An investigation into the dietary management of gestational diabetes in Australian women and postnatal health and lifestyle behaviours for future diabetes risk reduction

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Statement of originality

This thesis contains no material which has been accepted for the award of any other degree or diploma 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. 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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Acknowledgement of collaboration

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Melinda Morrison

Acknowledgement of authorship

I hereby certify that this thesis is in the form of a series of published papers of which I am a joint author. I have included as part of my thesis a written statement from each co-author, endorsed by the Faculty Assistant Dean (Research Training), attesting to my contribution to the joint publications.

Melinda Morrison

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List of abbreviations

AAQ   Active Australia Questionnaire

ADA   American Dietetic Association

AIHW   Australian Institute of Health and Welfare

ACHOIS   Australian Carbohydrate Intolerance Study

ADIPS   Australasian Diabetes in Pregnancy Society

AHEI   Alternate Healthy Eating Index

AMED   Alternative Mediterranean Diet (score)

ARFS   Australian Recommended Food Score

BG   Blood glucose

BGL   Blood glucose level

BMI   Body mass index

CALD   Culturally and linguistically diverse

CI   Confidence interval

DAA   Dietitians Association of Australia

DASH   Dietary Approaches to Stop Hypertension

DPP   Diabetes Prevention Program

DPS   Diabetes Prevention Study

DQES   Dietary Questionnaire for Epidemiological Studies

FBG   Fasting blood glucose

FFQ	Food frequency questionnaire
FSANZ	Food Standards Australia & New Zealand
GDM	Gestational diabetes mellitus
GI	Glycemic index
HAPO	Hyperglycemia and Adverse Pregnancy Outcomes (study)
Hb$_{A1c}$	Glycosylated haemoglobin
HEI	Healthy Eating Index
HR	Hazard ratio
IADPSG	International Association of Diabetes and Pregnancy Study Groups
IOM	Institute of Medicine
LGA	Large for gestational age
LR	Logistic regression
MiG	Metformin in Gestational Diabetes (study)
MNT	Medical nutrition therapy
NDSS	National Diabetes Services Scheme
NHMRC	National Health & Medical Research Council
NRV	Nutrient Reference Values
NSW	New South Wales
OGTT	Oral glucose tolerance test
OR	Odds ratio
RDI	Recommended dietary intake

RR   Relative risk

SD   Standard deviation

SEIFA   Socioeconomic Index for Areas

US   United States

WHO   World Health Organisation

Abstract

Gestational diabetes mellitus (GDM) is a form of diabetes with onset or first recognition during pregnancy. GDM has been associated with an increased risk of adverse pregnancy outcomes and longer term health consequences for both mother and offspring, including an increased risk of type 2 diabetes. With evidence suggesting rates of GDM are increasing in Australia, there is a need to optimise dietary interventions and strategies for future diabetes risk reduction, in order to ensure the best possible pregnancy outcomes and address the growing public health problem of type 2 diabetes. The primary purpose of this thesis is to investigate current Australian dietetic practice in the management of GDM; describe the postnatal health and lifestyle patterns of women with recent GDM and identify factors that influence preventive health behaviours for future type 2 diabetes risk reduction. Three research studies were undertaken to meet the aims of this body of research.

A survey of Australian dietitians (n=220) currently working in GDM management was undertaken to examine Australian dietetic practice in the management of GDM, identify current models of dietetic care and determine the need for national evidence based GDM guidelines. The study showed consistency in key components of nutrition education; however there were a number of differences in the implementation of medical nutrition therapy by Australian dietitians in regards to nutrient recommendations. Overall, the survey results strongly indicate a need for evidence-based gestational diabetes practice guidelines and nutritional recommendations and provided baseline data for future practice of Australian dietitians working in GDM.

Postnatal health and lifestyle behaviours in women with GDM were investigated in a cross sectional survey of women with diagnosed with GDM in the previous three years and registered with the National Diabetes Services Scheme (NDSS) (n=1372). This study highlighted low rates (27.4%) of return for follow-up diabetes screening compared to current recommendations, and found that receiving specialised diabetes care, risk reduction advice and postnatal reminders were associated with an increased

likelihood of returning for follow-up. Women with recent GDM also failed to achieve diet patterns in line with current national dietary recommendations, as evidenced by overall poor diet quality measured using the Australian Recommended Food Score (mean ±SD ARFS 30.9±8.1). Although women with known risk factors for type 2 diabetes were more likely to perceive that they were high risk for diabetes up to three years after a GDM pregnancy, one third still considered themselves to be at low or very low risk for the development of diabetes. In qualitative analysis of women's experiences of living with GDM in this study, the importance of health professional support was highlighted and some of the challenges and opportunities for future diabetes risk reduction identified.

Breastfeeding was examined as part of a mixed methods study within this body of work. In the quantitative component of this research a cross-sectional online survey was undertaken with women (n=729) diagnosed with GDM in 2010 and registered with the NDSS. Early breastfeeding cessation was found to be associated with breastfeeding problems at home, return to work prior to three months, not being married or in a de facto relationship, inadequate breastfeeding support, caesarean delivery, living in a lower socioeconomic area and having a higher BMI. This study identified those at highest risk of early breastfeeding cessation and suggests that additional breastfeeding support specifically targeting women with GDM is needed.

In conclusion, the study findings presented in this thesis highlight the need for an evidence based approach to dietetic interventions provided to women with GDM and improved access to postnatal care. The findings also demonstrated that the current postnatal health and lifestyle behaviours of Australian women with GDM are not conducive to chronic disease prevention. This research demonstrates the need for strategies to promote and support preventive health behaviours in Australian women with GDM in order to reduce risk factors for type 2 diabetes and optimise maternal health and well-being.

Chapter 1   Introduction

1.1 Background and context

1.1.1 Gestational diabetes: definition and pathophysiology

Gestational diabetes mellitus (GDM) is a form of diabetes with onset or first recognition during pregnancy [1]. It is characterised by elevated fasting and/or postprandial blood glucose levels (BGLs) on formal screening, most commonly in the third trimester of pregnancy [2]. The development of GDM results from an impaired response to the metabolic changes in glucose homeostasis occurring during the course of a normal pregnancy [3].

GDM develops when there is an inability to adapt to the increased metabolic stress of pregnancy, possibly as a result of underlying beta cell dysfunction and reduced sensitivity to insulin [1]. The mechanism of maternal insulin resistance during the third trimester is thought to be multifactorial [3]. Placental hormones, inflammatory cytokines, alterations in insulin signalling and maternal adiposity have all been implicated in these physiological changes [3].

Figure 1.1 describes the pathophysiology of maternal insulin resistance in GDM.
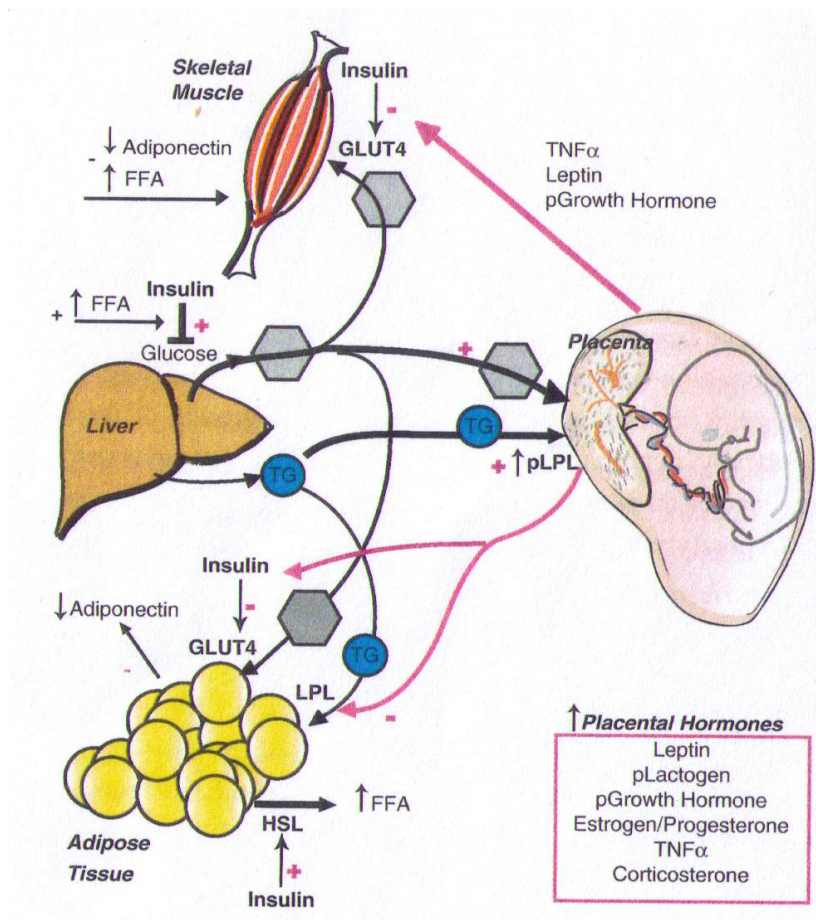
Figure 1.1: Hormone and metabolic factors contributing to insulin resistance

A rise in placental hormones suppresses maternal insulin sensitivity to shuttle necessary fuels to the foetus. Increased production of placental hormones, including pGrowth Hormone, pLactogen, leptin, and potentially TNFα, act on maternal insulin-responsive tissues, the liver, skeletal muscle, and adipose tissue, to decrease insulin responsiveness. In adipose tissue, insulin's ability to suppress hormone-sensitive lipase (HSL) and stimulate adipose tissue LPL activity results in increased maternal free fatty acids (FFA) and a production of maternal triglycerides (TG) to the placenta for festal use. In addition to placental hormones, the increased flux of FFA from maternal adipose tissue negatively impacts insulin signalling in both liver and skeletal muscle. In skeletal muscle, there is a reduction in insulin-stimulated glucose uptake and, in the liver, insulin fails to suppress glucose production. In combination, the insulin resistance in maternal liver and skeletal muscle in late pregnancy accelerates fuel availability to the foetus. In GDM, prior insulin resistance is compounded by the normal insulin resistance of pregnancy, resulting in a greater shunting of excess fuels to the foetus, which can lead to foetal overgrowth.

1.1.2 Incidence of gestational diabetes

Worldwide, the incidence of GDM varies from between 1% and 14% of pregnancies, depending on the ethnicity of the population studied and the classification used for diagnosis [5]. Estimates on gestational diabetes incidence in Australia suggest that between 3% and 9% of women develop this condition during pregnancy [2, 6], with hospital confinement data from 2005-2006 from the Australian Institute of Health and Welfare (AIHW) reporting that 4.6% of pregnant women in Australia were diagnosed with GDM in this period [7].

There is also some evidence to suggest that the rates of GDM are increasing worldwide [8, 9]. Ferrara (2007) in a review of six studies reported that incidence increased consistently across different population groups during the 20 years prior [8]. These trends ranged from increases of 16 - 127% depending on the population examined, length of observation and study methods. In Australia, data from the AIHW showed that the incidence of GDM in women aged 15-49 years increased by more than 20% from 3.5% in 2000/01 to 4.4% in 2005/06 [7]. In NSW specifically, data from the Department of Health Midwives dataset collected between 1995 and 2005 found that GDM in that state increased by 45%, from 3.0 to 4.4% during an 11 year period [10]. These figures may represent a true increase which reflects the trend towards older maternal age [8] and rising obesity rates [11], or be in part due to increasing screening and recognition [8].

1.1.3 Risk factors for the development of gestational diabetes

A number of risk factors have been associated with the development of GDM. Advanced maternal age has been shown to increase the risk [7, 12, 13]. In an early study, McFarland and Case (1985) demonstrated a progressive increase in mean serum glucose levels and a significantly higher incidence of GDM with increasing maternal age [12]. They reported that 4% of women aged <20 years tested positive for GDM compared with 15% in those >30 years of age (p < 0.001). More recently, a retrospective observational study found that a maternal age of ≥40 years was a strong independent risk factor for GDM (OR 7.0; 95% CI 2.9-17.2) [13]. In an analysis of births in NSW

between 1995 and 2005 women aged >40 years had an adjusted OR for the development of GDM of 6.13 (95% CI 5.79, 6.49) relative to women in their early 20s [10]. AIHW data from 2005-2006 reported that the proportion of confinements with GDM increased with age from 1.3% among women aged 15–19 years to 13.2% in those aged 45–49 years [7].

Ethnicity has also been associated with the risk of GDM. In an early Australian study, the incidence of GDM was reported to be higher in women born on the Indian subcontinent (15%), Africa (9.4%), Vietnam (7.3%), Mediterranean countries (7.3%), Egypt and Arabic speaking countries (7.2%), China (13.9%) and other parts of Asia (10.9%) when compared with Australian born women [14]. More recently, data from the AIHW reported that women born overseas have rates of GDM more than twice that of Australian born women [7]. Likewise, GDM incidence has also been shown to be higher in women from indigenous cultural backgrounds [8] with an incidence of 4.8% in 2005-2006 and age-standardised rates of GDM 1.5 times that of non-indigenous women [7]. The pattern of incidence of GDM appears to follow the prevalence of type 2 diabetes across ethnics groups [15].

Although GDM can affect women of a healthy weight, those above the healthy weight range have been identified as a group at substantially higher risk. Chu et al (2007) reported that overweight, obese, and severely obese women had unadjusted ORs for developing GDM of 2.14 (95% CI 1.82, 2.53), 3.56 (95% CI 3.05, 4.21), and 8.56 (95% CI 5.07, 16.04), respectively when compared with women of a normal weight [16]. Comparably, in an Australian study, McIntyre et al (2012) reported that having a BMI>30 significantly increased the odds of developing GDM when compared to women in a healthy weight range (OR 3.99; 95% CI 3.47, 5.49), after adjusting for maternal age, parity, insurance status, smoking, ethnicity and year of birth [17]. High rates of gestational weight gain, especially early in pregnancy, have also been shown to increase a woman's risk of GDM, as has weight gain in the five years preceding pregnancy [18]. Yeung et al (2009) in an examination of life-course weight characteristics also reported that lower birth weight, higher adolescent and adult BMI and abdominal adiposity were all significantly associated with an elevated risk of

GDM, independent of other known risk factors [19]. The overall percentage of GDM attributable to overweight and obesity has been estimated to be 46%[20].

Family history of type 2 diabetes is an important risk factor for the development of GDM. In the development of a clinical prediction model for GDM, van Leeuwen et al (2009) calculated that a family history of diabetes resulted in almost twice the risk of developing GDM (OR 1.8; 95% CI 0.9, 3.3) [21]. While a study examining the association between family patterns of diabetes and gestational diabetes mellitus, reported that after adjustment for age and ethnicity, a sibling history of diabetes was more likely to increase the odds of developing GDM (OR 7.1; 95% CI, 1.6, 30.9). Both paternal (OR, 3.3; 95% CI, 1.1, 10.2) and maternal (OR 3.0; 95% CI, 1.2, 7.3) diabetes history have also been shown to be important risk factors[22].

Other identified GDM risk factors have been shown to include previous GDM, high parity, a history of perinatal complications, smoking and a diagnosis of polycystic ovarian syndrome [23-26].

1.1.4 The diagnosis of gestational diabetes

The risk of adverse outcomes from a GDM pregnancy appears to occur on a continuum of blood glucose levels [27, 28]. However, until recently there has been a lack of international consensus on the criteria for characterising glucose intolerance during pregnancy [29]. The Hyperglycemia and Adverse Pregnancy Outcomes (HAPO) study was designed to better understand the risks of adverse outcomes at varying degrees of maternal glucose intolerance [27]. This study of more than 50,000 women across nine countries demonstrated a continuous association between maternal glucose levels during pregnancy (below those diagnostic of diabetes) and increased birth weight and cord-blood serum C-peptide levels.

In Australia, the Australasian Diabetes in Pregnancy Society (ADIPS) issued guidelines for screening in 1998 [2], which were subsequently revised in 2002 [6] and again more recently in 2013 [30]. The revised 2013 guidelines recommend universal screening for GDM at 24-28 weeks gestation with a 75 gram two hour OGTT. The revised guidelines also recommend early screening at the first opportunity after conception for high risk

women, such as those with previous GDM, aged ≥40 years, overweight women and those from high risk ethnic groups. This screening strategy aligns with that recommended by the International Association of Diabetes and Pregnancy Study Groups (IADPSG)[31]. The IADPSG guidelines have been endorsed by several other international organisations, including the American Diabetes Association [32]. These guidelines provide the first internationally developed criteria for the diagnosis of GDM and if universally adopted across Australia, are expected to diagnose more women with GDM than previous ADIPS guidelines. In Australia, one study has suggested that rates of diagnosis are expected to rise to approximately 13% of all pregnant women[33], while internationally GDM prevalence rates have been projected to be 2.4 times higher in multicultural populations using IADPSG compared with WHO criteria [34].

1.1.5 Health consequences of gestational diabetes

The health consequences of GDM for both mother and offspring have been well documented [35-37]. For the offspring of a GDM pregnancy, there is an increased risk of adverse perinatal health outcomes as a result of exposure to elevated blood glucose levels. Despite reports that absolute risks of stillbirth and infant death are low [35], excess neonatal morbidity and mortality remains more frequent in infants exposed to GDM compared with no diabetes (3.2% vs. 2.3%) (OR 1.4; 95% CI 1.3, 1.5) [37]. Babies born to mothers with GDM are also more likely to require admission to a special care nursery (32%) when compared with babies born to mothers without diabetes (14%) [36].

Foetal macrosomia (defined as a birthweight exceeding 4000 grams) is the result of hyperglycaemia stimulating insulin production in the developing foetus and thereby increased foetal growth and large for gestational age infants [38]. Excess foetal growth in GDM may pose problems for delivery, increasing the frequency of delivery interventions [39]. The infant is also at risk of shoulder dystocia which can result in foetal injury or maternal uterine haemorrhage [39]. Aside from the risks relating to macrosomia, other perinatal risk factors for babies born to women with GDM include

neonatal hypoglycaemia, respiratory distress syndrome, jaundice, hypocalcaemia, polycythaemia [40].

As well as the risk of perinatal complications, the diagnosis of GDM also poses longer term health consequences for the affected offspring. Foetal exposure to elevated blood glucose levels may predispose the offspring to obesity, impaired glucose tolerance and type 2 diabetes in later life [41, 42]. This 'foetal programming' may result from an intrauterine environment that promotes the above mentioned metabolic abnormalities on top of an already increased genetic risk for the development of type 2 diabetes [43]. It has been hypothesised that in utero exposure to hyperglycaemia may create a transgenerational effect contributing to the expected significant increase in prevalence of type 2 diabetes worldwide [24].

For the woman diagnosed with GDM, the risk of delivery interventions, maternal medical complications and long term health consequences is increased. The overall odds of maternal medical complications during a GDM pregnancy has been reported to be 4.3 (95% CI 2.7, 6.8) times greater than that of a woman without GDM [44]. AIHW data from the period 2005/2006 reported that women with GDM in Australian hospitals were more likely to be induced (40%), compared with women who gave birth without diabetes in pregnancy (25%) [36]. The age-standardised caesarean section rate from 2005-2008 was 38.4 (95% CI 37.8, 39.0) compared with 30.3 (95% CI 29.7, 30.8) for women without diabetes, and mothers with GDM were twice as likely to have an antenatal stay of 2–6 days or 7 or more days compared with those without diabetes.

Women who develop GDM have also been shown to have higher rates of maternal hypertension [40]. In a large population based case controlled study, GDM was associated with increased risk of severe preeclampsia (OR 1.5; 95% CI 1.1, 2.1), mild preeclampsia (OR 1.5; 95% CI 1.3, 1.8), and gestational hypertension (OR 1.4; 95% CI 1.2, 1.6) after adjustment for body mass index, age, ethnicity, parity, and prenatal care [45]. These findings were confirmed in the HAPO study whereby increased odds of developing preeclampsia were found with increased fasting (OR 1.21; 95% CI 1.13,

1.29), one hour (OR 1.28; 95% CI 1.20, 1.37) and two hour blood glucose values (OR 1.28; 95% CI 1.20, 1.37) [27].

In most affected women, glucose tolerance reverts to normal after a GDM pregnancy [46]. However, the woman remains at elevated risk for GDM in subsequent pregnancies, future type 2 diabetes and metabolic disturbances including hyperlipidaemia and hypertension [29]. Rates of recurrence of GDM in subsequent pregnancies vary depending on the characteristics of the population studied. In Australia, two studies have examined recurrence rates which have been reported to be between 35-62% [47, 48]. In a multicultural Australian population study, Foster Powell et al (1998) reported that older age and insulin were the strongest predictors of being diagnosed with GDM in a subsequent pregnancy [48]. However, in a systematic review, of the recurrence of GDM, ethnicity was the only risk factor consistently associated with development of GDM in a subsequent pregnancy, with women from minority populations at greater risk [49]. Other risk factors, including maternal age, parity, BMI, oral glucose tolerance test results and insulin use were inconsistent across studies in their ability to predict the development of recurrent GDM [49].

The risk of the developing type 2 diabetes following a GDM pregnancy has been recognised since the pioneering work of O'Sullivan and Mahan in the 1960's, when 50% of women diagnosed with GDM were identified as glucose intolerant in subsequent years [50]. Since this time, the elevated risk of type 2 diabetes in this group has been widely reported [11], and shown to be independent of preconception glucose tolerance and obesity or a family history of diabetes [51]. A systematic review of 28 studies undertaken by Kim et al (2002) reported a cumulative incidence of type 2 diabetes ranging from 2.6% to more than 70% in studies with follow-up from 6 weeks to 28 years [11]. They also reported that cumulative incidence of type 2 diabetes increased markedly in the first 5 years after delivery which appeared to plateau after 10 years. A subsequent systematic review of the risk of type 2 diabetes reported at least a seven fold increased risk in women with GDM compared to those with a normoglycaemic pregnancy [52]. In an Australian study reporting the prevalence of type 2 diabetes in women with prior GDM, Lee et al (2008) reported a 9.6 (95% CI 5.9,

16.7) times greater risk in women with previous gestational diabetes with a cumulative risk of 25% after 15 years [53]. A study examining the population health significance of GDM estimated that 21-31% of cases of diabetes in parous Australian women were associated with previous GDM [54].

In addition to type 2 diabetes risk, GDM has been associated with future metabolic syndrome and additional cardiovascular risk factors. Retnatkaran et al (2010) in a prospective cohort study of women with GDM at three months after the index pregnancy reported both GDM (OR 2.05; 95% CI 1.07, 3.94) and impaired glucose tolerance in pregnancy (OR 2.16; 95% CI 1.05, 4.42) independently predicted postnatal metabolic syndrome [55]. Likewise the same authors reported a more atherogenic lipid profile by three months post GDM pregnancy, characterized by increased LDL and apoB in this group [56]. Analysis of data from the longitudinal Nurses' Health Study II showed that women with previous GDM had a 26% increased risk of developing hypertension compared with those without a history of GDM (hazard ratio 1.26; 95% CI 1.11, 1.43; p = 0.0004), independent of other known risk factors for high blood pressure [57]. Clustering of cardiovascular risk factors has also been demonstrated in this group [57]. These findings translate into a prevalence of cardiovascular disease reported to be more than 1.5 times that of women without prior GDM [58, 59].

1.1.6 Management of gestational diabetes

The rationale for treating GDM is to reduce the risk to mothers and infants during pregnancy and later in life [60]. Glycaemic control to achieve blood glucose targets as close as possible to normoglycaemia has been demonstrated to improve perinatal outcomes [61]. The Australian Carbohydrate Intolerance Study in Pregnancy (ACHOIS), a randomised control trial of 1000 women examining the effects of GDM treatment, found a significant reduction in serious perinatal complications in the treatment group (1 vs. 4%, adjusted p = 0.01) when compared to controls [62]. More recently, the benefits of treating GDM were demonstrated in a systematic review of randomised control trials [60] and a Cochrane review [63] both of which confirmed lower rates of adverse infant outcomes with treatment of GDM when compared with routine antenatal care. In addition to the effects of treatment on short-term neonatal

outcomes, the benefits of improving maternal glycaemic control may also be to reduce the risk of type 2 diabetes to the offspring in later life [64].

