis (Van Ryswyk et al 2014; paper contained in this thesis).

Communication of the diagnosis of GDM to those responsible for postnatal follow-up care is likely to be an important factor influencing rates of follow-up testing. A study assessed documentation of GDM history in the electronic problem list of the Brigham Women's Hospital (BWH) in Boston Massachusetts (Stuebe et al 2010). In this study, primary care providers and obstetric care providers were asked if they used the electronic problem list for communication; 93% of primary care providers (127 surveyed) and 81% of obstetric care providers (80 surveyed) said they did. The study team found that 772 women with GDM gave birth at BWH. Of those, only 58% (450/772) had any entry on their problem list, with 18% (141/772) having the correct code of "diabetes of pregnancy" and 8% (65/772) having a free text entry indicating the diagnosis of GDM. This low rate of documentation of the diagnosis of GDM may be more widespread than just this individual hospital.

Another study examined rates of referrals for follow-up, rather than documentation of the diagnosis of GDM. This study was a retrospective chart review (n = 2617) at a major academic hospital in Philadelphia, USA. The study found that only 20% of women with GDM had documented orders from an obstetrician for glucose screening tests. When referrals to primary care physicians was included as a method of providing this follow-up, only 33% of women had either documented orders for postpartum screening from obstetricians or referral to a primary care provider for postpartum follow-up of GDM (Almario et al 2008). Thus, rates of postpartum follow-up testing are affected by referrals from care providers, not just by whether or not women choose to return for recommended testing.

Which postpartum glucose test should be used?

Current Australian guidelines recommend use of an OGTT at 6-8 weeks postpartum for T2DM screening (Nankervis et al 2013). However, OGTTs have several disadvantages in terms of ease of completion: the test itself takes at least two hours to complete, it requires overnight fasting, and the glucose drink is sometimes poorly tolerated and can lead to nausea and vomiting (d'Emden 2014). Other, shorter tests may be more acceptable to women and more likely to increase test completion rates. Recent research has focussed on the possibility of using HbA1c, which requires no fasting and no waiting time, specifically for postpartum T2DM screening (Benaiges et al 2013; Garcia de Gadiana Romualdo et al 2012; Gingras et al 2013; Katreddy et al 2013; Kim et al 2011; Megia et al 2012; Noctor et al 2013; Picon et al 2012).

Guidelines in New Zealand have been updated to recommend postpartum screening using HbA1c at three months after birth, with repeated annual testing if results are normal (Ministry of Health 2014). Australasian Diabetes in Pregnancy Society guidelines still recommend use of OGTTs for early postpartum screening (6-12 weeks) and for women contemplating another pregnancy, but recommend HbA1c as an option for subsequent screening (Nankervis et al 2014).

Reminder systems to increase uptake of follow-up testing

Since 2002, the South Australian GDM Recall Register sent registered South Australian women a reminder to undertake glucose testing at 15 months. This recall register has now been replaced by the National Gestational Diabetes Register, which sends registered women postal reminders at 12-16 weeks after their expected due date (The National Diabetes Services Scheme 2012), and the SA Perinatal Practice Guidelines recommend that all women with GDM (and Medicare-coverage) should be offered the opportunity to join this register (South Australian Perinatal Practice Guidelines 2012). Chittleborough et al (2009) studied the effectiveness of the South Australian GDM Recall Register and found that of the 429 women who had been sent their first reminder letter (at 15 months), 46.4% had returned the update form and 56.3% of those who returned the update form had undertaken a glucose test for diabetes. If none of the 429 women who did not return the update form had the test, the actual rate of testing may be as low as 26%. It is also worth noting the high variability of recruitment rates to the South Australian register over the years; a high of 71.6% of eligible women were recruited in 2003, and a low of 26.6% of those eligible were recruited in 2006 (Table 4). The authors of the Chittleborough (2009) paper speculated that reasons for this variability in recruitment rates may have been due to time constraints during appointments, change in staff, and differences in staff efforts to recruit.

Table 4: Recruitment to the GDM Recall Register at participating hospitals (Chittleborough et al 2010)

Year	Total number of women with GDM	Number of women on register	Register recruitment
2002	38	26	68.4%
2003	74	53	71.6%
2004	62	31	50.0%
2005	123	48	39.9%
2006	268	72	26.9%
2007	309	199	64.4%

In 2014, a Cochrane systematic review was published on the topic of reminder systems for women with previous GDM to increase uptake of testing for T2DM or impaired glucose

tolerance (Middleton and Crowther 2014). This Cochrane review, with last search in April 2013, found that there was only one trial available for assessment (Clark et al 2009), and that, whilst this trial showed increased OGTT completion in the reminder arms, the trial had unclear risk of bias in most assessment criteria (including allocation concealment, blinding of women, attrition bias, selective reporting, and baseline imbalance) and was therefore of low quality evidence for efficacy.

This trial (Clark et al 2009) included 256 women, regardless of age, who attended the High Risk Obstetrical Unit (Ottawa Hospital, Ontario, Canada) between 29 August 2002 and 31 March 2005, for treatment of GDM, who provided written informed consent. The trial had four arms: (1) reminder sent to primary care physician and woman, (2) reminder sent to primary care physician only, (3) reminder sent to woman only, and (4) usual care, no reminder. The postal reminders were sent at three months after birth. The primary outcome of the trial was the proportion of women who underwent OGTT within 1 year after birth, and the results from 223 women were analysed (33 were excluded due to loss to follow-up). Oral glucose tolerance test rates were significantly increased in all three reminder groups compared with the no reminder group (Table 5).

Table 5: Primary outcome of RCT of postal reminders for postpartum OGTTs (Clark et al 2009)

Reminder Group	Proportion screened with OGTT
Physician and woman	49 of 81 women (60.5%)
Physician only	16 of 31 women (51.6%)
Woman only	42 of 76 women (55.3%)
No reminder	5 of 35 women (14.3%)

The same research team then implemented a women only reminder system into routine care (Shea et al 2011), and conducted a non-randomised study examining the effects of implementation of the reminder system at two different healthcare sites in their region compared with no reminder at a third healthcare site. The primary outcome was the proportion of women who were screened for T2DM with an OGTT within 6 months of

delivery. The study included all women who had antenatal GDM education classes at one of the three healthcare sites included in the study (the Ottawa Hospital General Campus, the Queensway Carleton Hospital and The Ottawa Hospital Civic Campus). The GDM education classes gave information on the development of T2DM after birth, as well as other aspects of GDM. Women were excluded from the study if they did not have Ontario Health Insurance Plan (OHIP) coverage (provincial health insurance that is universally available without co-payment, covers all physician visits, medical care and diagnostic testing). Whilst the study had ethical approval, it was not clear whether informed consent was gained from the included women.

Three months after delivery, women in one study site were mailed a reminder that included information on the importance of diabetes screening and a laboratory requisition for an OGTT at a non-hospital based laboratory; women at a second study site were either sent a letter with a laboratory requisition (for OGTT) or phoned, or both. Women at a third site were not sent a postal reminder or given a reminder phone call. None of the sites provided routine postpartum GDM-specific follow-up visits.

The results of their implementation of a women only reminder system into routine care, with regards to postpartum oral glucose tolerance testing within 6 months after birth, were lower than those found in the previous randomised controlled trial of postal reminders (Clark et al 2009). 23.3% (21/90) at the first Shea study site completed OGTTs, compared with 55.3% in the women only arm of the Clark RCT, while 36.4% (20/55) at the second Shea site completed OGTTs. The rate of OGTT completion at this site was higher than at the non-reminder site (13.7%, 16/117, $p = 0.03$), as was the combined reminder site rate ($p = 0.01$) (Table 6).

Table 6: Results of implementation of postal women's reminder Shea et al 2011)

Site	Reminder Type	OGTT completion	
		n	%
The Ottawa Hospital- General campus	Mailed information and lab requisition for OGTT at 3 months postpartum	21/90	23.3
Queensway Carleton Hospital	Mailed information and lab requisition for OGTT/phoned/both at 3 months postpartum	20/55	36.4
The Ottawa Hospital - Civic campus	None	16/117	13.7

A small number of non-RCT studies have also examined reminder systems for postpartum blood glucose testing, with positive results. For example, a Finnish prospective observational study found that a special call or reminder from their central hospital increased the rates of postpartum OGTT uptake (OR 13.4 [4.6-38.1], $P < 0.001$) (Korpi-Hyovalti et al 2012). Also, a Canadian study (Toronto), examined the efficacy of a physician checklist for increasing postpartum screening in women who have had GDM. They found by retrospective chart review that the checklist was associated with a 3 fold increase in odds of being screened postpartum, and an almost 4 fold increase in postpartum follow-up visits (OR 2.99, 95% CI 1.84–4.85 and OR 3.71, 95% CI 2.26–6.11) (Lega et al 2012).

Given the apparent efficacy of postal based reminders, it follows that SMS-text reminders may be an effective way to increase postpartum oral glucose testing rates. In Australia, in 2011, there were at least 28 million mobile phone subscriptions (i.e. 6 million more subscriptions than people) (Budde and McNamara 2011). With the very high rate of mobile phone usage in, it is likely that most women of reproductive age have access to a mobile phone. In addition, text messages may be less easy to lose than mail reminders, more likely to be read than emails, and less invasive, time consuming and expensive than voice calls.

A Cochrane review found that there is low to moderate quality evidence that mobile phone text messaging reminders increase attendance at healthcare appointments compared with no reminders, or postal reminders (Gurol-Urganci et al 2013). This review included randomised controlled trials assessing mobile phone reminders for healthcare appointments, in which it

was possible to assess effects of mobile phone messaging independent of other technologies or interventions. A total of eight randomised controlled trials, involving 6615 participants, were included. The authors concluded that there was moderate quality evidence (7 studies, n = 5841) of efficacy of text message reminders, compared with no reminders, for increasing healthcare appointment attendance (RR 1.14, 95% CI 1.03 to 1.26), as well as moderate quality evidence that mobile text reminders had a similar impact to phone call reminders (three studies, 2509 participants, RR 0.99, 95% CI 0.95 to 1.02). There was low quality evidence from just one study, with n = 291 participants, that mobile text message reminders combined with postal reminders improved the rate of attendance at healthcare appointments compared with postal reminders alone (RR 1.10, 95% CI 1.02 to 1.19). This potential to increase rates of attendance may translate into increased rates of women's attendance for oral glucose tolerance testing in the postpartum period for women who have had gestational diabetes. The authors recommended that further high quality randomised trials of mobile phone messaging reminders are needed

Summary

In summary, GDM is an increasingly common health condition that indicates a substantially increased lifetime risk for development of T2DM, and the postpartum period is an important time for early T2DM detection and intervention to prevent T2DM. Screening in the postpartum period for T2DM is recommended, although frequently women do not complete or are not offered screening. It is important to investigate both the causes of the low postpartum screening rate, as well as methods of improving follow-up. Mobile (SMS) reminder systems have been found to be effective for increasing attendance at various healthcare appointments in some studies, but the quality of the existing evidence is low-moderate, and there is only low quality evidence from one randomised controlled trial that postal reminders increase completion of oral glucose tolerance testing in women who have had GDM. A combination of decreased use of the postal system and very high use of mobile

phones indicates that mobile text reminders may be preferable and possibly more effective for increasing postpartum glucose test attendance. The research covered in the following chapters further explores reasons for sub-optimal postpartum follow-up, with systematic synthesis of the results of qualitative/survey studies on the topic from the perspective of both clinicians and women. The efficacy of an SMS text reminder system specifically for women who have experienced GDM to increase postpartum glucose test completion is also explored via a randomised controlled trial, as are the barriers and facilitators to postpartum testing from the perspective of the women in the study.

Thesis Purpose

The following chapters examine several related aims, all of which seek to answer the research questions: (1) why is postpartum follow-up of gestational diabetes, particularly screening for T2DM sub-optimal, and (2) what can be done to improve this situation?

Aim 1: To examine the factors that influence postpartum follow-up of women with gestational diabetes, from the perspective of clinicians.

Aim 2: To examine the factors that influence postpartum healthcare seeking for women who have had gestational diabetes, from the perspective of women.

Aim 3: To test whether a SMS reminder system may help improve the rate of attendance for postpartum oral glucose tolerance testing – The DIAMIND Trial.

Aim 4: To examine other factors that may have influenced completion of glucose testing in the DIAMIND Trial.

Aim 5: To ascertain the views of women in the DIAMIND Trial relating to barriers and facilitators to postpartum OGTT completion

Statement of Authorship

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Author Contributions

By signing the Statement of Authorship, each author certifies that their stated contribution to the publication is accurate and that permission is granted for the publication to be included in the candidate's thesis.

Name of Principal Author (Candidate)	Emer Van Ryswyk	
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Women's views and knowledge regarding healthcare seeking for gestational diabetes in the postpartum period: a systematic review of qualitative/survey studies

Abstract

Aim: To identify factors influencing postpartum healthcare seeking, from the perspective of women who have experienced gestational diabetes mellitus (GDM).

Methods: Systematic review that searched PubMed, Web of Science, EMBASE and CINAHL on 27th February 2013. Qualitative studies and surveys, with women as participants, which reported pre-specified outcomes, including barriers and facilitators to healthcare seeking for GDM after birth, were included. For each included study, two authors independently assessed quality and undertook thematic synthesis.

Results: 42 studies were included, with data from 7949 women. Studies were conducted in the United States, Australia, Europe, the United Kingdom, Canada, Brazil, Vietnam and Tonga. For some women, being diagnosed with GDM was a concerning or upsetting experience. Antenatal care for GDM was sometimes a very positive experience, whilst for others it was a more difficult or confusing experience. There was a need for more specific information about GDM to be available around the time of diagnosis. Holistic, non-judgemental and positive care was preferred.

While women were often knowledgeable about their type 2 diabetes risk and about ways of preventing it, they faced multiple barriers to undertaking such preventive behaviours.

Lifestyle change support was needed. Women would like healthcare providers to take a more pro-active approach to postpartum care.

Conclusions: Improved GDM education and materials coupled with the provision of holistic, non-judgemental and pro-active care from diagnosis of the condition through all stages of

postpartum follow-up may increase healthcare seeking by women with GDM in the postpartum period, which may facilitate both prevention and early diagnosis of type 2 diabetes.

Introduction

Gestational diabetes mellitus (GDM) is strongly associated with future risk of type 2 diabetes mellitus (T2DM) (Bellamy et al 2009;Feig et al 2008). The risk of development of T2DM in the first 10 years for women after GDM has been reported to be between 20% and 50%, and the lifetime risk may be greater than 70% (Feig et al 2008;Kim et al 2002;Lee et al 2007). International and national organisations recommend postpartum screening following GDM (American Diabetes Association 2013;Canadian Diabetes Association Clinical Practice Guidelines Expert Committee 2013;IADPSG Consensus Panel 2010;Nankervis et al 2014;National Institute for Health and Care Excellence 2008). Previous research shows that many women who have experienced GDM do not complete, or are not offered, adequate follow up for their GDM, particularly postpartum diabetes screening (Dietz et al 2008;McGovern et al 2014;Tovar et al 2011). This deficiency in postpartum follow-up for women with GDM has been recognised by clinicians and researchers, with calls for improvements in the United States (Gabbe et al 2012) and Australia, with researchers highlighting fragmentation and inconsistencies in postpartum care and the need for a professional group to take responsibility for care of women who have had GDM (Wilkinson et al 2014).

Considerable research has been conducted into factors influencing healthcare seeking and preventive behaviour from the perspective of women with a history of GDM, although only a fraction of this research has been systematically synthesised. A previous meta-synthesis of 16 qualitative studies relating to women's experiences of GDM, their perception of their risk of T2DM and their views on T2DM prevention reported on several themes. These included an emotional response to their GDM diagnosis, loss of a "normal" pregnancy experience, the importance of "personal control" in relation to GDM management, a motivation to have the best possible glucose control or GDM management in order to do their best for the baby, as well as the importance of adequate information relating to GDM and healthcare support (Parsons et al 2014).

The objective of this systematic review is to identify factors that influence postpartum healthcare seeking for women who have experienced GDM through synthesis of results from qualitative and survey studies.

Methods

The protocol for this review is registered with the international systematic review register PROSPERO 2013:CRD42013003599.

Search strategy

PubMed, EMBASE, Web of Science, and CINAHL were searched from inception to 27th February 2013, with no date or language restrictions. The full search strategy is available in Appendix 1. Reference lists of included studies were searched for additional studies. Titles and abstracts were examined for eligibility by one author. The full text of studies that appeared to meet inclusion criteria were assessed independently by two authors, with a final list of included studies resulting from discussion and consensus between two authors.

Selection of studies

Studies were selected for inclusion in the review if they met the following criteria: (a) qualitative study, or survey; (b) participants were women who have experienced GDM; and (c) reported at least one of the following pre-specified outcomes:

Primary outcomes

- (1) Barriers to postpartum healthcare seeking, for women who have experienced GDM
- (2) Facilitators to postpartum healthcare seeking, for women who have experienced GDM

Secondary outcomes

- (1) Knowledge of risk of type 2 diabetes
- (2) Perception of risk of type 2 diabetes
- (3) Attitudes towards postpartum follow up of GDM
- (4) Attitudes towards postpartum blood glucose testing

- (5) Attitudes towards reminders for follow up or blood glucose testing
- (6) Knowledge of complications of type 2 diabetes (for mothers and/or babies)
- (7) Knowledge of how to prevent type 2 diabetes in the future

Data extraction

At least two authors (EVR, ES, PM) independently extracted data on the characteristics, pre-specified outcomes, and funding sources of the included studies.

Quality assessment

Quality assessment was carried out using the Critical Appraisal Skills Programme (CASP) checklist for qualitative studies (Critical Appraisal Skills Programme). Any differences between assessments were resolved through discussion amongst authors.

Data synthesis

The qualitative synthesis method chosen was thematic synthesis, due to its successful application in previous systematic reviews of qualitative studies (Schumann et al 2012; Thomas and Harden 2008; Tong et al 2009). The authors of this paper also used thematic synthesis in a companion review of healthcare provision by clinicians (Van Ryswyk et al 2014). The independently extracted outcome data from each included study were compared and finalised by two authors. Potential themes and theme categories were then identified, discussed and modified until a final decision regarding each was reached.

Results

Study selection process

This systematic review is reported in accordance with the PRISMA statement (Moher et al 2009). 1249 abstracts and full-text articles were identified. After removal of duplicates and exclusion on the basis of title and abstract alone, two authors assessed the records of 68 studies (with 81 abstract/full-text records) for inclusion. Twenty seven studies were excluded; for the list of excluded studies, with reasons, refer to Appendix 2. The abstract for one

additional study was identified during assessment, and was also included (Wylie et al 2011). As a result of this process, 42 studies (with 55 records) were included (Figure 1). For the full list of included study references, including abstracts, please refer to Appendix 3.

Study characteristics

A summary of the characteristics of the included studies is provided in Table 1. The 42 included studies had data from 7949 women, who spoke languages including English, Hindi, Bengali, Vietnamese, Cantonese, Mandarin, Filipino, Spanish, Danish, Arabic, Swedish, French, German and Portuguese. The included studies were conducted via interviews (18 studies), a combination of interviews and surveys (four studies), interviews and focus groups (three studies), survey-only (15 studies), or focus groups (two studies). Twelve of the studies were conducted in the United States, ten in Australia, nine in Europe/UK, seven in Canada, two in Brazil, one in Vietnam and one in Tonga. The results from one group of six studies by the same author (Hjelm) were grouped together as one study, as the studies appeared to have included results from the same women across the six studies, albeit with different comparison groups; this was done to reduce inappropriate amplification of views from the same women.

Quality assessment

All included studies were appraised using the 10-item CASP checklist for qualitative studies (Critical Appraisal Skills Programme) (Table 2). Two studies met all of the criteria for quality assessment (Bieda 2009;Doran and Davis 2010). In all other studies, it was unclear whether one or more quality assessment criteria were met, and in 11 studies less than half of the quality assessment criteria were clearly met. Seven studies were not in full text format, limiting the information available for quality assessment; six studies were abstracts only (Bell et al 2011;Hoy-Rosas and Lancaster 2011;Remsberg 2012;Segall-Gutierrez et al 2011;Wylie et al 2011;Wylie et al 2012), whilst one study was published in commentary format (Keely et al 2012).

Most included studies had clearly stated aims (n = 36/42), and warranted a qualitative approach (40/42). Whilst most studies had well described and justified research design (n =

26/42), several did not meet this criteria, due to being in abstract or commentary format, with insufficient details of the research design reported, or through having the design reported but not adequately justified by the authors. Just over half of the included studies had adequately described recruitment strategies, but nineteen studies had insufficient details of their strategies reported to make a clear assessment of their method. Fourteen study records did not include details on their data collection methods; six were in abstract format. The other eight studies either did not discuss data saturation, did not provide the actual questions asked in their data collection process or did not explain why their data collection methods were the most appropriate for their research question.