1.1.6.1 Medical Nutrition Therapy

Treatment of GDM involves both lifestyle and medical management. Medical nutrition therapy (MNT) is the primary therapeutic strategy with the goal of ensuring that a pregnancy affected by GDM results in the delivery of a healthy infant without related complications [65, 66]. ADIPS guidelines recommend a diet that conforms to the principles of dietary management of diabetes, meets the nutritional requirements of pregnancy, is individualised according to factors such as maternal weight and is culturally appropriate [6]. Although there is limited evidence of the efficacy of dietary interventions, there is some evidence supporting MNT in the management of GDM. In a randomised control trial, when compared with standard care, evidence-based GDM nutrition care was associated with a reduction in insulin use (24.6% vs. 31.7% p = 0.05) and a trend towards improved blood glucose management [67]. To date there has been no research reporting on GDM nutrition care in Australia. Further discussion of the nutritional management of GDM and dietetic practice is detailed in Chapter 2 of this thesis.

1.1.6.2 Physical Activity

Physical activity has been demonstrated as an important adjunct to dietary management of diabetes through its effects on improving insulin sensitivity [68]. Several small studies examining modest amounts of physical activity in women with GDM have shown resultant improvements in fasting and postprandial blood glucose levels [69], post exercise BGLs [70] and a delay in the requirements for, or a lower likelihood of using insulin [71]. In these studies, the amount of physical activity required to confer these benefits was of a low to moderate intensity (e.g. low intensity walking or exercise at ~35-55% VO2 max). In a Cochrane review of four randomised control trails evaluating the effect of exercise on perinatal outcomes and maternal morbidity in pregnant women with GDM, the authors concluded that there was insufficient evidence to recommend, or advise against exercise programs during pregnancy [72]. Although studies to date examining the outcomes of physical activity

in GDM are limited by small sample sizes and a lack of data on neonatal outcomes [72], national and international guidelines acknowledge the role of physical activity as an important component of GDM management [2, 73].

1.1.6.3 Self Blood Glucose Monitoring

Self monitoring of BGLs is essential in this group to achieve fasting and postprandial targets as close to normal as possible. This in turn has been demonstrated to reduce the risk of foetal macrosomia and the risk of other complications [29]. Current Australian guidelines recommend both fasting and postprandial testing [30], however until the recent development of the IADPSG guidelines [31], there had been no widely accepted international consensus on blood glucose targets [29].

1.1.6.4 Pharmacological Management

Pharmacological treatment, including the use of insulin and more recently oral hypoglycaemia agents, may be required for women who exceed predetermined glycaemic targets with lifestyle interventions alone [29]. Data from the AIHW 2005/06 estimates that 32% of Australian women aged 15-49 years required insulin therapy during the course of their GDM pregnancy [7]. The Metformin in Gestational Diabetes (MiG) study has also demonstrated that the oral hypoglycaemic agent metformin can also be a viable alternative to insulin for some women [74]. However, there is presently limited information about its use in Australia.

1.1.7 Gestational diabetes – what next?

With the prevalence of type 2 diabetes increasing rapidly around the world [75], a diagnosis of GDM presents an ideal opportunity for lifestyle interventions aimed at preventing future diabetes. Several large randomised control trials have provided evidence of the preventable nature of type 2 diabetes in high risk groups [76-78]. The results of the three landmark diabetes prevention trials are summarised below.

Table 1.1: Summary of diabetes prevention studies and incidence of type 2 diabetes

Study	Subjects	Intervention	Time to follow-up	Reduction in diabetes incidence
Da Qing Diabetes Prevention Study	577	Diet, exercise or diet plus exercise	6 years [76]	51-56%
			20 years [79]	43%
Finnish Diabetes Prevention Study (DPS)	522	Intensive lifestyle intervention	Mean 3.2 years [77]	58%
			Median 7 years [80]	43%
Diabetes Prevention Program (DPP)	3234	Intensive lifestyle intervention	Mean 2.8 years [78]	58%
			10 years [81]	34%

The Diabetes Prevention Program (DPP) reported a 58% reduction in the development of type 2 diabetes in adult male and female subjects with impaired glucose tolerance at an average 2.8 year follow-up. This was achieved through an intensive lifestyle intervention which resulted in a 5–7% reduction in body weight through calorie restriction and regular moderate physical activity [78]. Likewise, the Finnish Diabetes Prevention Study (DPS) of 522 middle-aged, overweight male and female subjects with impaired glucose tolerance demonstrated consistent findings in a primary care setting [77]. In this study, the risk of diabetes was reduced by 58% with intensive lifestyle interventions including a low fat high fibre diet and an increase in weekly moderate to vigorous physical activity. Findings from the Da Qing diabetes prevention study in China reported a comparable 51% lower incidence of diabetes with a diet plus exercise group intervention in men and women with impaired glucose tolerance over a six year period [76].

The longer term benefits of these intensive lifestyle interventions for the prevention of type 2 diabetes have been recently demonstrated. In the DPP, after 10 years the diabetes incidence was reduced by 34% in those who received the intensive lifestyle interventions when compared with control group [81]. In Da Qing China, 20 year follow-up showed a significantly lower average annual incidence of diabetes in the intervention group (7%) when compared to controls (11%), suggesting that the benefits of preventing or delaying type 2 diabetes persist beyond the active intervention period [79]. While in follow-up of the Finnish DPS cohort at a median of seven years, a

marked reduction in the cumulative incidence of type 2 diabetes was sustained with the relative risk reduction of 43% during the total follow-up [80]. These findings provide evidence for the efficacy of lifestyle interventions including weight management and regular physical activity for mediating future risk of type 2 diabetes.

While the above mentioned prevention studies were not specific to GDM, subgroup analyses for women with prior GDM participating in the DPP demonstrated a 50% reduction in the development of type 2 diabetes in this high risk group [82]. More recently, feasibility studies have confirmed that intensive pre and postnatal lifestyle interventions based on a DPP model may reduce diabetes related risk factors in women with GDM [83]. However, it is not clear if less intensive interventions can be effective in this high risk population. The few small short-term studies reported to date have failed to demonstrate the effectiveness of dietary counselling, behavioural strategies or exercise interventions in improving postnatal glucose tolerance [84-86]. In part, this is possibly reflects the real life challenges of implementing lifestyle change in this group of women. Translation of lifestyle intervention studies to meet the needs of women with GDM must therefore take into account the specific family, social and cultural characteristics of this high risk group.

Despite the potential for the prevention of type 2 diabetes in this high risk group, there is some evidence to suggest that that women diagnosed with GDM have postnatal lifestyle behaviours that are not consistent with guidelines for prevention of type 2 diabetes, including poor return for follow-up, suboptimal physical activity levels, poor intakes of fruit and vegetables and high fat diets [87, 88]. To date however, there has been little published data on the postnatal lifestyle and preventive health behaviours of Australian women with prior GDM. Likewise, little is known about the dietary interventions provided to Australian women with GDM, risk perceptions for the development of future diabetes or women's experiences with the health care system all of which may influence longer term preventive health behaviours.

1.2 Research aims

The overall purpose of this thesis is to investigate the dietary management of gestational diabetes in Australian women, describe postnatal health and lifestyle patterns of Australian women with GDM and identify factors that influence preventive health behaviours for future type 2 diabetes risk reduction. The specific aims of this body of research are to:

1. Examine current dietetic practice in the management of GDM, describe the dietary interventions provided to women with GDM which may influence antenatal and postnatal health behaviours, and determine the need for national evidence-based GDM dietetic practice guidelines and nutrition recommendations.

2. Explore breastfeeding practices, attitudes, barriers and factors associated with breastfeeding duration, and determine the level of breastfeeding information and support provided to Australian women with GDM.

3. Describe postnatal GDM follow-up and factors associated with adherence to postnatal glucose tolerance testing guidelines in Australian women with previous GDM.

4. Describe the quality of dietary intakes of Australian women with a recent history of GDM and determine factors associated with adherence to national dietary recommendations.

5. Investigate the risk perceptions of Australian women with a recent history of GDM and determine factors associated with a high level of perceived risk for the development of type 2 diabetes.

6. Describe Australian women's experiences of living with GDM and explore the challenges and opportunities for diabetes risk reduction.

1.3 Thesis structure and study design

This thesis begins with a review of the literature (Chapter 2). The background, methods, results and discussion undertaken for this thesis are then presented as a series of research papers (Chapters 3, 4, 5, 6, 7 and 8). The final chapter of this thesis

(Chapter 9) summarises these findings and discusses the implications for research and practice.

The six aims of this body of research were investigated in three separate studies that included:

Study One: A postnatal health and lifestyle study of Australian women with previous GDM

Study Two: An investigation into current Australian dietetic practice in the management of GDM

Study Three: An exploratory study of breastfeeding practices, attitudes and barriers in women with previous GDM

An overview of each study contributing to this thesis is provided below and a summary of the research aims, design, participants, data collection, analysis and the corresponding papers presented in this thesis is provided in Table 1.2.

1.3.1 Study One: Postnatal health and lifestyle study

This study was a cross sectional survey of the lifestyle patterns and postnatal follow-up of Australian women with a recent history of GDM. The study sample consisted of Australian women diagnosed with GDM (n=1372) who were registered with the National Diabetes Service Scheme (NDSS) in the previous three years. The NDSS is an initiative of the Commonwealth Government to provide subsidised products to people with diabetes and is the only complete national database of women with GDM in Australia, estimated to capture 77% of all cases [7].

Women registered with a GDM diagnosis on the NDSS database between June 2003 and June 2005, aged ≥18 years and consented to be contacted for research purposes were invited to participate. The database search excluded women from a Queensland postcode due to a simultaneous GDM research being conducted by the University of Queensland and potential contamination between the studies.

The Gestational Diabetes Postnatal Lifestyle Survey was a 69 item written survey (Appendix B). The survey examined demographics, anthropometry, infant feeding practices, gestational diabetes health care, postnatal follow-up, medical and family history, diabetes risk perceptions, smoking, physical activity levels and diet quality. Women were also provided with the opportunity to document their experience of living with GDM. Where they existed, validated questions were utilised in each section of the survey including the Active Australia Questionnaire (AAQ) and the Australian Recommended Food Score (ARFS). Standardised definitions were used for collection of breastfeeding data [89] and tobacco smoking behaviours (National Health Data Dictionary), and standard demographic items from the 2001 Australian census were used. The University of Newcastle Human Research Ethics Committee approved the study and application for variation (approval number H-167-1205). Diabetes Australia Ltd. approved the NDSS database search.

As outlined in Table 1, detailed methodology and findings from study one are presented in four papers (Chapters 5, 6, 7 and 8). Also included is additional diet quality data which was pooled with that collected by researchers from the University of Queensland. The methods and results of this collaboration are described in detail in the paper presented in Chapter 6 of this thesis.

1.3.2 Study Two: Dietetic practice survey

Diet is widely accepted as the primary therapeutic strategy for management of GDM. Because of the complexity of nutrition issues, it is recommended that GDM dietary interventions be provided by a dietitian who can implement nutrition therapy into diabetes management and education [6]. Dietitians are therefore an integral part of the multidisciplinary team providing education and support for women diagnosed with GDM and may play a key role in influencing antenatal and postnatal health behaviours.

Study two was devised to better understand the current dietetic management of GDM in Australia. This cross sectional online survey of Australian dietitians currently practicing in GDM (n=220) was undertaken between March and June 2009 (Appendix

C). Dietitians were recruited from the Dietitians Association of Australia (DAA) membership database, public and private hospitals providing maternity services and diabetes services across Australia.

Survey development was guided by national GDM management guidelines, as well as international practice guidelines and nutrition recommendations. The 55 item questionnaire survey was administered using the survey monkey online survey tool. Questions included multiple choice open-ended questions and Likert scale responses that addressed demographics, GDM service provision, dietetic assessment and interventions, screening and management guidelines, postnatal management practices, as well as information on current guideline use and perceived need for Australian evidence based dietetic practice guidelines. The University of Newcastle Human Research Ethics Committee approved the study (approval number H-2009-0006) and DAA approved the invitation to current members.

Detailed methodology and findings of this study are reported in Chapter 3 of this thesis.

1.3.3 Study Three: Breastfeeding mixed methods study

Data collection from the first study provided some information on breastfeeding initiation, duration and factors associated with breastfeeding in a sample of women with previous GDM. However, information on breastfeeding practices, attitudes and barriers in women with GDM arose as an area needing further exploration.

To meet the research aims, a breastfeeding study was conducted in a more recent cohort of women with GDM. These women were recruited from the NDSS and were diagnosed with GDM in 2010, aged ≥18 years and had consented to be contacted for research purposes. The database search included women from all Australian states. Recruitment was completed in March 2012, with eligible women (n=729) being 12-24 months post GDM pregnancy at the time of data collection. This group was selected due to evidence that recall of retrospective breastfeeding practices is more accurate where the period of recall is relatively short (12-36 months) [89].

This study was a mixed methods study using a concurrent dominant status design. This involved collecting the data in two sequential phases. The first phase was a quantitative 59 question online survey of women with recent GDM which represented the dominant phase of the study (Appendix D). For this phase the survey monkey online survey tool was used to collect information on demographics, GDM management, pregnancy outcome, infant feeding practices, breastfeeding intention, duration, difficulties, support and attitudes (Iowa Infant Feeding Attitude Scale).

Phase two involved semi-structured telephone interviews with 21 women recruited from the first phase of the study to further elucidate and describe breastfeeding experiences, as well as factors that contribute to decisions about the initiation, continuation and cessation of breastfeeding and the breastfeeding support available to women with GDM. The University of Newcastle Human Research Ethics Committee approved the study and application for variation (approval number H-2011-0144). Diabetes Australia Ltd. approved the NDSS database search.

Detailed methodology and findings from study three are presented in Chapter 4 of this thesis.

Table 1.2: Overview of research studies contributing to thesis

Study	Title	Research aims	*n*	Participants	Data source	Design	Analysis	Factors measured	Chapters
1	Gestational diabetes postnatal health and lifestyle study	3,4,5,6	1372	Women with GDM diagnosed ≤3 yrs previously	NDSS database of women diagnosed with GDM between 2003-2005	Cross sectional postal survey	Descriptive statistics, univariate chi square, multiple variable and multinominal LR analysis, qualitative thematic analysis	Demographics, BMI pregnancy outcomes, GDM management and health care, postnatal follow-up, diabetes risk perception, Australian Recommended Food Score, breastfeeding, Active Australia Questionnaire, qualitative GDM experiences	5, 6, 7, 8
2	Dietetic practice in the management of gestational diabetes	1	220	Australian dietitians currently practising in the area of GDM	DAA membership database, public and private hospitals, specialised diabetes services	Cross sectional online survey	Descriptive statistics	Demographics, GDM service provision, occasions of service, components of nutrition education, postnatal follow-up, policies and guidelines	3
3	Breastfeeding mixed methods study	2	729	Women diagnosed with GDM in the previous 1-2 years	NDSS database of women diagnosed with GDM in 2010	Mixed methods study - partially mixed concurrent dominant status design	Descriptive statistics, univariate chi square, multiple variable LR analysis, qualitative thematic analysis	Demographics, GDM management, infant feeding practices, breastfeeding intention, duration, difficulties, support and attitudes (Iowa Infant Feeding Attitude Scale	4

GDM – Gestational Diabetes Mellitus, NDSS – National Diabetes Services Scheme, DAA – Dietitians Association of Australia, BMI – Body Mass Index , LR – Logistic Regression

Chapter 2   Literature review

Chapter 2 presents a review of the literature regarding the dietary management of GDM (Section 2.1) and the prevention of future diabetes in women with GDM (Section 2.2). Figure 2.1 provides a literature review framework to illustrate the structure and content of this section of the thesis.

Figure 2.1 Literature review framework
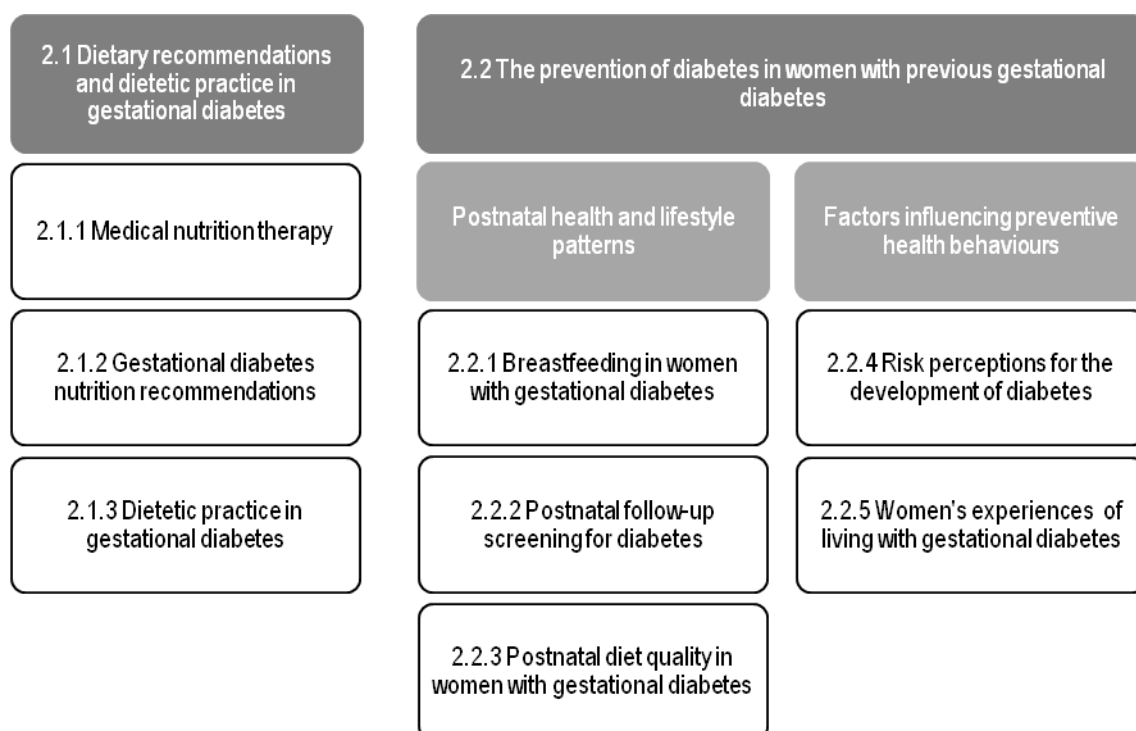
2.1 Nutrition recommendations and dietetic practice in gestational diabetes

Key components of the management of GDM include self-blood glucose monitoring, physical activity and dietary interventions, with medication/insulin used as additional therapy when required to achieve BG targets [2]. It is widely recognised that GDM management requires a multidisciplinary approach to care which includes nutrition interventions from a qualified dietitian [2, 90].

2.1.1 Medical nutrition therapy

Medical nutrition therapy (MNT) is a term used to describe the process of nutrition therapy conducted by a dietitian in the treatment of an illness or condition requiring dietary management. MNT for diabetes has been identified as a four step process of (1) nutrition assessment, (2) the development of individualised treatment goals, (3) nutrition intervention/education and (4) ongoing monitoring [91]. Medical nutrition therapy (MNT) conducted by a qualified dietitian is a primary therapeutic strategy for the management of GDM. The objectives of MNT in the management of GDM are to meet the nutrient requirements for pregnancy, assist with the maintenance of normoglycaemia, achieve appropriate maternal and foetal weight gain and promote a healthy lifestyle for reducing the risk of future type 2 diabetes.

The efficacy of MNT in diabetes management has been demonstrated in studies with all forms of diabetes. Kulkarni et al (1998) demonstrated that the implementation of dietetic practice guidelines in type 1 diabetes when compared with standard nutrition intervention significantly increased time spent with patients, frequency of visits and improved clinical outcomes, including a lower Hb_{A1c} (1.0 vs. 0.33%) at three-month follow up [92]. In type 2 diabetes, a randomised control trial with 179 individuals compared usual nutrition care (one visit) with intensive nutrition intervention (at least three visits) delivered by a dietitian. The intensive nutrition intervention resulted in improvements in blood glucose levels with a 1-2% reduction in Hb_{A1c} at six month follow-up [93]. More recently, in a review of the effectiveness of MNT in diabetes, Franz et al (2010) summarised the evidence from 21 randomised control trials and observational studies [94]. They reported decreases in Hb_{A1c} ranging from 0.5% to 2.6% (average of 1% to 2%) with MNT, which was reported to be similar to the effects of many glucose lowering medications.

More specifically in GDM, a randomised control trial evaluating the implementation of the American Dietetic Association (ADA) evidence-based GDM guidelines provides some evidence for the benefit of MNT [67]. Outcome data from 215 women receiving either standard care or guideline based care was compared across 24 sites in the US. When MNT was implemented using dietetic practice guidelines, fewer subjects given

practice-guideline care required insulin (24.6% vs. 31.7%; p = 0.05) and there was a higher proportion of women in the usual care group with Hb$_{A1c}$ levels that exceeded 6% at follow-up compared with women in the nutrition practice guidelines group (13.6% vs. 8.1%), although this finding was not statistically significant (p=0.26). No differences were found however in outcomes among diabetes speciality sites using practice guideline care. These sites appeared to have a level of usual care similar to that recommended by the guidelines.

In a smaller study examining outcomes of multiple GDM nutrition interventions provided by a dietitian, benefits for maternal and perinatal outcomes were also reported [95]. When women (n=51) in the intervention group receiving an average of 2.4 dietitian visits were compared with the control group (n=25) who received 0.2 dietitian visits, fasting BG were significantly lower in the intervention group (p<0.001) as was insulin use (12%vs. 2% p<0.05), and more babies were born <4000g in those receiving multiple nutrition interventions (60% vs. 14% p<0.05). This study provides some evidence that multiple dietetic interventions can result in a reduction in the complications associated with GDM.

The only findings relevant to dietetic interventions in an Australia context to date are those of Crowther and colleagues in the 2005 ACHOIS study [62]. In this clinical trial designed to examine the effects of GDM treatment, the intervention group received individualised dietary advice from a qualified dietitian, which took into consideration a woman's pre-pregnancy weight, activity level, dietary intake and weight gain. Dietetic advice was received by 92% of the women in the intervention group and only 10% of those in the routine care group. The intervention group also undertook frequent blood glucose monitoring while the control group received routine pregnancy care. The findings showed a 1% rate of serious perinatal complications (defined as death, shoulder dystocia, bone fracture, and nerve palsy) with GDM treatment compared with 4% in the routine care group (p=0.01). Although the study did not compare outcomes of specific health professional interventions, nor provide details of dietetic interventions, the results provide support for the treatment of GDM using a multidisciplinary health care model.

More recently, a Cochrane review of nine trials with a total of 429 women aimed to assess the effects of different types of dietary advice for women with GDM on pregnancy outcomes [96]. In assessing eleven different types of dietary advice they did not find that any one type of advice was more effective than another in reducing the number of births that requiring assisted delivery or the number of large for gestational age or macrosomic babies. The researchers concluded that it remained unclear as to the most effective dietary advice for women with GDM to improve maternal and infant health in the short and longer term. They recommended that larger, well designed randomised trials be conducted.

2.1.2 Gestational diabetes nutrition recommendations

2.1.2.1 Weight gain

Evidence suggests that prenatal overweight and obesity as well as excess maternal weight gain in the first trimester of pregnancy are risk factors for the development of GDM [16, 18]. In 2009 the Institute of Medicine (IOM) published revised pregnancy weight gain guidelines [97]. These guidelines outlined in table 2.1, provide recommended weight gain during pregnancy based on prenatal BMI. A number of organisations endorse these guidelines for women with GDM [98]. In Australia, the ADIPS guidelines do not currently recommend specific weight management targets [6].

Table 2.1: IOM pregnancy weight gain recommendations [97]

BMI category	BMI (kg/m^2)	Total pregnancy weight gain (kg)	Second and third trimester weight gain (kg/week)
Underweight	<18.5	12.5-18	0.44-0.58
Normal	18.5-24.9	11.5-16	0.35-0.50
Overweight	25-29.9	7.0-11.5	0.23-0.33
Obese	≥30	5.0-9.0	0.17-0.27

Weight gain during a GDM pregnancy may play an important role in pregnancy outcomes [99, 100]. Ouzounian et al (2011) in a study of more than 1500 women with GDM reported that both maternal pre-pregnancy weight and weight gain were independent risk factors for macrosomia [99]. Women who were obese (BMI ≥30

kg/m2) were twice as likely to have a macrosomic infant compared with women in the normal BMI group (OR 2.0; 95% CI 1.4, 3.0; p=0.0005). Independently, women who exceeded the IOM guidelines were three times more likely to have a macrosomic infant (OR 3.0; 95% CI 2.2, 4.2; p<0.0001). In a retrospective study, the relative contribution of pre-pregnancy weight, weight gain and GDM has also been recently examined [101]. Of the 9835 US women in this study, that more than half (59.5%) were overweight or obese and 19.2% had GDM. The researchers reported that the effects of GDM and maternal BMI appear to be additive, with the combination of being overweight or obese and having GDM accounting for 23.3% of large for gestational age (LGA) infants. The benefits of limiting gestational weight gain in women with GDM have also been reported by Park et al (2010) [100]. In a study of 215 Korean women, they found that only 2.4% of women in the inadequate maternal weight gain group having a macrosomic infant compared with 18.2% of those who gained in excess of the IOM guidelines (p=0.005). There were however no significant differences in other foetal outcomes between the groups. Recently, Barnes et al (2013) in an Australian study examined predictors of large and small for gestational age offspring in women with GDM in a retrospective audit of clinical data from 1695 women [102]. Significant independent large for gestational age predictors were: weight gain before intervention (OR 1.07; 95% CI 1.05, 1.09; p<0.0001), pre-pregnancy BMI (OR 1.06; 95% CI 1.04, 1.08; p<0.0001) weight gain after GDM (OR 1.09; 95% CI 1.04, 1.14; p<0.001) intervention and treatment with insulin (OR 1.51; 95% CI 1.12, 2.03; p=0.007). They concluded that all pregnant women should be provided with individualised weight gain targets by antenatal services according to the IOM guidelines.

There is currently limited evidence regarding weight management interventions in women with GDM. In an Australian study examining patterns of weight gain in women with and without GDM, Stewart el at (2012) reported on the results of a clinical audit of 212 pregnancies (115 GDM, 97 normal glucose tolerance) [103]. Women with GDM received lifestyle advice, weekly-second weekly clinic reviews and home blood glucose monitoring, while women without GDM received routine antenatal care. Relative to those without GDM, women with GDM had a lower rate of weight gain in

the 8 weeks post-diagnosis (p>0.0001) and a diagnosis of GDM was the only factor associated with post-diagnosis weight gain (R=-0.53; p<0.0001). While there were some limitations to the study design, it does provide some evidence for the benefits of intensive GDM management for optimising maternal weigh gain.

Recent research has demonstrated that weight gain between pregnancies may increase the risk of GDM in future pregnancies [104, 105]. Whiteman et al (2011) among a cohort of women with two consecutive live, singleton births of 20-44 weeks gestation (n = 232,272) demonstrated a threefold increased risk for developing diabetes (OR 3.21; 95% CI 2.76-3.73) in women who moved from normal pre-pregnancy weight (BMI = 18.5-24.9 kg/m²) in the first pregnancy to obese pre-pregnancy weight (BMI ≥ 30.0 kg/m²) in the second pregnancy [104]. Similarly, in a retrospective cohort analysis of 22,351 women Ehrlich (2011) reported that weight gain after pregnancy was associated with an increased risk of GDM in the second pregnancy OR 1.71(95% CI 1.42, 2.07) for gaining 1.0-1.9 BMI units; OR 2.46 (95% CI 2.00, 3.02) for 2.0-2.9 BMI units; and OR 3.40 (95% CI 2.81, 4.12) for 3.0 or more BMI units [105].

2.1.2.2 Energy intake

Women with GDM are a heterogeneous group of normal weight, overweight and obese individuals. Energy intake must therefore be individualised during pregnancy to ensure appropriate weight gain while preventing hyperglycaemia and ketonuria [32]. For women who are underweight or within a healthy weight range, the American Dietetic Association GDM Practice Guidelines recommend that the Dietary Reference Intakes for pregnancy are appropriate for this group due to a paucity of evidence regarding energy requirements in GDM [106].

The use of energy restricted diets in overweight or obese women with GDM and the impact on maternal weight gain, ketonuria and maternal or foetal health has been examined a number of studies. Dornhorst et al (1991) examined the effects of dietary energy restriction on birth weights of 35 infants born to mothers with GDM when compared with two age, race, BMI and parity matched control groups (A – normal OGTT and B- abnormal screening but normal OGTT) [107]. Women were prescribed a

1200-1800 kcal diet which was calculated individually to be 30% less than that consumed prior to pregnancy and based on pre-pregnancy ideal weight. They reported lower weight gain from booking to delivery (4.6 ± 4.9kg) than controls (group A 9.7± 5.3kg and group B 9.7 ± 5.4kg). They also found no infants of a GDM mother below the 10th percentile for weight, and birth weights were similar to those of the control groups even though mean weight gain after the 28th wk of gestation was only 1.7 ± 1.6 kg. The frequency of macrosomia (birth weight > 4000 g) was also not significantly different from controls.

In an Australian study, Rae et al (2000) randomly assigned 117 women with GDM to either an energy restricted (70% RDI for pregnancy) or non-energy restricted diet [108]. Standard diabetes education and usual GDM management was provided to both groups. Dietary energy restriction did not alter the frequency of insulin usage in the intervention (17.5%) or control group (16.9%). There were no differences in mean birth weight, neonatal outcomes and no increase in the presence of urinary ketones between the two groups. In addition, there was considerable slowing of maternal weight gain in both groups. While this study provides some evidence of the efficacy of an energy restricted diet, it is limited by the fact that there was no significant difference between the energy intake in the intervention and control groups (p=0.263).

Studies of 50% energy restricted diets have shown benefits for blood glucose levels and insulin concentrations, however when energy restriction was as low as 1200kcal ketonuria and ketonaemia also resulted [109]. With maternal body weight being the primary determinant of energy requirements, Algert et al (1985) demonstrated that obese women with GDM do not develop ketosis with or foetal growth retardation if consuming at least 25kcal/kg actual pregnancy body weight [110]. Guidelines from the US support the use of moderate energy restriction (30%) in the management of overweight or obese women with GDM [106, 111].

2.1.2.3 Carbohydrate

Carbohydrate intake directly influences postprandial glycaemia and is therefore an important consideration in the dietary management of GDM. Studies examining the

optimal percentage of dietary energy from carbohydrate have to date, produced mixed results. Major et al (1998) in a study of 42 women with diet controlled GDM examined perinatal outcomes in women on a low carbohydrate diet (<42% energy) compared with those with higher carbohydrate intakes (>45% energy) [112]. They reported significant reductions in postprandial glucose values among subjects in the low carbohydrate group (p < 0.04). Fewer women in the low-carbohydrate group required the use of insulin during pregnancy (RR 0.14; 95% CI 0.02, 1.00; p <0.047) and the incidence of large for gestational aged infants was significantly lower in the low carbohydrate group (RR 0.22; 95% CI 0.05, 0.91; p<0.035). Subjects in the low carbohydrate group also had a lower rate of caesarean deliveries and macrosomia (RR 0.15; 95% CI 0.04, 0.94; p<0.037). In contrast a more recent randomised control trial of 152 women with GDM assigned to follow either a low carbohydrate diet (40% of the total diet energy) or a control diet (55% of the total diet energy) showed no difference in the rate of insulin use between treatment groups (low carbohydrate 54.7% vs. control 54.7%; p =0 10), as well as no differences in the obstetric and perinatal outcomes between the treatment groups [113].

Interestingly, there is evidence from one study that a higher carbohydrate intake may be of benefit in reducing the incidence of macrosomia in this group. Romon et al (2001) in a prospective study of intensive management of GDM examined the relationship between dietary intake and infant birth weight in eighty women with GDM by assessing dietary intake by diet history at diagnosis and two three day food records at weeks three and seven post diagnosis [114]. Unexpectedly, they found that there we no large for gestational age infants born to women in the highest two quintiles of carbohydrate intake (> 210g of carbohydrate per day). While this study questions some of the previous evidence regarding the optimal macronutrient composition of a GDM diet, further studies are needed to confirm these findings.

While there is no nutrient reference value in Australia for carbohydrate during pregnancy, evidence suggests that adequate energy from carbohydrate is required to ensure appropriate foetal growth and prevent ketosis [32, 106, 111]. Currently the American Dietetic Association [106] and American Diabetes Association guidelines

[111] suggest that dietary carbohydrate intake should be between 40-45% of energy with minimum of 175g of carbohydrate consumed per day. The Canadian dietetic practice guidelines recommend a similar amount of carbohydrate, with up to 50% of energy deemed appropriate if the source is of carbohydrate predominately low glycemic index [66]. There are currently no GDM nutrient recommendations in Australia.

Aside from the total amount of carbohydrate, distribution throughout the day may be an important strategy for maintenance of glycaemic control. It is generally accepted that 3 small meals and 2-3 snacks throughout the day provides an even spread of carbohydrate with the objective of reducing postprandial BG spikes [111]. To date there is little data in the literature to guide optimal carbohydrate distribution. There is however some evidence that carbohydrate is generally less well tolerated at breakfast [111]. In an early study examining the optimal amounts of carbohydrate at meals and subsequent glycaemic response, postprandial BG values and food records were examined for 14 women with GDM [115]. The researchers reported that glycaemic response to a mixed meal was highly correlated with the percentage of carbohydrates. The correlation between percentage carbohydrates and postprandial glucose level at 1 hour was strongest for dinner (r=0.95, p<0.001) with more variability seen at breakfast (r=0.75, p=0.002) and lunch (r=0.86, p=0.001). To maintain a 1 h postprandial BGL <6.67mmol, the optimal percentage carbohydrate was reported to be 33%, 45% and 40% for breakfast, lunch and dinner, respectively. The researchers concluded that the amount of carbohydrate appropriate to maintain glycaemic control should be individualised based on self blood glucose management.

The type of carbohydrate is an additional consideration in the dietary management of GDM. The benefit of a lower glycemic index (GI) diet has recently been the subject of several studies in women with GDM [116-118]. In an Australian study examining pregnancy outcomes in women (n=63) prescribed either a low GI or high fibre/higher GI diet, researchers aimed to determined if a low GI diet could reduce the need for insulin use during pregnancy [116]. Of the 31 women randomised to the low GI diet, 29% met the criteria for insulin use compared with 59% of those randomised to the

higher GI diet (p=0.023). However, almost half of these women (47%) were subsequently able to avoid insulin by switching to a lower GI diet. There were no significant differences between obstetric and foetal outcomes in the two groups and women randomised to the low GI group achieved and maintained a significantly lower dietary GI at all stages of the study and change in GI from baseline to final visit in the low GI group was significant (-8.4±1.0; p<0.001).

More recently, Grant et al (2011) conducted a pilot study to examine both the feasibility and impact on glycaemic control of a low GI diet in women with GDM or impaired glucose tolerance during pregnancy [117]. In this multi-ethnic study, 47 women were randomised to either a low GI diet or control group. The low GI group were able to achieve a mean GI of 49 which was significantly lower than the 58 achieved by the control group (p=0.001). From baseline to one month there were no significant differences in fasting glucose, insulin, lipids, CRP or insulin use between the two groups. Overall glycaemic control improved on both diets, but more postprandial glucose values were within target on the low GI (58.4%) compared with the high GI diet (48.7%; p <0.001). The diet was also reported to be feasible and acceptable to study participants.

In contrast to the abovementioned findings, Louie et al (2011) in a randomised control trial of Australian women with GDM failed to demonstrate the benefits of a low GI in this group [118]. Women in this study (n=99) were randomised to either a low GI diet (target GI~50) or a high fibre, moderate GI diet (GI~60). At the end of the intervention period there were no significant differences in birth weight, prevalence of macrosomia, insulin treatment or adverse pregnancy outcomes. It is noteworthy however, that while the GI of the two diets was significantly different (GI=47 vs. GI=53; p <0.001), the moderate GI diet group did not achieve the target GI value. The high level of education of participants and wide recognition of the GI concept in Australia were two factors offered to explain the similarities between the two diets, which may have impacted on the findings.

2.1.2.4 Dietary fat

Manipulation of amount and type of fat is a key nutrition recommendation for managing blood lipids and reducing cardiovascular risk in people with diabetes [111]. In the case of GDM however, there is presently a lack of data regarding optimal fatty acid composition and the impact of degree of saturation on metabolic parameters during pregnancy. In a small study of women with GDM, Illic et al (1999) examined glucose and insulin responses to a test meal containing added saturated vs. monounsaturated fatty acids, with a lower glycaemic and insulin response reported the high saturated fat test meal [119]. Considering that this group has been identified as high risk for future diabetes and cardiovascular disease, such findings have not been incorporated into GDM nutrition recommendations. In the absence of evidence regarding dietary fat in GDM, nutrition recommendations focus on achieving intakes in line with dietary reference values for pregnant women [106].

In the longer term, the dietary management of GDM may have the potential to attenuate future risk of chronic disease in a high risk group. Dietary messages consistent with those for prevention of type 2 diabetes include a reduction in saturated fat and replacement with poly and monounsaturated fats. In a study of Australian women with GDM randomised to follow a low fat diet (<30% energy) compared with a diet which included targeted intakes of unsaturated fats, Gillen and Tapsell (2004) reported more favourable polyunsaturated: saturated fat ratios in the intervention group (1.1 for the intervention group vs. 0.4 for the control group, $P<0.001$) [120]. This led the authors to conclude that this type of dietary advice may support future risk management in women with GDM.

2.1.2.5 Micronutrients

Meeting nutrient requirements for pregnancy is an important goal of MNT for GDM. There is no evidence of different micronutrient requirements for women with GDM compared with healthy pregnant women. It is therefore appropriate to apply the Nutrient Reference Values for pregnancy to this group [121].

For pregnant women, NHMRC guidelines currently recommend supplementation with 400μg folate in the prenatal period and first trimester [121]. In women with existing diabetes (type 1 and type 2) high dose (5mg) folate supplementation is recommended due to an increased risk of congenital malformations [122], however recommendations for women with GDM are the same as that for the general population. In addition to folate supplementation, the NHMRC recommend that women who are pregnant, breastfeeding or considering pregnancy take an iodine supplement of 150μg each day [121]. This guideline applies equally to women with GDM. In MNT, additional vitamin and mineral supplementation is considered appropriate where dietary inadequacies have been identified and requirements cannot be met through food [106].

A number of other vitamins and minerals have been examined in the context of GDM. These include chromium, magnesium and Vitamin D. However, the evidence relating to the relationship between these micronutrients and the aetiology of GDM is beyond the scope of this thesis.

2.1.2.6 Alternative sweeteners

Alternative sweeteners include both nutritive and non-nutritive sweeteners. In Australia eight non-nutritive sweeteners are approved by Food Standards Australia & New Zealand (FSANZ) [123]. Acceptable Daily Intakes (ADI) have been established for each sweetener.

With evidence that moderate sucrose consumption does not increase glycaemia more than isocaloric amounts of starch [111], reliance on alternative sweeteners is not necessary for the management of diabetes. However, sweeteners may be recommended for reducing energy intake or as a replacement for foods and drinks with a high carbohydrate content in the form of added sugars.

Internationally, a number of non-nutritive sweeteners are deemed as unsafe for use during pregnancy. The Canadian GDM Nutrition Best Practice Guidelines [66] advise against the consumption of saccharin or cyclamates during pregnancy due to evidence that these sweeteners cross the placenta and remain in foetal tissue for longer than in adults. The American Dietetic Association GDM Evidence Based Guidelines

recommend that non-nutritive sweeteners can be consumed within ADIs, with the exception of saccharin [106]. They also caution that non-nutritive sweeteners be only used moderation during pregnancy due to a lack of research.

In Australia, the FSANZ Food Standards Code requires warning statements for products sweetened with aspartame for people with phenylketonuria and nutritive sweeteners which may have a laxative effect [123]. No sweeteners however, have been identified as unsafe for consumption during pregnancy. Consumption research by FSANZ has demonstrated mean exposure to non-nutritive sweeteners to be below the ADI, with no evidence that people with diabetes are exposed to higher amounts than other consumers who use these sweeteners [124].

2.1.2.7 Alcohol

Alcohol recommendations for people with diabetes are the same as those for the general population [125]. The current National Health and Medical Research Council (NHMRC) guidelines recommend that women abstain from alcohol consumption during pregnancy. This guideline is based upon the available evidence regarding the potential harm to the foetus and the fact that a safe drinking level during pregnancy has not been established. The American Dietetic Association Evidence Based Nutrition Practice Guidelines for GDM support dietetic advice for pregnant women, including those with GDM to avoid the consumption of alcohol [106]. There is currently no available data on alcohol consumption in Australian women with GDM.

2.1.2.8 Postnatal care

Postnatal dietary management of women with GDM presents an opportunity for the prevention of future type 2 diabetes. This includes dietary interventions to achieve appropriate postnatal weight management, optimise dietary intakes to reduce diabetes related risk factors, encourage physical activity and promote breastfeeding. The American Dietetic Association GDM guidelines currently recommend that women with GDM who are overweight receive weight management advice from a dietitian after delivery [106]. Likewise, the ADIPS guidelines recommend that maternal follow-up includes information about the importance of healthy eating and exercise patterns

[6]. To date there is no published data regarding postnatal dietetic care provided to Australian women with GDM or the impact of dietary interventions on longer term lifestyle behaviours in this group.

2.1.3 Dietetic practice in gestational diabetes

Internationally, there are a number of published dietetic practice guidelines for the management of GDM which outline the optimal provision of MNT. The American Dietetic Association Evidence Based Guidelines for GDM recommend that women with GDM be seen by a dietitian within one week of diagnosis and then receive a minimum of three nutrition visits [106]. These guidelines outline the specific components of nutrition assessment, interventions, monitoring and evaluation as well as outcomes management. Similarly, the Canadian Nutrition Best Practice Guidelines outline the nutrient recommendations for GDM management, however other than recommending that nutrition counselling be provided by a registered dietitian, they do not specify the frequency or specific components of dietetic interventions [66]. Diabetes UK state that women with diabetes during pregnancy should have access to a multidisciplinary team (linking diabetes and obstetric professionals, which includes an experienced dietitian), so that individualised nutritional care plans can be negotiated [126].

In Australia, the ADIPS guidelines recommend that the dietary management of GDM should (1) conform with the principles of optimal dietary management of diabetes; (2) meet the nutritional requirements of pregnancy; (3) be individualised according to maternal weight and body mass index and (4) be culturally appropriate [6]. However, there are currently no Australian evidence based nutrition recommendations or dietetic practice guidelines to ensure a systematic approach to dietary interventions and follow-up for women with GDM.

2.1.4 Summary

To summarise, this section of the literature review has outlined the key components of MNT for the management of GDM and findings to date on optimal nutrient prescription. It also highlighted evidence for the benefits of MNT when implemented

as guideline based care within a given timeframe and with a minimum number of interventions. There are currently no GDM nutrition recommendations or dietetic practice guidelines in Australia and to date, little is known about nutrition interventions provided to Australian women with GDM. Further research in this area is warranted to ensure that the care provided to women with GDM both now and in the future is evidence based and provides the best possible maternal and infant outcomes.

2.2 The prevention of diabetes in women with previous gestational diabetes

This section reviews the literature on preventive health beliefs and behaviours in women with GDM that may influence the risk of future type 2 diabetes. Specifically, the postnatal health and lifestyle behaviours examined in this thesis include breastfeeding, return for follow-up blood glucose testing and diet quality. To date there is limited information about these health seeking and preventive behaviours in an Australian context. Other preventive health behaviours such as physical activity have not been examined in this thesis.

This literature review concludes with a summary of the literature regarding factors influencing preventive health behaviours, specifically risk perceptions for developing diabetes, and women's experiences of living with GDM, including both the antenatal and postnatal period. These perceptions and experiences may be important determinants of health beliefs, behaviours and engagement with health care providers, and offer insight into challenges and opportunities for diabetes prevention.

2.2.1 Breastfeeding in women with gestational diabetes

2.2.1.1 The benefits of breastfeeding

Breastfeeding has been consistently demonstrated to confer a range of short and long-term benefits for mother and infant [127]. These can be summarised to include nutritional, immunological, health, developmental, psychological, social, economic and environmental benefits [128].

Nutritionally, breast milk provides the optimal balance of nutrients in readily digested and biovavailable forms essential for infant growth and development [129]. It contains numerous immunological factors which contribute to protection against acute infection and may also influence the development of the infant's immune system [128]. In infants, lower rates of otitis media, atopic conditions, respiratory and gastrointestinal illnesses have been widely reported [128-130], while maternal benefits have been reported to include lower rates of breast and ovarian cancer as well as a reduction in the risk of chronic disease, including type 2 diabetes [130]. In addition, breastfeeding has developmental and psychological benefits related to the unique composition of human milk and the important role of breastfeeding in maternal infant bonding [129]. Breastfeeding has demonstrated economic benefits with a reduction in health care costs associated with this form of infant feeding [131]. It is also recognised as an environmentally sound practice [129].

Breastfeeding and chronic disease risk

In population studies, breastfeeding has been demonstrated to have favourable effects reducing future maternal chronic disease risk [132]. A reduction in the risk of type 2 diabetes and metabolic syndrome has been shown in several large epidemiological studies [133, 134].

In a prospective observational cohort of more than 80,000 parous women in the Nurses' Health and Nurses' Health Study II, Stuebe et al (2005) reported that women who had given birth in the past 15 years had a decrease in the risk of developing type 2 diabetes of 15% (95% CI 1-27%) and 14% (95%CI 7-21%) per additional year of breastfeeding in each cohort respectively [133]. These findings were independent of other risk factors including BMI, diet, exercise and smoking. Liu et al (2010) in an Australian study found both the total duration of breastfeeding and duration per child were associated with a reduced risk of type 2 diabetes [135]. A 14% reduction in the risk of diabetes per year of breastfeeding (adjusted OR 0.86; 95% CI 0.82, 0.90) was reported.

In a longitudinal study of more than 139 000 post menopausal women in the Women's Health Initiative, those who reported a lifetime history of lactation of greater than 12 months were less likely to have hypertension (OR=0.88; p<0.001), hyperlipidaemia (OR=0.81; p<0.001), diabetes (OR= 0.80; p<0.001) or cardiovascular disease (OR= 0.91; p=0.008) when compared to women who had never breastfed [136].

Postnatal weight loss is one proposed mechanism through which lactation may influence cardiometabolic health. Lactation has been shown to increase maternal total energy expenditure by an estimated 15-25% [137]. However, to date the findings of studies regarding the benefits of breastfeeding on postnatal weight loss are equivocal. Several studies have suggested lower post-pregnancy weight retention [138, 139] while others have found only small non-statically significant differences in weight [140]. These inconsistent findings may be due to the large number of confounding factors which may impact on weight loss in the postnatal period, including diet, physical activity, pre-pregnancy BMI, lactation intensity and ethnicity [141]. Alternatively, some of the benefits of lactation may be explained by changes in body composition and body fat distribution rather than weight loss itself [140].

Aside from the maternal benefits of breastfeeding, studies have also demonstrated some evidence of longer term chronic disease risk reduction for breastfed infants [142, 143]. Breastfeeding has been associated with a reduced risk of childhood overweight and obesity [142]. In a systematic review of nine studies with more than 69,000 participants, Arenz (2004) reported that breastfeeding significantly reduced the risk of childhood obesity, with an adjusted odds ratio of 0.78 (95% CI 0.71, 0.85) in the fixed model [142]. These findings have also been demonstrated to extend into adult life. A 2008 meta-analysis of 39 studies spanning 40 years concluded that breastfed individuals were less likely to be overweight or obese compared to those who were not breastfed (OR 0.78; 95%CI 0.72, 0.84), even after adjustment for confounders including birth weight, parental weight and socioeconomic variables [144]. A dose response relationship has also been demonstrated in a meta-analysis examining duration of breastfeeding and weight status. Harder et al (2005) reported a reduction in the risk of overweight of 4% for every month of breastfeeding (OR 0.96/month of breastfeeding,

95% CI: 0.94, 0.98)[145]. The proposed mechanism for this protective effect is the regulation of energy balance, fat deposition and metabolism due to the unique composition of nutrients and bioactive substances [146].

The association between breastfeeding and the subsequent development of type 2 diabetes in offspring has also been examined in the literature. A systematic review of 23 studies examined the relationship between infant feeding and risk factors for, and the development of, type 2 diabetes in later life [143]. They reported a lower risk of type 2 diabetes in later life in subjects who were breastfed compared with those who were formula fed (7 studies; 76 744 subjects; OR 0.61; 95% CI 0.44, 0.85; p =0.003). In addition, they reported marginally lower fasting blood insulin concentrations in both children and adults and lower fasting blood glucose concentrations in infancy.