It was evident in just nine of the included studies that the authors had critically examined their own potential bias and role (relationship criteria) in formulation of the research questions, methods and their response to events in the study. Just over half of the included studies (n = 22) had clearly taken ethical issues into consideration, although in the remaining studies there were either insufficient details of how the research was explained to participants for the reader to assess whether ethical standards were maintained, or the researchers did not discuss ethical issues such as informed consent.

Data analysis was sufficiently rigorous in most of the included studies (n = 26). Sixteen studies had either insufficient information reported to allow assessment of the data analysis process and results, or it was unclear whether the authors had critically examined their own potential bias in the selection of data for presentation.

Most studies (n = 26) had explicit findings, with adequate discussion of the credibility of results, and how the results related to the original research question. Studies mainly had well described value and research implications (n = 29).

Data synthesis

Seven theme categories were identified: experiences relating to antenatal GDM diagnosis and management; maternal role; perception and knowledge of risk of T2DM; how healthcare is provided; barriers to healthcare access; T2DM detection postpartum; and T2DM prevention.

Experiences of GDM diagnosis and management

Four studies reported that for some women, being diagnosed with GDM was a concerning or upsetting experience, particularly where the women were concerned about the possibility of future complications of type 2 diabetes:

“When I heard the diagnosis, it was scary. I panicked (Lawson and Rajaram 1994).”

“I was really depressed for weeks. I cried and cried. It was like: *Oh no, I don't have diabetes!* I mean, the whole thing was very scary (Lawson and Rajaram 1994).”

Women who had previously experienced medically complicated pregnancies had more subtle reactions to the diagnosis (Lawson and Rajaram 1994).

A diagnosis of GDM sometimes resulted in a change in or loss of identity as a healthy person with a “perfect” or “normal” pregnancy (Lawson and Rajaram 1994), and due to a pressure to conform to this ideal, women sometimes felt the need to hide their diagnosis:

“I took my blood at LaMaze classes (pregnancy and birth classes), and it was interesting, because I wanted to hide it, even though other gestational diabetics could have been in the class (Lawson and Rajaram 1994).”

Women had varied experiences of their antenatal GDM care. Some women had positive experiences of their care, with increased confidence relating to the lifestyle changes they had been able to make, and their now good understanding of GDM and its management. Others experienced antenatal management of GDM as confusing or difficult:

“They told me I'm supposed to be on this crazy diet where there's only lettuce and vegetables and they put me on this diet that made my blood go up to like 20. And I told them, *I'm not going to go on that diet because the diet you guys put me on—the way you're talking, you guys are killing me quicker than [when] I was eating my fries!* (Neufeld 2011)”

Some women would have preferred for pregnancy and GDM care to be better integrated, or more holistic, rather than segmented:

“...both the pregnancy and the diabetes need to be focused, so that it is not just the diabetes when you come here [diabetes clinic] and that it is not just the pregnancy when you come to the midwife...that it feels like co-operation...and...there are a lot of specialists involved (Hjelm et al 2007).”

“...not that they [clinicians] mean to be, but they are very clinical and removed and don't seem to understand, you are attempting to deliver a healthy baby and manage and plan the rest of your life; whereas they are with you for 20 minutes and are attempting to determine why you decided to eat your toast with jam! (Nicklas et al 2011)”

A small number of women expressed a preference for more positive, constructive care:

“I found myself very annoyed at the clinicians because I always felt they were a tinge judgmental about the GDM and had a lot of assumptions. Any meeting with them started with, ‘Now you have to change your lifestyle,’ and I thought: *You don't know what my lifestyle is, so how do you know what is bad or what needs to change?* I may already know and be changing what I need to in order to be healthy. I am not a child (Nicklas et al 2011).”

“GDM comes with a whole team of professionals, but what is missing is a place to bounce off how to move forward [after delivery] with life ideas in a positive surrounding, as opposed to looking back at mistakes (Nicklas et al 2011).”

The information available for GDM was an aspect of care that women viewed as being deficient. Women sought information on their GDM from multiple non-medical sources, and were often able to find much information on T2DM, but little information specific for GDM.

Furthermore, the education and information was sometimes in a different language or needed to be adapted to the woman's own culture.

Maternal role

The maternal role sometimes presented a barrier to care seeking, with children's needs taking priority over care seeking:

“I don't really spend too much time thinking about [my risk for diabetes]. Because I've got two kids under four and I am too busy to spend my day worrying about [my health] (Razee et al 2010).”

Similarly, time constraints, lack of sleep or fatigue, maternal attachment and adjustment to a new baby all played a role. Some women found it difficult to attend postpartum care due to breastfeeding, and may have been more receptive to health messages relating to diabetes after their babies have been weaned.

Perception and knowledge of risk of T2DM

More often than not, women had good or frequent knowledge of their risk of T2DM:

“I hope it will be over after the delivery, but it is latent, there is an increased risk of diabetes (Hjelm et al 2005).”

In eight studies, women had poorer knowledge of their risk:

“The doctor did discuss some of the risks for the baby, but they didn't discuss what my risks would be of getting diabetes later (Collier et al 2011).”

Women reportedly used differing primary sources of information relating to T2DM risk, with some women getting most of their information from health professionals, and others from their families. A small number of studies reported a need to increase public awareness of the link between GDM and T2DM.

Perceptions and emotional associations

There was variation in perception of future T2DM risk, with women's personal risk perceptions being increased with longer time since diagnosis, family history of T2DM, and other known risk factors for T2DM. For some, the development of chronic T2DM was "dreaded" (Lawson and Rajaram 1994), especially the prospect of needing lifelong insulin, or of having complications that may have been witnessed in others:

"I don't know if I could handle giving myself shots forever. I could not handle it.

Someone would have to give me shots all my life (Lawson and Rajaram 1994)."

"I guess one thing . . . is fear. People coming back at 6 weeks, they know they have to do that blood sugar check-up, and they probably fear that . . . they're gonna have to continue doing blood sugars, and, continue with their diets like they were during the pregnancy (Bennett et al 2011)."

The hope that diabetes may no longer be present after birth made it easier to tolerate the condition and its strict management. Some women saw GDM as an indicator of a need to take positive steps to try to prevent T2DM, whilst others felt that they lacked control over the development of T2DM, or perceived that it was inevitable.

How healthcare is provided

Some women felt a sense of postpartum abandonment, after intensive antenatal management of their GDM:

"You're kind of left on your own. I don't know, it's kind of hard to elaborate on something like that, like I feel I was abandoned. Like, OK, what am I supposed to do? (Evans et al 2010)"

Similarly, some women expressed that there was a need for clinicians to take a more proactive approach to postpartum care, including recommending the diabetes screening test, providing advice on self-blood glucose monitoring, making follow-up appointments for

monitoring and support of T2DM prevention. Reminders to facilitate attendance for care were considered to be helpful. Positive connections with clinical staff were important facilitators to care attendance, and women valued trustworthiness, professional competence and cultural sensitivity in their interactions with healthcare providers.

Barriers to healthcare access

Socioeconomically disadvantaged women often faced barriers to accessing care, such as lack of health insurance, out of pocket costs. Women also experienced long waiting times for appointments, and a clash between their own working hours and the opening hours of healthcare clinics. For some, there was not enough time with providers, and women sometimes did not have their healthcare questions answered:

“A lot of times those doctors will see so many Medicaid patients. They don’t want to answer your questions (Collier et al 2011).”

“A doctor only has you for so many minutes. They don’t explain in detail how you should take care of the gestational diabetes (Collier et al 2011).”

Not having a specific primary care provider was also a barrier for some.

T2DM detection postpartum

Postpartum testing for T2DM was an emotional experience, with feelings ranging from fear and sadness at the prospect of a diagnosis of T2DM to great happiness at receiving a normal result. Numerous reasons for non-completion of T2DM screening in the postpartum period were apparent. Some, but not all women understood the need for follow-up T2DM screening. Other women had continued to perform self-blood glucose monitoring after birth and therefore did not see a need to attend for glucose screening; others forget the test, became pregnant again or lost their laboratory request form. Some women experienced postpartum mood symptoms or had no desire to take the test. The oral glucose tolerance test was a barrier for some women, with a more convenient, pleasant test being desired. Women were more likely to attend for T2DM screening if they had a desire to know their blood glucose status,

and also when their test was able to be coupled with other reasons for postpartum clinic attendance, such as clearance for their return to work, birth-related health checks and family planning.

T2DM prevention

Education about T2DM prevention was evenly distributed between the family, health care providers and the media. Women often had a positive attitude towards T2DM prevention, along with knowledge of how to prevent T2DM, with many having knowledge of the role of diet, exercise and weight control in diabetes prevention:

“It’s good to learn about it, otherwise the way I was going, definitely I would have diabetes 2 (sic). I didn’t know about it but now I can control myself and . . . Yeah, because the way I’m not having anything, I was having heaps of sugars every day (Carolan et al 2012).”

Motivators for lifestyle change included high risk perception and fear of future GDM and T2DM. Many had a high awareness of the need to take steps to prevent T2DM. However, numerous barriers existed to achieving and maintaining these preventive changes. Barriers to healthy eating included cost, lack of time, being unsure which foods to eat, a focus on food in social situations, lack of motivation and personal or cultural food preferences. For some women, there was a lack of knowledge of how to prevent T2DM. Given the numerous barriers to lifestyle change, lifestyle change support both in the short and long term was important, although the types of support required varied between women e.g. social support was needed by some, whilst financial or professional support was required by others.

Discussion

Summary of the main results

The diagnosis of GDM was for some women, concerning or upsetting experience. Following the diagnosis, women sought information from multiple sources and found that there was a

lack of specific information on GDM compared with other forms of diabetes. Some women had difficult or confusing experiences relating to antenatal management of their GDM, whilst other women had more positive experiences of antenatal care.

Knowledge of the risk of T2DM was common, although in some studies women had poorer knowledge and could benefit from better education. There was wide variation in perception of future T2DM risk, with some women believing development of T2DM to be inevitable.

Women had increased perception of risk of T2DM with increased time from their GDM diagnosis, family history of T2DM and other known risk factors for GDM. Women worried about receiving a diagnosis of chronic diabetes, especially in relation to the prospect of lifelong insulin or the possibility of complications.

The maternal role played an important part in determining attendance for postpartum care, with children's needs often taking priority over care seeking. A need for clinicians to take a more pro-active approach to postpartum care was identified. This included recommending the diabetes screening test to women, providing advice on blood glucose self-monitoring after birth, and making follow-up appointments relating to T2DM prevention. Women also expressed positive views relating to reminders to facilitate care.

Knowledge of how to prevent T2DM, including the role of diet, exercise and weight control was common amongst women in a third of studies. In a smaller number of studies, women lacked knowledge relating to T2DM prevention, and could have benefited from better education. Women's views on T2DM prevention likely also played an important role in postpartum healthcare seeking, with many women having a positive attitude towards T2DM prevention. Motivators for lifestyle changes included high risk perception and fear of future GDM and T2DM. Although, the lifestyle changes required, particularly healthy eating, were often difficult to achieve and maintain on a long term basis, and women often described a need for lifestyle change support.

Agreements and disagreements with other studies or reviews

Similar themes were found relating to barriers to postpartum diabetes screening as those described in another recent systematic review, which investigated “determinants” and barriers to GDM care from initial screening to postpartum follow-up, and which included studies from searching only one database, PubMed. Their barriers to attendance for postpartum care included time constraints and a focus on the baby’s health (Nielsen et al 2014), although only two qualitative studies specific to postpartum diabetes screening were included in their systematic review (Bennett et al 2011;Keely et al 2010). The same systematic review (Nielsen et al 2014) included several studies relating to barriers to having a healthy lifestyle in the postpartum period, and there were similarities in the themes identified, particularly in relation to a need for lifestyle change support.

Our systematic review had some similar findings to the meta-synthesis of 16 qualitative studies by Parsons et al 2014 (Parsons et al 2014) examining women’s experiences of GDM. One similar finding included a significant emotional response to the GDM diagnosis; the emotions in response to the GDM diagnosis described in the qualitative meta-synthesis were shock, denial, sadness, fear and difficulty coming to terms with a condition for which there were no symptoms (Parsons et al 2014). Other similar findings were a preference for holistic and non-judgemental care; a lack of specific information on GDM; a wide variety of perception of type 2 diabetes risk; and several similar barriers to adopting a healthier lifestyle.

Strengths and limitations

The search strategy for this systematic review did not use date or language restrictions, encompassed four databases, and there were well defined pre-specified outcomes. This systematic review included several additional studies relevant to postpartum care for women with GDM than a comparable synthesis of qualitative studies (Parsons et al 2014).

While there was variation in locations and settings of the included studies, there were common themes across studies. For each included study, two authors independently extracted data, and appraised study quality using a CASP checklist, which is a commonly used tool for

quality assessment (Critical Appraisal Skills Programme). More than half of the included studies were of good to excellent quality, meeting seven or more of the ten quality assessment criteria. Nine studies (>20%) were average to moderate quality, meeting five to six criteria. Just ten studies met less than half of the criteria (six of which were in abstract or commentary format and contributed little to the overall findings of the review, and two of which were in languages other than English).

Conclusion

Implications for practice

Care provision from diagnosis of GDM through to postpartum follow-up may influence the likelihood of women's seeking and participation in care after they give birth. It is important to recognise the potential emotional impact of the GDM diagnosis, with associated loss of the "normal" or "perfect" pregnancy experience, and for adequate support such as counselling to be available. Having culturally and language-appropriate written information on GDM is similarly important. Following the diagnosis, some women indicated a preference for provision of non-judgemental, holistic and positively focussed care.

In the postpartum period, care could be improved by healthcare providers taking a more proactive approach, including recommending the diabetes screening test, providing advice on blood glucose self-monitoring, making follow-up appointments for monitoring and support of T2DM prevention, and providing reminders to facilitate attendance. Other critical factors are improving the education given to women regarding their risk of type 2 diabetes and how to prevent the condition.

Implications for research

Further research is required on how to best manage the emotional impacts of GDM such that women find being diagnosed with GDM to be a more positive experience. Production and assessment of educational materials is important. Methods for provision of more holistic care

require further exploration. Systematic methods of improving follow-up care and support for women who have experienced GDM into diabetes prevention is necessary.

Acknowledgements

We are grateful to Michael Draper, who provided guidance and assistance with development of the search strategy for this review, to Dr Caroline Schneeberger, who kindly translated an included study, and also to Dr Mojgan Vatani, who assisted with assessment of a study in Swedish.

Figure 1: A flow chart of study selection, with excluded studies reasons included in the flow chart

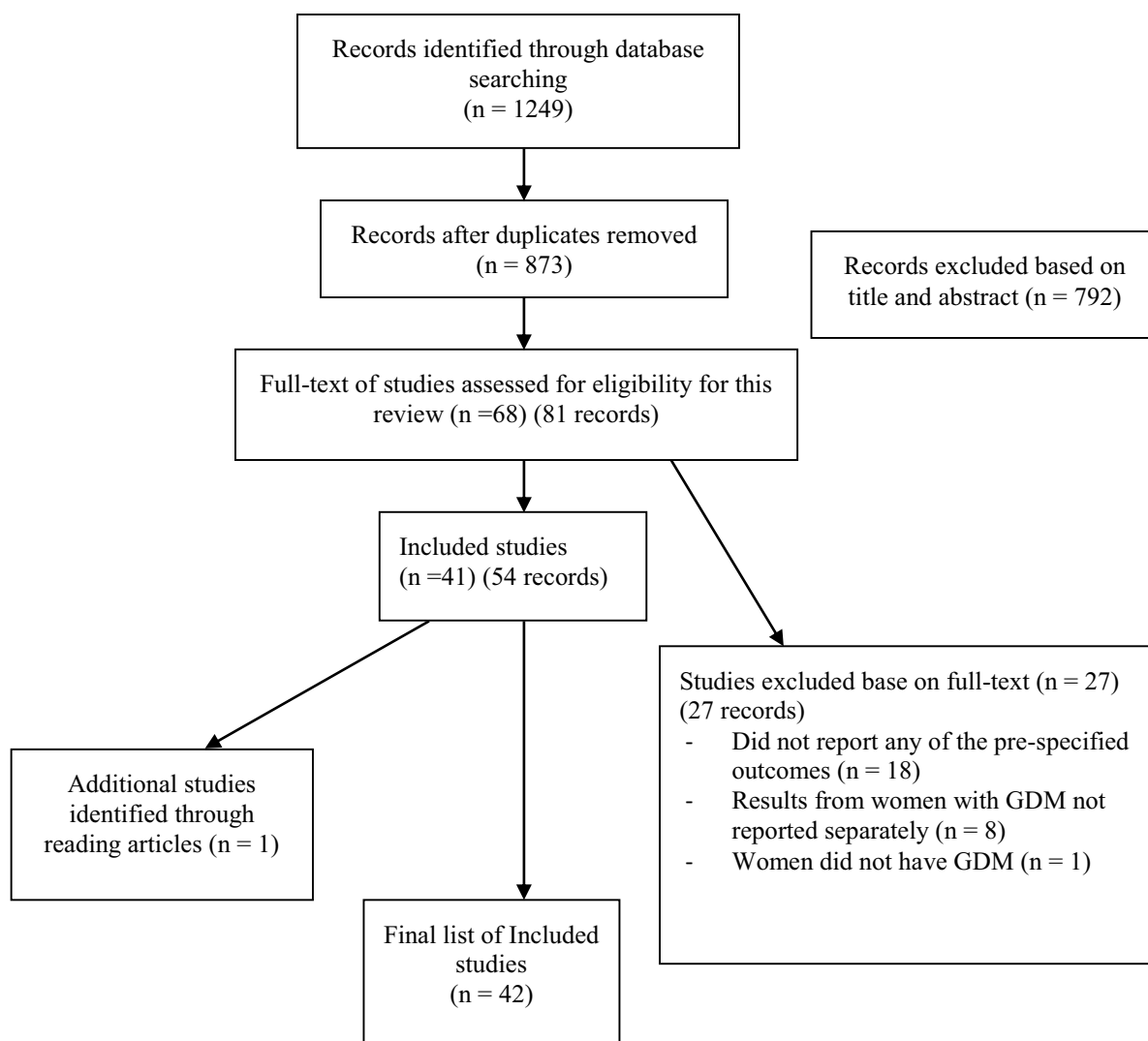


Table 1: Characteristics of Included Studies

#	Study ID	Location	Type of study	Participants (women with GDM)	Data collection period (year)
	Australia				
1	Bandyopadhyay 2011	Melbourne	Interviews	17 South Asian (Hindi, Bengali or English speaking)	Antenatal, Postpartum (2009)
2	Carolan 2013	Melbourne	Interviews/focus group	15 English speaking	Antenatal (NS)
3	Graco 2009	Victoria	Interviews	10 English speaking women	Postpartum (2004)
4	Doran 2008	New South Wales	Survey and interviews	38 Survey (subset of 8 Interviewed) English speaking	Antenatal, Postpartum (unclear)
5	Morrison 2010	National	Survey	1176 English speaking	Postpartum (2003-5)
6	Carolan 2010	Melbourne	Survey	143 Vietnamese, Indian, Chinese, Filipino or Caucasian (interpreters utilised)	Antenatal (2007)
7	Razee 2010	Sydney	Interviews	57 (20 Arabic, 20 Cantonese/Mandarin & 17 English speaking)	Postpartum (2006)
8	Smith 2005/Zehl 2008	Sydney	Survey	244 English speaking	Postpartum (unclear)
9	Sterne 2011	Queensland	Survey	88 English speaking	Postpartum (2006-7)
10	Swan 2007	Victoria	Survey	53 women (either in English, or with interpreters)	Postpartum (2004-5)
	United States				
11	Jones 2012	“A South-western State”	Interviews and survey	22 self-identified American Indian	Postpartum (unclear)
12	Hoy-Rosas 2011	New York	Interviews	3 (1 Latina, 1 Asian, 1 African-American)	Postpartum (unclear)
13	Bennett 2011	Baltimore	Interviews	22 English speaking	Postpartum (unclear 2008-9)
14	Collier 2011	Atlanta	Focus group	54 English or Spanish speaking	Postpartum (2004-5)
15	Downs 2006	Pennsylvania	Survey	28 English speaking	Postpartum (2004)
16	Bieda 2009	Michigan	Interviews	25 African-American (English speaking)	Antenatal (unclear)
17	Kim 2007 Risk	Michigan	Survey	217 English speaking	Postpartum (unclear)

18	Kim 2007 Racial	National	Survey	4718 English speaking	Antenatal, Postpartum (2001-3)
19	Lawson 1994	Kentucky	Interviews	17 English speaking	Antenatal (unclear)
20	Nicklas 2011	Boston	Interviews/focus group	25 English speaking	Postpartum (2009)
21	Remsberg 2012	Ohio	Survey	73 (language not specified - abstract only)	Postpartum (unclear)
22	Segall-Gutierrez 2011	California	Survey	75 English or Spanish speaking	Postpartum (unclear)
	Canada				
23	Evans 2005	Ontario	Interviews	12 English speaking	Antenatal, Postpartum (unclear)
24	Evans 2010	Ontario	Interviews and survey	13 English speaking	Postpartum (unclear)
25	Feig 1998	Toronto	Survey	65 English speaking	Postpartum (1996)
26	Gaudreau 2012	Quebec	Interviews	7 Algonquin (Native American)	Postpartum (2006)
27	Keely 2010	Ottawa	Survey	140 English speaking	Postpartum (2002-5)
28	Keely 2012	Ottawa	Survey	51 English speaking	Antenatal (2010-11)
29	Neufeld 2011	Winnipeg	Interview	29 Aboriginal (Canadian)	Antenatal, Postpartum (2006-7)
	Europe/UK				
30	Stage 2004	Denmark	Survey	121 Danish speaking (Caucasian)	Postpartum (unclear)
31	Hjelm 2005-12 (all Hjelm studies i.e. 2005, 2007, 2008, 2009, 2012, 2011/12b)	Lund, Sweden	Interview	<ul style="list-style-type: none"> • 14 born in the Middle East • 10 African born • 13 Swedish born (Clinic A – Hospital Endocrinology) • 10 Swedish born (Clinic B – Specialist Maternity Clinic) 	Antenatal, Postpartum (2000-1)
32	Lindmark 2010	Sweden	Interview	10 Swedish speaking	Postpartum
33	Persson 2010	Sweden	Interview	10 Swedish speaking	Antenatal (1998, 2000, 2006)
34	Clarke 2012	Paris, France	Survey	124 French speaking	Postpartum (2008-9)
35	Trutnovsky 2012	Austria (not AUS)	Interview and survey	45 German speaking	Antenatal (unclear)
36	Bell 2011	UK (NS)	Interviews	31 (abstract only)	NS (unclear)

37	Wylie 2011	UK (Plymouth)	Interviews	12 (abstract only)	Antenatal (unclear)
38	Wylie 2012	UK (Plymouth)	Interviews	12 (abstract only)	Unclear
	South America				
39	Saloman 2004	Minas Gerais Brazil	Interviews	9 Portuguese speaking	Antenatal (2003)
40	Soares 2006	Minas Gerais Brazil	Interviews/focus group	56 interviewed and 7 in focus group (Portuguese speaking)	Unclear (translated from Portuguese)
	Asia				
41	Doran 2010	Nuku'alofa, Tonga	Interviews	11 English speaking	Postpartum (2006)
42	Hirst 2012	Ho Chi Minh, Vietnam	Focus group	34 Vietnamese women	Antenatal (2010-11)

Abbreviations are: not specified (NS).