2.2.1.2 Breastfeeding in Australia

The Dietary Guidelines for Australians recommend that infants be exclusively breastfed for the first six months of age with continued partial breastfeeding after the introduction of solids until 12 months or beyond if mother and infant wish [127].

Data from the Growing Up in Australia Longitudinal Study of Australian Children provides the most current information on breastfeeding rates in Australia [147]. This data suggests that 92% of Australian babies are breastfed at birth, with a decline in breastfeeding thereafter. At one week of age only 80% of infants are fully breastfed, with rates at three, five and six months being 56%, 28% and 14% respectively. Although breastfeeding initiation rates in Australia exceed those of many other developed nations, the continuation rates fall behind many other OECD countries and are well below the targets set by health authorities [148].

Factors affecting breastfeeding

Factors that influence a women's decision to initiate and continue breastfeeding are numerous and complex. These include factors at an individual level, within the immediate environment, as well as societal influences [148]. A number of variables that contribute to breastfeeding initiation and duration have been identified in the

literature. Following is a brief discussion of some of the key factors shown to influence breastfeeding practices in Australia.

Rates of breastfeeding have been shown to vary by socioeconomic and demographic characteristics. In the 2001 National Health Survey, 54% of mothers aged 30 years or over were still breastfeeding their infant at six months, compared with 38% of mothers aged 18–29 years [149]. Those aged 30 years or over were also twice as likely to be breastfeeding at 12 months of age (28%) compared with mothers aged 18–29 years (14%). Likewise, breastfeeding rates have been shown to vary by level of education. In 2001, 64% of tertiary educated mothers were breastfeeding infants at six months of age, compared with 41% of non-tertiary educated women [149].

Australia National Health Survey data has demonstrated a socioeconomic gradient for both initiation and duration of breastfeeding [150]. Comparing breastfeeding rates in the national health surveys by quintiles of Socio-Economic Indexes for Areas (SEIFA) classifications, Amir and Donath (2008) reported a six month breastfeeding rate of 37.1% in the lowest compared with 66.0% in the highest quintile of SEIFA [150]. The reasons for these differences between socioeconomic groups are thought to be numerous and may include differences in health seeking behaviours, family support for breastfeeding, ability to seek help with breastfeeding problems, employment arrangements and concerns about breastfeeding in public.

Data from the Longitudinal Study of Australian Children [151] demonstrated a relationship between maternal postnatal employment status and breastfeeding. They found that fewer women employed full time were breastfeeding their infants at six months (39%) compared with non-employed women (56%). Participation in full-time employment prior to six months also had a strong, negative effect on the likelihood of breastfeeding at six months (adjusted OR 0.35; 95% CI 0.22, 0.55). The relationship between return to work and breastfeeding is complex, with other factors such as maternal and family characteristics also thought to influence breastfeeding decisions [147].

Mothers from Aboriginal and Torres Strait Islander backgrounds have been found to have breastfeeding rates below those of the general population [152]. Data from 2004–05 National Aboriginal and Torres Strait Islander Social Survey reported higher proportions of non-Indigenous children aged less than three years (in non-remote areas) had ever been breastfed (88%) compared with Aboriginal and Torres Strait Islander children (79%). This survey also demonstrated differences between breastfeeding rates in indigenous communities by remoteness, with those living in remote areas more likely to breastfeed. There is inconsistent evidence as to whether breastfeeding rates in culturally and linguistically diverse groups in Australia are comparable to those in the general population rates [153-155]. There also seems to be considerable variation amongst different cultural groups in Australia which may reflect cultural norms and factors such as family support [148].

A number of biomedical factors have been identified in influencing maternal breastfeeding practices. These range from infant prematurity, multiple births and infant medical problems to maternal health status (antenatal, perinatal and postnatal) [148]. Data from a longitudinal Australian study has shown a negative association between caesarean delivery and exclusive breastfeeding at hospital discharge (adjusted OR 0.42; 95% CI 0.26, 0.68) with the strongest negative predictor being having had an infant admitted to a special care nursery after delivery (OR 0.30; 95% CI 0.5, 0.59) [156]. Forster et al (2006) in analysis of data from a breastfeeding education program reported that infants who received infant formula while in hospital were less likely to be breastfed at six months (adjusted OR 0.43; 95% CI 0.30, 0.62) [154].

Maternal obesity has also been identified as a barrier to breastfeeding initiation and duration [157, 158]. In a systematic review of maternal weight status and breastfeeding, Amir (2007) reported that overweight and obese women were consistently found to be less likely to breastfeed than normal weight women [157]. In examining possible reasons for these differences they reported on several studies that suggested delayed lactogenesis, as well as practical/mechanical difficulties with breastfeeding in this group. In addition, other medical complications such as polycystic ovarian syndrome may hinder breastfeeding success. Several socio-cultural reasons for this trend have

been proposed, including lower socioeconomic status and concerns regarding breastfeeding in public. Postnatal depression and body image issues may also present barriers to breastfeeding in this group [157]. Data from the Longitudinal Study of Australian Children was used by Donath and Amir (2008) to examine breastfeeding patterns in overweight and obese women [159]. Their findings suggest that initiation of breastfeeding was less frequent in overweight (92.8%) and obese (87.1%) women compared to women in the healthy weight range (95.1%). Overweight and obese women were also more likely to cease feeding in the first week (OR 1.52; 95% CI 1.02, 2.28; OR 2.54; 95% CI 1.70, 3.79) and in those who did breastfeed for at least one week, overweight women had an adjusted OR of 1.26 (95% CI 1.04, 1.53) and obese women and adjusted OR of 1.38 (1.10, 1.73) of ceasing breastfeeding prior to six months compared with normal weight women. More recently, Wojcicki (2011) confirmed these findings in a literature review of 12 international studies, suggesting however that there may also be differences between ethnic groups and in women with weight related co-morbidities [158].

Maternal smoking has been negatively associated with both breastfeeding initiation and duration [160, 161]. In a review of epidemiological evidence Amir et al (2002) reported that this finding was consistent across different study designs in a range of countries. Women who smoke have also been reported to be less likely to intend to breastfeed[160]. They have also been shown to have a lower prevalence and shorter duration of breastfeeding than non-smoking mothers (28 vs. 11 wk, 95% CI 8.3; 13.7)[161]. A dose response relationship has also been demonstrated. In an Australian cohort, Forster et al (2006) reported maternal smoking of 20 or more cigarettes per day was negatively associated with 'any' breastfeeding at six months (adjusted OR 0.47; 95% CI 0.26, 0.86) [154]. While there is some suggestion for a physiological effect of smoking on lactation, psychosocial factors associated with smoking are thought to be more important [160].

Maternal psychological well-being is another important variable impacting on breastfeeding. Breastfeeding discontinuation has been associated with both maternal depressive symptoms and anxiety in a number of studies [154, 162]. Forster et al (2006)

using data from 764 Melbourne women found that those with self reported depression in the six months after childbirth were less likely to be breastfeeding at six months (adjusted OR 0.64; 95% CI 0.46, 0.90) [154]. In another study of 1745 women from two large Australian obstetric hospitals it was found that early cessation of breastfeeding was significantly associated with postnatal depression (adjusted hazard ratio 1.25, 95% CI 1.03, 1.52) [162]. The median duration of breastfeeding for women with early-onset depression was 26 weeks, for those with late-onset depression duration was 28 weeks and 39 weeks for women without depression.

Infant feeding attitudes and breastfeeding intentions are important determinants of breastfeeding outcomes. In an Australian study, Rempel (2004) reported that a strong desire to breastfeed was positively associated with breastfeeding at six months with having no intention to breastfeed being negatively associated [163]. These findings were confirmed by Forster et al (2006) who reported that women who had not intended on breastfeeding for the first six months were less likely to do so (adjusted OR 0.41; 95% CI 0.25, 0.67) [154]. In examining the importance of breastfeeding attitudes, Scott et al (2006) using the Iowa Infant Feeding Attitude Scale reported that odds of breastfeeding at hospital discharge for women in Perth increased with increasing total attitude score (adjusted OR 1.10; 95% CI 1.06, 4.26) [164]. Studies have also reported that along with maternal attitudes towards breastfeeding those of partners and family members also play an important role in breastfeeding success [165].

Health professional support for breastfeeding and management of problems has been identified as being an important determinant of breastfeeding success [166]. In a systematic review of breastfeeding support interventions Hannula et al (2008) reported that combined interventions including group and individual interactions during pregnancy, early postnatal practical support which included patient empowerment, as well as discharge telephone support, home visits and breastfeeding support services were all shown to be effective [167]. In this review a number of studies highlighted the crucial role of the health professional in breastfeeding support and encouragement [168, 169].

2.2.1.3 Breastfeeding in Women with Diabetes

Lactation in women with GDM has been shown to have immediate beneficial effects on cardiometabolic risk factors. In the early postnatal period, this includes improved glucose tolerance at 4-12 weeks, lower fasting serum glucose and 2 hour glucose tolerance after controlling for BMI, maternal age and insulin use [170]. Favourable effects were also found by Buchanan et al (1998) in studies with Latino women with diet controlled GDM [171]. They found that those diagnosed with type 2 diabetes within the first six months post-delivery were less likely to be currently breastfeeding compared with those with normal glucose tolerance (42% vs. 71%; p=0.03). Recently, the results of the SWIFT cohort study found a dose response relationship between breastfeeding intensity and markers of maternal glucose and insulin sensitivity [172]. They reported women in the exclusively or predominately breastfeeding groups had lower adjusted fasting plasma glucose, fasting and 2 hour glucose levels and improved insulin sensitivity at 6-9 weeks following a GDM pregnancy. These findings provide further support for the short term beneficial effect of lactation on glucose metabolism and insulin sensitivity.

Due to limited and inconsistent evidence, the favourable effects of breastfeeding on longer term diabetes risk reduction have until recently been less apparent in women with GDM. In earlier studies, no association was found between lactation and the future development of type 2 diabetes in women with GDM [133, 173]. However these studies were limited by retrospective study designs, self report of subsequent type 2 diabetes, variable definitions and assessment of breastfeeding status, and failure to account for potential confounders including postnatal lifestyle [146].

The Coronary Artery Risk Development in Young Adults (CARDIA) study examined the incidence of metabolic syndrome by GDM status in a multicenter, population-based, 20 year prospective observational cohort [174]. Among women with GDM, increased lactation duration was associated with lower crude metabolic syndrome incidence rates from 0–1 month through >9 months. Fully adjusted relative hazards showed that risk reductions associated with longer lactation were actually stronger

among the GDM group (relative hazard range 0.14–0.56; p =0.03) when compared to the women with normal glucose tolerance (relative hazard range 0.44–0.61; p =0.03).

More recently, in a 19 year prospective study of 304 German women with GDM, Ziegler et al (2012) found that breastfeeding in women with prior GDM was associated with a >40% risk reduction for development of postnatal diabetes [175]. Women who breastfed for >3 months had the lowest 15 year postnatal diabetes risk (42%; 95% CI 28.9-55.1) when compared to those who didn't breasted or did so for ≤3 months (72%; 95% CI 60.5-84.7; p= 0.0002), as well as a longer diabetes free duration (18.2 years; 95% CI 10.4-25.90. The benefits of breastfeeding were found for both exclusive and partial breastfeeding. Although this study did not control for the possible confounding effects of lifestyle on diabetes risk, it adds to the limited evidence available to date. The authors concluded that breastfeeding represents a low cost intervention for postnatal diabetes risk reduction.

Aside from the well documented benefits of breastfeeding for the infant, there is some, albeit limited, evidence that breastfeeding may confer protection against some of the associated health risks of exposure to diabetes in utero. In the short term, it has been suggested that breastfeeding may assist with management of hypoglycaemia, a neonatal complication of GDM. Chertok et al (2009) in a pilot study of 84 infants examined the impact of early postnatal breastfeeding on neonatal blood glucose levels [176]. They reported lower rates of borderline hypoglycaemia (10% vs. 28%; p=0.05) and higher mean blood glucose levels in those who were breastfed compared with formula fed for their first feed (3.20 vs. 2.68mmol/L; p=0.002). While this study had a number of limitations, it is one of few studies to date to provide some evidence of short term benefits of breastfeeding in this group. Further research is needed to examine early feeding methods and subsequent neonatal outcomes.

An increased risk of overweight and obesity has been widely reported in the offspring of women with diabetes during pregnancy [41, 42]. It is plausible therefore that the method of infant feeding, specifically breastfeeding, may be able to attenuate some of the risks posed by in utero exposure to hyperglycaemia, however evidence to date is

equivocal. Crume et al (2011) in a study of women with GDM and pre-existing diabetes examined the long term impact of breastfeeding on childhood adiposity and fat distribution [177]. In comparing women classified as having adequate (>6 breast milk months) versus low (<6 breast milk months) breastfeeding status they reported significantly lower BMI (18.0 vs. 20.1; p=0.05) and waist circumference (62.4 vs. 68.4; p=0.03). Among those in the adequate breastfeeding category, exposure to diabetes in utero was not associated with measures of adiposity and body fat distribution. In a study of German children exposed to GDM, Schaefer-Graf et al (2006) found negative association between exclusive breastfeeding for three months or more and the risks of overweight (OR 0.55; 95% CI 0.33, 0.91), however this was only found among offspring of obese mothers [178]. Data from the Nurses' Health Study II also reported a non-significant lower risk of overweight in offspring of women with GDM and pre-gestational diabetes who were ever vs. never breastfed (OR 0.62; 95% CI 0.24, 1.60) [179],warranting further research in this area. The possible benefits of breastfeeding on weight status have not been consistently demonstrated in other studies. In a study of women with both type 1 and gestational diabetes, Plagemann et al (2002) actually reported an adverse effect of breastfeeding in the first week of life on relative weight at two years [180]. However, a follow-up of this study examining breastfeeding exposure beyond the first week showed no association with weight or glucose tolerance in the second year of life [181]. The conflicting results to date may be the result of studies including women with different types of diabetes and not controlling for maternal glycaemic control or postnatal environmental influences.

The influence of breastfeeding on the future development of type 2 diabetes in children exposed to GDM has been examined in several studies. In the Pima Indian population, exclusive breastfeeding (>2 months) was found to be associated with a lower prevalence of type 2 diabetes in the offspring of women with normal glucose tolerance in pregnancy, but not for those exposed to GDM [182]. In a case control study of Native Canadian children diagnosed with type 2 diabetes (n=46) and age-sex matched controls (n=92), Young et al (2002) found a lower OR of diabetes among offspring breastfed for >12 months when compared with those not breastfed (OR 0.24; 95% CI 0.13, 0.84), after

adjustment for type of maternal diabetes during pregnancy [183]. In another case control study, the SEARCH for diabetes in youth study, Mayer-Davis et al (2008) examined breast-feeding and incidence of type 2 diabetes among African American, Hispanic and non-Hispanic white youth [184]. They reported a history of lower prevalence of any duration of breast-feeding among youth with type 2 diabetes than among control subjects (19.5% vs. 27.1% for African Americans, 50.0% vs. 83.8% for Hispanics, and 39.1% vs. 77.6% for non-Hispanic whites). They found a protective association between breastfeeding duration in childhood and incidence of type 2 diabetes (OR 0.43; 95% CI 0.19, 0.99) adjusted for 12 covariates including maternal diabetes status. While the data on the beneficial effects of breast-feeding on reducing future type 2 diabetes risk in the child is limited, more research is needed. This will help to determine if this modifiable health behaviour may contribute to breaking the cycle of obesity and type 2 diabetes in children exposed to a hyperglycaemic intrauterine environment.

Internationally, breastfeeding initiation rates amongst women with GDM have been reported to be comparable with those of women without diabetes [185-187]. Soltani et al (2008) in a UK study of women with all types of diabetes (type 1, type 2; GDM) reported higher breastfeeding initiation rates (81.9%) compared with the local population rate of 71% [185]. When data from women with GDM was analysed separately, this group were significantly more likely to initiate breastfeeding at birth (92.5%) compared to women with type 1 (66.7%) and type 2 diabetes (81.8%; p=0.022)[187]. In a four year retrospective study of New Zealand women with GDM, Simmons et al (2004) reported that women with GDM who had a normal delivery had similar breastfeeding rates at discharge (84%) compared to the population rates (87.8% European women and 88.2% Polynesian women) [186]. However, more recently, Finklestein et al (2103) in a retrospective cohort analysis conducted across four Canadian hospitals reported lower rates of breastfeeding in women with GDM (OR 0.77; 95% CI 0.68, 0.88) when compared to women without diabetes [188]. Interestingly, they also reported that women who had antenatal care provided by a health professional other than an obstetrician (e.g. family physician, midwife or practice

nurse) were 2-3 times more likely to breastfeed in hospital and on discharge. There is presently no data available on breastfeeding rates in Australian women with GDM.

There is limited information on factors associated with breastfeeding in women with GDM. While delayed lactogenesis has been described in women with type 1 diabetes, clinical studies have not shown this in women with GDM [189]. However, difficulties expressing colostrum in the early stages breastfeeding have been reported in this group [189]. As overweight and obesity are associated with an increased risk of GDM, as well as delayed lactogenesis, this may also play a role in early breastfeeding success or failure in this group [157].

Soltani and Arden (2009) in a UK study of women with GDM, type 1 and type 2 diabetes examined the predictors of breastfeeding from birth to six months. They reported that type of diabetes was the most significant predictor of breastfeeding at birth, with women with GDM more likely to breastfeed (OR 5.20; 95% CI 1.12, 24.25) than women with other types of diabetes [187]. These findings have been reported elsewhere [186] and may be in part explained by higher rates of neonatal complications in women with type 1 and to a lesser extent, type 2 diabetes [190]. The type of first feed has also been shown to be associated with breastfeeding in women with GDM, with those who breastfed at birth more likely to do so up to six weeks postpartum ($p<0.05$) [191]. Time to first feed may also play as role, as prolonged separation of mother and infant at birth as a result of birth complications has been suggested to have a potential adverse effect on the initiation of breastfeeding. While parity may also be important in this group, women with higher parity have been shown to be more likely to be breastfeeding at 6 weeks than those with lower parity ($p<0.05$) [191].

Similar to findings in general population studies, maternal body mass index has been suggested to be an important determinant of breastfeeding in women with GDM. Soltani and Arden (2009) found that maternal BMI was consistently negatively associated with breastfeeding at one, two and six weeks, as well as at four months post- pregnancy($p<0.05$) in women with all types of diabetes, although GDM and BMI were not examined separately in this study [187]. Conversely, Simmons et al (2005) in a

study of New Zealand women did not find any difference between BMI in women with diabetes who did and did not breastfeed at hospital discharge (33.9±6.7 vs. 35.0±7.6; p=0.264) [186].

Despite the fact that until recently there has been a paucity of evidence regarding the benefits of breastfeeding in women with GDM, this form of infant feeding has been consistently encouraged in this group. The recommendations of the Fifth International Workshop on GDM (2007) concluded that while the effect of breastfeeding per se on diabetes risk was unclear, women should be actively encouraged to exclusively breastfeed to the greatest extent possible during the infants first year [192]. Similarly, The Australasian Diabetes in Pregnancy Society (ADIPS) guidelines state that breastfeeding should be actively encouraged in this group [2]. Further research is needed regarding breastfeeding in Australian women with GDM.

2.2.2 Postnatal follow-up screening for diabetes

As a major risk factor for the development of maternal metabolic abnormalities, it is widely recognised that postnatal follow-up of women with GDM is important for the early identification of glucose intolerance in a high risk group. It also presents an opportunity for targeting lifestyle interventions to reduce the risk of type 2 diabetes or in the case of those found to have diabetes, early detection and management to reduce the risk of complications [11].

2.2.2.1 Postnatal diabetes screening recommendations

Internationally, postnatal blood glucose testing is recommended for reclassification of glucose tolerance status after a GDM pregnancy [6]. The American Diabetes Association 5th International Workshop on GDM summarised the rationale for postnatal testing as the detection of abnormal glucose tolerance and early diagnosis; identification of those at highest diabetes and cardiovascular risk; pre-pregnancy planning for subsequent pregnancies and determination of those for whom intensive lifestyle interventions would be most appropriate [46].

To date recommendations on postnatal screening have varied between countries and health care organisations. Table 2.2 shows a summary of international postnatal screening recommendations.

Table 2.2: International postnatal screening recommendations

Organisation	Recommended test	Schedule
American Diabetes Association 2013[193])	FBG or 75g OGTT	6–12 weeks At least every 3 years
American College of Obstetrics & Gynecologists 2009 [194]	FBG or 75g OGTT	6-12 weeks Annual for IGT 3 years for normal results
World Health Organisation 1999 [195]	FBG and/or 75g OGTT	>6 weeks
National Institute for Health & Clinical Excellence 2008 [73]	FBG	6 weeks Annual
Canadian Diabetes Association 2008 [196]	75g OGTT	6-26 weeks Follow type 2 diabetes screening guidelines
Australasian Diabetes in Pregnancy Society 2013[30]	75g OGTT	6-12 weeks High risk OGTT with frequency depending on risk factors Annual OGTT if planning pregnancy Low risk FBG 1-2 years

The efficacy of postnatal screening strategies has been examined in a 2009 systematic review of eleven studies. Bennett et al (2009) reviewed studies which compared a single fasting blood glucose (FBG) level with an oral glucose tolerance test (OGTT) for postnatal screening of women with previous GDM [197]. For FBG they reported sensitivities of 14-100% in studies using 1985 WHO diagnostic criteria and 16-89% in those using the 1999 WHO criteria. Kitzmiller et al (2007) in their study of postnatal screening methods reported that the poor sensitivity of the FBG persisted across different ethnic groups and BMI categories [46].

In a simulated model examining efficacy and cost of postnatal screening strategies, Kim et al (2007) compared the OGTT with FBG and Hb_{A1c}. They determined that OGTTs resulted in lower costs per case detected than other screening methods [198]. These lower costs were seen with screening strategies at every one, two or three years. The FBG test however, may be more acceptable to women because it requires less time, may be more readily tolerated and help overcome attrition in attendance for repeated

follow-up testing [199]. As a result, some health care organisations recognise the FBG as an acceptable alternative to the OGTT [73, 194].

In Australia, the revised 2013 ADIPS guidelines recommend maternal follow-up with an OGTT performed 6-12 weeks after delivery [30] with the frequency of subsequent screening for diabetes depending on level of risk and future pregnancy plans. In a study of a large multiethnic group of women with GDM from Western Sydney Flack et al (2010) provided support for the use of the OGTT in this group of Australian women [200]. In examining 1077 postnatal glucose tolerance test results they reported that relying on fasting glucose alone at six week postnatal assessment would have missed 33% of mothers shown to have ongoing type 2 diabetes and 76%of those with impaired glucose tolerance.

2.2.2.2 Rates of postnatal screening

Return for follow-up diabetes screening after a pregnancy complicated by GDM has been reported to be suboptimal in studies spanning a number of different countries, and including subjects with a variety of different ethnic and demographic characteristics [201, 202]. In a systematic review of postnatal screening for diabetes in women with GDM, Tovar et al (2011) examined eleven studies published between 2008 and 2010 that evaluated rates of postnatal screening [203]. Together, these studies included 32,240 women with pregnancies affected by GDM from 1999 through 2008. Postnatal diabetes screening rates varied, but were poor overall (34-73%) with a median of 48% of women being screened after a GDM pregnancy. These low rates of testing were further highlighted in one study showing a 37% postnatal screening rate at a median of 428 days from time of delivery compared with a 94% rate for cervical screening with a median time of only 49 days in the same group of women [201]. Although there is currently no Australian data on postnatal rates of testing, a study of 360 Australian hospitals reported that screening was routinely recommended by 72% of facilities with the majority (76%) recommending testing at six weeks post delivery [204].

In examining screening trends over time in a cohort of 14,448 US women, Ferrara et al (2009) reported an increase in the age and ethnicity adjusted proportion of women who undertook postnatal screening from 20.7% (95% CI 17.8 –23.5) in 1995 to 53.8% (51.3–56.3) in 2006 [205]. They noted however that screening rates in this population remained suboptimal. Likewise, Clark et al (2003) in a study of Canadian women examined screening rates pre and post publication of postnatal screening clinical practice guidelines [206]. They reported a significant increase in measurement of serum glucose (72.5% vs. 92.3%; p<0.05) and Hb_{A1c} (11.6% vs. 38.5%; p<0.01) from the pre to post guideline period. However, they found that the publication of guidelines did not lead to an increased use of the recommended OGTT during this time.