Table 1: CASP Quality Assessment

Location	Studies containing either interviews or focus groups (±surveys)													
	Australia				United Kingdom			Sweden			Austria	Tonga	Vietnam	
CASP	Bandyopadhyay 2011	Carolan 2013	Graco 2009	Doran 2008	Razee 2010	Bell 2011	Wylie 2011	Wylie 2012	Persson 2010	Lindmark 2010	Hjelm 2005-12	Trutnovsky 2012	Doran 2010	Hirst 2012
Clear aims	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Qualitative	+	+	+	+	+	+	+	+	+	+	+	+	+	+
Design	+	+	+	+	+	?	?	?	+	+	+	+	+	+
Recruitment	+	+	?	+	?	?	?	?	?	+	?	?	+	+
Collection	+	+	+	+	?	?	?	?	+	+	+	?	+	+
Relationship	?	?	?	?	?	?	?	?	+	?	+	?	+	+
Ethics	+	+	?	+	?	?	?	?	?	+	+	?	+	+
Analysis	+	+	+	+	+	?	?	?	+	+	+	?	+	?
Findings	+	+	+	?	+	?	?	?	+	+	+	?	+	?
Value	+	+	+	+	+	?	?	?	+	+	+	?	+	+

Location	USA								Canada				Brazil	
	Bennett 2011	Collier 2011	Bieda 2009	Lawson 1994	Nicklas 2011	Hoy-Rosas 2011	Jones 2012	Evans 2005	Evans 2010	Gaudrea 2012	Neufeld 2011	Saloman 2004	Soares 2006	
CASP														
Clear aims	+	+	+	?	+	?	+	?	+	+	+	+	?	
Qualitative	+	+	+	?	+	+	+	+	+	+	+	+	?	
Design	+	+	+	?	+	?	+	+	+	+	+	+	?	
Recruitment	+	+	+	+	?	?	+	?	?	+	?	?	?	
Collection	+	+	+	+	+	?	+	?	+	+	+	+	?	
Relationship	+	?	+	?	?	?	?	?	?	?	?	?	?	
Ethics	?	+	+	?	+	?	+	?	+	+	+	+	?	
Analysis	?	+	+	+	+	?	+	?	+	?	?	?	?	
Findings	?	+	+	+	+	?	+	?	+	?	?	?	?	
Value	+	+	+	+	+	?	+	+	+	+	?	?	?	

Studies which are exclusively survey type																
Location	Australia						United States						Canada		France	Denmark
	Morrison 2010	Sterne 2011	Smith 2005	Carolan 2010	Swan 2007	Kim 2007a	Downs 2006	Kim 2007b	Remsberg 2012	Segall-G. 2011	Feig 1998	Keely 2010	Keely 2012	Clarke 2012	Stage 2004	
Clear aims	+	+	+	+	+	+	+	+	+	+	+	+	+	?	?	
Qualitative	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	
Design	+	?	+	+	?	?	?	?	?	?	+	+	?	-	?	
Recruitment	+	+	+	+	+	?	?	?	?	?	+	+	+	?	+	
Collection	+	+	+	+	+	?	+	?	?	?	+	?	+	+	+	
Relationship	?	?	?	+	+	?	?	?	?	?	?	?	?	-	?	
Ethics	+	+	+	?	+	?	+	?	?	?	?	?	+	+	?	
Analysis	+	+	+	-	+	+	+	?	?	?	?	+	?	?	+	
Findings	+	+	+	?	+	+	+	?	?	+	+	+	+	-	+	
Value	+	+	+	+	+	+	+	?	?	+	+	?	?	?	+	




 = Met quality assessment criterion.
  = Unclear whether criterion was met.
  = Criteria not met.
 Segall-G = Segall-Gutierrez.

Table 2: Theme categories and themes

Experiences relating to antenatal GDM diagnosis and management	Australia	United States	Canada	South America	Europe/UK	Asia
Difficult or confusing experience relating to antenatal management of GDM		Bennett 2011 Lawson 1994	Neufeld 2011		Hjelm 2005-12 Trutnovsky 2012 Persson 2010	
More information specific for GDM wanted		Collier 2011		Saloman 2004	Hjelm 2005-12 Lindmark 2010	Hirst 2012
Concern or sadness about the GDM diagnosis and its implications (may be worse in women with greater knowledge of T2DM complications, and lessened in women with previously complicated pregnancies)		Bieda 2009 Lawson 1994		Saloman 2004	Lindmark 2010	
Positive experiences of antenatal GDM care (increased confidence relating to lifestyle changes, good understanding of GDM and its management)					Hjelm 2005-12 Lindmark 2010 Trutnovsky 2012 Persson 2010	
GDM education must be adapted to culture and language		Collier 2011	Gaudreau 2012		Hjelm 2005-12	
Women obtained information on GDM from multiple non-medical sources		Collier 2011 Lawson 1994				Hirst 2012
Change in identity from being a healthy person and loss of normal pregnancy experience		Lawson 1994			Persson 2010	
Preference for care to be holistic, non-judgemental and focussed on positive change		Nicklas 2011			Hjelm 2005-12	
High motivation for GDM treatment to do the best for the baby					Trutnovsky 2012	

Maternal role	Australia	United States	Canada	South America	Europe/UK	Asia
Women still undertaking most house work, leaving less time for self-preventive care	Razee 2010					
Time constraints		Bieda 2009 Nicklas 2011	Keely 2010			
Child's needs taking priority over care seeking	Razee 2010	Nicklas 2011 Bennett 2011		Soares 2006	Hjelm 2005-12 Bell 2011	
Breast-feeding, with more receptivity to health messages after weaning		Bennett 2011	Keely 2010		Bell 2011	
Lack of sleep or fatigue		Bennett 2011 Nicklas 2011			Bell 2011	
Maternal attachment and adjustment to the new baby	Bell 2011 Bennett 2011					
Perception and knowledge of risk of T2DM	Australia	United States	Canada	South America	Europe/UK	Asia
Good or frequent knowledge of risk of T2DM	Bandy. 2011 Graco 2009 Morrison 2010 Razee 2010	Bieda 2009 Jones 2012 Kim 2007a Remsberg 2012 Segall-Gutierrez 2011	Feig 1998	Saloman 2004	Hjelm 2005-12 Lindmark 2010 Wylie 2012 Persson 2010	
Poor knowledge of risk of T2DM	Carolan 2013	Bieda 2009 Collier 2011	Feig 1998		Hjelm 2005-12 Lindmark 2010 Clarke 2012 Wylie 2012 Trutnovsky 2012	
Need to increase public awareness of link between GDM and T2DM	Doran 2008					Doran 2010

Differing primary sources of information on future risk - Health professionals for some, family for others		Bieda 2009							
Women had increased perception of risk of T2DM with increased time from diagnosis, family history of T2DM and other known risk factors for GDM	Morrison 2010 Sterne 2011	Bieda 2009 Kim 2007a		Saloman 2004, Saloman 2004					
Dread of chronicity of diabetes, including the prospect of lifelong insulin, and distress relating to witnessing complications of T2DM in others		Bennett 2011 Bieda 2009 Lawson 1994	Neufeld 2011	Saloman 2004					
GDM perceived as an indicator of the need to take steps to prevent T2DM		Kim 2007a			Hjelm 2005-12				
Perception of inevitability or no control over development of T2DM (sometimes due to religious beliefs)	Doran 2008	Bieda 2009		Saloman 2004	Persson 2010				
The hope that diabetes may no longer be present after birth made it easier to tolerate the condition and its strict management		Lawson 1994		Saloman 2004	Persson 2010 Hjelm 2005-12				
Much variation in perception of future diabetes risk	Morrison 2010	Kim 2007a Nicklas 2011			Stage 2004				
How healthcare is provided	Australia	United States	Canada	South America	Europe/UK	Asia			
Need for clinicians to take a more pro-active approach to postpartum care (recommending the diabetes screening test, providing advice on blood glucose self-monitoring, making follow-up appointments for T2DM prevention)	Doran 2008 Sterne 2011 Graco 2009	Nicklas 2011	Keely 2010 Evans 2010		Wylie 2011 Hjelm 2005-12				
Positive views on reminders to facilitate attendance for care	Doran 2008 Razee 20104 Sterne 2011 Swan 2007		Keely 2010 Keely 2012						
Positive connection with clinical staff important		Bennett 2011			Hjelm 2005-12				

Other reasons for non-attendance at T2DM screening (forgetting the test, new pregnancy, mood symptoms, lost laboratory test form, no desire to take the test)	Sterne 2011			Keely 2010	Soares 2006		
OGTT difficult to complete (more convenient, pleasant test as a facilitator)	Sterne 2011		Keely 2010				
Reasons for postpartum clinic attendance other than T2DM risk (clearance for work, birth-related issues, family planning)		Bennett 2011					
Follow up care well understood by some	Carolan 2010						
T2DM prevention	Australia	United States	Canada	South America	Europe/UK	Asia	
Positive attitude towards T2DM prevention	Carolan 2013 Doran 2008 Swan 2007	Lawson 1994 Jones 2012	Evans 2005 Evans 2010 Neufeld 2011		Hjelm 2005-12 Lindmark 2010		
Common knowledge of how to prevent T2DM including the role of diet, exercise, weight control	Carolan 2013 Doran 2008 Swan 2007	Jones 2012 Kim 2007a Lawson 1994 Hoy-Rosas 2011 Remsberg 2012	Gaudreau 2012 Neufeld 2011 Evans 2005 Evans 2010		Hjelm 2005-12 Lindmark 2010		
High awareness of need to take steps to prevent T2DM	Swan 2007	Bieda 2009 Kim 2007a		Saloman 2004	Hjelm 2005-12		
Motivators for lifestyle change included high risk perception and fear of future GDM and T2DM		Hoy-Rosas 2011 Nicklas 2010	Evans 2010			Doran 2010	
Difficult to achieve or maintain healthy lifestyle (esp pregnancy motivated behaviour change)	Swan 2007	Jones 2012 Nicklas 2011	Evans 2010		Bell 2011 Hjelm 2005-12 Lindmark 2010		
Lifestyle change support (long-term) is critical but types of desired support varies (e.g. social or financial or professional support)	Smith 2005	Nicklas 2010 Bieda 2009		Soares 2006	Bell 2011 Lindmark 2010		

Statement of Authorship

Title of Paper	The DIAMIND study: postpartum SMS reminders to women who have had gestational diabetes to test for type 2 diabetes: a randomised controlled trial - study protocol
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Author Contributions

By signing the Statement of Authorship, each author certifies that their stated contribution to the publication is accurate and that permission is granted for the publication to be included in the candidate's thesis.

Name of Principal Author (Candidate)	Emer Van Rysywk (maiden surname = Heatley)	
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Contribution to the Paper	Contributed to study design and trial protocol, participated in ethics submission and edited the manuscript for publication.	
Signature		Date 15/2/15

STUDY PROTOCOL

Open Access

The DIAMIND study: postpartum SMS reminders to women who have had gestational diabetes mellitus to test for type 2 diabetes: a randomised controlled trial – study protocol

Emer Heatley^{1*}, Philippa Middleton¹, William Hague¹ and Caroline Crowther^{1,2}

Abstract

Background: Postpartum follow up of women who have been found to have gestational diabetes during pregnancy is essential because of the strong association of gestational diabetes with subsequent type 2 diabetes. Postal reminders have been shown to increase significantly attendance for oral glucose tolerance testing postpartum. It is possible that a short message service (text) reminder system may also be effective. This trial aims to assess whether a text message reminder system for women who have experienced gestational diabetes in their index pregnancy will increase attendance for oral glucose tolerance testing within six months after birth.

Methods/Design: *Design:* Single centre (Women's and Children's Hospital, South Australia), parallel group randomised controlled trial.

Inclusion criteria: Women diagnosed with gestational diabetes in their index pregnancy (oral glucose tolerance test with fasting glucose ≥ 5.5 mmol/L and/or two hour glucose ≥ 7.8 mmol/L), with access to a mobile phone, whose capillary blood glucose profile measurements prior to postnatal discharge are all normal (fasting glucose < 6.0 mmol/L, postprandial glucoses < 8.0 mmol/L).

Exclusion criteria: Pregestational diabetes mellitus, triplet/higher order multiple birth or stillbirth in the index pregnancy, requirement for interpreter.

Trial entry and randomisation: Allocation to intervention will be undertaken using a telephone randomisation service (computer-generated random number sequence generation, with balanced variable blocks, and stratification by insulin requirement).

Study groups: Women in the intervention group will receive a text reminder to attend for an oral glucose tolerance test at 6 weeks postpartum, with further reminders at 3 months and 6 months if they do not respond to indicate test completion. Women in the control group will receive a single text message reminder at 6 months postpartum.

Blinding: Baseline data collection will be undertaken blinded. Blinding of participants and blinded collection of primary outcome data will not be possible for this study.

Primary study outcome: Attendance for the oral glucose tolerance test within 6 months postpartum.

Sample size: 276 subjects will be required to show an 18% absolute increase in the rate of attendance ($\alpha=0.05$ two tailed, $\beta=80\%$, 5% loss to follow up) from 37% to 55% in the intervention group.

(Continued on next page)

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Discussion: Given the heightened risk of impaired glucose tolerance and type 2 diabetes in women who have had gestational diabetes, ensuring the highest possible rate of attendance for postpartum glucose tolerance testing, so that early diagnosis and intervention can occur, is important. A text message reminder system may prove to be an effective method for achieving improved attendance for such testing. This randomised controlled trial will assess whether such a system will increase rates of attendance for postpartum oral glucose tolerance testing in women who have experienced gestational diabetes.

Trial Registration: Australian New Zealand Clinical Trials Registry - ACTRN12612000621819

Keywords: Gestational diabetes mellitus, Reminder system, SMS text reminder, Randomised controlled trial, Postpartum care, Oral glucose tolerance test, Type 2 diabetes mellitus

Background

Introduction

Gestational diabetes mellitus (GDM) has been defined as carbohydrate intolerance of variable severity with onset or first recognition during pregnancy [1]. GDM affects 5% of pregnancies in Australia, and the prevalence of GDM is likely to rise with increases in maternal age and obesity [2]. Women who have had GDM are at higher risk for development of type 2 diabetes mellitus (DM) in the future compared with women who have had normal blood glucose values during pregnancy, as well as being at increased risk of GDM in future pregnancies [3-7]. Therefore, many clinical practice guidelines recommend screening for type 2 DM and impaired glucose tolerance in the postpartum period [8-13]. Such follow up is important, given the well-documented risks to women and their babies resulting from type 2 DM and GDM [14], the availability of interventions for prevention of type 2 DM and recurrent GDM such as lifestyle changes, use of metformin, and encouragement of breastfeeding [15], and because direct medical costs increase greatly with progression from impaired glucose tolerance to type 2 DM with complications [16]. However, follow up rates for GDM tend to be sub-optimal and need to be improved [17]. Increasing the rate of follow up with an oral glucose tolerance test (OGTT) is important, given that it is the most sensitive test for detection of impaired glucose tolerance and type 2 DM within 6 months postpartum [18].

Reminder systems for increasing postpartum follow up of GDM

Reminder systems have been used to improve healthcare with positive results, and some research studies have assessed the effect of reminders on increasing attendance for follow up of GDM. For example, implementation of a postpartum patient reminder system for women who had experienced GDM into routine care at two hospital sites in Canada (The Ottawa Hospital, General Campus and the Queensway Carleton Hospital) resulted in higher rates of completion of oral glucose tolerance testing by 6 months postpartum, with a rate of 28% (41/145) compared with

14% (16/117 women) in the site where reminders were not used (The Ottawa Hospital, Civic Campus) ($p = 0.01$) [19].

However, the rate of completion in both sites where reminders were used was considerably lower than the rates of OGTT completion observed in the randomised controlled trial (RCT) of postal reminders previously conducted by the same team at The Ottawa Hospital in Canada [20]. In the RCT, OGTT completion rates were 60% (49/81 women) in the physician and patient reminder group, 55% (42/76 women) in the patient-only reminder group, 52% (16/31) in the physician-only reminder group and 14% (5/35 women) in the group with no reminders sent ($p < 0.05$). It should be noted that OGTT completion was measured up until six months postpartum in the implementation study, compared with up to one year postpartum in the RCT.

A small number of non-randomised studies have examined reminder systems for postpartum blood glucose testing in women who have experienced GDM. A Finnish prospective observational study found that a phone call reminder by a nurse increased rates of postpartum oral glucose tolerance testing at one year after birth (odds ratio 13.4, 95% confidence interval 4.6–38.1) [21]. Another study examined the efficacy of a checklist as a physician reminder for increasing postpartum screening for type 2 DM in women who had GDM at the Endocrine Obstetrics Clinic of the Women's College Hospital in Toronto, Canada. In this study, retrospective chart review revealed that use of the reminder checklist for physicians was associated with a 3 fold increase in odds of a woman being screened with an OGTT, as measured at ≥ 6 months postpartum (odds ratio 2.99, 95% confidence interval 1.84–4.85) [22].

Following on from a previous study investigating trends in postpartum glucose test ordering by clinicians and completion by women (with recent GDM) that found increasing but suboptimal rates at Kaiser Permanente Northwest (KPNW, a large non-profit health organisation in western Oregon and Washington state) [23], another study at KPNW examined the efficacy of several interventions aimed at increasing the proportion of postpartum glucose test ordering by clinicians and test completion by women (including revising the nursing protocol

for pregnant women with GDM, improving the electronic medical record system, educating clinical staff and providing additional reminders to women who did not complete the test within 3 months of delivery) [24]. Orders for postpartum glucose screening increased from 77% of (155/200) women in the pre-implementation period, to 89% (159/179) in the post-implementation period ($p = 0.004$), and completion of postpartum glucose screening increased from 60% (pre-implementation) to 72% (post-implementation) (hazard ratio, 1.37; 95% confidence interval, 1.07–1.75).

Postpartum reminders for GDM follow up in Australia

The South Australian Gestational Diabetes Recall Register was established in July 2002 [25]. This register sent a reminder letter at 15 months after birth to women who had experienced GDM to encourage oral glucose tolerance testing. A study examining the efficacy of the register found that, of the 429 women who had been sent their first reminder letter (at 15 months), 56% had undertaken a glucose test for diabetes (response rate 46%) [25]. There was considerable variation in the rate of recruitment of eligible women to the register, with a nadir of 27% in 2006, and a peak of 72% in 2003. The authors of this study speculated that reasons for this variability in recruitment rates may have included time constraints during appointments, change in staff, and differences in staff efforts to recruit to the register. The South Australian register has now been replaced by a national register, the National Gestational Diabetes Register [26]. Women resident in Australia and eligible for a Medicare card are recruited to this register at the time of registering for the National Diabetes Services Scheme (NDSS) following a diagnosis of GDM, and the register sends a follow-up reminder letter to such women to visit a general practitioner to arrange an OGTT at 12–16 weeks after the expected due date (provided to the register at the time of registration) and an information booklet called *Life after Gestational Diabetes*.

Short message service (SMS) reminders – the reminders of the future?

In Australia in 2011, there were at least 28 million mobile phone subscriptions (i.e. 6 million more subscriptions than people) [27]. With the very high rate of mobile phone usage, it is likely that almost all women of reproductive age have access to mobile phones. Given the high rate of mobile phone use in Australia, and the low cost of SMS messages, a reminder system that utilises SMS technology might prove to be a cost-effective way of increasing the number of women in Australia with a recent history of GDM, who could then be prompted to undertake oral glucose tolerance testing in the postpartum period. Several studies in other areas of health care have indicated that SMS reminders can increase appointment attendance rates [28–31]. This potential to increase rates of attendance may

translate into increased rates of oral glucose tolerance testing in the postpartum period for women who have had GDM.

Aims and objectives

The primary aim of this RCT is to determine whether an SMS reminder system will significantly increase attendance for oral glucose tolerance testing by 6 months postpartum in women who have recently experienced GDM.

Hypotheses

The primary hypothesis is that a SMS reminder system for women who have recently had GDM will increase the number of women who complete oral glucose tolerance testing by 6 months postpartum.

Methods/Design

Ethics statement

Ethics approval was obtained from the Women's and Children's Health Network Human Research Ethics Committee (REC2200/8/2015).

Study design

Single centre (Women's and Children's Hospital, South Australia), parallel group randomised controlled trial.

Inclusion criteria

Women diagnosed with GDM in their index pregnancy (positive 75 g OGTT with fasting glucose ≥ 5.5 mmol/L and/or two hour glucose ≥ 7.8 mmol/L), with access to a personal mobile phone, whose capillary blood glucose profile measurements prior to hospital discharge after giving birth are normal (fasting blood glucose < 6.0 mmol/L and 2 hour postprandial blood glucoses < 8.0 mmol/L), who provide written, informed consent, will be included in the trial.

Exclusion criteria

Pregestational diabetes mellitus, triplet/higher order multiple birth or stillbirth in the index pregnancy or requirement for interpreter.

Trial entry

Women who are potentially eligible for the study will be approached in the postnatal ward, counselled and given the study information sheet. They will be entered into the trial if they give written consent and have normal blood glucose profile results prior to discharge from hospital.

Study groups and management

Eligible women will be randomised into one of two study groups: either the '6 week (intervention) group' or the '6 month (control) group'.

Randomisation

Randomisation will be carried out using a telephone randomisation service. The randomisation schedule has balanced variable blocks and has been prepared by an investigator not involved in recruitment or clinical care. Randomisation will be stratified by antenatal requirement for drug therapy to treat GDM.

Treatment schedules

Intervention (6 week reminder) group

Women in the intervention group will be sent a SMS reminder at six weeks after the birth of their baby: "*Hi (Participant Name), This is a reminder from the DIAMIND study team for you to have your oral glucose tolerance test for type 2 diabetes. Please let us know when you have done the test, and what the results were by texting us on (study number) or emailing us at (study email address) - Thanks for participating and best wishes*". If the participant responds to say she has completed the test, no further text reminders will be sent. If not, a further text reminder will be sent at three and six months (same message).

Control (6 month reminder) group

Women in the control group will receive no text reminders for the first 6 months of the study period. A single text message reminder (same text as for intervention group) will be sent to these women at 6 months postpartum (measured from date of birth of baby).

Primary study outcomes

Oral glucose tolerance test undertaken by 6 months postpartum

Secondary study outcomes

Fasting blood glucose test undertaken by 6 months postpartum

Glycated haemoglobin (HbA1c) test undertaken by 6 months postpartum

Data collection

Baseline data collection

Baseline data will be collected to assess the similarity between the two groups in terms of factors that may influence attendance for postpartum oral glucose tolerance testing. At trial entry, information will be collected on demographic characteristics of the participants as well as smoking history, current BMI at booking and previous pregnancy outcomes. With regards to GDM, women will be asked whether or not they were given the opportunity to join the National Diabetes Services Scheme (NDSS) and therefore the National Gestational Diabetes Register, whether they joined, and where they intend to have their postpartum OGTT completed. Data regarding control of GDM (dietary control only or requirement for metformin

or insulin), diagnostic OGTT date and results, and complications at birth relating to GDM (requirement for induction, caesarean section, perineal injury, blood loss) will also be collected.

Baseline data relating to the health of the newborn(s) will be collected: singleton or twin, birth order (if twin), gestational age at birth, birth weight (grams), time of birth, gender, Apgar scores, mode of birth (normal vaginal birth, operative vaginal birth, caesarean section), nerve palsy, bone fracture, newborn hypoglycaemia (plasma glucose ≤ 2.0 mmol/L), neonatal intensive care admission, respiratory distress syndrome, neonatal jaundice requiring phototherapy, and death prior to first discharge.

The following information will be collected at hospital discharge: breastfeeding status (given the link between breastfeeding and reduced risk of type 2 DM [32,33], as well as the possible influence that breastfeeding may have on the mother's ability to attend for oral glucose tolerance testing [34]), mention of GDM in the problem list of the discharge summary and whether or not follow up oral glucose tolerance testing was recommended in the discharge summary.

Outcome data collection: 6 months postpartum

All women in the study will be asked to complete a questionnaire at 6 months after the birth of the baby either by post or by email (using Survey Monkey), depending on their expressed preference at trial entry, to ascertain whether an OGTT was undertaken within the first 6 months, or whether a fasting blood glucose or glycated haemoglobin (HbA1c) test was used instead. The questionnaire also asks for the date and results of these tests, where known. The date and results of the OGTT will be confirmed using the hospital clinical information system, or by contact with the participant's general practitioner, where necessary. The questionnaire also examines women's attitudes towards the OGTT, as well as reasons for not being able to undertake the test, if applicable. Where questionnaires are not returned within 2 weeks, participants will be contacted by telephone, and then again in another 2 weeks if the questionnaires are still not received by the study team. During this telephone contact, participants will be asked whether or not they have completed an OGTT within the six months since they gave birth.

Sample size

The baseline rate of OGTT uptake used in the sample size calculation for the proposed trial is 37%; this rate is at the lower end of the range in the recent review by Tovar and colleagues (2011) [17]. Using a figure from the lower end of this range is a sound estimate, given that the health centres in the study had reminder systems in place, and that some results came from surveys with moderately low

response rates [17]. Data from the South Australian Gestational Diabetes Mellitus Recall Register indicates that the actual rate may be somewhere between 26 and 56 percent [25].

The Stata version 10.0 sample size calculator has been used to calculate the target sample size.

The figures entered were:

- baseline uptake of postnatal OGTT 37%
- projected 18% absolute improvement to 55% (48% relative increase)
- power 80%
- significance (two-tailed) 5%

This resulted in a calculation that the study will require 262 women (131 in each arm). With a predicted up to 5% loss to follow up, 276 women will be required.

Analyses and reporting of results

Baseline characteristics of all randomised women will be compared descriptively between the study groups. Outcome comparisons will be made according to the treatment allocation at randomisation on an 'intention to treat' basis. Categorical variables will be reported as risk ratios with corresponding 95% confidence intervals. Continuous outcomes will be reported as mean (and standard deviation) for normally distributed results, or median (interquartile range) for results which are not normally distributed. All model assumptions will be assessed. Statistical significance will be defined at the 0.05 level using a two-sided comparative test.

Discussion

This randomised controlled trial of a SMS reminder system to improve the rate of attendance for follow up oral glucose tolerance testing in women who have experienced GDM is important given the high, and rising, rate of GDM, and the strong association between GDM and subsequent type 2 DM worldwide. In Australia, this is a particularly timely trial, given the recent establishment of the National Gestational Diabetes Register, the increasingly ubiquitous use of mobile phones, and the decreasing use of postal services ("snail mail") for communication. Such a reminder system may prove to be a cost-effective measure to reduce future rates of type 2 DM in Australian women, and is therefore of public health as well as obstetric importance. Such a system has the potential to be implemented locally or on a wider scale to improve the health of all women who have experienced GDM.

Abbreviations

DM: Diabetes mellitus; GDM: Gestational diabetes mellitus; HbA1c: Haemoglobin A1c; OGTT: Oral glucose tolerance test; RCT: Randomised controlled trial; SMS: Short message service.

Competing interests

The author(s) declare that they have no competing interests.

Authors' contributions

EH, PM, WH and CAC are all members of the DIAMIND Study Group. The primary investigator of the DIAMIND Study (EH) prepared the initial draft of the DIAMIND protocol. All members of the DIAMIND study team participated in the design of the study. The DIAMIND Study Group participated in the protocol development, commented on drafts of the protocol, and have read and approved the final draft of the protocol. All authors read and approved the final manuscript.

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Statement of Authorship

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Author Contributions

By signing the Statement of Authorship, each author certifies that their stated contribution to the publication is accurate and that permission is granted for the publication to be included in the candidate's thesis.

Name of Principal Author (Candidate)	Emer Van Ryswyk	
Contribution to the Paper	Contributed to study design. Recruited participants, collected and analysed data. Wrote manuscript drafts for publication.	
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Contribution to the Paper	Conceived study idea, wrote and led initial study design and protocol for ethics submission, participated in conduct of the study and interpretation of the data and edited the manuscript for publication.	
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Contribution to the Paper	Contributed to study design and trial protocol, participated in ethics submission and conduct of the study, interpretation of the data and edited the manuscript for publication.	
Signature		Date 15/2/15

Postpartum SMS reminders to women who have experienced gestational diabetes to test for type 2 diabetes: the DIAMIND randomised trial

Abstract

Aims: This parallel group randomised controlled trial assessed whether an SMS reminder system for women, after gestational diabetes (GDM), would increase their attendance for an oral glucose tolerance test (OGTT) by six months postpartum.

Methods: Women were eligible for inclusion if they were diagnosed with GDM in their recent pregnancy, had a mobile phone and normal blood glucose profile prior to postnatal discharge from the Women's and Children's Hospital, Adelaide. A computer-generated random number sequence and telephone randomisation were used. 276 women were randomised. Women in the six week group (n = 140) were sent a text reminder to attend for an OGTT at six weeks postpartum, with further reminders at three and six months if required. Women in the control group (n = 136) received one text reminder at six months postpartum. Blinding was not feasible. The primary outcome was OGTT attendance within six months postpartum.

Results: Women in the six week group did not increase their attendance for an OGTT within six months postpartum compared with women in the control group, 104 (77.6% of 134) versus 103 (76.8% of 134), RR 1.01, 95% CI 0.89-1.15.

Conclusions: The SMS reminder system did not increase postpartum OGTT, fasting plasma glucose or HbA1c completion, although high rates of test completion were measured in both groups. Further research is required into factors influencing attendance for postpartum testing

from the perspective of women, and into optimal counselling relating to type 2 diabetes risk in the postpartum period for increasing postpartum glucose testing rates.

Introduction

Women who have had GDM are at much higher risk of type 2 diabetes in the future; they are also at risk of recurrent GDM in future pregnancies (Kim et al 2007;Kim et al 2002). Due to this increased risk of type 2 diabetes, clinical practice guidelines recommend screening for prediabetes and type 2 diabetes in the postpartum period (American Diabetes Association 2014;Nankervis et al 2014;Thompson et al 2013). More specifically, the Australasian Diabetes in Pregnancy Society (ADIPS) guidelines recommend that women diagnosed with GDM should have a 75 gram oral glucose tolerance test (OGTT), preferably at six to twelve weeks postpartum, unless clinically contraindicated (Nankervis et al 2014). Women identified with prediabetes can then be counselled regarding type 2 diabetes prevention options (Diabetes Prevention Program Research Group 2009;Herman 2011;Knowler et al 2002;Ratner et al 2008). Identification of previously undiagnosed type 2 diabetes prior to a subsequent pregnancy allows treatment to prevent early pregnancy hyperglycaemia. This can reduce the risk of several complications for the mother and her baby (Bell et al 2008;Feig et al 2006;Macintosh et al 2006;Thompson et al 2013).

Postpartum screening rates are often reported to be low, and vary considerably between settings (Carson et al 2013;Tovar et al 2011). In Australia, women who are eligible for Medicare now have the option of joining the National Gestational Diabetes Register, which sends women postal reminders at 12-16 weeks after their expected due date. A previous Canadian trial of postal reminders for a postpartum oral glucose tolerance test (OGTT) in women who had GDM, found that postal reminders increased OGTT completion (Clark et al 2009). Short message service (SMS) reminders have been found to increase attendance for healthcare appointments in general (Gurol-Urganci et al 2013).

The DIAMIND study aimed to determine whether an SMS reminder system would increase attendance for an OGTT by six months postpartum in women who have had GDM.

Methods

Study design and population

The protocol for this single centre parallel group randomised controlled trial was published in 2013 (Heatley et al 2013), and the methods used followed this protocol. Ethical approval was obtained from the Women's and Children's Health Network Human Research Ethics Committee (REC2200/8/2015).

Women were eligible for inclusion in the trial if they were diagnosed with GDM in their most recent pregnancy (positive 75 gram OGTT with fasting glucose ≥ 5.5 mmol/L and/or two hour glucose ≥ 7.8 mmol/L), had access to a personal mobile phone, and had normal capillary blood glucose profile measurements prior to postnatal discharge from hospital (fasting plasma glucose < 6.0 mmol/L and 2 hour postprandial blood glucoses < 8.0 mmol/L). Women were excluded if they had pre-existing diabetes mellitus (type 1 or type 2 diabetes), a triplet/higher order multiple birth, requirement for an interpreter (due to text reminders being written in English), or if they had experienced a perinatal death in their most recent pregnancy.

The daily postnatal midwifery coordinator was consulted about women's eligibility. Women who were eligible were then approached and provided with verbal and written information about the study. Women were enrolled if they gave written informed consent and had a normal blood glucose profile prior to discharge from hospital. Recruitment for the DIAMIND Study took place from June 2012 until January 2014, when the pre-specified sample size was reached, in the postnatal ward of the Women's and Children's Hospital, South Australia, with follow-up of study outcomes completed by September 2014.

Randomisation procedures

Women were randomised into one of two study groups: either the 'six week group' or the control group. Allocation to study groups was carried out using a telephone randomisation service. The randomisation schedule was prepared by an investigator not involved in

recruitment or clinical care and used balanced variable blocks, with stratification by antenatal requirement for insulin therapy to treat GDM.

Treatment schedules

Women in the six week group were sent a SMS reminder at six weeks after the birth of their baby (Heatley et al 2013). Messages were sent automatically based on the date of birth of the baby using Clickatell bulk SMS gateway. Participants who responded to say they had completed the test were not sent further text reminders. All other women in the six week group were sent a further identical reminder at three and six months postpartum. A single text message reminder, using the same text as for the six week group, was sent to women in the control group at six months postpartum.

Baseline variables

Data were collected to assess the similarity between the two study groups in terms of factors that may have influenced attendance for a postpartum OGTT. At trial entry, information was collected on demographic characteristics of the participants, as well as smoking history, body mass index (BMI) and previous pregnancy outcomes. Women were asked whether or not they were offered the opportunity to join the National Diabetes Services Scheme (NDSS) and therefore the National Gestational Diabetes Register, whether they joined, and where they intended to have their postpartum OGTT. Data were collected regarding the date and the results of the antenatal diagnostic OGTT, control of GDM (dietary control only or requirement for metformin or insulin), and maternal complications at birth relating to GDM (requirement for induction, caesarean section, perineal injury, blood loss).

Health outcomes of the newborn(s) were collected that included: birth order (if twin), gestational age at birth, birth weight, time of birth, gender, Apgar scores, mode of birth, nerve palsy, bone fracture, newborn hypoglycaemia (plasma glucose ≤ 2.0 mmol/L), neonatal

intensive care admission, respiratory distress syndrome, neonatal jaundice requiring phototherapy, and neonatal death prior to first discharge.

Breastfeeding status at hospital discharge was collected given the link between breastfeeding and reduced risk of type 2 diabetes (Liu et al 2010;Stuebe et al 2005), as well as the influence that breastfeeding may have on the mother's ability to attend for an OGTT (Keely et al 2010). Inclusion of GDM in the problem list of the discharge summary and whether or not a follow up OGTT was recommended were also recorded.

Assessment of outcomes

The primary outcome was attendance for an OGTT by six months postpartum. Secondary outcomes were attendance for a fasting plasma glucose (FPG) test, or glycated haemoglobin (HbA1c) test by six months postpartum (if no attendance for OGTT recorded).

All women in the study were asked to complete a questionnaire at six months after the birth of their baby either by post or by email (using Survey Monkey), to ascertain whether an OGTT was undertaken within the first six months, or whether a FPG orHbA1c may have been undertaken instead. The questionnaire also asked for the date and results of these tests, where known. These results were confirmed by checking the participant's medical records. Women were contacted by telephone two weeks after the questionnaires were sent if no reply was received, and offered the opportunity to complete the questionnaire over the phone, or to have the questionnaire sent to them again. Women were asked during this telephone contact if and where they undertook their postpartum OGTT. Non-responding participants were contacted again two weeks later, and offered the same options. A final reminder and copy of the questionnaire was mailed to the remaining non-responders after a further four weeks.

Statistical analysis

The sample size calculation used an estimated baseline rate of attendance for OGTT of 37%, at the lower end of the range in the review by Tovar and colleagues (Tovar et al 2011). This

was chosen because the health centres in the Tovar study often had reminder systems in place. The Stata version 10.0 sample size calculator was used to estimate the target sample size needed. To detect an 18% absolute improvement in attendance for OGTT from 37% to 55%, with 80% power, two-tailed significance level of 5%, and estimated 5% loss to follow up, it was estimated that 276 women would be required.

Baseline characteristics of all randomised women were compared descriptively between the study groups. Outcome comparisons were made according to the treatment group allocation at randomisation on an intention to treat basis. The primary and secondary outcomes were reported as risk ratios, with corresponding 95% confidence intervals, calculated using Epi Info 7 Software. Differences between categorical postpartum factors that may have influenced OGTT attendance were assessed using χ^2 test

Results

Recruitment and participant flow

A total of 554 women were assessed for inclusion in the trial. Of those women, 179 did not meet the inclusion criteria, 54 eligible women declined to participate, and 45 potentially eligible women were not counselled for other reasons (see Figure 1). Women were randomised into either the six week group (n = 140) or the control group (n = 136). 137 women in the six week group received their allocated reminders; two did not, due to mobile phone repairs in the early postpartum period, and one woman's mobile phone was unable to receive the text messages. All three were included in the analysis according to intention to treat. A total of 268 women (97%) were followed up to six months. Results for eight women (3%) were not available to be included in the analysis, due to being unable to be contacted after six months postpartum (n = 5), being no longer interested in the trial (n = 1), moving overseas (n = 1) or moving interstate (n = 1). Two participants had a 50 gram oral glucose challenge test (OGCT) rather than an OGTT; one was pregnant at the time, and the other

participant had an OGCT due to pathology testing centre error (both counted as OGTT non-completions).

Sociodemographic characteristics of included women

There were no notable sociodemographic differences between the allocated study groups at trial entry (Table 1). The majority of women in each study group were between 30-39 years of age (61%), and were being treated within the public health system (95-6%). At trial entry, most of the women were either overweight (BMI 25.0-29.9 kg/m²) (~30%), or obese (BMI ≥ 30.0 kg/m²) (~40%), with only a fifth of the women being normal weight.

Ethnicities were similar between study groups as was socioeconomic status. Just under half (49%) of the women in each study group were Caucasian (of European descent), and most other women (47%) were of Asian descent (from all Asian countries, including the Indian subcontinent). There were five Indigenous Australian women, with three in the six week group (2%) and two in the control group (1.5%). Similarly, three women in the six week group and two women in the control group were from African countries (including Ethiopia, Liberia and Egypt).

There were high levels of socioeconomic disadvantage amongst participants, as judged according to postcode, with about half classified as disadvantaged or extremely disadvantaged. All participants had at least some secondary education, and half had a bachelor degree or higher.