2.2.2.3 Barriers and enablers

Barriers and enablers to returning for postnatal care have been reported qualitative interviews with women with a history of GDM. In semi-structured interviews with 22 women, Bennett et al (2011) reported feelings of emotional stress due to adjusting to a new baby, lack of time for self care, child care needs, the fear of a diabetes diagnosis and logistics of accessing care as barriers to return for follow-up [207]. While availability of childcare, desire for postnatal health check, rapport with health care facility staff and family planning discussions were identified as facilitators to return for follow-up care.

Several studies examining rates of postnatal screening have also reported predictors of return for postnatal diabetes screening in women with GDM. In the TRIAD study, older age, Asian or Hispanic ethnicity, higher education, earlier GDM diagnosis, treatment with diabetes medications and more postnatal provider contacts were independent predictors of postnatal screening [205]. In a retrospective cohort study of 344 women, Russell et al (2006) reported that attendance at a postnatal health professional visit was the only factor strongly associated with postnatal blood glucose testing in their clinic (54% attending visit vs. 17% who did not attend (adjusted RR 3.04; 95% CI 1.75, 5.34; p<0.001) [202]. Similarly, Kim et al (2007) in a study of 228 women with GDM enrolled in a university affiliated managed care plan highlighted the benefit of health professional follow-up and advice [208]. They reported that recall of advice

along with distribution of laboratory slips for glucose screening was associated with postnatal diabetes screening on self report (OR 2.07; 95% CI 1.51, 2.84) or verified by claims data (OR 1.64; 95% CI 1.16, 2.32). While the considerable variation in findings of the above mentioned studies possibly reflects differences in demographics or health care delivery, the importance of health care professional follow-up was consistently reported across all studies.

Models of antenatal and postnatal GDM care may also influence return for diabetes screening after delivery. Kim et al (2006) in a study examining screening rates in 533 women attending a university affiliated health care system suggested that fragmentation of medical care between obstetric, endocrine and primary care services may have contributed to low screening rates in this group [209]. Similar models of care are commonly seen in GDM services in Australia.

2.2.2.4 Postnatal screening interventions

With the importance of postnatal follow-up blood glucose testing widely recognised, there is considerable interest in effective approaches to improve screening attendance. To date these approaches have included recall and reminder systems implemented by health care providers, postal reminders, as well as patient counselling to advise on postnatal follow-up recommendations.

In a randomised control trial of postal reminders, Clark et al (2009) compared rates of postnatal OGTTs within one year delivery in those who received postal reminders either directly, via a physician or not at all [210]. Among 223 women with GDM, OGTT rates were significantly higher in the physician/patient reminder group (60.5%), in the patient only reminder group (55.3%) and in the physician only reminder group (51.6%) compared with the no reminder group (14.3%; p<0.05). In a follow-up study of the effectiveness of implementing such a system into clinical practice, the same authors examined the rates of postnatal testing when a letter or phone call was incorporated into routine care of women with GDM at three clinical sites [211]. They reported that although postnatal reminders doubled rates of screening using an OGTT, screening rates remained low at 28% for the intervention group and 14% for controls.

More recently, a multilevel approach to increase postnatal screening rates has also been shown to be effective [212]. A system based intervention which included obstetric staff education, revised GDM care protocols and an electronic reminder system was shown to effective in increasing screening rates from 59.5 to 71.5% in insured women attending a antenatal group practice (HR 1.37; 95% CI 1.07, 1.75). This demonstrates that multiple strategies may be advantageous in encouraging postnatal screening.

The effectiveness of patient counselling for increasing postnatal follow-up has also been tested in this patient population. Stasenko et al (2011) in a racially and socioeconomically diverse population demonstrated that antenatal counselling (verbal and written) increased rate of postnatal testing in Caucasian (28% to 53%; p<0.001), Latino (15% to 50%; p<0.001) and Asian (43% to 59%; p=0.005) women with GDM, with a non-significant decrease in African American women (28%to 17%; p=0.414) [213]. Likewise a physician reminder in the form of a checklist implemented at 35-38 weeks gestation has been associated with a 3 fold increase in the odds of being screened postnatally (OR 2.99; 95% CI 1.84, 4.85) and an almost 4 fold increase in postnatal follow-up visits (OR 3.71; 95% CI 2.26, 6.11) [214]. It has been suggested that these interventions may be effective because clear allocation of responsibility for follow-up, which may be otherwise problematic when multiple health professionals are providing care.

To date the only intervention reported in an Australian context is the South Australia GDM recall register. This register was established in 2002 and currently involves recall of women enrolled from three hospitals in South Australia. Registrants receive an annual letter reminding them of their increased risk of type 2 diabetes and encouraging them to seek BG testing with their primary care provider [215]. Participants also register results of any annual blood glucose tests. An evaluation of the register undertaken reported a recruitment rate of 64.4% in 2007, of which 56.3% had undergone BG testing. Further to this, the DIAMIND study is a trial currently underway to assess whether a text message reminder system for women who have experienced GDM in their index pregnancy will increase attendance for OGTT within six months after birth [216].

In summary, the importance of postnatal diabetes screening in women with GDM is widely recognised. Despite a lack of data in Australia, there is evidence internationally of poor attendance at follow-up in this high risk group. The failure to screen women with GDM in the postnatal period has been suggested to present a missed opportunity for disease identification and prevention in a high risk group [209]. Further research is warranted to describe postnatal screening rates in an Australian population better understand the most effective interventions for encouraging return for postnatal testing.

2.2.3 Postnatal diet quality in women with gestational diabetes

With the preventable nature of type 2 diabetes clearly established in landmark diabetes prevention studies [76-78], the importance of diet in mediating the risk of type 2 diabetes is well recognised. For women with GDM, postnatal diet therefore represents an important modifiable determinant of future health status. However, with a lack of evidence for the dietary interventions implemented in prevention studies in the absence of physical activity and weight loss [217], what is clear is the importance of multiple lifestyle interventions to address diabetes risk reduction and the need for further research regarding optimal dietary approaches for type 2 diabetes prevention.

2.2.3.1 Dietary patterns and diet quality

Epidemiological evidence to date has investigated a number of dietary components associated with reduced risk of type 2 diabetes. Inverse associations have been reported between fibre [218], whole grains [219, 220], nuts/seeds [221], dairy foods [222], vegetable intake [223, 224] and the development of type 2 diabetes or the metabolic syndrome. Conversely, in some studies high intakes of sugar-sweetened beverages [225], white potato [226], red and processed meats [227] have been associated with increased risk. However, discordant results have been reported in many studies examining the association between individual foods and risk of diabetes [228].

Additionally, the glycemic index or GI (a ranking of carbohydrate foods according to glycaemic response) and glycemic load or GL (the mathematical product of the GI and

carbohydrate content of a food), have both been associated with a lower risk of type 2 diabetes [229]. In a meta-analysis of 37studies Barclay et al (2008) reported that diets with a high GI or GL independently increased the risk of type 2 diabetes (GI RR 1.40; 95% CI 1. 23, 1.59; GL RR 1.27; 95% CI: 1.12, 1.45) [229]. The adverse impact of high GI/GL diets on β cell function and insulin resistance are two mechanisms proposed to explain this association. Interestingly, the relationship between higher GL diets and poorer nutrient intake has also been recently reported in women with GDM [230].

Recently, there has been a growing interest in examining whole diets and dietary patterns to determine the association between diet and disease. Focusing on patterns of dietary intake takes into account that individuals consume foods as meals, not nutrients, recognises possible interactions between dietary constituents and the balance between potentially protective and harmful components of the diet [231]. An understanding of the relationship between whole diets and disease risk is also important in developing food based approaches and practical interventions for chronic disease prevention [232].

Two main approaches to the analysis of dietary patterns and overall diet quality have been identified [228, 233]. The first approach, uses data driven techniques such as factor and cluster analysis, these are known as known as posteriori methods. Alternatively, priori approaches define dietary patterns based on current knowledge of dietary recommendations for disease prevention, which are then quantified and summed to provide an overall diet quality score.

There is a growing body of evidence supporting the relationship between food patterns and diet quality scores and chronic disease risk. Wirt and Collins (2009) in a review of diet quality and variety scores reported relationships with a number of health outcomes [232]. Of the 25 indices of reviewed, the majority reported inverse relationships between overall diet quality calculated using diet indexes or score and mortality and disease risk. In these studies, all cause mortality was reduced by 17-42%, cardiovascular mortality by 18-53% and cardiovascular risk by 14-28% in association with higher diet quality. These associations were found to be stronger for men than

women. The findings support those of the earlier work by Kant (1996) who in a review of diet quality indexes reported that indexes of overall diet quality were related to the risk of disease more strongly than individual foods or nutrients [234]. However, a number of limitations of these tools have also been noted. One of these being that a low proportion of participants consuming a diet in line with the dietary guidelines can result in a lack of variation in the population being studied and an inability to detect associations with health outcomes [235]. In addition, discrepancies in development processes and scoring methods have also been highlighted [235]. Dietary patterns identified in posteriori methods are also dependent on the population from which they are derived [217] which may limit their generalisability.

To date, there have been a number of studies specifically examining food patterns, diet quality and the risk of type 2 diabetes. Montonen et al (2005) in a 23 year prospective study of >4000 Finnish men and women identified two major dietary patterns, the 'prudent' pattern characterised by higher consumption of fruits and vegetables and the 'conservative' pattern, characterised by consumption of butter, potatoes and whole milk [233]. After adjusting for non-dietary confounders, the authors reported a lower relative risk for the development of type 2 diabetes with the 'prudent' dietary pattern (RR 0.72; 95% CI 0.53, 0.97; p$trend$=0.03).

Similarly, in a 4 year prospective Australian study investigating the association of dietary patterns and type 2 diabetes Hodge et al (2007) identified dietary factors positively and negatively associated with diabetes risk [236]. Dietary pattern factor 2, characterised by salad and cooked vegetables was inversely associated with diabetes risk (p$trend$=0.02), while factor 3, characterised by meats and high fat foods was positively associated with diabetes risk (p$trend$<0.001). However, after adjusting for BMI and waist/hip ratio, these results were no longer significant suggesting that these effects are mediated to a large extent by body weight.

In a US study of >5000 participants aged 45-84 years, the relationship between dietary patterns and type 2 diabetes was also examined in a multi-ethnic cohort [237]. The investigators studied two different dietary patterns as well as an analysis of each of the

individual dietary components. They reported an 18% greater risk (p*trend* = 0.004) in the diet characterised by high intakes of refined grains, beans, tomatoes and high fat dairy and a 15% lower risk (p*trend*=0.005) in that characterised by high intakes of whole grains, fruits, nuts/seeds, green leafy vegetables and low fat dairy. There were no individual foods associated with diabetes risk in this study and associations were not modified by gender or ethnicity suggesting that messages regarding healthy eating for diabetes prevention are transferrable across different cultural groups.

Several studies have also examined diet quality and dietary patterns in sex specific cohorts [238, 239]. Fung et al (2007) used the Alternate Healthy Eating Index (AHEI) to assess associations between diet quality and diabetes risk at 18 year follow-up in >80,000 women from the nurses' health study [239]. AHEI scoring was based on intake of fruits, vegetables, the ratio of white (seafood and poultry) to red meat, trans fat, polyunsaturated to saturated fat ratio, cereal fiber, nuts and soy, moderate alcohol consumption and long-term multivitamin use. Women who scored high on the AHEI had a reduced risk of diabetes when compared with lowest AHEI score (RR 0.64, 95% CI 0.58, 0.71; p*trend* <0.001).

In more recent studies with men [238] from the Health Professionals Follow-Up Study, several different diet quality tools were used to determine the association with risk of diabetes. In multivariate analysis the Alternative HEI (AHEI), the Alternative Mediterranean Diet (AMED) Score and the Dietary Approaches to Stop Hypertension (DASH) Score were all associated with a lower risk of type 2 diabetes. A one standard deviation increase in each of these scores was associated with a 9-13% reduction in risk of type 2 diabetes. These diet quality scores all reflect a common optimal dietary pattern characterised by high intakes of plant-based foods; moderate alcohol consumption; with low intakes of red meat, processed meats, sodium, sugar sweetened beverages and trans fats. Likewise in Australian research examining diet quality in participants of the Australian Diabetes, Obesity and Lifestyle study, a food-based dietary index based on the *Dietary Guidelines for Australian Adults* and the *Australian Guide to Healthy Eating* was utilised [231]. Inverse associations were found with diet quality and abdominal obesity (OR for top quartile 0.68; 95% CI, 0.48, 0.96),

hypertension (OR 0.50; 95% CI 0.31, 0.81), and type 2 diabetes (OR 0.38; 95% CI 0.18, 0.80) among men.

Although the evidence for the importance of dietary patterns and diet quality in mediating the risk of type 2 diabetes is convincing, to date only one study has reported the association between diet quality in women with GDM and progression to type 2 diabetes. In this study of women with prior GDM from the Nurses' Health Study II cohort, multiple diet quality tools were used to determine associations between diet quality and type 2 diabetes [240]. In adjusted models participants with the highest compared with lowest quartile for diet quality were compared. The AMED pattern was associated with 40% lower risk of diabetes (HR 0.60; 95% CI 0.44, 0.82; p=0.002); the DASH pattern, with 46% lower risk (HR 0.54; 95% CI 0.39, 0.73; p<0.001) and the AHEI pattern, with 57% lower risk (HR 0.43; 95% CI 0.31, 0.59; p<0.001]). Adjustment for body mass index moderately attenuated these findings. These findings suggest that in women with GDM, diet quality may therefore play an important role in mediating the development of type 2 diabetes.

Although research to date investigating dietary patterns and diet quality has included a variety of different measurement tools in diverse population groups, similarities can be seen in dietary patterns associated with the risk of type 2 diabetes across a number of studies. Diets characterised by whole grains, fruits, vegetables and legumes which are nutrient dense, high in fibre and likely to have a low GI, have been associated with lower risk of diabetes [231, 240, 241]. In contrast, dietary patterns characterised by refined grains, potato, butter, meats and full fat dairy foods [233, 237] which are likely to be high in saturated fat, high GI and low in fibre have been associated with a higher risk of type 2 diabetes [217].

2.2.3.2 Postnatal diet in women with gestational diabetes

Research to date examining lifestyle patterns in women with GDM has consistently shown suboptimal dietary intakes in the postnatal period [87, 242, 243]. In an early Australian study Neilsen and Tapsell (1994) investigated weight control and dietary intake in 22 women from a diabetes clinic population who were diagnosed with GDM

in the previous five years [242]. They reported that in the postnatal period only four women in the study adhered with recommended percentage energy intake for dietary fat, 16 had gained weight since pregnancy and eight women were categorised as obese or morbidly obese. While this study provides interesting insights into the clinical risk factors for women with prior GDM, the sample size was small and the women were not representative of the population studied, limiting the applicability of the results to women with GDM nationally.

More recently, Zehle et al (2008) in a larger sample of women with GDM from Western Sydney examined postnatal dietary behaviours and associated psychosocial factors [87]. In a random sample of 226 women diagnosed with GDM in the previous six to 24 months, the researchers measured dietary intake using a validated short food frequency questionnaire, and gathered additional data regarding self-efficacy and social support. They reported that only 5% of respondents consumed the recommended five serves of vegetables per day, 44% consumed adequate fruit serves and 50% regularly consumed full-cream milk. Busy lifestyles, household taste preferences and lack of knowledge about food choices to reduce the risk of diabetes were cited as common barriers to healthy eating. Self-efficacy to cook healthy foods ($p=0.009$) and self-efficacy adhering to a healthy lifestyle when busy ($p<0.001$) were two factors associated with higher consumption of vegetables and fruit.

In a follow-up study of women participating in a low GI dietary randomised control trial during pregnancy, Moses et al (2007) examined the diets of 43 women with previous GDM three months after birth [244]. They used three day food records to determine the GI and nutrient composition of postnatal diets. Despite being advised of the health advantages of a low GI diet, there were no significant differences in the GI of postnatal diets between those following the low GI diet during pregnancy and those in the higher GI group (55.30 ± 1.04 vs.56.43 ± 1.25). There were also no significant differences between glycemic load, kilojoules, fat, carbohydrate, protein or fibre content of the two groups. The researchers concluded that all of the study participants reverted to a diet with a composition that was approximately the same as the diet they

were following before participating in the GI study, despite being made aware of the potential health benefits.

In another follow-up study of a low GI pregnancy intervention, postnatal outcomes were examined for 58 women with GDM assigned to either a low GI or conventional diet during pregnancy [245]. Chronic disease risk factors were compared between the two groups at a three month follow-up, with no significant differences reported between maternal outcomes, including OGTT results (p=0.117), the proportion of women with abnormal glucose tolerance (p=0.237) or subsequent type 2 diabetes (p=0.373), BMI (p=0.652), waist circumference (p=0.990) or LDL-cholesterol levels (p=0.337). However, this study was not adequately powered to detect small but clinically meaningful differences in these risk factors. In addition, postnatal diet was not assessed within this study, so it is possible that the women reverted to their previous dietary intakes, reducing any benefits obtained from the antenatal dietary intervention. Further studies are needed examining longer term outcomes of low GI diets for chronic disease risk reduction specifically in women with GDM.

Internationally, several studies have also investigated postnatal dietary behaviours in women with GDM. A study with 19 Canadian women with GDM investigated whether dietary changes made during a GDM pregnancy were sustained in the postnatal period [246]. Using four day food records administered at two weeks post-intervention, then again at six weeks and six months after delivery, the researchers assessed nutrient intake and diet quality using the US Department of Agriculture Healthy Eating Index (HEI). In reporting their findings, they noted that while favourable dietary changes were made after the intervention, these were not sustained post-delivery. Food group analysis showed significant reported decreases in several key food groups in the postnatal period, including milk product consumption (p=0.001), fruit and vegetable consumption (p=0.001), as well as increased consumption of high fat, high sugar nutrient poor foods (p=0.002). A low HEI score was reported across the entire course of the study. Interestingly, laboratory values also indicated that 45% of participants had impaired glucose tolerance at six months follow-up, suggesting a high risk of future type 2 diabetes. However, as this study was small and unlikely to be representative of

women with GDM, further research is required to confirm these findings in a population based cohort.

Stage et al (2004) in a written survey with 121 Danish women with GDM diagnosed in the preceding 11-24 months examined weight change, self-reported dietary fat intake and worry about the future development of type 2 diabetes [243]. Among women with a prenatal BMI >25kg/m^2, 33% had gained weight and 18% reported weight loss, and overall more women gained than lost weight ($p<0.05$). Positively, despite the fact that 74% of women reported following a high fat diet prior to pregnancy, only 47% reported doing so at follow-up. However, these results were based on self assessment of dietary fat intake rather than other validated methods of dietary assessment. They also did not distinguish between different fatty acids which may have an important influence on future diabetes risk [120]. Although the authors reported that 86% of women were worried about developing type 2 diabetes, there was also no association between worry about diabetes and postnatal weight loss.

Dietary intakes in US women with GDM have been examined in a nationally representative population based random sample telephone survey of 177,420 women with and without self-reported history of GDM [88]. A number of health behaviours were examined including physical activity, BMI, self-rated health status and fruit and vegetable consumption. Women with previous GDM reported worse self-rated health than those without GDM ($p<0.001$). However, there were no differences reported in regards to fruit and vegetable consumption with less than three daily serves being consumed by 36.6% of women with previous GDM and 39.5% of those without GDM ($p=0.21$). In multivariate analyses women with previous GDM who lived with children were also less likely to meet fruit and vegetable guidelines (OR 0.78; 95% CI 0.63, 0.9) than women without previous GDM.

Despite evidence for the preventable nature of type 2 diabetes in high risk groups, the evidence outlined above consistently demonstrates suboptimal dietary patterns in women with previous GDM. Although there is some evidence to suggest that adherence to national dietary recommendations may reduce the risk of progression to

type 2 diabetes following a GDM pregnancy [240], diet quality has not been examined in Australian women with previous GDM and no studies to date have investigated postnatal diet in a national sample of women. Such research would provide important data on the eating patterns of Australian women with previous GDM, as well as information for developing targeted food based advice and dietary intervention messages aimed at improving postnatal dietary intake as a strategy to reduce the risk of type 2 diabetes.

2.2.4 Risk perceptions for the development of diabetes

Theoretical models of preventive health behaviour suggest that risk perception may be one important component of behaviour change [247]. As a group at increased risk of postnatal diabetes and cardiovascular disease, communicating risk to women with GDM is therefore a primary strategy for promoting awareness of the need to adopt healthy lifestyle behaviours for chronic disease prevention.

2.2.4.1 The risk of developing type 2 diabetes

The risk of type 2 diabetes in women with a history of GDM has been examined in a number of different population groups. Estimates of risk in the literature range from 3% up to 50%, with follow-up ranging from several months to 20 years [248-251]. Differences in diagnostic criteria, time to follow-up, cohort retention and racial background of the population studied may explain some of these variations in estimates of postnatal risk [252]. In a systematic review of 28 studies examining incidence of type 2 diabetes in women with GDM and after adjustment for variable testing rates and length of follow-up, Kim et al (2002) reported a marked increase in cumulative incidence in the first five years after the index pregnancy [11]

A recent systematic review of the risk of type 2 diabetes reported at least a seven fold increased risk in women with GDM compared to those with a normoglycaemic pregnancy [52]. In an Australian study reporting the prevalence of type 2 diabetes in women with prior GDM, Lee et al (2008) reported a 9.6 (5.9 –16.7) times greater risk in women with previous gestational diabetes with a cumulative risk of 25% after 15 years [53]. They found insulin use, Asian origin, elevated one hour BGLs and high BMI to be

the strongest predictors of type 2 diabetes. While another Australian study examining the population health significance of GDM estimated that 21-31% of cases of diabetes in parous women were associated with previous GDM [54].

2.2.4.2 The concept of risk

The concept of risk in health psychology has been described as the perception of the subjective likelihood of the occurrence of a negative health event for a person in a specific period of time [253]. The goals of communicating this are therefore to highlight the risks that people may face in a useful and meaningful way, and help them better decide on a course of action to improve health or prevent disease. Despite this, there is evidence that knowledge alone does not equate with behaviour change in this group [254] confirming that there are many elements that influence decisions about preventive health behaviours [255].

Weinsten (1999) describes risk comprehension as a multidimensional process which is influenced by a number of variables [255]. Understanding the severity of the hazard, which includes both the outcomes that may occur and the seriousness of these has been deemed essential for understanding risk. Secondly, comprehending the probability of harm may be an important influence on risk perceptions, with evidence suggesting that numeric estimates of risk may be poorly understood by the public and risk communications may therefore be misinterpreted. Likewise, optimistic bias or the belief that one's own risk is less than that of others has been reported in the health literature which may skew individual perceptions of risk [256]. Finally, the likelihood of preventive action reducing risk and the perceived difficulty in carrying out preventive behaviours have been identified as important components of risk comprehension [255].

2.2.4.3 Diabetes risk perceptions

Diabetes risk perceptions have not been well studied thus far. Early research with first degree relatives of those with type 2 diabetes examined perceived likelihood of developing diabetes among 481 siblings, as well as variables associated with perceptions of risk [257]. Despite the fact that family history is a strong predictor of

diabetes risk, fewer than half of siblings in this study considered themselves likely to get diabetes. Independent predictors associated with increased risk perception were being female (p=0.003), being in the younger age group (35-54 years; p=0.003) and having a parent with diabetes (p<0.00001). Although BMI was the strongest factor predicting the development of diabetes, it was not associated with perceived risk.

Studies with physicians using self reported risk factors have also examined personal risk perceptions for developing diabetes [258]. In this study of 535 US physicians, almost 37% were considered to be at high risk for developing diabetes, and when compared to lower risk physicians they were more likely to have a greater perception of diabetes risk (p≤0.001). Nearly 50% of higher risk physicians however, reported an optimistic bias that they were less likely to develop diabetes than others of the same age and sex. They also reported that there were sex and racial differences in risk perceptions among this group.

Despite the evidence of a low level of perceived diabetes risk amongst some groups, few studies to date have reported on diabetes risk perceptions in women with GDM. In an early study using the *Diabetes in Pregnancy Knowledge Screen*, Spirito et al (1990) examined the knowledge of women with GDM recruited from a diabetes in pregnancy clinic in the US using an 18 item questionnaire [259]. Of the 67 women with GDM who completed the questionnaire, two thirds did not believe they would develop GDM again in a subsequent pregnancy and one fifth did not believe they were at increased risk of developing diabetes in the future.