Perinatal factors that may have influenced postpartum healthcare seeking: A comparison of study groups

There were no differences between the study groups with regards to perinatal factors (Table 2). Although, fewer women in the six week group had experienced a previous preterm birth (3%) than women in the control group (11%); the national rate of preterm birth in women

with GDM in Australia in 2005-7 was reported as 10% (Australian Institute of Health and Welfare 2010).

Outcomes and estimation

Primary and secondary outcome data were available for 268 participants (97%). Women in the six week group did not increase their attendance for an OGTT within six months after birth, with 104 (77.6%) women attending in the six week group and 103 (76.8%) women attending in the control group (RR 1.01, 95% CI 0.89-1.15) (Table 3).

Six women (4.5%) in the six week group, and five women (3.7%) in the control group attended for FPG tests; thus the intervention had no effect on the secondary outcome of FPG attendance within six months postpartum (RR 1.20, 95% CI 0.37 –3.84) (Table 3). Only one participant had an HbA1c test as their primary screening test (Table 3).

Finally, the SMS reminder for the six week group had no effect on the rate of completion of any of the tests combined (either OGTT or FPG or HbA1c) within six months postpartum, with 83% (n = 111) of the women in the six week group and 81% (n = 108) of the women in the control group having either test (RR 1.03, 95% CI 0.92 – 1.15).

Postpartum follow-up results: prediabetes and type 2 diabetes frequency

Overall, 11% of women were diagnosed with prediabetes and 2.3% diagnosed with type 2 diabetes by six months postpartum (Table 3).

Additional postpartum factors that may have influenced OGTT completion

Most women in both study groups ($\geq 87\%$) self-reported that they had been offered an opportunity to join the Australian National Gestational Diabetes Register and had joined ($\geq 83\%$) (National Diabetes Services Scheme 2014), and therefore would have received postal reminders at 12-16 weeks after their expected due date from this register (Table 3).

Over 98% of women in each group receiving public medical care had a discharge summary forwarded to their postpartum care provider, with no difference seen between groups. The majority of these discharge summaries listed GDM in their problem list, although approximately 20% did not include recommendations of an OGTT in the follow-up plan.

Harms

No significant harms resulted from the study.

Discussion

SMS reminders at six weeks and three months postpartum were not found to affect the rate of attendance for postpartum screening for type 2 diabetes by six months after birth, with either OGTT, FPG or HbA1c tests. This is in contrast to the results of a previous Canadian randomised trial of postal reminders for women who had GDM (Clark et al 2009). In their study, completion of OGTTs was higher in those women who were sent a reminder (42 of 76 (55%), compared with five of 35 women (14%) in the control arm.

Within our trial, overall attendance for an OGTT within both study arms was more than 20% higher than previously reported rates of postpartum glucose testing in South Australia (Chittleborough et al 2010), and much higher than the vast majority of studies conducted worldwide (Carson et al 2013). Only a small number of studies, focussed on assessing rates of postpartum glucose intolerance or type 2 diabetes in women with recent GDM, have reported higher rates (Carson et al 2013). High rates of postpartum testing shows the positive influence of raised awareness of the need for postpartum screening amongst health professionals and women alike. The increase observed in our study may partially reflect the transition from the South Australian GDM Recall Register (established in July 2002) to the Australian National GDM recall register, which occurred just prior to the beginning of recruitment for the DIAMIND Study. A key difference between the function of these two registers was much earlier postal reminders from the National GDM Register at 3-4 months after birth, compared

with the South Australian GDM Recall Register that had provided reminders 15 months after birth (Chittleborough et al 2010).

The low use of HbA1c for type 2 diabetes screening is likely to reflect that, during the period of DIAMIND Study data collection, relevant Australian guidelines recommended use of an OGTT for postpartum type 2 diabetes screening (Nankervis et al 2014), and that Medicare reimbursement for HbA1c was only possible in people with established diabetes (d'Emden 2014).

It is noteworthy that a high proportion of women in the study received postal reminders from the national reminder scheme ($\geq 83\%$). Furthermore, discharge summaries were completed and sent to the relevant clinicians in a very high proportion of cases (98% in each study group). Most summaries not only provided the diagnosis of GDM in the problem list (92%), but also recommended an OGTT in the follow-up treatment plan section (81%). This communication of the diagnosis of GDM is likely to have positively influenced rates of OGTT completion, as previous studies with clinicians' views have indicated that lack of communication of the diagnosis was a key factor preventing adequate postpartum healthcare provision for women with GDM (Van Ryswyk et al 2014). Most women in the study planned to attend for postpartum care with their general practitioners in the community (64%) rather than at the hospital, highlighting the importance of communication of the diagnosis to the relevant postpartum care providers.

The postpartum glucose test results from our study indicate the importance of screening relatively soon after birth; although, the rates of prediabetes (11%) and diabetes (2.3%) are at the lower end of the range of those found in previous studies of testing up to six months postpartum (prediabetes was reported in 13-32% of participants, and type 2 diabetes detected in 1-25% (Carson et al 2013). These lower rates were expected given that the women in the DIAMIND Study were only eligible if they had had a normal blood glucose profile before discharge after giving birth.

Limitations and generalisability

Rates of perinatal adverse outcomes known to be associated with GDM generally did not differ between study groups, indicating that the randomisation process was effective. As expected in GDM, women were slightly older (Kirke et al 2014), with higher BMIs (Torloni et al 2009) and more likely to be Asian (Teh et al 2011), compared with the overall population of women giving birth in South Australia (Scheil et al 2013) or Australia (Australian Institute of Health and Welfare 2010).

Most women in the study had been educated beyond secondary school. Almost half of the women in the study lived in either extremely disadvantaged (n = 64, 23%) or disadvantaged areas (n = 74, 27%), and a higher proportion of women in the study had received public rather (n = 264, 96%) than private care compared with other women giving birth in South Australia (71% public in 2011 (Scheil et al 2013)). This concurs with previous studies showing that socioeconomic disadvantage is linked with increased risk for GDM (Anna et al 2008).

Women recruited to the DIAMIND trial were largely representative of women with GDM in South Australia.

Women were not eligible for recruitment to the study if they had an abnormal blood glucose profile after giving birth, if they had experienced a perinatal death, a triplet or higher order multiple pregnancy or if they required an interpreter. These women are likely to be at increased risk for development of type 2 diabetes compared with the eligible participants, and any reminder system implemented into care should include these women.

In any trial with behavioural outcomes, such as attendance for glucose testing, there is the potential for aspects of research participation to contribute to the observed frequency of the behavioural outcome (McCambridge et al 2014). Thus, it is possible that raised awareness of the risk of type 2 diabetes and the benefits of postpartum screening resulted from participation in the study, and that this contributed to an increase in attendance for postpartum glucose testing in both study groups.

Further research is required into the efficacy of a more convenient glucose test for postpartum screening, counselling relating to type 2 diabetes risk in the postpartum period, and better communication of the diagnosis of GDM, to optimise the rate of postpartum glucose testing.

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Competing interests

None declared.

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Figure 1: Participant Flow Diagram

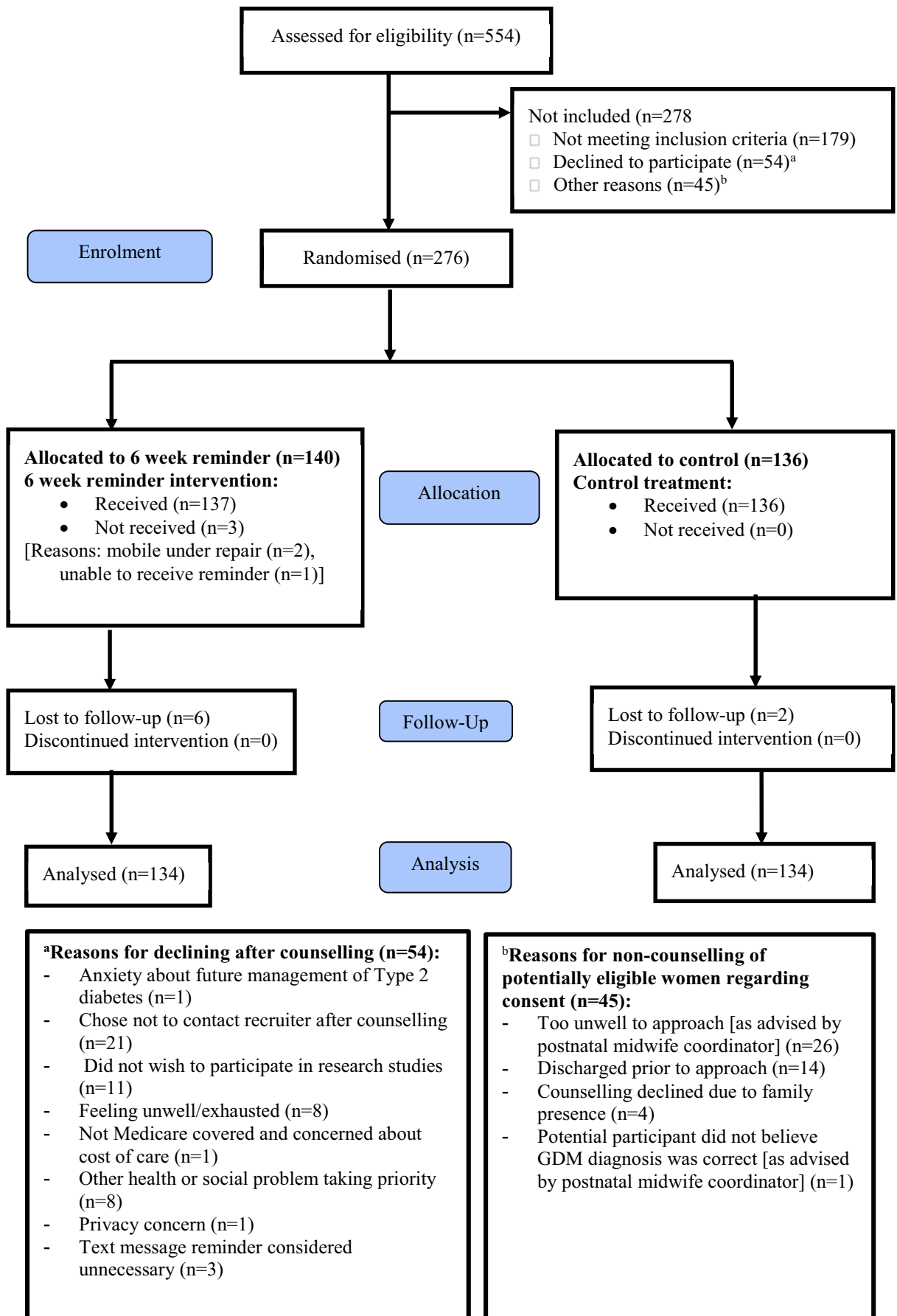


Table 1: Comparison by study group of the sociodemographic characteristics of included women at trial entry

Characteristic	6 Week Group (n = 140)	Control Group (n = 136)
Age (years)^a	32.1 (5.3)	32.8 (5.0)
≤ 19	1 (0.7%)	0 (0%)
20-29	50 (36%)	41 (30%)
30-39	80 (57%)	84 (62%)
≥ 40	9 (6.4%)	11 (8%)
Public care	133 (95%)	131 (96%)
BMI at trial entry (kg/m²)^b	29.2 (25.7 – 33.2)	29.0 (25.1 – 33.3)
< 18.5 (underweight)	1 (0.7%)	1 (0.7%)
18.5 – 24.9 (normal)	26 (19%)	28 (21%)
25.0 – 29.9 (overweight)	42 (30%)	39 (29%)
≥30.0 (obese)	52 (37%)	52 (38%)
Unknown	19 (14%)	16 (12%)
Ethnicity		
Caucasian	69 (49%)	67 (49%)
Asian	65 (46%)	65 (48%)
Indigenous Australian	3 (2%)	2 (1.5%)
Other	3 (2%)	2 (1.5%)
Socioeconomic Index^c		
Extremely disadvantaged	31 (22%)	33 (24%)
Disadvantaged	38 (27%)	36 (26%)
Average	24 (17%)	20 (15%)
Advantaged	32 (23%)	30 (22%)
Most advantaged	15 (11%)	17 (13%)
Highest level of education^d		
Postgraduate degree	24 (17%)	22 (16%)
Graduate diploma/certificate	2 (1.4%)	3 (2%)
Bachelor degree	42 (30%)	48 (35%)
Advanced diploma/diploma	16 (11%)	12 (9%)
Certificate level	20 (14%)	14 (10%)
Secondary education (junior ± senior)	36 (26%)	37 (27%)
Primary/other/unknown	0 (0%)	0 (0%)
Pre-pregnancy smoker	18 (13%)	20 (15%)

Values are number (%) unless otherwise indicated.

^a Value is mean (standard deviation).

^b Median (interquartile range).

^c Socioeconomic index for area (SEIFA), where higher index scores indicate decreasing levels of social disadvantage. The index of relative socio-economic advantage and disadvantage was used.

^d Broad level of education from the Australian Standard Classification of Education 2001.

Table 2: Comparison by study group of perinatal factors that may have influenced postpartum healthcare seeking

Maternal Data	6 Week Group (n = 140)	Control Group (n = 136)
Treatment for GDM		
Diet only	105 (75%)	98 (72%)
Metformin only	26 (19%)	32 (24%)
Insulin only	5 (4%)	1 (<1%)
Metformin and insulin	3 (2%)	5 (4%)
None	1 (<1%)	0 (0%)
Diagnosis of GDM in index pregnancy		
GA at diagnosis (weeks +days) ^a	28 ⁺³ (27 ⁺³ – 29 ⁺⁵)	28 ⁺⁴ (28 ⁺⁰ – 29 ⁺⁵)
Fasting OGTT result (mmol/L) ^b	5.0 (0.9)	5.0 (0.7)
2 hour OGTT result (mmol/L)	8.8 (1.4)	8.8 (1.3)
Past obstetric history		
Previous pregnancy ≥ 20 weeks GA	66 (47%)	67 (49%)
Preterm birth	4 (3%)	15 (11%)
Stillbirth	1 (<1%)	0 (0%)
Neonatal death	0 (0%)	0 (0%)
Index pregnancy		
Induction of labour	66 (47%)	56 (41%)
Perineal injury requiring suturing (%vaginal births)	50/85 (59%)	50/78 (64%)
Postpartum haemorrhage 600-999ml	26 (19%)	26 (19%)
Postpartum haemorrhage (≥1000ml)	6 (4%)	8 (6%)
Mode of birth		
Any vaginal birth	85 (61%)	78 (57%)
Normal vaginal birth	69 (49%)	67 (49%)
Assisted vaginal birth ^c	16 (11%)	11 (8%)
Caesarean section	55 (39%)	58 (43%)
Caesarean section elective	27 (19%)	19 (14%)
Caesarean section emergency	28 (20%)	39 (29%)
Neonatal data (babies)		
	(n = 147)	(n = 140)
Birthweight (kg) ^b	3.2 (2.8-3.6)	3.2 (2.8-3.6)
Sets of twins ^d	7 (5%)	4 (3%)
GA at birth < 37 weeks	27 (18%)	26 (19%)
GA at birth 34 ⁺⁰ - 36 ⁺⁶ weeks	19 (13%)	19 (14%)
GA at birth < 34 weeks	8 (5%)	7 (5%)
Macrosomia (≥4000grams)	13 (9%)	13 (9%)
Birth injury ^e	1 (<1%)	0 (0%)
Respiratory distress syndrome	8 (5%)	5 (4%)
Apgar < 7 at 5 minutes	4 (3%)	5 (4%)
Neonatal hypoglycaemia ^f	25 (17%)	24 (17%)
Neonatal jaundice ^g	14 (10%)	13 (9%)
NICU admission	6 (4%)	3 (2%)

Unless otherwise specified, figures are number (%).

^a Median (interquartile range).

^b Mean (standard deviation).

^c Assisted vaginal birth includes vaginal breech, forceps and ventouse.

^d Number of sets of twins (i.e. number of twin babies is double this figure).

^e Birth injury includes musculoskeletal or neurologic injury.

^f Neonatal hypoglycaemia defined as ≤ 2.0 mmol/L at 1 or 4 hours after birth.

^g Neonatal jaundice requiring phototherapy

Abbreviations are: gestational age (GA), oral glucose tolerance test (OGTT), neonatal intensive care unit (NICU).

Table 3: Postpartum glucose testing and postpartum care practices

	Overall (n = 268)	6 Week Group (n = 134)	Control Group (n = 134)	Treatment Effect (95%CI)
Oral glucose tolerance test	207 (77%)	104 (78%)	103 (77%)	1.01 (0.89-1.15)
Fasting plasma glucose test	11 (4.1%)	6 (4%)	5 (4%)	1.20 (0.37 – 3.84)
HbA1c	1 (0.4%)	1 (0.7%)	0 (0%)	N/A
<i>Overall attendance for testing</i>	219 (82%)	111 (83%)	108 (81%)	1.03 (0.92-1.15)
<i>Postpartum glucose test results</i>				
<i>Overall results (either test)</i>	(n = 219)	(n = 111)	(n = 108)	N/A
Normal	184 (84%)	96 (86%)	88 (81%)	N/A
Prediabetes ^a	24 (11%)	11 (10%)	13 (12%)	N/A
Type 2 diabetes ^b	5 (2.3%)	0 (0%)	5 (4.6%)	N/A
Unknown	6 (2.7%)	4 (3.6%)	2 (1.8%)	N/A
<i>Postpartum Care Practices</i>	Overall (n = 276)	Intervention (n = 140)	Control (n = 136)	P-value
Opportunity to join NDSS given	246 (89%)	122 (87%)	124 (91%)	0.28
Reminder from NDSS	235 (85%)	116 (83%)	119 (88%)	0.28
OGTT location at WCH ^c	99 (36%)	45 (32%)	54 (40%)	0.19
Breast-feeding at discharge	253 (92%)	126 (90%)	127 (93%)	0.31
<i>Discharge summary^d</i>	(n = 264)	(n = 133)	(n = 131)	N/A
Available	259 (98%)	131 (98%)	128 (98%)	0.64
GDM in problem list	242 (92%)	125 (94%)	117 (89%)	0.17
OGTT recommended	212 (80%)	109 (82%)	103 (79%)	0.50

Figures are number (%). Treatment effect is relative risk. P-value calculated using χ^2 test.

^a Prediabetes defined as either impaired glucose tolerance (7.8-11.0 mmol/L), impaired fasting glucose (6.1 -6.9 mmol/L), or HbA1c \geq 5.7%, equivalent to HbA1c \geq 38.7 mmol/mol

^b Type 2 diabetes was defined as fasting plasma glucose \geq 7.0 mmol/L or 2 hour glucose tolerance \geq 11.1 mmol/L or HbA1c \geq 6.5% , equivalent to HbA1c \geq 47.5 mmol/mol.

^c Refers to the planned OGTT location specified by the participant at trial entry.

^d Figures are for women who received public (not private) care.

Abbreviations are National Diabetes Services Scheme (NDSS), Women's and Children's Hospital (WCH), gestational diabetes (GDM) oral glucose tolerance test (OGTT).

Predictors of OGTT completion in the DIAMIND Study: Associations with sociodemographic, perinatal and postpartum factors

Introduction

Given that women with gestational diabetes (GDM) are at increased risk for prediabetes and type 2 diabetes (T2DM) (Bellamy et al 2009;Kim et al 2002), and that rates of postpartum screening for diabetes after GDM are reportedly low or moderate (Carson et al 2013;Tovar et al 2011), it is important to study the factors that may positively or negatively influence postpartum diabetes test completion. In particular, determining which groups of women are less likely to complete postpartum diabetes screening may allow improved care through proactive strategies such as better tailored counselling, education and written information.

Predictors of postpartum diabetes screening have been examined in previous studies. The most commonly reported predictors were: insulin treatment during pregnancy (Almario et al 2008;Kerimoglu et al 2010;Kwong et al 2009;Lawrence et al 2010;Ogonowski and Miazgowski 2009;Stasenko et al 2010); being of older age (Ferrara et al 2009;Lawrence et al 2010;Stasenko et al 2010; Kwong et al 2009;Ogonowski and Miazgowski 2009); nulliparity or lower parity (Ferrara et al 2009;Kwong et al 2009;Lawrence et al 2010;Stasenko et al 2010), and higher education (Ferrara et al 2009;Kerimoglu et al 2010;Lawrence et al 2010). Less commonly reported predictors include GDM diagnosed earlier in pregnancy (Almario et al 2008;Ferrara et al 2009); more healthcare provider contacts after birth (Ferrara et al 2009;Lawrence et al 2010); living in small rural areas (Swan et al 2010); non-smoking status (Peticca et al 2014); sites of care with postal reminder systems (Peticca et al 2014); GDM diagnosis code in women's charts at discharge (Lawrence et al 2010); private health insurance

(Amorosa et al 2014); non-indigenous ethnicity (Chamberlain et al 2014); higher socioeconomic status or higher income (Chamberlain et al 2014; Lawrence et al 2010); being foreign born (Lawrence et al 2010); and family history of diabetes (Almario et al 2008).