More recently, Kim et al (2007) examined risk perception in a cross sectional survey of women with GDM in the previous five years using a modified version of the *Risk Perception Survey for Developing Diabetes* [260]. This tool encompasses the multiple dimensions of risk perception including optimistic bias, personal control, knowledge of risk factors, and beliefs in the benefits and barriers to lifestyle modification. They also examined lifestyle behaviours and intention to modify behaviour. They reported that of the 217 women surveyed >90% were aware that GDM was a risk factor for future diabetes, but only 16% believed that they had a high chance of developing diabetes.

They also found that women with greater risk perceptions were more likely to have risk factors for diabetes including family history, being overweight and shorter duration of breastfeeding. Interestingly, women who reported a moderate/high risk of developing diabetes were also more likely to report plans to modify future health behaviours (OR 9.1; 95%CI 1.5, 57.0).

Similar findings were reported by Malcolm et al (2009) in research with Canadian women [261]. In a 9-11 year follow up of women with GDM enrolled in a randomised control trial, they examined risk perceptions and rates of undiagnosed diabetes in this cohort. Of the 88 participants, 30% felt that their risk was no different to other women or did not know, yet only 52% of women in this study had normal glucose tolerance at follow-up. They also reported that all of the women with newly diagnosed diabetes in the high risk perception group had known risk factors for diabetes, including BMI>25, waist circumference >88cm and/or family history of type 2 diabetes.

In an earlier Canadian study, Feig et al (1998) examined the impact of a GDM diagnosis on self perceived health status of women [262]. In a survey of women diagnosed with GDM in the past three to five years (n=106) and matched controls (n=317) they examined self perceived health (SF-36), health distress, worry scales and diabetes risk perceptions. They reported no significant differences in health perceptions, however women with GDM were more worried about their own health (p=0.02, two tailed), rated their children as less healthy (p=0.005, two tailed) and perceived themselves as more likely to have diabetes (p<0.001, two tailed). The authors concluded that a diagnosis of GDM leads to long term changes in women's perceived health status, they also highlighted that despite moderate to high risk perceptions, some women with GDM viewed the possibility of development of type 2 diabetes as inconsequential.

Qualitative studies also provide some insight into some of the health beliefs which may influence perceptions of risk in women with GDM. Hjelm et al (2008) in semi-structured interviews with 23 women with GDM reported that those managed under a diabetes service were concerned about the future development of diabetes, while those managed under obstetric services were more likely to view GDM as a transient

condition [263] These findings suggest that the health care dialogue between provider and patient and knowledge of risk among health care providers, may also have an important influence on perceived risk. In an Australian mixed methods study, Doran (2008) reported a high level of knowledge of GDM as a risk factor for type 2 diabetes [264]. However, it was also reported that concerns about the development of diabetes did not motivate women to engage in more physical activity, suggesting either a weak link between knowledge and behaviour change or alternatively, a lack of recognition of the role of physical activity in diabetes prevention.

2.2.4.4 GDM risk communications

In Australia, communications about the risk of developing future diabetes to women with GDM may come from a number of different sources. Health professionals including general practitioners, obstetricians, endocrinologists, diabetes educators, dietitians and midwives may all interact with women with GDM during antenatal and postnatal care. However, the extent to which future risk of diabetes is discussed during communication between patient and health care provider has not been examined.

Messages about future diabetes risk may also come from health care organisations. These messages are described in a number of patient education materials available to women with GDM.

The Australian Diabetes Society and the Australasian Diabetes in Pregnancy Society *Life after GDM* patient education materials provides the following information about future diabetes risk [265]:

Women who have had gestational diabetes face a 50 per cent risk of developing type 2 diabetes at some point later in their lives.

Diabetes Australia member organisations fact sheets state [266]:

While blood glucose levels usually return to normal after the birth, women who have had gestational diabetes are at an increased risk of developing type 2 diabetes later in life with a 30%–50% chance of developing it within 15 years after their pregnancy

The National Diabetes Services Scheme website **www.ndss.com.au/GD** includes the following statement [267]:

After the baby is born, gestational diabetes usually goes away. A Glucose Tolerance Test (GTT) is performed after the birth to ensure that blood glucose levels have returned to normal. However, 1 in 2 women who have had gestational diabetes will develop type 2 diabetes within 10-20 years.

The National Diabetes Services Scheme booklet *Gestational diabetes caring for yourself and your baby* provided to women registered with the scheme describes future diabetes risks as follows [268]:

Once you have had gestational diabetes, you are at a higher risk of developing diabetes later in life. Approximately 50% of women who have had gestational diabetes will develop type 2 diabetes within 10-20 years. If you have another pregnancy, there is a very high chance of developing gestational diabetes again.

The Australian Diabetes Council written information states [269]:

Although gestational diabetes usually disappears after the baby is born, women who've had GDM have a 10 times greater risk of developing type 2 diabetes in the future

Interestingly, the information provided by healthcare organisations regarding diabetes risk shows variability in methods chosen to numerically communicate risk (percentage scales, frequency). This may have an important influence in how women with GDM perceive risk, with innumeracy in interpretation of percentage scales and poor understanding of probability demonstrated in work with other health conditions [270], as well difficulties in comprehension of the exponential accumulation of risk over time. A lack of consistency in descriptions of actual risk and timeframe within which this occurs are also evident in the way diabetes risk is communicated to women. These differences may be important, with evidence showing that inconsistency and ambiguity in messages may influence risk interpretation [270]. The risk communications examined here have only described those available from key diabetes organisations in Australia, however, many health services also produce their own

written materials for women with GDM which may provide further communications about future risk. These materials have not been examined in this review of GDM risk communications.

Despite the well documented risks of type 2 diabetes following a GDM pregnancy, risk perceptions in Australian women and the comprehension and effectiveness of risk communications have not been reported. The findings of this literature review suggest that further research in risk perceptions relevant to Australian women with a history GDM is warranted.

2.2.5 Women's experiences of living with gestational diabetes

Women's experiences of living with GDM may be an important influence on both antenatal and postnatal health behaviours. An understanding of how women cope from diagnosis of GDM, through to the postnatal period can assist health professionals with providing quality care during the antenatal and postnatal periods and identify areas where additional education and support may be required. While diabetes prevention research has provided evidence for prevention of diabetes in individuals at high risk of type 2 diabetes, an understanding of effective approaches to diabetes prevention are also needed in the context of having experienced GDM.

2.2.5.1 Living with gestational diabetes

Evidence suggests that a diagnosis of GDM may increase a woman's anxiety [271], result in poorer health perceptions and a less positive pregnancy experience when compared with women with normal glucose tolerance [272].

Evans and O'Brien (2005) in qualitative research with 12 Canadian women with diabetes during pregnancy described the experiences of women during semi-structured interviews [273]. Women described feelings at diagnosis as being shocked, scared and anxious, with the prospect of living with an 'at risk' pregnancy and potentially having a chronic condition. Living with GDM changed the women's pregnancy perceptions as they were required to live a 'controlled pregnancy' in which they had feelings of loss of control, as well as of being controlled. The concept of 'balance' was also identified as a key theme. This related to the process of adaptation to

the diagnosis as they tried to establish a balance in their lives and maintain a sense of normality. For the sake of their anticipated child's and their own health and well-being, the women acknowledged the need to be a 'responsible mother' and actively engage in diabetes self-management. Some women however also described not adhering to their diabetes management regimen to retain their autonomy. The authors highlighted the need to understand the lived experience of women in a process that further medicalises pregnancy.

Research with Swedish women described both positive and negative elements of the GDM pregnancy experience [274]. This qualitative research was conducted with ten pregnant women diagnosed with GDM using a grounded theory approach. They identified ten themes with a core category of 'from stun to gradual balance' capturing the overall experience. They described the shock of the diagnosis and the feeling of threat to the mother and her foetus, which for women with prior GDM was reported to be less 'paralysing'. Women described having an increased responsibility to take care of themselves and like in the previous study a feeling of being controlled by both their families and health care professionals. Other themes related to the varying degrees of support received by the women, coming to terms with GDM, changes in self- image from being healthy to having a disease and concerns about the birth outcome.

In examining the psychosocial consequences of GDM, Lawson and Rajaram (1994) used an ethnographic approach to their research with 17 women from a high risk maternity clinic in the US [271]. They reported the profound impact of the diagnosis on levels of fear, anxiety and depression. They highlighted the elusive definition of the illness due to the asymptomatic nature of GDM. The women described guilt about factors which they believed may have contributed to the diagnosis, while there was some positivity around the temporary aspect of the illness. Difficulties and challenges with dietary management were described and emotional distress was identified with regards to the dietary restrictions placed on the women. Emotional distress was also indentified around insulin administration and the process of adapting to GDM was described. The women participating in this study described difficulties around the patient-provider interactions with health professionals, particularly in relation to

informing women of the diagnosis and the absence of comprehensible nutrition information.

Several small Australian studies to date have provided some insight into the experiences of women with GDM from specific high risk groups. In s study with 17 immigrant South Asian women using face-to-face in depth interviews, thematic analysis of women's experiences highlighted a number of key issues for this group [275]. In particular, difficulties with dietary advice and a lack of individualised dietary prescription were raised by participants, as were concerns about the impact of dietary restrictions on the growth of the baby. Central to the narrative were concerns about the wellbeing of the unborn child, which was more of a focus than the woman's own health.

Razee et al (2010) in telephone interviews with 57 women with previous GDM described the burden of living with GDM and the constant struggle to follow a strict diet [276]. Mental health and psychological distress emerged as important themes for all groups, but in particular for Arabic-speaking women, some of whom believed this to be the underlying cause of GDM. Cultural expectations and social support were also identified as playing an important role in addressing barriers to managing diabetes.

Carolan (2012) recently reported on the diabetes self-management experiences of 15 women with GDM from a variety of ethnic backgrounds [277]. Using telephone and face-to-face interviews as well as focus groups, they reported five key themes emerging from the data; the shock of the diagnosis, coming to terms with GDM, working it out, looking to the future and the importance of a supportive environment. They highlighted the importance of both family and health professional support throughout the GDM pregnancy, particularly in light of the fact that there was a very short time period in which to adapt to living with diabetes and master the skills of GDM self management.

2.2.5.2 Perspectives on postnatal care

Several studies have examined the experience of women with GDM in the postnatal period. Evans et al (2010) using a concurrent mixed method approach with Canadian

women examined their experiences in the first year following a GDM pregnancy [278]. They described four themes. Firstly, 'being on one's own', which described a sense of abandonment and a lack of immediate postnatal diabetes care. They also described 'feeling uncertain' about the potential for developing diabetes. Women talked about 'making lifestyle changes' to stay healthy and the challenges in maintaining these changes, including lack of time, family responsibilities, work, infant care, fatigue, finances, climate and transportation. The final theme related to 'moving on' whereby in the latter part of the first postnatal year concerns about developing diabetes waned.

Doran (2008) examining perspectives on lifestyle changes in interviews with eight Australian women also reported a lack of support for postnatal risk reduction [264]. Interestingly, they reported that despite concern about the risks of future diabetes, this did not serve to motivate all women to engage in preventive health behaviours. They highlighted the issue of responsibility for postnatal care being unclear amongst health care services.

Razee et al (2010) in their study with women from Western Sydney also examined issues relevant to the prevention of type 2 diabetes [276]. They reported that mental health emerged even more strongly as an issue in influencing participants' ability to adopt and maintain a healthy lifestyle to lower the risk for diabetes. Social roles and cultural expectations seemed to be an underlying and recurring theme in determining postnatal health behaviours, including healthy eating and participating in physical activity.

2.2.5.3 Diabetes prevention in the context of gestational diabetes

Diabetes prevention studies to date have focused on intensive interventions to reduce the risk of type 2 diabetes development in those at highest risk. In the DPP, this included a subgroup of 350 women with a history of GDM enrolled in the study [82]. In subgroup analyses of diabetes incidence in this group, it was found that both intensive lifestyle and metformin therapy reduced the incidence of diabetes by approximately 50% over 3 years when compared with controls. Despite the fact that the whole cohort were considered high risk for diabetes, women with a history of

GDM had a higher rate of developing diabetes overall compared with those without previous GDM (38% vs. 26%). These findings may in part be explained by the inability of many women with previous GDM to meet intensive lifestyle intervention targets. On average, these women were less able to sustain the level of physical activity and demonstrated a lower peak weight loss and more rapid weight regain, resulting in a significantly lower weight loss over time compared with women without a history of GDM. Despite these findings, the results of this DPP subgroup analysis suggest that intensive lifestyle interventions are highly effective in delaying or preventing diabetes in women with IGT and a history of GDM.

While these findings support the case for postnatal lifestyle interventions, it is noteworthy that the women in the DPP had a mean 12 year interval since delivery from their first GDM pregnancy, suggesting that some of the barriers evident for new mothers may not have been as applicable to this group. In addition, the intensity of the intervention may be difficult to translate to a real life setting in the context of limited health care resources.

Recently, a randomised control trial has investigated the feasibility of lifestyle interventions based on the DPP model initiated soon after the diagnosis of GDM and continued into the postnatal period [83]. The telephone delivered intervention focused on achieving a healthy postnatal weight to reduce the risk of future type 2 diabetes. Follow-up occurred at four clinic visits between 6 weeks and the end of the intervention at 12 months after the index pregnancy. Overall the findings were positive, with significant reductions in dietary fat intake (-3.6% energy from fat; p = 0.002), and although not significant, trends towards increased weight loss and breastfeeding in the intervention group. Interestingly, no differences in postnatal physical activity levels were found, suggesting that additional strategies may be needed to address this risk factor.

While the benefits of intensive interventions appear promising for women with GDM, it is not clear if less intensive interventions can be effective in this high risk population. Several short term studies to date have produced mixed results. Cheung et al (2011) in

a pilot year long structured behavioural intervention to increase physical activity with 43 women with previous GDM found that increases in achievement of physical activity targets were not attained [84]. Recruitment and subject retention were identified as major challenges. Likewise McIntyre et al (2012) in a randomised control trial of 28 women with GDM reported that a postnatal home based exercise program with telephone support was feasible [85]. However, no measurable improvement in metabolic or biometric variables were observed over the three month intervention period.

In another Australian study, a telephone based lifestyle intervention using motivational interviewing was examined with 38 rural women with GDM [279]. At follow-up, when compared to the control group, the intervention group significantly reduced total fat intake by -19 g/day (95%CI -37 to -1), total carbohydrate intake by -42 g/day (95%CI -82 to -1), and glycemic load by -26 units (95%CI -48 to -4). However, no significant changes in total physical activity levels were found. At six month follow-up, BMI in the intervention group improved by -1.5 kg/m2 (95%CI -2.8 to -0.1) compared to the controls. Positive results were also reported in a one year, group based behaviour change program for women who had GDM in the previous 6–24 months [280]. Improvements in physical activity from baseline were reported (15mins vs.105mins/week; p=0.001) as was a reduction in BMI (29.9 vs. 29.1; p=0.04). However, difficulties in maintaining continued participation in a group-based program for this group were reported with only 14 out of 25 enrolled women regularly attending the program.

Two recent qualitative studies have provided some insight into the barriers faced by women in the postnatal period as well as information on specific intervention approaches that would facilitate participation in postnatal lifestyle intervention programs [281, 282]. Focus groups and informant interviews with 25 US women with previous GDM identified time, financial constraints, child care duties, low levels of motivation, fatigue, and work related obstacles as barriers to lifestyle change [281]. Informants suggested facilitators for lifestyle change included nutrition education, accountability, exercise partners/groups, access to gyms with childcare, and home

exercise equipment. The majority of women expressed interest in an intervention program delivered primarily via the internet that would include the opportunity to work with a lifestyle coach. In another study, semi-structured interviews with 31 women explored factors associated with postnatal lifestyle and looked at the influence of the passage of time on health behaviours [282]. The UK women in this study reported awareness of the risk of developing diabetes, but did not always act on such knowledge. Pregnancy motivated behaviour changes were often not maintained. Tiredness, maternal attachment and childcare demands were prominent barriers in the early postnatal period. Later, work, family and child development became more significant barriers, with many women becoming more receptive to healthy eating messages around the time of weaning. Women were also positive about long-term support for self-management to reduce their diabetes risk.

In summary, although there is strong evidence for interventions to prevent type 2 diabetes in those at highest risk, translation of the evidence into appropriate interventions for women with GDM remains challenging. Any intervention must take into account family, social and cultural characteristics of this group, as well as barriers to participation. Programs also need to be tailored to the cultural and behavioural needs of individual women. Novel approaches to diabetes prevention in this group are also worthy of investigation.

2.2.6 Summary

This review of the literature on preventive health behaviours has examined a number of postnatal factors that may be important in determining the risk of type 2 diabetes in women with previous GDM. Although each of these behaviours has been reported separately in this thesis, recent research has examined the effect of adopting multiple preventive health behaviours on metabolic profile in women with GDM [283]. Gingras et al (2012) examined preventive practices in 181 women who had GDM between 2003 and 2010. They examined the impact of (1) regular physical activity (≥150 minutes per·week) (2) healthy eating patterns (AHEI); and (3) exclusive breastfeeding (≥6 months). Women were classified according to the number of preventive practices adopted. For each preventive practice adopted, women were 30% less likely to have a

BMI ≥ 25 kg·m-2 (OR 0.70; 95% CI 0.50, 0.98), they were 34% less likely to have a waist circumference ≥ 88 cm (OR 0.66; 95% CI 0.47, 0.92) and 33% less likely to have an insulin sensitivity index< 9.69 (OR 0.67; 95% CI 0.48, 0.94). These results suggest that women with prior GDM who adopt the recommended preventive practices in the years following a GDM pregnancy are less likely to have risk factors for the development of type 2 diabetes. While these findings highlight the importance of multiple postnatal preventive health behaviours, the researchers also reported that early one-third of women in the study adopted none of the listed preventive practices. Overall, this section of the literature review provides evidence of the need for further research into factors associated with preventive postnatal health and lifestyle behaviours and the best approaches to type 2 diabetes prevention in this high risk group.

Chapter 3   Dietetic practice in the management of gestational diabetes mellitus: A survey of Australian dietitians

This chapter was published in 2011.

Morrison, M.K., Collins, C.E. and Lowe, J.M. Dietetic practice in the management of gestational diabetes mellitus: A survey of Australian dietitians. Nutrition & Dietetics 2011; 68:189–194.

The work presented in the manuscript was completed in collaboration with the co-authors (Appendix A). Permission to reproduce the text and figures from the manuscript has been granted by the publishers (Appendix E).

3.1 Background

Gestational diabetes mellitus (GDM) is a form of diabetes with onset or first recognition during pregnancy [2]. In Australia, GDM affects approximately 5% of pregnancies, increasing up to 14% in some high risk groups [7]) and is usually diagnosed through selective or universal antenatal screening between 26-28 weeks of pregnancy [2]. GDM has been demonstrated to pose significant perinatal risks [284] as well as adverse maternal health consequences including future type 2 diabetes [53].

Medical nutrition therapy (MNT) is the primary therapeutic strategy for the management of GDM with the goal of ensuring that a pregnancy affected by GDM results in the delivery of a healthy infant without related complications [65, 66]. Studies evaluating the implementation of the American Dietetic Association (ADA) evidence based GDM guidelines have demonstrated the benefit of MNT when implemented as intended [67]. In a randomised control trial of 215 women receiving either standard care or guideline based MNT, fewer subjects in the MNT group required insulin (24.6% vs. 31.7%; p=0.05) and there was a trend towards improved blood glucose management during the treatment period in those receiving MNT. Likewise, studies with type 1 and type 2 diabetes have demonstrated beneficial outcomes as a result of systematic and consistent care when MNT practice guidelines are implemented [93, 285]. Kulkarni et al (1998) demonstrated that the implementation of dietetic practice guidelines in type 1 diabetes significantly increased time spent with patients and the frequency of visits, but also improved clinical outcomes, including a lower Hb_{A1c} at 3 month follow-up [92].

The Australasian Diabetes in Pregnancy Society (ADIPS) Guidelines support the need for dietetic interventions in a GDM pregnancy [2]. The recommendations for dietary therapy suggest that the diet should (1) conform with the principles of optimal dietary management of diabetes; (2) meet the nutritional requirements of pregnancy; (3) be individualised according to maternal weight and body mass index and (4) be culturally appropriate. However, there are currently no Australian evidence based nutrition

recommendations or dietetic practice guidelines developed on which a systematic approach to MNT for GDM can be based, and currently there is limited evidence of the outcomes of dietetic interventions in an Australian context.

The Australian Carbohydrate Intolerance Study (ACHOIS), a randomised control trial, showed that perinatal complications were reduced to 1% with management of GDM compared to 4% with routine pregnancy care (p=0.01) [62]. In ACHOIS, the intervention group received individualised dietary advice from a qualified dietitian, which took into consideration a woman's pre-pregnancy weight, activity level, dietary intake, and weight gain. They also undertook frequent blood glucose monitoring while the control group received routine pregnancy care. While this study provides evidence of the benefit of GDM treatment, it did not compare outcomes of specific health professional interventions to provide a basis for defining optimal dietetic practice.

While the significance of the dietitian in the management of GDM is widely recognised, at the time of the present study there was no agreed approach to dietetic practice in Australia for management of GDM. Therefore the aims of the present study are to (1) examine current Australian dietetic practice in the management of GDM; (2) identify models of dietetic care currently being implemented; and (3) determine the need for national evidence based GDM dietetic practice guidelines and nutritional recommendations.

The results of this study will provide baseline practice data and identify models of dietetic intervention currently being implemented across Australia that could be used to refine practice and guide the future development of dietetic practice guidelines.

3.2 Methods

A cross-sectional survey of Australian dietitians providing MNT to women with gestational diabetes was undertaken between March and June 2009. Electronic invitations were sent to 3495 financial members of the Dietitians Association of Australia (DAA), and those registered with the national Diabetes, Private Practice and Paediatric & Maternal Interest Groups. Written invitations were also mailed to the nutrition & dietetic departments of 210 public and private hospitals providing

maternity services and 85 diabetes services across Australia. Dietitians currently working in the area of gestational diabetes were requested to participate. The University of Newcastle Human Research Ethics Committee approved the study and DAA approved the invitation to interest group members. Completion of the online survey or return of the paper questionnaire was considered implied consent for participation.

The survey development was guided by the American Dietetic Association Gestational Diabetes Evidence Based Practice Guidelines [106], ADIPS GDM Management Guidelines [2, 6], DAA Evidence Based Practice Guidelines for the Nutritional Management of Type 2 Diabetes Mellitus for Adults [286] and the American Diabetes Association Nutrient Recommendations [111]. The 55 item questionnaire survey included multiple choice, open-ended questions or used Likert scale responses to report demographics (12 questions), GDM service provision (12 questions), dietetic assessment and interventions (11 questions), screening and management guidelines (5 questions), postnatal management practices (8 questions), as well as information on current guideline use and perceived need for Australian evidence based guidelines (6 questions). The online survey was pilot tested with seven DAA members who were current specialist dietitians in the area of diabetes and provided services to women with GDM.

Descriptive statistics were reported as response category frequencies using SPSS version 15.0 (SPSS Inc, Chicago, Ill, USA).

3.3 Results

A total of 222 respondents completed the survey (220 online and two paper responses). Responses from two dietitians currently working overseas were excluded, resulting in a final sample of 220 dietitians currently working in Australia. Dietitians representing all states responded to the survey, with the majority working in NSW (30%), VIC (24%) and QLD (20%). Respondents were predominately employed full-time (61%), most were current DAA members (97%) and members of a DAA diabetes interest group (69%). Table 3.1 describes the demographic profile of survey respondents.