The DIAMIND study measured the effects of a postpartum SMS reminder system on attendance by women for follow-up oral glucose tolerance test (OGTT) completion for T2DM, and also examined the views of the women in the study relating to postpartum diabetes screening. The protocol for DIAMIND is available in chapter 4 (Heatley et al 2013). The objective of this nested study is to examine the associations between OGTT completion and maternal sociodemographic characteristics, obstetric and perinatal outcomes, and postpartum healthcare factors experienced by women in the DIAMIND randomised controlled trial.

Methods

The protocol and results for the DIAMIND Study (randomised controlled trial and follow-up questionnaire) have been previously reported in full, including recruitment, data collection and outcome details (chapters 4-6). The association between sociodemographic, perinatal and postpartum factors and attendance for OGTTs of women in the DIAMIND Study was examined in this sub-analysis study using t-tests for continuous variables and X² test for categorical variables. As previously described, the outcome data for the DIAMIND study was entered into a Microsoft Access database. The statistical software program Epi Info 7.4 was used for analysis.

Results

A total of 207 women completed postpartum OGTTs, with 61 not attending during the six month follow-up period; completion status for eight women was unknown.

Sociodemographics

In this study, women were more likely to complete OGTTs if they were of Asian ethnicity ($P = 0.007$), had a bachelor's degree ($P = 0.036$), and if they did not smoke prior to pregnancy ($P = 0.045$) (Table 1). There was also a non-significant trend towards increased OGTT completion with postgraduate education ($P = 0.095$).

Women were less likely to attend if they had gained excessive weight during their pregnancy ($P = 0.004$) or were Caucasian ($P = 0.001$). No association was apparent between women's ages, public/private care status, body mass index (BMI) or level of socioeconomic disadvantage as indicated by postcode.

Perinatal factors

The frequency of perinatal factors, which had the potential to influence OGTT attendance, did not differ the OGTT completer and non-completers groups (Table 2); methods of antenatal control of GDM did not vary between these groups, nor did timing of the diagnosis of GDM, nor GDM diagnostic results. There were also no significant differences between past obstetric histories, labour complications, mode of birth or neonatal health outcomes. There was a trend towards increased attendance for postpartum diabetes testing when the mode of birth was emergency caesarean section ($P = 0.093$).

Postpartum factors

No differences were apparent between the OGTT completer and non-completer groups with regards to postpartum factors that may have influenced OGTT attendance (Table 3), with $\geq 85\%$ of women receiving reminders from the NDSS in both groups, most women planning to have their OGTTs in the community rather than the WCH ($\geq 63\%$), and most women breastfeeding at discharge ($\geq 85\%$).

For women who received public medical care, there were also no differences between attending and non-attending groups with regards to completion of discharge summaries for clinicians providing postpartum care with GDM in the problem list and OGTTs recommended in most cases.

Discussion

Principal findings and comparison with other relevant studies

The predictors of postpartum diabetes screening completion in the DIAMIND Study (having a bachelor's degree, being non-smokers and being of Asian ethnicity) have all previously been found to be positively associated with postpartum glucose testing (Ferrara et al 2009;Kerimoglu et al 2010;Lawrence et al 2010; Peticca et al 2014).

The reasons for the higher rate of attendance for Asian women and lower rates of attendance amongst Caucasian women were unclear. At least two previous studies have found that Asian women were more likely to attend for postpartum testing (Lawrence et al 2010;Ferrara 2009;Tovar 2011). A study using data from the 2001-2003 Behavioural Risk Factor Surveillance System (BRFSS) survey in the United States, which assessed access to healthcare among women aged 18-44 years with a history of GDM, found that "Asian/Pacific Islander" women were the most advantaged in terms of health care access (Kim et al 2007). This was in comparison with "non-Hispanic white," "non-Hispanic African American," "Hispanic or Latina" and "Native American or Native Alaskan" women. In their study, healthcare access was measured in the survey by questions inquiring about lack of health insurance, the presence of cost barriers to physician visits in the past year, lack of a primary care provider, location of primary health care facility and lack of a physical examination within the past year. Additionally, Asian/Pacific Islander women were older and wealthier and had a lower body mass index than women who were "non-Hispanic whites," and were less often smokers. Both higher income (Chamberlain et al 2014;Lawrence et al 2010) and

non-smoking status (Peticca et al 2014) have been found to be associated with increased attendance for postpartum diabetes testing.

Aside from healthcare access differences and other factors, it is possible that differences in risk perception led to an increased attendance amongst women of Asian descent and lower attendance amongst women of Caucasian descent. Women with a history of GDM who also have other known risk factors for T2DM, such as obesity and family history of diabetes, have been found to have higher personal risk perception than women without additional risk factors (Kim et al 2007; Morrison et al 2010; Salomon and Soares 2004; Sterne et al 2011). There is evidence that risk perception influences health behaviour (Brewer et al 2007), and more specifically that women with a history of GDM who perceive themselves to be at higher risk of T2DM have a greater intention to improve their own health behaviour (Kim et al 2007). This may translate into increased diabetes screening attendance for women with a history of GDM who have greater risk perception.

It has previously been pointed out that studies examining predictors of completion of postpartum diabetes screening have had conflicting results (Keely 2012); in particular, that some studies have identified that women with more severe GDM (i.e. needing insulin, higher diagnostic glucose levels during pregnancy) are more likely to undergo postpartum diabetes screening, whereas others have found that women with less serious hyperglycaemia and lower BMIs are more likely to have testing. In our study, there was no correlation between women's BMI at trial entry nor method of GDM control with their attendance for OGTTs. However, there was an association with excessive weight gain during pregnancy, although this outcome is subject to recall bias.

Limitations and generalisability

Whilst this sample of women is likely to be representative of women with GDM attending for care at the Women's and Children's hospital, as described in detail in chapter 5, this study had a relatively small sample size in comparison with other studies that have examined predictors

of postpartum diabetes screening, with some having sample sizes exceeding 10,000 women (Ferrara et al 2009;Lawrence et al 2010). The small sample may have therefore limited the ability of the study to identify predictors of screening. For example, the trend towards increased attendance with postgraduate degrees and emergency caesarean section may have become significant with a greater sample size, and other less common predictors may have been undetectable with this sample size.

Our study agreed with other studies on the small number of predictors of postpartum screening that were detected (higher education and non-smoking status); these factors may be common predictors of screening in other regions. However, the generalisability of this study to other populations is somewhat limited given the small sample size, and the fact that the study was carried out at a single centre. The results are therefore more useful for application at a local level.

Implications

The reasons for higher rates of postpartum OGTT completion by women of Asian descent and lower rates by women of Caucasian descent need to be further explored. Research should be conducted into interventions that may specifically improve postpartum screening amongst women known to be less likely to attend (e.g. lower socioeconomic status/income, smokers, and lower levels of education). Raising clinician awareness of predictors of diabetes screening and non-attendance may assist them to increase attendance through more targeted postpartum care and information provision for those women at greater risk of non-attendance.

Table 1: Sociodemographics of women who attended for an OGTT compared with women who did not

Characteristic	OGTT Attenders (n = 207)	OGTT Non-attenders (n = 61)	P-value
Age^a (years)	32.6 (4.7)	32.3 (6.5)	0.662
≤ 19	1 (0.5%)	0 (0.0%)	0.590
20-29	68 (32.7%)	19 (31.6%)	0.881
30-39	122 (58.9%)	36 (59.0%)	0.991
≥ 40	16 (7.7%)	4 (3.0%)	0.177
Public patient	197 (95.2%)	59 (96.7%)	0.606
Medicare eligible	196 (94.7%)	57 (93.3%)	0.710
Body Mass Index^a (kg/m²)	29.9 (6.7)	30.9 (6.3)	0.338
< 18.5 (underweight)	1 (0.5%)	1 (1.7%)	0.347
18.5 – 24.9 (normal)	44 (21.1%)	8 (13.3%)	0.177
25.0 – 29.9 (overweight)	61 (29.3%)	19 (31.7%)	0.727
≥30.0 (obese)	74 (35.6%)	27(45.0%)	0.184
Unknown	27 (13.0%)	6 (9.8%)	0.287
Excessive pregnancy weight gain^b	49 (23.7%)	26 (42.6%)	0.004
>18.0kg (underweight)	0 (0.0%)	0 (0.0%)	N/A
>16.0kg (normal weight)	1 (0.5%)	2 (3.3%)	0.068
>11.5kg (overweight)	18 (8.7%)	10 (13.4%)	0.084
>9.0kg (obese)	30 (14.5%)	14 (23.0%)	0.117
Unknown	47 (22.7%)	12 (19.7%)	0.615
Ethnicity^c			
Caucasian	91 (44.0%)	42 (68.8%)	0.001
Asian	110 (52.8%)	20 (33.3%)	0.007
Indigenous Australian	4 (1.9%)	1 (1.7%)	0.897
African origin	2 (1.0%)	1 (1.7%)	0.647
Socioeconomic Index for Area^d			
Extremely disadvantaged	43 (20.7%)	18 (29.5%)	0.129
Disadvantaged	53 (25.5%)	18 (29.5%)	0.623
Average	35 (16.8%)	7 (11.7%)	0.332
Advantaged	51 (24.5%)	11 (18.3%)	0.316
Most advantaged	26 (12.5%)	6 (10.0%)	0.355
Level of education^e			
Postgraduate degree	40 (19.2%)	6 (10.0%)	0.095
Graduate diploma/certificate	4 (1.9%)	1 (1.6%)	0.897
Bachelor degree level	75 (36.0%)	13 (21.7%)	0.036*
Advanced diploma/diploma	21 (10.0%)	4 (6.7%)	0.420
Certificate level	23 (11.0%)	11 (18.3%)	0.136
Secondary education	44 (21.6%)	26 (42.6%)	0.001*
Primary education	0 (0.0%)	0 (0.0%)	N/A
Pre-pregnancy smoker	24 (11.5%)	13 (21.7%)	0.045*

Values are number (%) unless otherwise indicated.

^a = Mean (standard deviation).

^b = Based on the recommendations for weight gain during pregnancy from the Institute of Medicine and National Research Council (US), and used recall pre-pregnancy weight and recall weight prior to birth according to study participants (Rasmussen KM et al 2009)

^c = Racial classifications from the Pregnancy Outcome in South Australia 2010 Report (Scheil et al 2013)

^d = The index of relative socio-economic advantage and disadvantage was used (SEIFA 2011) (Australian Bureau of Statistics 2011)

^e = Broad level of education from the Australian Standard Classification of Education 2001 (Trewin 2001)

Table 2: Perinatal factors that may have influenced OGTT attendance

	OGTT Attenders (n = 207)	Non-attenders (n = 61)	P-value
Method of control of GDM			
Diet only	151 (72.9%)	45 (73.8%)	0.899
Metformin only	45 (21.7%)	12 (19.7%)	0.729
Insulin only	5 (2.4%)	1 (1.6%)	0.719
Metformin and insulin	5 (2.4%)	3 (4.9%)	0.313
Diagnosis of GDM			
GA at diagnosis ^a (weeks ^{+days})	28 ⁺⁴ (27 ⁺⁴ – 29 ⁺⁴)	28 ⁺⁵ (27 ⁺⁰ – 30 ⁺⁴)	0.208
Fasting OGTT result ^b (mmol/L)	5.0 (0.9)	4.9 (0.6)	0.515
2 hour OGTT result ^b (mmol/L)	8.9 (1.4)	8.6 (1.4)	0.112
Past obstetric history			
Previous pregnancy > 20 weeks GA	100 (48.3%)	30 (49.2%)	0.905
Preterm birth	17 (8.2%)	2 (3.3%)	0.187
Neonatal death	0 (0.0%)	0 (0.0%)	N/A
Stillbirth	1 (0.5%)	0 (0.0%)	0.586
Index pregnancy			
Induction of labour	87 (42.0%)	30 (49.2%)	0.322
Perineal injury requiring suturing	74 (35.7%)	22 (36.1%)	0.964
Postpartum haemorrhage	54 (26.0%)	10 (16.4%)	0.119
600-999ml	42 (20.3%)	8 (13.1%)	0.206
≥1000ml	12 (5.8%)	2 (3.3%)	0.437
Neonatal data (babies)			
	OGTT Attenders (n = 214)	Non-attenders (n = 64)	P-value
Twins	7 sets (14 babies)	3 sets (6 babies)	0.441
GA at birth < 37 weeks	38 (17.7%)	14 (21.9%)	0.458
Birthweight ^a	3260 (2790-3625)	3150 (2765-3605)	0.576
Macrosomia (≥4000grams)	19 (8.9%)	7 (10.9%)	0.620
Birth injury ^c	1 (0.5%)	0 (0.0%)	0.583
Respiratory distress syndrome	11 (5.1%)	2 (3.1%)	0.503
Apgar < 7 at 1 minute	30 (14.0%)	6 (9.4%)	0.331
Apgar < 7 at 5 minutes	8 (3.7%)	1 (1.6%)	0.338
Neonatal hypoglycaemia (≤ 2.0 mmol/L at 1 or 4 hours)	38 (17.7%)	10 (15.6%)	0.692
Jaundice requiring phototherapy	21 (9.8%)	6 (9.4%)	0.917
NICU admission	5 (2.3%)	4 (6.3%)	0.120
Death prior to discharge	0 (0.0%)	0 (0.0%)	N/A
Mode of birth (babies)			
	(n = 214)	(n = 64)	
Any vaginal delivery	117 (54.7%)	42 (65.6%)	0.120
Normal vaginal	100 (46.7%)	33 (51.6%)	0.497
Assisted vaginal ^d	17 (7.9%)	9 (14.1%)	0.140
Vaginal breech	0 (0.0%)	0 (0.0%)	N/A
Forceps	11 (5.1%)	9 (14.1%)	0.015
Ventouse	6 (2.8%)	0 (0.0%)	0.175
Caesarean section	97 (45.3%)	22 (34.4%)	0.120
Elective	38 (17.7%)	11 (17.2%)	0.916
Emergency	59 (27.6%)	11 (17.2%)	0.093

Unless otherwise specified, figures are number (%).

^a = Value is median (interquartile range)

^b = Value is mean ± standard deviation.

^c = Birth injury includes musculoskeletal or neurological injury.

^d = Assisted vaginal birth includes vaginal breech, forceps, ventouse.

Abbreviations are: gestational age (GA), oral glucose tolerance test (OGTT).

Table 3: Postpartum factors that may have influenced OGTT attendance

	OGTT Attenders (n = 207)	Non-attenders (n = 61)	P-value
Opportunity to join national GDM register	185 (89.4%)	54 (88.5%)	0.851
Reminder from national GDM register	175 (84.5%)	53 (86.9%)	0.651
OGTT planned at WCH	74 (35.7%)	23 (37.7%)	0.780
Breast-feeding at discharge	193 (93.2%)	53 (86.9%)	0.112
Public medical care	(n = 197)	(n = 59)	N/A
Discharge summary available	194 (98.5%)	57 (96.6%)	0.496
GDM in problem list	182 (92.4%)	53 (89.8%)	0.818
OGTT recommended	162 (82.2%)	43 (72.9%)	0.208

Unless otherwise specified, figures are number (%).

Abbreviations are: Women's and Children's Hospital (WCH), gestational diabetes mellitus (GDM)

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Name of Principal Author (Candidate)	Emer Van Ryswyk	
Contribution to the Paper	Contributed to study design. Prepared and sent questionnaires, made follow-up phone calls to participants, analysed results. Wrote manuscript drafts for publication.	
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Name of Co-Author	Philippa Middleton	
Contribution to the Paper	Conceived study idea, wrote and led initial study design and protocol for ethics submission, participated in conduct of the study and interpretation of the data and edited the manuscript for publication.	
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Contribution to the Paper	Contributed to study design, conduct of the study, interpretation of the data and editing of the manuscript for publication.	
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Contribution to the Paper	Contributed to study design and trial protocol, participated in ethics submission and conduct of the study, interpretation of the data and edited the manuscript for publication.	
Signature		Date 15/2/15

Women's views on postpartum testing for type 2 diabetes after gestational diabetes: six month follow-up for the DIAMIND randomised controlled trial

Abstract

Background: This study assessed the views of the women who participated in the DIAMIND randomised trial (of postpartum SMS reminders to test for type 2 diabetes after gestational diabetes) on their preferred type of postpartum reminder system and barriers and facilitators to completion of postpartum diabetes testing.

Method: A written questionnaire was sent to women who participated in the DIAMIND trial (n = 276) via post or email at six months after the birth of their baby.

Results: 208 women (75%) returned the study questionnaires. Preferred postpartum reminder types were: SMS (67%), email (17%), postal (12%) and voice call (1%). Women who had not yet completed an OGTT indicated that they planned to undertake one in the future (61%). Common barriers to postpartum OGTT completion included: not having enough time (73%), inadequate childcare (30%), and a need to focus on the health of the baby (30%). The most common facilitator was having a shorter test (33%).

Conclusions: Most women preferred postpartum SMS reminders, followed by email, postal and voice call reminders. Time constraints and test inconvenience were the most common barriers to postpartum test completion, with the option of a shorter postpartum test being the foremost facilitator.

Introduction

Women who have had gestational diabetes mellitus (GDM) are at significantly higher risk for the development of type 2 diabetes (T2DM) (Bellamy et al 2009;Kim et al 2002). Therefore, postpartum blood glucose screening is important to detect prediabetes and T2DM, allowing timely treatment (Nankervis et al 2014;South Australian Perinatal Practice Guidelines 2012;American Diabetes Association 2014;The American College of Obstetricians and Gynecologists 2013;Thompson et al 2013;Walker 2008).

However, often women are not offered or do not attend for postpartum screening for T2DM (Carson et al 2013;Tovar et al 2011). For example, in England, a study which examined postpartum glucose screening rates in women with a history of GDM, using a nationally representative sample from 127 urban and suburban primary care practices, found that just 18.5% of women had glucose screening within six months of birth (McGovern et al 2014). Similarly, a study from Boston, in the United States, found that just 23.4% of GDM affected women received any glucose test by six months postpartum (McCloskey et al 2014). Furthermore, a recent Australian study found rates of postpartum oral glucose tolerance testing of 25% in Indigenous women and 34% in non-Indigenous women at three years after birth (Chamberlain et al 2014).

Previous qualitative studies have identified reasons for non-attendance or non-completion from the perspective of women (Bennett et al 2011;Keely et al 2010;Sterne et al 2011). These reasons included: time pressures, lost laboratory forms, not knowing a test was necessary (Keely et al 2010;Sterne et al 2011), feelings of emotional stress whilst adjusting to a new baby and fear of a T2DM diagnosis (Bennett et al 2011;Sterne et al 2011).

In Australia, there is now a national scheme that sends postal reminders to women who have had GDM, and their general practitioners, at 12-16 weeks after the expected birth date (National Diabetes Services Scheme 2014). It is possible that a short message service (SMS)

reminder system may be preferable to women, given the greatly decreasing use of the postal system in Australia and other developed countries (Australia Post 2013).

This paper reports the findings of the six month postpartum follow-up questionnaire for the DIAMIND randomised controlled trial (RCT) (n = 276), conducted at the Women's and Children's Hospital, Adelaide, Australia. This RCT examined the efficacy of an SMS reminder system, with reminders being sent to women who had recently experienced GDM, for increasing completion of an oral glucose tolerance test (OGTT) by six months postpartum (Heatley et al 2013).

The objectives of this follow-up study were to obtain the views of the women who participated in the DIAMIND RCT regarding: (1) their preferred type of postpartum reminder system (2) ease of completion and acceptability of their postpartum blood glucose test, (3) their intention to undertake postpartum blood glucose testing where not yet completed, and (4) their perceived barriers and facilitators to postpartum glucose testing.

Materials and Methods

Overall study design and participants

A questionnaire was designed to ascertain the views of participants of the DIAMIND RCT (Heatley et al 2013). This method of study was thought to be more acceptable to the women than focus groups or interviews, given their time constraints. The questionnaire was distributed to participants six months after the birth of their baby by post or email (using Survey Monkey), depending on the expressed preference at the time of recruitment. The DIAMIND RCT included women diagnosed with GDM in their most recent pregnancy (OGTT with fasting plasma glucose ≥ 5.5 mmol/L and/or two hour glucose ≥ 7.8 mmol/L), with access to a mobile phone, whose capillary blood glucose profile measurements prior to postnatal discharge were all normal (fasting glucose < 6.0 mmol/L, postprandial glucoses < 8.0 mmol/L) (Heatley et al 2013). Women were not eligible for the study if they had

pregestational diabetes mellitus, triplet/higher order multiple birth or stillbirth in the index pregnancy, or if they required an interpreter (SMS reminders were sent in English).

Recruitment for the DIAMIND RCT took place in the postnatal ward of the Women's and Children's Hospital, Adelaide, Australia. Women were counselled regarding the nature of the study and provided with a written information sheet.

Ethical approval for the DIAMIND study was obtained from the Women's and Children's Health Research Network Human Research Ethics committee.

Questionnaire content

The questionnaire was based on a review of the relevant literature, and the final questions were chosen by consensus amongst the investigators (for full questionnaire, please refer to the Appendix 4). Face validity of the questionnaire was checked with three non-investigators. The questionnaire was designed for ease of completion by women from both English and non-English speaking backgrounds.

Women were asked to choose (by ticking a box) their first preference for the type of postpartum reminder system. The options listed were: *Postal, SMS, Email, Voice Call*, or *Don't know*. Women who had completed postpartum glucose testing were asked for their opinion on the tests. Those who completed the OGTT were asked if: (1) it was easy to fast for the test, (2) it was easy to find time to take the test, and (3) overall whether they were happy with the test experience.

The same questions were asked of women who had completed alternative tests, such as the fasting plasma glucose (FPG) test and the HbA1c test (except for the question relating to fasting, which was not applicable to the HbA1c test).

A 5-point Likert scale was used, with the options being either *strongly disagree, disagree, neither agree nor disagree, agree* or *strongly agree*. These questions were included due to the

OGTT being previously reported to be a barrier in itself, with women saying the test is too long, inconvenient, and unpleasant (Sterne et al 2011). Also, it is possible that screening recommendations with regards to the type of glucose test, may change in the future for postpartum screening for T2DM. Recent research has examined use of HbA1c and/or fasting plasma glucose for this purpose, although timing, cut-off points and the long-term outcomes of changing the test needs to be investigated and balanced against the likelihood of increasing postpartum screening rates by using more convenient tests (Benaiges et al 2013;d'Emden 2014;Katreddy et al 2013;Kim et al 2011;Megia et al 2012;Nankervis and Conn 2013;Noctor et al 2013;Wilkinson et al 2014).

Women who had not completed a postpartum OGTT were asked whether they planned to have an OGTT in the near future (options were *Yes, No, Don't Know*). Women were asked to tick all of the boxes which applied to them regarding several previously reported barriers that may have prevented them for attending for an OGTT in the six months since the birth of their baby; those were concern or anxiety about being diagnosed with T2DM (Bennett et al 2011;Sterne et al 2011), baby's health (Bennett et al 2011), not having enough time (Keely et al 2010), feeling down or low (Bennett et al 2011), childcare not available/inadequate (Bennett et al 2011), transport not available/inadequate (Sterne et al 2011), perception of low risk of T2DM (Bennett et al 2011;Kim et al 2007;Morrison et al 2010), the test being too unpleasant (Sterne et al 2011) or not knowing where to go for the test.

Women who had not completed a postpartum OGTT were then asked two open ended questions:

- (1) Are there any other reasons that you did not have an oral glucose tolerance test?
- (2) Is there anything that would have helped you to have had an oral glucose tolerance test in the six months after the birth of your baby?

Questionnaire follow-up

Women who did not return their questionnaire within two weeks were followed up with a telephone reminder call, and then again two weeks later where necessary. During these follow-up conversations, women were offered the option of completing the questionnaire over the phone, or having the questionnaire sent to them again via post or email. A final reminder was sent to non-completers of the questionnaire via post one month after the second telephone call, along with a paper copy of the questionnaire.

Analysis

Paper and Survey Monkey results were entered in a Microsoft Access database using an electronic data entry form created using Epi Info 7.4 (Centers for Disease Control and Prevention 2013). Statistical analysis was undertaken using Epi Info 7.4, to assess differences between questionnaire completers and non-completers.

Results

Questionnaire responders

275 women from the DIAMIND Study were sent the follow-up questionnaire (one participant requested that no questionnaire be sent due to time constraints), and 208 (75%) completed questionnaires either by email (n = 100) or post/telephone (n = 108). One participant returned their questionnaire with blank responses and was unable to be contacted for further clarification. For three women, responses to the questionnaire conflicted with the known test results, and so their barriers and/or facilitators were not included in the analysis.

Compared with women who returned their questionnaires, women who did not return the study questionnaire were more likely to have not attended for postpartum glucose testing within the six month study period, to have not undertaken education further than secondary schooling, and younger and/or of Indigenous Australian descent (Table 1). Neither maternal

body mass index (BMI) nor allocation to either study group (six week SMS reminders versus no reminder until six months) was associated with questionnaire completion.

Questionnaire results

207 women indicated their preferred postpartum reminder system, and there was little variation between the allocated treatment groups' responses. Most women (nearly 70%) selected SMS reminders as their preferred postpartum reminder type (Table 2). Email was preferred by about 17% of women, postal by 12% and voice call reminders by less than 1%.

A total of 168 women gave their views on their postpartum glucose test, of which 165 were able to be included (Table 3). Most women who completed a postpartum OGTT agreed or strongly agreed that it was easy to fast for (n = 137, 86%), easy to find time for (n = 100, 63%) and that they were happy with the test experience (n = 124, 78%). Women who had completed a FPG test (n = 5) rather than an OGTT were generally happy with their experience (n = 3, 60%): two of these women thought it was easy to fast for, and all thought it was easy to find time for. No views were available from women who completed an HbA1c test.

Some women (n = 33/69, 48% of those who did not complete OGTTs) gave their views relating to barriers to postpartum glucose testing (Table 4). The most frequently indicated barrier was *not having enough time* (n = 24/33, 73%), followed by *inadequate or non-availability of childcare* (n = 10/33, 30%), and a *need to focus on the health of the baby* (n = 10/33, 30%). Some women believed the test was *too long* (n = 6/33, 18%), that they were *at low risk of T2DM* (n = 5/33, 15%), and some women did not seek testing because of their *concern or anxiety relating to the possibility of being diagnosed with T2DM* (n = 5/33, 15%).

A small subset of the women who did not complete a postpartum OGTT (n = 15/69, 22%), provided information on what may have facilitated their attendance for postpartum OGTT completion (Table 4). A third of those women said that a shorter test would have made it easier for them to attend. Others suggested that having a health professional arrange the test,

doing the test before discharge from hospital, or having a reminder for attendance would facilitate test completion. Most women who had not had an OGTT reported that they planned to complete one in the future (61%), with more women in the control group of the study indicating their intention to complete an OGTT than women in the six week reminder group.

Discussion

Principal findings and comparison with other relevant studies

Our study found that most women preferred SMS reminders over other forms of reminder systems, followed by email, then post, and lastly voice call reminders. Women's views on reminder systems have previously been elicited in a small sample of women attending either of two tertiary care sites for antenatal GDM education (n = 51) in Ottawa, Canada, with data collected from November 2010 until February 2011. They found that women's first preferences for postpartum reminder types were home phone/landline, followed by email, postcard, SMS message and voice message (Keely et al 2012); although, their study sample may not have been representative due to its small size, and the study did not collect the sociodemographic characteristics of the participants, so it was not possible to assess this aspect of their study. Furthermore, the differences in women's views between our findings and the Canadian study may be partially explained by antenatal versus postpartum data collection, with postpartum experiences and caring responsibilities possibly influencing preferences for reminder system types. It is also possible that preferences towards use of mobile phone SMS technology may have also increased with time from 2010 to 2012-14, and may differ between women in Canada and Australia.

Just over half of the women in the DIAMIND Study were still breast-feeding at six months postpartum and several others had breast-fed for six months and only recently stopped. Breast-feeding as a barrier to undertaking postpartum diabetes screening was only reported by one woman in both the DIAMIND Study and in the Canadian study of postal reminders for

postpartum OGTTs (Keely et al 2012), and is therefore unlikely to be a barrier for most women.

Women who completed postpartum oral glucose tolerance testing agreed or strongly agreed that it was easy to fast for, easy to find time for, and that overall they were happy with the test experience. Many of the barriers to OGTT completion were related to lack of time and to the test itself. Taking time out from caring for their new baby and other children, in the absence of readily available and acceptable childcare, was also difficult for many women, so a shorter test would be preferable for this reason as well.

Suggested facilitators were often related to OGTT convenience, with women suggesting that having a shorter test, not having to arrange a separate appointment for the test, and being able to do the test in a more convenient location (such as home), would facilitate their glucose test completion. This suggests that for many women, the OGTT itself does not pose a barrier to T2DM screening, but for a minority it is a significant barrier. Changing from a two hour OGTT to an HbA1c test for T2DM screening would therefore probably increase completion of a postpartum test. With regards to convenience for women, the HbA1c test has several advantages when compared with a two hour OGTT, including not requiring the women to fast, consume a glucose drink, wait for two hours for final blood sampling and having more than one blood sample to be taken. Further research is required into the sensitivity, specificity and concordance of HbA1c compared with an OGTT for T2DM screening in the postpartum period (Duke et al 2015).

Postpartum counselling and education regarding the risk of T2DM is important, given the range of perception of risk from anxiety and concern about the possibility of being diagnosed with T2DM to perception of low risk of future T2DM development, both of which posed barriers for some women in the study. It is important that T2DM screening is linked with T2DM prevention interventions for the majority of women, who would not yet have developed the condition. There is ongoing research into interventions specifically for women

who have experienced GDM (Ferrara et al 2014;Shih et al 2013), and positive results have been found for sub-groups of women with a history of GDM in previous diabetes prevention studies (Knowler et al 2002;Ratner et al 2008;Rautio et al 2014).

Only five women gave their views on their FPG test, so only limited conclusions can be drawn from this aspect of the data. No women gave their views on HbA1c. The low use of HbA1c for T2DM screening, was largely because during the period of DIAMIND RCT data collection, relevant Australian guidelines recommended use of an OGTT for postpartum T2DM screening (Nankervis et al 2014;South Australian Perinatal Practice Guidelines 2012), and Medicare reimbursement for HbA1c was only possible in people with established diabetes (d'Emden 2014).

Over half of the women who had not had an OGTT by six months after birth reported they planned to undertake a test in the future, indicating that for some women, testing during the first six months postpartum may be difficult, but they do intend to have future diabetes screening. It is important that the opportunity to provide these women with screening is not missed, and the yearly reminders being provided by the Australian national GDM register may assist with this (National Diabetes Services Scheme 2014).

Strengths and limitations of this study

The study questionnaire was designed to be user-friendly and visually appealing, and it contained mainly short, easy to answer questions with tick box option answers to cater for women with low health literacy and for whom English was not their first language. The moderate response rate for the questionnaire indicates that the views of most women in the DIAMIND RCT on the questionnaire topics are likely to be accurately represented (Draugalis and Plaza 2009). Our response rate was higher than the women's response rate in the follow-up survey of the Canadian RCT of postal reminders (63%, 140 of 223), the most comparable study to this one (Keely et al 2010).

Questions eliciting views on the postpartum blood glucose tests themselves were timely, given the possible move towards use of HbA1c for T2DM diagnosis in Australia (d'Emden 2014), as was the question relating to preferred reminder system type, given the fairly recent inception of the national Postal GDM reminder system (National Diabetes Services Scheme 2014). Women were given the opportunity, if they wished, to list further barriers and facilitators in addition to the suggested barriers. These are important to consider when planning strategies to increase uptake of postnatal T2DM testing.

Conclusion

Most women expressed a preference for SMS reminders over other methods of postpartum reminders, followed by email, postal and voice call reminders. Generally, women who completed oral glucose tolerance testing found the test easy to find time for, easy to fast for and were happy with their overall test experience. However, for women unable to attend, time constraints and test inconvenience were the most commonly cited barriers, and doing a shorter test was stated to be the main facilitator. This suggests that changing from an OGTT to an HbA1c test might facilitate an increase in the rate of postpartum glucose testing that would be clinically important, although further research is required into the accuracy of HbA1c for postpartum T2DM diagnosis. Screening for T2DM needs to be coupled with provision of effective counselling on T2DM risk, and risk reduction. Further research into T2DM prevention programs specific for women who have experienced GDM is important.

Table 1: Questionnaire responder characteristics compared with non-responders

Maternal characteristics	Total (n = 276)	Responders (n = 208)	Non- responders (n = 68)	P-value
<i>Age (years)^a</i>	32.5 (5.1)	32.9 (5.0)	31.2 (5.6)	0.020
<i>BMI at trial entry (kg/m²)^a</i>	30.2 (6.7)	30.2 (6.7)	30.3 (6.6)	0.910
<18.5	2 (0.7)	1 (0.5)	1 (1.5%)	0.413
18.5 – 24.9	55 (20)	42 (20)	13 (19%)	0.794
≥25.0	185 (67)	139 (67)	46 (68%)	0.901
Unknown	34 (12)	26 (13)	8 (12%)	0.873
<i>Highest education level</i>				
Post-secondary	203 (74)	164 (78)	39 (59)	0.001
Secondary	73 (26)	44 (21)	29 (43)	0.001
<i>Ethnicity</i>				0.003 ^b
Caucasian	136 (49)	109 (52)	27 (41)	0.069
Asian	130 (47)	96 (46)	34 (50)	0.581
Indigenous Australian	5 (2)	1 (0.5)	4 (6)	0.004
Other ethnicity	5 (2)	2 (1)	3 (4)	0.064
<i>Diet control</i>	203 (74)	157 (75)	46 (68)	0.203
<i>Allocated treatment group</i>				
6 week reminder	140 (51)	109 (52)	31 (46)	0.329
Control	136 (49)	99 (48)	37 (54)	0.329
<i>OGTT completed</i>	207 (75)	170 (82)	37 (54)	<0.001
<i>OGTT/FPG/HbA1c done</i>	219 (79)	181 (87)	38 (56)	<0.001
<i>Postpartum BMI^c (n = 194)</i>	26.8 (23.1–32.2)		N/A	N/A
<i>Breastfeeding duration (n = 206)</i>				
Did not breast-feed	9 (5)	N/A	N/A	N/A
One week	10 (5)	N/A	N/A	N/A
One month	23 (11)	N/A	N/A	N/A
Three months	27 (13)	N/A	N/A	N/A
Six months	28 (14)	N/A	N/A	N/A
>Six months	106 (51)	N/A	N/A	N/A
Unsure/Don't know	3 (1.4)	N/A	N/A	N/A

Figures are number (%). ^a = Value is mean (SD). ^b = Calculated using χ^2 test for trend. ^c = Value is median (interquartile range). BMI = body mass index. OGTT = oral glucose tolerance test, FPG = fasting plasma glucose. N/A = not applicable.

Table 2: Preferred postpartum reminder method for test for type 2 diabetes

Preferred reminder type	Overall (n = 207)	6 week group (n = 109)	Control group n = 98	P-value
Postal	25 (12)	13 (12)	12 (12)	0.944
SMS	139 (67)	76 (70)	63 (65)	0.405
Email	35 (17)	18 (16)	17 (17)	0.940
Voice call	2 (1)	1 (<1)	1 (1)	0.587
Unsure	6 (3)	1 (<1)	5 (5)	0.073

Figures are number (%).

Table 3: Women's views on their postpartum glucose test

Test	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
<i>OGTT (n = 160)</i>					
Easy to fast for	72 (45)	65 (41)	9 (6)	11 (7)	3 (2)
Easy to find time for	26 (16)	74 (46)	20 (13)	35 (22)	5 (3)
Happy with experience	37 (23)	87 (55)	27 (17)	5 (3)	4 (2.5)
<i>HbA1c (n = 0)</i>					
Easy to find time for	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
Happy with experience	0 (0)	0 (0)	0 (0)	0 (0)	0 (0)
<i>Fasting plasma glucose (n = 5)</i>					
Easy to fast for	2 (40)	1 (20)	1 (20)	1 (20)	0 (0)
Easy to find time for	3 (60)	0 (0)	2 (40)	0 (0)	0 (0)
Happy with experience	3 (60)	1 (20)	1 (20)	0 (0)	0 (0)

Figures are number (%).

Table 4: Barriers and facilitators to postpartum glucose testing

	Overall	6 Week Group	Control Group
<i>Barriers as listed on questionnaire</i>	(n = 33)	(n =17)	(n = 15)
Concern or anxiety about being diagnosed with T2DM	5 (15)	4 (23)	1 (7)
Baby's health	10 (30)	4 (23)	6 (40)
Not enough time	24 (73)	14 (82)	10 (67)
Feeling down or low	4 (12)	2 (12)	2 (13)
Childcare not available or inadequate	10 (30)	3 (18)	7 (47)
Transport not available or inadequate	4 (12)	1 (6)	3 (20)
Did not know needed OGTT	1 (3)	0 (0)	1 (7)
Low perceived risk of type 2 diabetes	5 (15)	4 (23)	1 (7)
Test too unpleasant	2 (6)	1 (6)	1 (7)
Did not know where to go	0 (0)	0 (0)	0 (0)
<i>Barriers suggested by women</i>			
Test too long	6 (18)	4 (23)	2 (13)
Doctor wanted me to do a different glucose test (not OGTT)	1 (3)	1 (6)	0 (0)
Doctor access difficult (rural/remote)	1 (3)	0 (0)	1 (7)
Too difficult to attend while breast-feeding	1 (3)	0 (0)	1 (7)
6 weeks too soon for attendance	2 (6)	0 (0)	2 (13)
Overseas trip	1 (3)	0 (0)	1 (7)
Attended for OGTT but was given OGCT	1 (3)	0 (0)	1 (7)
No lab form	2 (6)	2 (12)	0 (0)
<i>Facilitators suggested by women</i>	(n = 15)	(n =8)	(n = 7)
Shorter test	5 (33)	3 (38)	2 (28)
Reminders	3 (20)	1 (13)	2 (28)
Do OGTT pre-discharge (after birth)	3 (20)	3 (38)	0 (0)
Arrange OGTT appointment for me	3 (20)	3 (38)	0 (0)
Do OGTT in own home	1 (7)	0 (0)	1 (14)
Partner available for assistance	1 (7)	0 (0)	1 (14)
Provide more information on how to get postpartum OGTT done	1 (7)	1 (13)	0 (0)
<i>Plans for future OGTT completion</i>	(n = 31)	(n =15)	(n = 16)
Planning to have OGTT	19 (61)	7 (47)	12 (75)
Not planning to have OGTT	4 (13)	2 (13)	2 (13)
Unsure	8 (26)	6 (40)	2 (13)

Figures are number (%). Women were able to choose multiple barriers. Some women suggested more than one facilitator.

Final Chapter: Conclusions

Postpartum follow-up of women with GDM, to test for T2DM and to offer treatment or preventive options for diabetes, is an important area where further improvements can be made. There are well-documented low rates of postpartum diabetes test completion, and increasing evidence that follow-up is essential to ensure the best possible future health.

The results of the studies throughout this thesis give insight into the factors influencing postpartum follow-up of women with GDM from the perspective of both clinicians and women, as well as specifically examining whether an SMS reminder system may be a helpful intervention for improving postpartum diabetes screening. In concluding this thesis, the findings of these studies are summarised and final conclusions are made.

Factors influencing postpartum follow-up of women with GDM, from the perspective of clinicians.

This systematic review collated clinician views and knowledge regarding postpartum healthcare provision for women who have experienced GDM, and incorporated results from qualitative and survey studies. The review found that most clinicians knew of the increased risk of T2DM in women with a history of GDM, but that there was a gap between this knowledge, and their actual practice of postpartum screening. Several barriers prevented optimal care provision including non-communication of the diagnosis of GDM, deficiencies in knowledge regarding relevant follow-up, being unsure who was responsible for postpartum care, and difficulty with collaboration. Often clinicians observed that healthcare opportunities were not taken up by women, but recognised deficiencies

in the GDM education and support available for women, and that women faced significant cost and other barriers to attendance. Some clinicians thought that facilitators of provision of healthcare to women who had had GDM included creating an empowering relationship, providing advice about future risk of T2DM, and public health promotion relating to T2DM prevention.

*Implications for practice and research: healthcare provision
systematic review*

Lack of communication of the diagnosis of GDM between care providers often contributes to lower rates of postpartum follow-up. Communication could be improved using systematic methods, such as documentation of GDM in diagnostic lists, having patient intake forms that ask about GDM history, or by utilising reminder systems for clinicians and/or women.

There is a need to clarify responsibility for follow up of women with GDM, to improve referral pathways between GDM-related care providers, and to ensure that clinician training covers all relevant aspects of postpartum screening.

For women who are diagnosed with GDM, it is important that they are provided with appropriate and timely verbal and written education on their condition and associated short-term and long-term risks. It is equally important to ensure that obstacles to women accessing healthcare, such as cost, are minimised.

More research is required into improvement of communication between clinicians regarding GDM diagnosis and care. It is important to investigate methods of education provision for women who have experienced GDM so that they can be optimally informed about their ongoing risk of T2DM. There is also a need to raise awareness of the risks of GDM and subsequent T2DM for women, using public health promotion methods.