Table 3.1: Demographic characteristics of survey respondents (n=220)

	Percentage of respondents %
Employment sector[a]	
Public hospital	52
Diabetes service	13
Community health	26
Private practice	26
Other	11
Geographic location	
Metropolitan	55
Regional	28
Rural/Remote	17
Primary area of dietetic practice[a]	
Diabetes	58
Obstetrics	14
General clinical nutrition	46
Community nutrition	24
Other	13
Years of dietetic practice	
<1 year	8
1-5 years	29
5-10 years	24
>10 years	39
GDM clients/month	
<5	55
6-20	32
>20	13
Accredited Practising Dietitian	95
Credentialed Diabetes Educator	9

[a] Results do not tally to 100% due to multiple responses for these categories

The majority of dietitians (87%) reported working within a multidisciplinary service and of these, 92% included access to a diabetes educator, 51% an endocrinologist or diabetes specialist and 38% an obstetrician. Of those not working in a multidisciplinary team, 86% reported that their clients had access to other diabetes team members through another service. Seventy seven percent (77%) of respondents reported that all women with GDM attending their service were referred to a dietitian. Individualised appointments were the most frequently reported format for dietetic interventions (93%), with dietitians also providing group education (33%) as well as telephone, email and/or fax follow-up (39%). Table 3.2 reports the different types of dietetic interventions provided by length of consultation.

Table 3.2: Dietetic services for GDM provided by length of consultation

Duration	Individual Consultation		Group Education	
	Initial *n*=182	Follow-up *n*=181	Initial *n*=70	Follow-up *n*=21
≤30 minutes	14%	92%	7%	62%
30-60 minutes	84%	8%	57%	29%
≥60 minutes	2%	0%	36%	9%

Dietitians reported seeing women predominately within one to two weeks of referral (48% and 47% respectively) and 32% were provided with some initial nutrition information prior to their first dietetic appointment. The majority of dietitians were able to provide on average between one and three face to face interventions (including individualised and group appointments) per client throughout the course of a GDM pregnancy as shown in Figure 3.1.
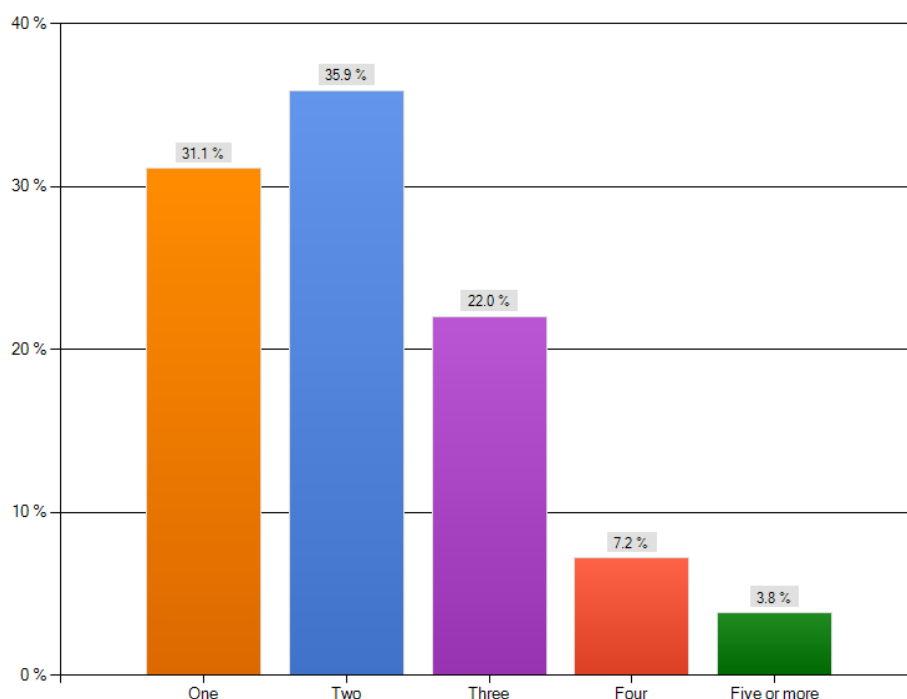
Figure 3.1: Frequency of dietetic consults provided to women with GDM

Factors influencing the frequency of dietetic interventions included glycaemic control (75%), dietitians clinical judgement (71%), use of insulin (53%), dietetic staffing levels

(50%), client specific issues such as literacy (22%) and language spoken (21%), as well as department or health service guidelines (22%) or scheduled appointments with other team members (35%). Fifty four percent (54%) believed that their service currently offered adequate dietetic interventions for women with GDM

Seventy three percent (73%) of dietitians reported that their service or area health service recommend universal GDM screening for all pregnant women. Self blood glucose monitoring was routinely advised by 94% of services and recommended testing times were fasting (90%), one hour postprandial (6%) and two hour postprandial (87%). Five percent (5%) of dietitians were unsure of recommended testing times and 13% reported advice to test at other times. A range of different fasting (3.5-6.7mmol/L), one hour (6.7-8.0mmol/L) and two hour (3.5-10.0 mmol/L) postprandial blood glucose targets were reported by respondents. When compared with the ADIPS glycaemic control targets 43% were recommending a fasting level <5.5mmol/L, 31% a one hour postprandial level <8.0mmol/L and 48% a two hour postprandial target of <7.0mmol/L.

Sixty percent (60%) of dietitians reported that clients with GDM were routinely weighed and 40% provided specific weight gain advice as part of their dietetic care. Sixty four percent (64%) of respondents reported recommending a minimum carbohydrate intake ranging from 60–300 grams per day. Macronutrient targets were reported to be in the ranges of 20-75% carbohydrate, 10-40% protein, 7-45% fat and 5-15% saturated fat.

Carbohydrate distribution advice was provided in the format of flexible carbohydrate portions or exchanges (67%), general advice regarding small frequent meals spread over the day (67%), use of a plate model (37%), prescribed amounts of carbohydrate at meals and snacks (34%) or Australian Guide to Healthy Eating serves (26%). Carbohydrate portions or exchanges were reported to be used as a teaching tool as deemed appropriate to the client's needs (language skills, level of education etc) by 62% of dietitians, while 35% routinely used this teaching method for all clients and 19% reported use in women requiring insulin.

Advice on glycemic index (GI) was incorporated into nutrition education by the majority of dietitians with 44% advising clients to *include one low GI food at each meal and snack,* 23% advising to *include one low GI food at each meal* and 20% providing advice such as *select low GI where possible*, *eat more low GI and limit high GI foods* or general advice on lower GI food alternatives.

Advice regarding the use of artificial sweeteners included *avoid saccharin (954) and cyclamate (952) and use other sweeteners in small amounts only* (37%), *use any sweeteners in small amounts only* (30%), *avoid saccharin (954) and cyclamate (952) and use other sweeteners as desired* (9%), *use any sweeteners as desired* (6%) and *avoid all sweeteners* (4%). Four percent (4%) did not provide any specific advice on artificial sweeteners and 11% provided *other* advice.

Respondents were asked to indicate the content of nutrition education information provided to women with GDM, Figure 3.2. Respondents reported that other nutrition information provided included advice on postnatal diet (61%), saturated fat (58%), fibre (55%), alcohol (52%), dining out (36%) and breastfeeding (35%).
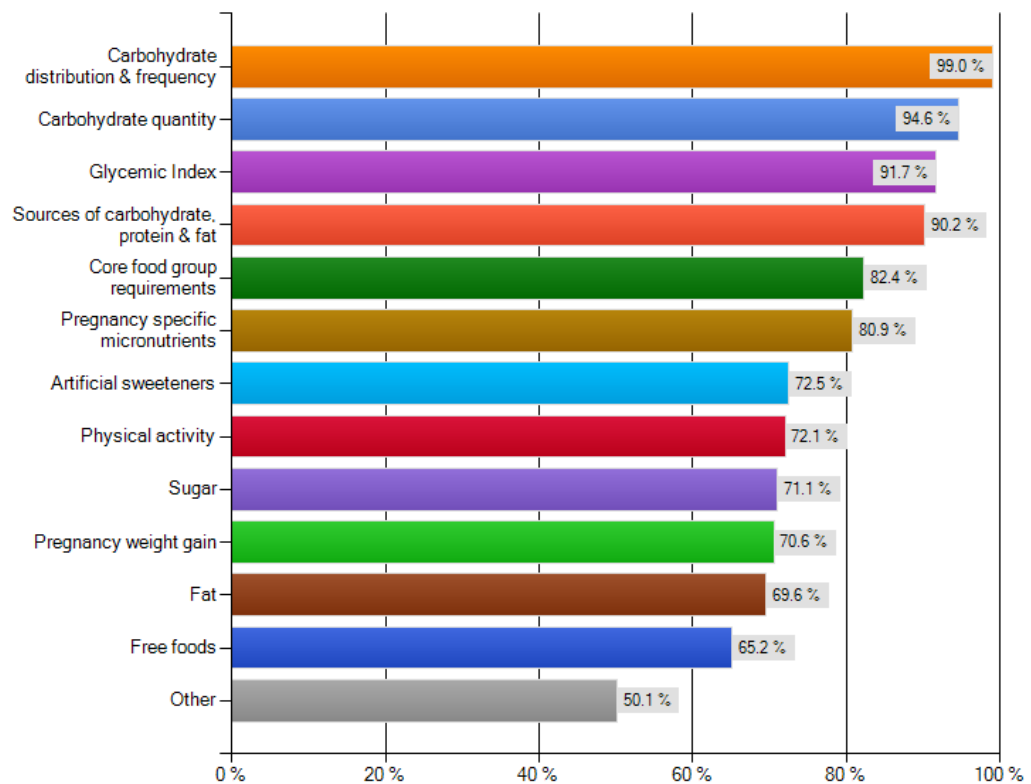
Figure 3.2: Content of GDM nutrition education provided by dietitians

On a 4-point Likert scale, when dietitians were asked to describe their level of confidence in GDM management, 33% were *very confident*, 50% *confident*, 16% *somewhat confident* and 1% *not confident*. Fifty four percent (54%) believed that their service currently offered adequate dietetic interventions for women with GDM.

The majority of dietitians believed that women with GDM were moderate (47%) to high (44%) risk of future type 2 diabetes and 35% reported that their service provided a postnatal glucose tolerance test reminder program for women with GDM. Postnatal dietetic appointments were provided by 10% of dietitians, 51% did not provide any postnatal dietetic services and 39% reported that they sometimes provided this service. Of those not providing postnatal services, less than one third (32%) referred women to another service (e.g. community prevention program, general dietetics clinic) for preventive lifestyle management. In regards to type 2 diabetes prevention advice, 68% reported routinely incorporating this information into antenatal dietetic interventions with 38% including postnatal weight management information and 35% breastfeeding

advice. Only 8% of respondents believed that their service currently offered adequate postnatal lifestyle interventions for the prevention of future type 2 diabetes.

The use of service specific practice guidelines or protocols, such as those specifying the frequency of visits and information to be covered in each session, was reported by 21% of dietitians. These were reported to be developed by health professional consensus (88%), adaptation of international guidelines (25%) or by other means (15%), including clinical experience, state based chronic disease management guidelines or quality assurance activities. Likewise, written nutrition recommendations, such as those specifying the macro and micronutrient content of the diet, were reportedly used in GDM management by 51% of dietitians. These were developed by health professional consensus (77%), from published nutrient recommendations (36%) or by other means (19%) including information from Diabetes Australia, as well as Commonwealth and State health publications. The majority of dietitians surveyed believed that there was a need for DAA endorsed evidence based GDM dietetic practice guidelines (86%) and nutrition recommendations (87%).

3.4 Discussion

This survey describes the dietetic services and nutrition education provided by Australian dietitians to women with GDM. While the results show that there was consistency in many key components of nutrition education, it also highlighted differences in the implementation of MNT by Australian dietitians and some discrepancies with international evidence based guidelines for GDM management.

The majority of survey respondents (77%) reported that all women with GDM attending their service were referred to a dietitian. While services provided varied in frequency, duration and type of intervention, two thirds of dietitians reported that they were only able to provide one to two consults per client. This is less than recommended by the ADA evidence based practice guidelines, which have been shown to result in beneficial outcomes with a minimum of three nutrition consultations [67]. Similarly, less than half of the dietitians surveyed were able to provide appointments in less than one week, compared to the ADA guidelines that recommend

an initial consult initiated within one week of diagnosis. However, the majority were able to provide an initial dietetic consult within one to two weeks of diagnosis and approximately one third reported that preliminary nutrition information was provided prior to the first dietetic appointment. While the reasons provided for frequency of dietetic interventions predominately related to achievement of glycaemic targets and clinical judgement, half of respondents also cited dietetic staffing levels to be a factor influencing the level of service provided. Given the increasing rates of GDM diagnosis [7] and consequential impact on the diabetes workforce, it is not surprising that only 54% of the dietitians surveyed believed that their service currently offered adequate dietetic interventions for women with GDM. With increasing maternal age and rates of obesity, the future impact of GDM on the dietetic workforce is likely to be considerable. Evidence based dietetic practice guidelines could in this case provide a basis for advocating for enhanced dietetic services for the management of GDM.

Consistent with international guidelines, the majority of services recommended universal GDM screening for diagnosis of GDM and self blood glucose monitoring in the management of GDM [29]. The current survey did however, show considerable variability in reported glycaemic targets. While the rationale for the development and use of specific targets was not explored within the context of this survey, these differences may be attributable to service specific protocols rather than individual dietitian practices. However blood glucose targets remain a contentious issue [287] and would need to be addressed as part of the development of any future dietetic practice guidelines.

Variation in practice among dietitians was most apparent in the areas of nutrition assessment and determination of macronutrient targets. With evidence demonstrating the important influence of maternal weight on pregnancy outcomes [97, 288] it was somewhat surprising that only 60% of dietitians routinely weighed clients and fewer (40%) provided specific weight gain targets. This highlights the need for an evidence based approach to weight gain advice in this high risk group. Similarly, inconsistencies in macronutrient targets used by dietitians in MNT were evident. The largest discrepancy was seen in minimum daily carbohydrate recommendations which varied

from 60-300 grams per day and a recommended percentage of energy from 20-75%. While there is no nutrient reference value (NRV) in Australia for carbohydrate during pregnancy [121], evidence suggests that adequate energy from carbohydrate is required to ensure appropriate fetal growth and prevent ketosis [289],with US guidelines suggesting a target minimum of 175 grams of carbohydrate per day [111].Likewise, postprandial hyperglycaemia has been associated with increased risk of adverse outcomes in GDM [290], hence international guidelines advising carbohydrate intake in the range of 40-45% or up to 50% if primarily from low GI carbohydrate sources [66, 106]. Similar variations in recommendations were seen with the other macronutrients, some of which were consistent with Australian Nutrient Reference Values and some not. While research is limited regarding optimal nutrient intakes in this group, of particular concern were saturated fat targets in excess of those advised for general population health [121], in a group known to be at increased risk of future type 2 diabetes and cardiovascular disease [53, 58]. Considering the paucity of Australian based GDM specific nutrition recommendations and the many controversial aspects of dietary management, these findings provide a strong argument in favour of developing evidence based nutrient recommendations for this target group.

Despite differences in GDM nutrition practice reported among dietitians, there was some consistency in the overall content of nutrition education. Dietitians provided advice on carbohydrate intake and distribution throughout the day, GI, core food group requirements and pregnancy specific micronutrients. The majority also incorporated methods of carbohydrate quantification such as fixed or flexible carbohydrate portions or exchanges which is in accord with evidence that both the amount and distribution of carbohydrate throughout the day may influence blood glucose control [112, 115].

The inclusion of advice to lower the GI of the diet was reported by most of the dietitians surveyed and is supported by recent evidence demonstrating the benefit of low GI diets in reducing insulin usage in women with GDM [116].There was however variability in GI information provided and in advice on how best to lower the GI of the diet. Differing advice was also demonstrated in regards to artificial sweeteners, with

some dietitians (30%) advising on the suitability of any sweeteners in small amounts and others (34%) against the use of saccharin and cyclamate. These variations may reflect discrepancies in advice available from health and food authorities, as well as international differences in sweeteners approved for use during pregnancy [66, 106]. This issue further highlights the need for Australian evidence based nutrition recommendations.

Although there was a high level of awareness among dietitians regarding the future type 2 diabetes risk posed by GDM, there was limited provision of postnatal dietetic follow-up for this high risk group, with the majority believing that their centre did not provide adequate postnatal risk reduction services. While a small proportion (10%) of dietitians were able to provide postnatal follow-up, the majority were either required to address future risk reduction during antenatal consultations or refer women to alternative services such as community prevention programs. There has been limited research on the outcomes of dietetic interventions for future diabetes prevention in this group, however evidence from large prevention trials confirms the benefits of lifestyle interventions [78]. With evidence suggesting poor return for follow-up diabetes screening [291], a low level of perceived risk in women with previous GDM [292] and ADIPS guidelines advocating for the provision of healthy eating and exercise advice to this high risk group [2], these results support the need for additional resources to address postnatal lifestyle management.

Overall, the results of this survey highlight a number of variations in usual practice among Australian dietitians in the implementation of MNT for the management of GDM. While many dietitians reported that their service had developed their own nutrient recommendations or practice guidelines, there was strong support for the development of national DAA endorsed dietetic practice guidelines and nutrition recommendations. With an increasing emphasis on evidence based medicine, the development of such guidelines along with national consensus on glycaemic targets would provide a framework to guide clinical decision making, provide specific recommendations by which consistent best practice nutrition care can be provided to

women with GDM and thereby ensure the best possible maternal and infant outcomes from MNT.

Chapter 4 Factors associated with early cessation of breastfeeding in women with gestational diabetes mellitus

This chapter was submitted for publication in 2013.

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The work presented in the manuscript was completed in collaboration with the co-authors (Appendix A).

4.1 Background

Gestational diabetes mellitus (GDM) is estimated to affect approximately 5% of Australian women during pregnancy [7] and poses significant short and long-term adverse health consequences, including increased risk of future type 2 diabetes [46]. Despite evidence in the general population of the favourable effects of breastfeeding on metabolic profile and maternal chronic disease risk, until recently there has been a paucity of evidence regarding specific long term health benefits for women with GDM [51].

Short term studies have demonstrated immediate beneficial effects of lactation on glucose metabolism and insulin sensitivity in women with GDM in the early postnatal period [170, 171, 293]. More recently, two longer term studies have reported protective effects for chronic disease risk, including the development of type 2 diabetes. In the Coronary Artery Risk Development in Young Adults (CARDIA) study [174], a longer duration of lactation was associated with lower incidence of metabolic syndrome from 0–1 month, through to >9 months among women with GDM. Fully adjusted relative hazard ratios indicated that risk reduction associated with longer lactation was stronger among women with GDM (relative hazard range 0.14–0.56; p=0.03). In a 19 year prospective study of 304 German women with GDM, Ziegler et al (2012) found that breastfeeding in women with prior GDM was associated with a >40% risk reduction for development of postnatal diabetes [175]. Women who breastfed for >3 months had the lowest 15 year post-GDM diabetes risk (42% [95% CI 28.9-55.1] when compared to those who didn't breasted or did so for ≤3 months (72% [95% CI 60.5-84.7]; p = 0.0002), as well as a longer diabetes free duration (18.2 years [95% CI 10.4-25.9]. The benefits of breastfeeding extend to both exclusive and partial breastfeeding. In addition to the benefits for infant health, recent evidence suggests that breastfeeding may be an important strategy for maternal type 2 diabetes risk reduction in women with previous GDM.

Therefore, the aims of the current study were to determine factors associated with early cessation of breastfeeding (≤ 3months) in women with recent GDM registered on a

national diabetes database. The results of this study will inform strategies to target breastfeeding promotion and support programs for women with GDM, particularly those at highest risk for early cessation of breastfeeding.

4.2 Methods

This study was a cross-sectional online survey of women aged ≥18 years, diagnosed with GDM in 2010 and registered with the National Diabetes Services Scheme (NDSS) in Australia. The NDSS is an initiative of the Commonwealth Government and provides subsidised diabetes self-management products to Australian residents with diabetes who have registered with the scheme. All registrants have the option of consenting to being contacted for research purposes. The University of Newcastle Human Research Ethics Committee approved the study and Diabetes Australia Ltd. approved and conducted the NDSS database search. All potential participants who met the inclusion criteria and had consented to be contacted were posted a letter of invitation, a participant information sheet and a flyer containing details of the URL to log on to the online survey. A reminder postcard was sent to all eligible women one month after the initial mail-out. Data from the 15817 women with GDM registered on the NDSS during the same period was used to determine whether respondents differed from those who did not consent to be contacted for research purposes or did not participate.

4.2.1 Survey design

The survey was a self-administered online questionnaire conducted May - June 2012. It included 59 predominately closed questions addressing demographics, including educational attainment, country of birth, language spoken at home and occupation. Age was calculated as of 1st January 2010 to allow for comparison with the entire NDSS dataset from which date of birth of the infant was not available. Information on household income was collected and low income was defined according to the Australian Taxation Office income categories.

Socioeconomic status of the geographical location of the household was measured using the Index of Relative Socio-economic Advantage and Disadvantage (SEIFA)

using respondent's postcodes. This measure is based on Australian Census data and provides information about the economic and social conditions of people and households within an area, including both relative advantage and disadvantage. Areas with a higher SEIFA index are more socioeconomically advantaged. SEIFA index was treated as a continuous variable for the purposes of this analysis. Information regarding parity, GDM management, prenatal smoking and smoking frequency were collected for the index pregnancy. Respondent's height and prenatal weight were self-reported.

Breastfeeding data collection included previous breastfeeding, as well breastfeeding duration, intention, attitudes, exclusivity, problems and health professional breastfeeding support for the index pregnancy. The definition of breastfeeding used in this study refers to 'any' breastfeeding as opposed to 'exclusive' breastfeeding. 'Any' breastfeeding refers to infants receiving some breast milk regardless of quantity or method of feeding, and includes infants receiving breast milk as well as complementary infant formula. This breastfeeding variable was chosen due to the inverse association reported between 'any' breastfeeding >3months and postnatal diabetes risk reduction reported by Zeigler et al (2013) [175] and the lower incidence of metabolic syndrome found in women with longer duration of lactation, unrelated to intensity [174]. Breastfeeding cessation ≤3months was defined as women who did not initiate breastfeeding after birth or ceased 'any' breastfeeding at or prior to three months from the birth of the infant.

4.2.2 Data analysis

Univariate chi-square analyses were performed to determine categorical variables associated with breastfeeding cessation at or prior to three months. Statistically significant variables ($P \leq 0.05$) as well as the continuous variables of age, SEIFA and BMI, were included in multiple variable logistic regression analyses using both stepwise and backward elimination variable selection methods to check both methods gave the same list of significant variables. All two way interactions between the surviving main effects were examined. Likelihood ratio tests were used to assess

significance of effects in the logistic regression (LR) models. The Hosmer and Lemeshow goodness-of-fit test was used to determine if there was a satisfactory fit of the model to the data. Odds ratios and 95% confidence intervals were calculated for each of the model effects. Analyses were completed using SPSS version 18.0 (SPSS Inc., Chicago, IL, USA).

4.3 Results

Of the 15817 women registered with the NDSS during 2010, invitations were sent to 5057 women who met the inclusion criteria, with 274 women unable to be contacted. Of those invited, 738 consented to participate (15% response rate). Ineligible respondents included 4 women who reported a stillbirth or neonatal death following a GDM pregnancy and 5 incomplete surveys, leaving total of 729 responses.

The age of respondents (mean±SD) was 32.9 ±4.8 years, 72.2% were Australian born, 9.7% spoke a language other than English, 0.7% were from an Aboriginal or Torres Strait Islander background and 59.3% were tertiary educated. Mean prenatal BMI was 26.5±6.4kg/m² and 51.1% were overweight or obese prior to the index pregnancy. The women in the sample were significantly older when compared with NDSS registrants (32.9 ±4.8 years vs. 32.5±5.3 years; p=0.02) and less likely to be from an Aboriginal or Torres Strait Islander background (0.7% vs. 2.0% p=0.003). There were no significant differences in rates of insulin use between respondents and NDSS registrants (34.7% vs.36.4%; p=0.40).

Breastfeeding initiation was reported by 96.8% of survey respondents with 9.7% of respondents having completely ceased breastfeeding at one month, 19.3% at three months and 32.1% at six months, while cessation of exclusive breastfeeding was reported by 28.7% of women at three months. Reasons cited for cessation in women who completely stopped breastfeeding at ≤3months included insufficient milk supply (45%), breastfeeding problems e.g. cracked nipples (10.1%), return to work (0.7%), infant self-weaning (0.7%), felt it was time to stop (0.7%), other reasons (37.4%), which included open ended responses citing factors such as postnatal depression, exhaustion, insufficient infant weight gain, maternal or child medical problems, infant fatigue

during feeding and family issues such as the demands of multiple children. Women who breastfed for ≤3months were also more likely to agree or strongly agree with the statement *it is more difficult for a woman with gestational diabetes to breastfeed when compared to a woman without gestational diabetes* when compared with those who breastfed for >3months (36.1% vs. 13.4%; p<0.001).