Factors influencing postpartum healthcare seeking for women who have had gestational diabetes, from the perspective of women

This systematic review synthesised views of women who have experienced GDM, relating to barriers and facilitators to postpartum healthcare seeking. Numerous contributory factors were found. The diagnosis of GDM was sometimes a worrisome or upsetting experience. Following the diagnosis, women sought information from multiple sources and found that there was a lack of specific information on GDM compared with other forms of diabetes. Some women had difficult or confusing experiences relating to antenatal management of their GDM, whilst other women had more positive experiences of antenatal care.

The maternal role played an important part in determining attendance for postpartum care, with children's needs often taking priority over their own care. A need for clinicians to take a more pro-active approach to postpartum care was identified.

Knowledge of the risk of T2DM was common, although in some studies women had poorer knowledge. There was much variation in perception of future T2DM risk. Women had increased perception of risk of T2DM with increased time from their GDM diagnosis, family history of T2DM and other known risk factors for GDM.

Women worried about the possibility of receiving a diagnosis of chronic diabetes. Knowledge of how to prevent T2DM, including the role of diet, exercise and weight control was common amongst women in a third of studies. In a smaller number of studies, women lacked knowledge relating to T2DM prevention, and could have benefited from better education. Many women had a positive attitude towards T2DM prevention. Motivators for lifestyle changes included high risk

perception and fear of future GDM and T2DM. Although the lifestyle changes required, particularly healthy eating, were difficult to achieve and maintain on a long term basis. Women often described a need for lifestyle change support.

Implications for practice and research: healthcare seeking systematic review

More research is required into how to best provide support relating to the emotional impacts of a GDM diagnosis. Production and assessment of educational materials is important. Methods for provision of more holistic care require further exploration. Further research into systematic methods of improving follow-up care for diabetes screening and prevention is necessary.

Findings from the DIAMIND Study: The DIAMIND SMS Reminders for T2DM Testing Trial, Predictors of Postpartum OGTT Completion, and Views of Women on Postpartum T2DM Screening

The DIAMIND Trial: Effects on an SMS reminder system on the rate of attendance for postpartum oral glucose tolerance testing.

The DIAMIND randomised controlled trial assessed the efficacy of an SMS reminder system for improving attendance for postpartum oral glucose tolerance tests (OGTTs), within six months after birth, for detection of T2DM and prediabetes in women who have recently had GDM. The trial found that SMS reminders at six weeks and three months postpartum did not affect the rate of attendance for postpartum screening with either OGTTs, fasting plasma glucose (FPG) tests or HbA1c by six months after birth. Although, overall attendance for an OGTT within both study arms was more than 20% higher than previously

reported rates of postpartum glucose testing (any test) in South Australia, and much higher than the vast majority of studies conducted worldwide.

Several factors are likely to have contributed to the relatively high rates of postpartum attendance in both groups, including raised awareness of participants and clinicians as a result of the trial, postal reminders received by most participants from the national GDM reminder register and high rates of communication of the diagnosis of GDM to postpartum care providers via discharge summaries.

Predictors of completion of glucose testing (OGTTs) in the DIAMIND Trial.

This study assessed the predictors of postpartum completion of OGTTs by women in the DIAMIND study. The study found that having a bachelor's degree, being non-smokers and being of Asian ethnicity was associated with increased attendance, whilst Caucasian ethnicity and excessive weight gain during pregnancy were predictive of non-attendance. Both higher education and non-smoking status had previously been found to be predictors of postpartum diabetes screening. The reasons for the higher rate of attendance for Asian women and lower rates of attendance amongst Caucasian women were unclear, and require further exploration. Previous studies have found that foreign born women were more likely to attend for postpartum testing and that Asian/Pacific Islander women were more advantaged than women from other ethnic groups with regards to healthcare access factors and income, although our study did not explore whether these factors played a role in influencing attendance.

Views of women in the DIAMIND Trial relating to barriers and facilitators to postpartum OGTT completion

Our six-month follow-up qualitative study for participants of the DIAMIND trial found that most women preferred SMS over other forms of reminders, followed by email, then post, and lastly voice call reminders. Many of the barriers to OGTT completion were related to lack of time and to the test itself. Taking time out from caring for their new baby and other children, in the absence of readily available and acceptable childcare, was also difficult for many women.

Suggested facilitators were often related to OGTT convenience, with women suggesting that having a shorter test, not having to arrange a separate appointment for the test, and being able to do the test in a more convenient location, such as their own home, would facilitate completion of their diabetes test. Over half of the women who had not had an OGTT by six months after birth reported they planned to undertake one in the future.

Women who completed an OGTT were generally happy with the test experience and found it easy to find time for and fast for. Only five women gave their views on their FPG test, and no women gave views on HbA1c, so firm conclusions could not be drawn on this aspect of the data.

Implications for practice and research from the DIAMIND Study

SMS reminders cannot be recommended over postal reminders on the basis of efficacy alone, although women's preferences for electronic forms of reminder systems should be taken into consideration. In order to maintain and further increase postpartum glucose screening, it is important to ensure that the diagnosis of GDM is communicated well between care providers, that postpartum reminders

are given to women and that women and clinicians are aware of the benefits of postpartum diabetes screening.

For women who did not attend for postpartum diabetes screening, raising clinician awareness of predictors of diabetes screening, such as higher education and Asian ethnicity, and non-attendance, such as Caucasian ethnicity, smoking and excessive weight gain, may assist them to increase attendance through more targeted postpartum care and information provision for those women at greater risk of non-attendance. Further research is required into reasons for non-attendance by specific groups of women.

Given that the barriers to oral glucose tolerance test completion were sometimes related to lack of time and test inconvenience, it is important to further research the efficacy of a more convenient test, such as HbA1c, for this purpose.

Overall Conclusion

In conclusion, postpartum care for women who have experienced GDM may be improved by provision of more holistic, pro-active and supportive care from diagnosis right through to postpartum follow-up. Communication of the diagnosis of GDM between healthcare providers involved in the care of individual women is essential, and women should continue to be provided with reminders for care. Further research is required on the advantages and disadvantages of using a more convenient glucose test for postpartum screening. Education for women with GDM relating to type 2 diabetes risk, screening and prevention requires improvement. Research should be conducted into interventions that may specifically improve postpartum screening amongst women known to be less likely to attend. Finally, further research is needed on how best to support diabetes prevention in women who have experienced GDM.

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Appendix A/1: Search Strategy (27th Feb 2013)

EMBASE (301 results) <ul style="list-style-type: none"> • Emtree was used to identify search terms. • Extensive searching (mapping, explosion, as keyword) un-ticked. • Used AND between columns. 		
('pregnancy diabetes mellitus'/syn OR 'gestational diabetes':ti,ab)	'help seeking behavior'/syn OR 'patient attitude'/syn OR 'reminder system'/syn OR reminder*:ti,ab OR 'child care' OR (risk* NEAR/10 perce*) OR 'follow up':ti,ab OR followup:ti,ab OR 'attitude to health'/syn OR 'knowledge':de,ti,ab OR barrier*:ti,ab OR facilitator*:ti,ab OR 'practice guideline'/syn OR 'oral glucose tolerance test'/syn OR 'hemoglobin A1c'/syn OR 'haemoglobin A1c':ti,ab OR 'glycated haemoglobin':ti,ab OR 'glycosylated haemoglobin':ti,ab OR (fast* NEXT/2 glucose) OR 'non insulin dependent diabetes mellitus'/syn	'qualitative research'/syn OR interview/syn OR (focus NEXT/3 group*):ti,ab OR survey*:ti,ab
WEB OF SCIENCE (301 results) <ul style="list-style-type: none"> • Used Topic search with lemmatization. • Used AND between columns. 		
"gestational diabetes"	risk* NEAR/10 perce* OR Patient* NEAR/2 attitude* OR Attitude* OR "Reminder Systems" OR Reminder* OR "child care" OR childcare OR follow up OR followup OR Barrier* OR Facilitator* OR knowledge OR postnatal OR postpartum OR "Practice Guidelines" OR guideline* "Glucose Tolerance Test" OR "Hemoglobin A, Glycosylated" OR glycated hemoglobin OR glycated haemoglobin OR glycosylated haemoglobin OR glycosylated hemoglobin OR HbA1c OR Haemoglobin A1c OR Hemoglobin A1c OR Fasting near/2 glucose OR "type 2 diabetes" OR diabetes	qualitative OR interview* OR "focus group" OR focus NEAR group* OR survey*

PUBMED (375 results)		
Used AND between columns.		
Diabetes, gestational [MH] OR gestational diabetes [TIAB]	Reminder Systems [Mesh] OR Reminder* [TIAB] OR "child care" [Mesh] OR "follow up" [TIAB] OR Followup [TIAB] OR Barrier* [TIAB] OR Facilitator* [TIAB] OR "Health Knowledge, Attitudes, Practice"[Mesh] OR "postpartum period"[MESH] OR Practice Guidelines as Topic [MESH] OR "Glucose Tolerance Test" [Mesh] OR Glucose tolerance test* [TIAB]] OR "Hemoglobin A, Glycosylated" [Mesh] OR glycated hemoglobin [TIAB] OR glycated haemoglobin [TIAB] OR glycosylated haemoglobin [TIAB] OR glycosylated hemoglobin [TIAB] ORHbA1c [TIAB] OR Haemoglobin A1c [TIAB] OR Hemoglobin A1c [TIAB] OR ((Risk [TIAB]] OR risks [TIAB])) AND perce* [TIAB] OR (Patient [TIAB] OR patients [TIAB] OR patient's [TIAB]) AND attitude* [TIAB]) OR Fasting blood glucose [TIAB] OR Fasting glucose [TIAB] OR "Diabetes Mellitus, Type 2"[Mesh]	"Qualitative Research"[Mesh] OR "Interviews as Topic"[Mesh] OR "Health Surveys"[Mesh] OR "focus groups"[Mesh] OR interview* [TIAB] OR qualitative [TIAB] OR survey
CINAHL (272 results)		
Advanced search, no changes to default.		
MH "Diabetes Mellitus, Gestational" OR TX "gestational diabetes"	MH "Reminder Systems" OR TX Reminder* OR TX Patient* N2 attitude* OR TX risk* N10 perce* OR MH "Child Care+" OR TX "child care" OR MH "after care" OR TX "after care" OR TX "follow up" OR TX "followup" OR MH "Attitude of health personnel" OR MH "attitude to health" OR MH "attitude to illness" OR TX Barrier* OR TX Facilitator* OR MH "health knowledge" OR TX "health knowledge" MH "Postnatal Period+" OR TX postnatal OR TX postpartum MH "Diabetes Mellitus, Type 2/EP" OR MH "Practice Guidelines" OR TX guideline* MH "Glucose Tolerance Test" OR TX "Glucose Tolerance Test" OR MH "Hemoglobin A, Glycosylated" OR TX glycated hemoglobin OR TX glycated haemoglobin OR TX glycosylated haemoglobin OR TX glycosylated haemoglobin OR TX HbA1c OR TX Haemoglobin A1c OR TX Hemoglobin A1c OR TX Fasting NEXT/2 glucose	MH "Qualitative Studies+" OR TX qualitative OR MH "Interviews+" OR TX Interview* OR MH "Focus Groups" OR TX focus NEXT/3 group* OR MH surveys TX survey*

Appendix 2: Excluded Studies Table with Reasons

Study ID	Exclusion Reason		
	Results from women with hGDM not reported separately	Did not report our pre-specified outcomes	Women did not have GDM
Ali et al 2010	•		
Coffman and Ray 2002		•	
Cosson et al 2012		•	
Dahlberg et al 1981			•
Daniells et al 2003		•	
Doran and Davis 2011		•	
Kieffer et al 2002	•		
Kim et al 2005		•	
Kim et al 2007		•	
Kim et al 2008		•	
Hoedjes et al 2011		•	
Hoedjes et al 2012	•		
Jefferson et al 2000	•		
Lapolla et al 2012		•	
Kim and Vahratian 2010		•	
Koh et al 2010		•	
Lie et al 2011		•	
Morrison et al 2009		•	
Morrison et al 2012		•	
Nolan et al 2011	•		
Persily 1996		•	
Rhoads-Baeza and Reis 2012	•		
Rumbold and Crowther 2002		•	
Smith-Morris 2005	•		
Swan et al 2010		•	
Trutnovsky et al 2010	•		
Wylie et al 2011		•	

Appendix 3: Included Studies Records (refer to Bibliography for full references)

#	Study ID	Article type
	Australia	
1	Bandyopadhyay 2011 (Bandyopadhyay et al 2011)	Full-text
2	Carolan 2013 (Carolan 2013;Carolan, et al. 2012)	Full-text
3	Graco 2009 (Graco et al 2009)	Full-text
4	Doran 2008 (Doran 2008)	Full-text
5	Morrison 2010 (Morrison, et al. 2010)	Full-text
6	Carolan 2010 (Carolan et al 2010;Carolan et al 2010)	Full-text
7	Razee 2010 (Razee, et al. 2010)	Full-text
8	Smith 2005 (Smith et al 2005)/Zehl 2008(Zehle et al 2008)	Full-text
9	Sterne 2011 (Sterne, et al. 2011)	Full-text
10	Swan 2007 (Swan et al 2007)	Full-text
	United States	
11	Jones 2012 (Jones and Appel 2011;Jones et al 2012)	Full-text
12	Hoy-Rosas 2011 (Hoy-Rosas and Lancaster 2011)	Abstract
13	Bennett 2011 (Bennett et al 2010;Bennett et al 2010;Bennett et al 2011)	Full-text
14	Collier 2011 (Collier, et al. 2011)	Full-text
15	Downs 2006 (Downs and Ulbrecht 2006)	Full-text
16	Bieda 2009 (Bieda 2009)	Thesis (full-text)
17	Kim 2007 (Kim, et al. 2007) (Risk = "a")	Full-text
18	Kim 2007 (Kim, et al. 2007) (Racial = "b")	Full-text
19	Lawson 1994 (Lawson and Rajaram 1994)	Full-text
20	Nicklas 2011 (Nicklas et al 2010;Nicklas et al 2011)	Full-text
21	Remsberg 2012 (Remsberg 2012)	Abstract
22	Segall-Gutierrez 2011 (Segall-Gutierrez et al 2011)	Abstract
	Canada	
23	Evans 2005 (Evans and O'Brien 2005)	Full-text
24	Evans 2010 (Evans et al 2010)	Full-text
25	Feig 1998 (Feig et al 1998)	Full-text
26	Gaudreau 2012 (Gaudreau and Michaud 2012)	Full-text
27	Keely 2010 (Keely, et al. 2010)	Full-text
28	Keely 2012 (Keely 2012)	Commentary
29	Neufeld 2011 (Neufeld 2011)	Full-text
	Europe/UK	
30	Stage 2004 (Stage et al 2004)	Full-text
31	Hjelm (Hjelm et al 2009;Hjelm, et al. 2007;Hjelm, et al. 2005;Hjelm et al 2012;Hjelm et al 2011;Hjelm et al 2008)	Full-text
32	Lindmark 2010 (Lindmark, et al.)	Full-text

33	Persson 2010 (Persson et al 2010)	Full-text
34	Clarke 2012 (Clarke et al 2012)	Full-text
35	Trutnovsky 2012 (Trutnovsky et al 2012)	Full-text
36	Bell 2011 (Bell, et al. 2011)	Abstract
37	Wylie 2011 (Wylie, et al. 2011)	Abstract
38	Wylie 2012 (Wylie, et al. 2012)	Abstract
	South America	
39	Saloman 2004 (Salomon and Soares 2004)	Full-text
40	Soares 2006 (Soares and Santos 2006)	Full-text
	Asia	
41	Doran 2010 (Doran and Davis 2010)	Full-text
42	Hirst 2012 (Hirst et al 2012;Hirst et al 2012)	Full-text

Abbreviations are: not specified (NS).

Appendix 4: Questionnaire (See Overleaf)



'DIAMIND'



Postpartum reminders to test for type 2 diabetes in women who have experienced gestational diabetes mellitus

Dear.....,

Thank you for taking part in the DIAMIND study.

The DIAMIND study is aiming to increase attendance for oral glucose tolerance testing for type 2 diabetes or prediabetes after birth in women who have experienced gestational diabetes. Many thanks for participating in this study and completing this questionnaire. Your response is highly valued, and it will help to improve healthcare for women who have experienced gestational diabetes. You will be provided with the results of the study once it is complete.

1. In this study, a text message reminder system was used to try to encourage attendance for oral glucose tolerance testing after birth. What type of reminder system would you have preferred? (Please tick one box)

Postal (mail) SMS text (used in this study)

Email Voice call

Unsure/Don't know

2. What's your current weight (in kilograms)? _____kg

3. For how long did you breastfeed your baby?

I did not breastfeed First week First month

First 3 months First 6 months Currently breastfeeding

Unsure/Don't know

4. Have you had an oral glucose tolerance test since your last baby was born?

Yes → please go to page 2 and answer questions 5-7

No → please skip to page 3 and answer question 8 onwards

Unsure/Don't know → please skip to page 3 and answer question 8 onwards



'DIAMIND'



Postpartum reminders to test for type 2 diabetes in women who have experienced gestational diabetes mellitus

Page 2: Questions for women who **have had** an oral glucose tolerance test in the six months after the birth of their baby

If you have not had an oral glucose tolerance test since the birth of your baby, please skip to page 3.

5. When did you have an oral glucose tolerance test after the birth (if known)?

Date of test: / /
 DD MM YY

6. Please provide your oral glucose tolerance test result (after birth), if known:

Fasting blood glucose result _____
OGTT two hour result _____

7. What did you think about taking the oral glucose tolerance test (since leaving hospital after the birth of your baby)?

It was easy to fast for the oral glucose tolerance test <i>(fasting is not eating or drinking anything except water for several hours)</i>	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
It was easy to find time to take the oral glucose tolerance test	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree
Overall, I was happy with the oral glucose tolerance test experience	Strongly agree	Agree	Neither agree nor disagree	Disagree	Strongly Disagree

The questions that follow are for women who have not had an oral glucose tolerance test since their most recent birth. If you have had an oral glucose tolerance test and completed questions 1-7, you have now completed the survey. Many thanks!



'DIAMIND'



Postpartum reminders to test for type 2 diabetes in women who have experienced gestational diabetes mellitus

Page 3: Questions for women who **have not had** an oral glucose tolerance test in the six months after the birth of their baby

8. Do you plan to have an oral glucose tolerance test in the near future?

Yes

No

Unsure

9. Please let us know what prevented you from having an oral glucose tolerance test in the six months after the birth of your baby.

Tick all the boxes that apply to you.

Concern or anxiety about being diagnosed with type 2 diabetes	Transport not available or inadequate
Baby's health	I didn't know I needed an OGTT after the birth
Not enough time	I'm healthy or at low risk of type 2 diabetes so it wasn't necessary
Feeling down or low	I thought the test would be too unpleasant
Childcare not available or inadequate	I didn't know where to go for the test

Are there any other reasons that you did not have an oral glucose tolerance test? *Please write any other reasons in the box below:*

10. Is there anything that would have helped you to have had an oral glucose tolerance test in the six months after the birth of your baby?



'DIAMIND'



Postpartum reminders to test for type 2 diabetes in women who have experienced gestational diabetes mellitus

Page 4: Questions for women who **have not had** an oral glucose tolerance test in the six months after the birth of their baby

11a. Have you had a fasting blood glucose test since leaving hospital after the birth of your baby, instead of an OGTT? *Sometimes a fasting blood glucose test is used to diagnose type 2 diabetes instead of an oral glucose tolerance test*

Yes No Unsure

11b. If known, please provide your fasting blood glucose result: _____

11c. What did you think of the fasting blood glucose test?

It was easy to **fast** for the fasting blood test Strongly agree Agree Neither agree nor disagree Disagree Strongly Disagree

(fasting is not eating or drinking anything except water for several hours)

It was easy to find time to take the fasting blood glucose test Strongly agree Agree Neither agree nor disagree Disagree Strongly Disagree

Overall, I was happy with the fasting blood glucose test Strongly agree Agree Neither agree nor disagree Disagree Strongly Disagree

12a. Have you had a HbA1c (glycated haemoglobin) test since leaving hospital after the birth of your baby? *This test does not require fasting. It indicates the glucose levels in your blood over the last 3 months, and is sometimes used for diagnosis of type 2 diabetes.*

Yes No Unsure

12b. If known, please provide your HbA1c (glycated haemoglobin) result: _____

12c. What did you think of the HbA1c test?

It was easy to find time to take the HbA1c test Strongly agree Agree Neither agree nor disagree Disagree Strongly Disagree

Overall, I was happy with the HbA1c test Strongly agree Agree Neither agree nor disagree Disagree Strongly Disagree

Many thanks for completing our survey!