In women who breastfed for three months or less, breastfeeding problems in hospital and at home were reported by 65% and 78% of women respectively. Breastfeeding problems are summarised in Table 4.1.

Table 4.1: Breastfeeding problems reported by women with GDM who breastfed for ≤3months

Problem	Hospital n (%[a])	Home n (%[a])
Attachment problems	48 (35)	42 (30)
Insufficient milk supply	46 (33)	47 (34)
Baby sucking problems	28 (20)	23 (17)
Low level of maternal confidence	25 (18)	25 (18)
Problems expressing milk	23 (17)	23 (17)
Cracked or sore nipples	22 (16)	34 (24)
Insufficient infant weight gain	17 (12)	20 (14)
Milk flow too slow	17 (12)	9 (6)
Baby too tired to feed	15 (11)	11 (8)
Milk flow too fast or too much	1 (0.7)	2 (1.4)
Breast engorgement	7 (5)	3 (2)
Mastitis	0 (0)	12 (9)
Other	22 (16)	16 (12)

[a] Do not tally to 100% due to multiple responses

Independent variables positively associated with early cessation of breastfeeding in univariate analyses included low income, prenatal smoking, return to work <3months, insulin use during the index pregnancy, postnatal depression, caesarean delivery, infant admission to a special care nursery, breastfeeding problems in hospital and at home and inadequate breastfeeding support from health professionals. Variables negatively associated were being tertiary educated, being married or de facto,

receiving breast milk as the first feed and being put to the breast with 30 minutes. As shown in Table 4.2, when these variables along with the continuous variables of age, prenatal BMI and SEIFA were included in multiple variable logistic regression analyses SEIFA, BMI, return to work <3months, caesarean delivery, breastfeeding problems and home and inadequate breastfeeding support remained significant. There were no two-way interactions between the surviving main effects and the model was a good in fit using the Hosmer and Lemeshow test (p=0.70).

Table 4.2: Univariate and multiple variable logistic regression analysis of factors associated with breastfeeding ≤3months.

	Univariate Analysis			Multivariable Model		
	Breastfeeding ≤3 months (%)[b]		Unadjusted OR	P	Adjusted OR	95%CI	P
Tertiary educated	Yes 15.6	No 24.9	0.56	0.002			
Employed	Yes19.6	No 18.2	1.10	0.683			
Australian born	Yes 20.9	No 15.3	1.46	0.091			
English speaking only	Yes 19.6	No 17.1	0.85	0.625			
SEIFA (1 unit increase)			0.89	0.001	0.89	0.81,0.97	0.012
Age (years)			0.99	0.500			
Prenatal BMI (2 unit increase)			1.13	<0.001	1.08	1.01, 1.57	0.037
Prenatal smoking	Yes 29.9	No 17.5	2.01	0.003			
Low income household	Yes 25.6	No 17.3	1.65	0.015			
Married or defacto	Yes 18.6	No 57.1	0.17	<0.001	0.14	0.03,0.62	0.010
Return work <3months	Yes 33.3	No 18.3	2.34	0.009	3.39	1.53,7.55	0.003
Previous GDM	Yes 22.1	No 19.0	1.21	0.490			
Insulin requiring	Yes 24.9	No 16.1	1.73	0.004			
Postnatal depression	Yes 32.1	No 16.7	2.36	<0.001			
Multiparous	Yes 20.0	No 18.5	1.10	0.622			
Caesarean delivery	Yes 24.1	No 15.8	1.69	0.005	1.70	1.04,2.76	0.034
Premature delivery (<36weeks)	Yes 25.0	No 18.9	1.14	0.283			
Infant special care nursery	Yes 24.4	No 17.3	1.54	0.030			
Breastmilk first feed	Yes 17.1	No 34.8	0.39	<0.001			
Put to breast within 30 minutes	Yes 16.5	No 25.7	0.57	0.004			
Aware breastfeeding guidelines	Yes 17.9	No 21.3	0.81	0.282			
Received breastfeeding advice	Yes 21.5	No 16.8	1.36	0.683			
Accessed breastfeeding services	Yes 20.6	No 15.2	1.49	0.117			
Previous breastfeeding	Yes 16.7	No 21.0	0.76	0.151			
Breastfeeding problems hospital	Yes 29.3	No 11.8	3.10	<0.001			
Breastfeeding problems home	Yes 31.2	No 6.5	6.54	<0.001	8.01	4.57,14.05	<0.001
Inadequate breastfeeding support	Yes 33.8	No 15.2	2.86	<0.001	1.88	1.10,3.22	0.021

[b] Yes/No descriptors refer to the % of women breastfeeding for 3 months or less within each of the levels of the binary explanatory variables

4.4 Discussion

This is the first study to examine breastfeeding in a national sample of Australian women with GDM. Breastfeeding initiation rates in respondents were higher than those reported in population based studies of Australian women [294]. This is consistent with the findings of Soltani et al (2006) who reported a higher breastfeeding rate in their sample of UK women with GDM compared with local and national population rates [187]. However, like our study their response rate was modest and participants were a self selected sample. In contrast, a recent Canadian study reported a much lower hospital discharge breastfeeding rate for women with GDM [188]. The fact that the outcome variable used in the current study was 'any' breastfeeding, regardless of exclusivity, may explain the difference in our findings. We also found that fewer women in the current study ceased breastfeeding completely by three months compared with the general population [147]. However, as our sample were highly educated and differed somewhat from other Australian women with GDM we were unable to accurately estimate breastfeeding rates in women with GDM in this study.

Breastfeeding problems at home were found to be the strongest predictor of early cessation in women with GDM in the current study. We found that women who reported problems at home were eight times more likely to stop feeding at or before three months. Although breastfeeding problems in hospital were significant in univariate analyses, it was only problems experienced at home that remained significant in the final model. It is likely that problems at home are a stronger predictor of breastfeeding cessation due to the fact that hospital length of stay for most women is relatively short and baby friendly hospital initiatives mean that more support for breastfeeding is available in the maternity ward than at home. These findings are important and highlight the need for home based breastfeeding support and follow-up to address breastfeeding problems experienced by women with GDM in the early postnatal period. In particular, attachment problems and insufficient breast milk supply were the two issues most frequently reported by women who breastfed for

three months or less. These breastfeeding problems are consistent with those reported with women with diabetes in the UK [185].

We found that women were more than three times as likely to stop breastfeeding at or before three months if they returned to work during this time. This has been demonstrated in a number of population based studies [151, 295]. Cooklin et al (2008) found that both full time and part time employment in the first six months post birth, significantly decreased the likelihood of breastfeeding for six months or more when compared to women who were not employed during this period [151]. The current study suggests that this pattern holds true for women with GDM. Interestingly, when describing reasons for stopping breastfeeding, only one woman in the current study reported "return to work" as a reason for cessation of feeding prior to three months. However it is plausible that women who returned to work early did not consciously choose to cease breastfeeding for this reason, but other factors such complementary use of infant formula affecting milk supply and/or maternal fatigue played a major role. Although maternity leave has been found to positively influence the duration of breastfeeding in a number of international studies [296, 297], at the time of the current study the Australian government did not have a universal paid maternity leave scheme. A national paid parental leave scheme providing financial assistance for up to 18 weeks has since been introduced. However, whether this has any impact on early breastfeeding cessation is yet to be determined.

Women in the current study who delivered via caesarean section were a group at risk of early cessation of breastfeeding. These findings are supported by an earlier New Zealand study where women with GDM were found to be less likely to breastfeed on discharge if delivery was via caesarean section (17% vs. 32%; p=0.006) [186].This is not unexpected given the negative consequences of delivery interventions on breastfeeding initiation and continuation, related to factors such as delayed skin to skin contact and reduced likelihood of early attachment to the breast, which are critical in establishing successful breastfeeding [298]. This issue is of particular concern for women with GDM in Australia amongst whom higher rates of caesarean section have been reported (38%

in Australian Institute of Health and Welfare statistics [36], 43% in our sample) compared with the 2010 Australian average (31.6%) [299].

Higher BMI was also associated with a higher risk of early breastfeeding cessation, as reported elsewhere [159]. We found that for every two unit increase in BMI women were 8% more likely to stop breastfeeding at or before three months. This is consistent with the findings of Donath and Amir (2008) who reported a dose response effect between BMI and breastfeeding initiation and duration [159]. They also reported that a higher BMI was predictive of lower rates of breastfeeding, with overweight women 1.5 times more likely to stop breastfeeding at one week and obese women twice as likely to do cease breastfeeding compared to normal weight women. Obesity has been associated with a number of breastfeeding difficulties including delayed lactogenesis and attachment difficulties, as well as body image concerns and medical issues such as polycystic ovarian syndrome and delivery interventions [157]. Women who are overweight prior to a GDM pregnancy are therefore a group highly likely to require additional support to sustain breastfeeding duration beyond three months and postnatal services should target them for more support to successfully breastfeed.

Socioeconomic factors have been consistently associated with breastfeeding in the literature [188, 300]. In the current study lower SEIFA increased the likelihood of early breastfeeding cessation, with every one unit increase in SEIFA (indicating increasing socioeconomic status) associated with approximately 10% reduction in the odds of ceasing breastfeeding at or before three months. The relationship between socioeconomic status and breastfeeding is complex. However factors such as a lack of family support, less ability to seek support for managing breastfeeding problems, inflexible working arrangements and concerns about breastfeeding in public have been identified as possible barriers [150]. Likewise marital status may be an important influence on breastfeeding, with those having a martial or de facto partner being more likely to breastfeed and continue to do so [301, 302]. This was also identified in the current study, with women in our study who were married or in a de facto relationship being less likely to stop breastfeeding early.

Women who ceased breastfeeding ≤ 3months in the current study were also more likely to report a lack of breastfeeding support from health professionals. Although breastfeeding programs and support services are in place in hospitals across Australia, this suggests that women either didn't have access to these services or found the support provided by health professionals to be insufficient. The fact that women who stopped breastfeeding early also perceived breastfeeding to be more difficult for women with GDM, suggests a role for breastfeeding education and support as part of routine antenatal GDM care, as well as the need to identify any difficulties that arise in the early postnatal period.

Contrary to expectations, there are a number of variables shown to be predictive of early breastfeeding cessation in population based studies which were not significant in the current study. Despite other studies demonstrating that younger women cease breastfeeding earlier than their older counterparts, maternal age was not associated with breastfeeding cessation here. As GDM is associated with increasing maternal age and our selection criteria were limited to women over the age of 18 years, this finding could possibly be explained by the fact younger women were also under-represented in the current study, with only 3% of respondents aged 25 years or less. Unlike studies in the general population [161], smoking and early cessation of breastfeeding also failed to reach significance in LR analyses. However, smoking data was collected on prenatal smoking (yes/no) and smoking frequency only and not postnatal rates, although there may be an association between prenatal and postnatal smoking, as found in other studies [303], many women may have ceased smoking prior to commencing breastfeeding which may explain the lack of association. The type of first feed, time to first breastfeed, postnatal depression and tertiary education were also significant in chi-square analyses, however did not remain so in the final model, suggesting that the remaining variables were stronger predictors of breastfeeding cessation on this group.

The reasons cited for early breastfeeding cessation by women with GDM in our study were consistent with that reported in other population based studies. Perceived inadequate milk supply and cracked nipples were noted in the Australian National

Health survey [149] as well as a number of other studies[304, 305]. Infant related reasons such as inadequate weight again and attachment problems as well as specific maternal issues such as depression and stress have also been reported elsewhere [305]. The current findings are therefore not unique to women with GDM, but highlight that additional maternal support for breastfeeding problems and barriers to continued breastfeeding need to be addressed in the early weeks of lactation.

4.4.1 Limitations

Our study has several limitations, the main one being the low (15%) response rate. Although this was considerably less that that achieved in our previously studies using postal survey methodology with women with GDM [292], it is comparable to that reported in other online health surveys using the NDSS [306]. Despite the fact that data suggests that 72% Australians have computer and internet access at home [307] and that the target group being predominately young women, recruitment may have been limited by the lack of access to email addresses such that respondents were required to enter a URL and log on to a survey website. This recruitment method also assumes computer skill competency and has significant potential for user error.

The differences between women who consented to be contacted for research purposes and participated in the survey and the entire NDSS dataset suggest that respondents were representative of NDSS registrants in regards to insulin usage. However, indigenous Australian women were under-represented. Despite the fact that respondents were significantly older (32.9 ±4.8) than NDSS registrants (32.5±5.3), these differences are small and unlikely to be practically significant. Our selected survey methods may have biased results towards women with a higher level of education and literacy. The survey was only administered in English, so non-English speaking women are likely to be underrepresented. There may have also been a bias towards women interested in breastfeeding being more likely to respond to the survey. Despite these limitations, our study is the first to examine breastfeeding in a national sample of women with GDM drawn from a population based registry and adds to the very limited international breastfeeding research with women with GDM to date.

4.5 Conclusion

In women with GDM, there are a number of factors influencing early cessation of breastfeeding which are consistent with those found in general population based breastfeeding studies. These include breastfeeding problems at home, BMI, caesarean section, SEIFA, marital status, early postnatal return to work and inadequate breastfeeding support. Compared to women without GDM, these risk factors for early cessation are likely to be more important for this group due to a disproportionate number of women with GDM in higher BMI categories, delivering via caesarean section and from lower socioeconomic groups [10]. Further, many of these risk factors are potentially modifiable and women with GDM could be targeted for interventions to reduce the risk of early cessation of breastfeeding given the potential benefits for future diabetes risk reduction. This highlights the need for improved breastfeeding support and appropriate follow-up to identify and address breastfeeding problems at home in the early postnatal period. Intervention studies to examining the effectiveness of targeted postnatal breastfeeding support in women with GDM are warranted.

Chapter 5 Postnatal testing for diabetes in Australian women following gestational diabetes mellitus

This chapter was published in 2009.

The work presented in the manuscript was completed in collaboration with the co-authors (Appendix A). Permission to reproduce the text and figures from the manuscript has been granted by the publishers (Appendix E).

5.1 Introduction

Women with a history of gestational diabetes mellitus (GDM) are a high risk group for the development of future type 2 diabetes [11]. While studies to date have varied in their estimates of long term risk, a recent Australian study reported a 9.6 times greater risk of developing type 2 diabetes in women with previous GDM, with a cumulative risk of 25.8%, fifteen years after diagnosis [53]. Studies investigating glucose tolerance in the early postnatal period have estimated the prevalence of diabetes to be 2–16% and impaired glucose tolerance up to 33% [46, 308].

Postnatal blood glucose testing is recommended for re-classification of glucose tolerance status after a GDM pregnancy [6]. The American Diabetes Association 5th International Workshop on GDM summarised the rationale for postnatal testing as the detection of abnormal glucose tolerance and early diagnosis; identification of those at highest diabetes and cardiovascular risk; pre-pregnancy planning for subsequent pregnancies and determination of those for whom intensive lifestyle interventions would be most appropriate [46]. Evidence suggests that the oral glucose tolerance test (OGTT) is the most sensitive test for detecting postnatal glucose abnormalities in this high risk group [46, 198].

The Australasian Diabetes in Pregnancy Society (ADIPS) guidelines recommend maternal follow-up with a 75gm OGTT 6-8 weeks post delivery [6]. Subsequent testing is recommended every 1-3 years thereafter, depending on potential for future pregnancies and clinical circumstances (e.g. ethnicity, insulin use, repeat GDM).

While studies have suggested that postnatal testing rates are generally low [201, 209], there is currently limited data on postnatal follow-up in Australian women or the factors associated with return for follow-up testing in this group. Therefore, the aim of this study was to describe maternal postnatal diabetes testing and factors associated with adherence to ADIPS postnatal testing guidelines following a GDM pregnancy. These data add to the limited research in this area and provide information that can be used to develop strategies for encouraging women with GDM to return for diabetes testing in the postnatal period.

5.2 Methods

This study was a cross-sectional survey of Australian women with a recent history of GDM. Participants were recruited from the National Diabetes Service Scheme (NDSS) database. The NDSS is an initiative of the Commonwealth Government that provides subsidised diabetes products to Australian residents diagnosed with diabetes who register with the scheme. All registrants also have the option of nominating whether or not they consent to being contacted for research purposes. Inclusion criteria were: registered with GDM on the NDSS database between June 2003 and June 2005, and consented to be contacted for further research. Women were excluded if they were aged <18 years at time of registration with the NDSS or resided in a Queensland postcode, due to a concurrent GDM lifestyle study being undertaken in that state. The University of Newcastle Human Research Ethics Committee approved the study and Diabetes Australia Ltd. approved the NDSS database search.

Participants were contacted by mail, with all eligible women sent a letter of invitation, a participant information package, a postnatal health and lifestyle survey, a reply paid envelope and a pen. A reminder postcard was sent to all eligible women one month after the initial mail-out. Data from the national NDSS data set from 2003-2005 was used to determine whether survey respondents differed from those who did not consent to be contacted for research purposes or did not complete the survey.

5.2.1 Survey design

The survey was a self-administered written questionnaire with 69 predominately closed questions addressing demographics, educational attainment, language spoken at home and occupation. Information regarding gestational diabetes management, antenatal and postnatal contact with health professionals, family and medical history, current smoking, recall of risk reduction advice and source and type of advice was collected. Postnatal follow-up questions included time to postnatal testing, type of test undertaken and testing notification procedures. The survey was pilot tested with a sub-group of women (n=23) from the Diabetes Australia-NSW membership database.

This pilot was approved by the Diabetes Australia-NSW Research Advisory Committee.

5.2.2 Statistical analyses

The primary outcome variable was return for follow-up postnatal OGTT at 6-8 weeks. Univariate chi–squared analyses were performed to determine variables associated with return for follow-up OGTT. Variables statistically associated ($p<0.05$) with return for follow-up were included in multiple variable logistic regression analyses using both stepwise and backward elimination variable selection methods to check both methods gave the same list of significant variables. All 2-way interactions between the surviving main effects were examined and any that were significant were added to the final model. Some 3 way and 4 way interactions with variables showing significant 2 way interactions were examined but none were significant. Wald tests were used to assess significance of effects in the logistic regression models. The Hosmer and Lemeshow goodness of fit test was used to determine if there was a satisfactory fit of the model to the data. Odds ratios and 95% confidence intervals were calculated for each of the model effects. Analyses were completed using SPSS version 15.0 (SPSS Inc, Chicago, Ill, USA).

5.3 Results

Of 15893 women registered on the NDSS with GDM, 5576 had consented to be contacted for research and 4098 women met the inclusion criteria, with 249 women unable to be contacted. Of those invited, 1381 women returned surveys, indicating consent to participate in the study (36% response rate). Nine ineligible surveys were excluded, resulting in 1372 eligible respondents.

The mean ± standard deviation (SD) age was 34.7±4.9years and mean ± SD duration since delivery was 21.2±8.4months. The majority of respondents were Australian born (72.1%) and employed (64.3%), 19.0% spoke a language other than English and 1.1% were from an Aboriginal or Torres Strait Islander background. A prior GDM pregnancy was reported by 14.5% of respondents, 26.5% used insulin during their GDM pregnancy and 54.8% reported family history of type 2 diabetes.

The women in the sample were significantly older (34.7±4.9 vs. 34.0±5.2) and more likely to be Australian born (72.1% vs. 64.2%) than other NDSS registrants (p<0.001). There were no significant differences in insulin use during pregnancy (p=0.496) or proportion of Aboriginal or Torres Strait Islander women in the sample (p=0.437) when compared to NDSS registrants.

Return for postnatal follow up screening was reported by 73.2% of survey respondents. Women were notified of the need for follow-up blood glucose screening by a diabetes health professional (33.5%), general practitioner (31.4%), reminder service (14.3%) or via other means (28.2%). Of those who returned for screening after their GDM pregnancy, 56.4% reported having an OGTT, 32.6% fasting plasma glucose, 23.5% capillary blood glucose testing, 6.1% non-fasting plasma glucose and 2.4% reported having an Hb_{A1c}. Any form of postnatal testing was completed at 6-8 weeks by 60.9% of respondents. When we examined adherence to ADIPS guidelines, a total of 27.3% of survey respondents returned for an OGTT at the recommended 6-8 weeks.

Table 5.1 illustrates the characteristics of the study sample by 6-8 week postnatal OGTT status and Table 5.2 summarises antenatal care providers and risk reduction advice by 6-8 week postnatal OGTT status.

Table 5.1: Sample characteristics by 6-8 week OGTT status

		Return for 6-8 week OGTT (%)	p value
Country of birth	Australia	28.1	0.497
	Other	26.1	
Language	English only	27.0	0.698
	Other	28.3	
Employed	Yes	30.0	0.005
	No	22.9	
Tertiary Educated	Yes	32.7	<0.001
	No	23.9	
GDM History	Previous GDM	28.3	0.796
	Single diagnosis	27.2	
GDM Management	Insulin requiring	32.4	0.019
	No insulin	25.8	
Family history type 2 diabetes	Yes	29.9	0.021
	No	24.2	
Overweight /Obese (BMI>25kg/m^2)	Yes	26.2	0.279
	No	29.1	

Table 5.2: GDM health care by 6-8 week OGTT status

		Return for 6-8 week OGTT (%)	p value
Endocrinologist	Yes	35.4	<0.001
	No	22.4	
Obstetrician	Yes	31.3	<0.001
	No	19.6	
Diabetes Educator	Yes	29.4	0.004
	No	21.7	
General Practitioner	Yes	24.5	0.063
	No	29.2	
Midwife	Yes	28.1	0.733
	No	27.0	
Individualised risk reduction advice	Yes	34.6	<0.001
	No	24.3	
Postnatal written information	Yes	32.1	0.015
	No	25.5	

The independent variables included in multiple variable logistic regression analyses were tertiary education, employment status, insulin use during GDM pregnancy, family history of diabetes, health professionals (endocrinologist, obstetrician, diabetes educator) seen during pregnancy and type of postnatal risk reduction advice (individualised advice, written information). Age was also included in the model.

In logistic regression (LR) analysis (Table 5.3), factors related to return for postnatal OGTT at 6-8 weeks post GDM pregnancy included receiving health professional delivered risk reduction advice (OR 1.41; 95% CI 1.08, 1.84) or written information after the birth (OR 1.35; 95%CI 1.03, 1.76). In two way interactions, being under the care of an endocrinologist and not tertiary educated (OR 2.09; 95% CI 1.49, 2.93) as well as seeing an obstetrician and diabetes educator during GDM pregnancy (OR 1.72; 95% CI 1.19, 2.48) were associated with return for appropriate postnatal testing. Increasing age (5 year increment) was associated with a lower likelihood of returning for postnatal testing (OR 0.83; 95% CI 0.73, 0.95). The Hosmer and Lemeshow goodness of fit test was not significant, p=0.78, indicating a satisfactory fit of the model to the data.

Table 5.3: Logistic regression analysis of factors associated with return for 6-8 week OGTT

		OR	95% CI
Postnatal written information		1.35	1.03, 1.76
Individualised risk reduction advice		1.41	1.08, 1.84
Age (5 year increase)		0.83	0.73, 0.95
Two way interactions			
Tertiary Education	Endocrinologist		
No	No	1.00	
	Yes	2.09	1.49, 2.93
Yes	No	1.00	
	Yes	1.23	0.85, 1.79
Obstetrician	Diabetes Educator		
No	No	1.00	
	Yes	0.80	0.49, 1.32
Yes	No	1.00	
	Yes	1.72	1.19, 2.48

In sensitivity analyses, we determined that if none of the 14,521 women from the NDSS dataset who did not take part in the survey had returned for postnatal screening then rates of any type of postnatal testing would actually be as low as 6.3%. We also examined rates of postnatal OGTT up to six months post-GDM pregnancy assuming for various reasons that not all women may not have been able to return for follow-up in the recommended 6-8 week time frame. This scenario increased the rate of return for OGTT by 9.5%, confirming that the majority of women who return for an OGTT do so in the first two months.

5.4 Discussion

This is the largest postnatal survey of Australian women with prior GDM to have been conducted in Australia to date. In this study, the rates of self-reported postnatal diabetes testing were higher (73.2%) than the 38%-45% reported elsewhere [201, 202, 209]. However, when we restricted the study population to women who had achieved

the ADIPS guidelines for type and timing of postnatal glucose re-evaluation, this number dropped to just over one quarter of the sample.

We found that women were more likely to return for follow-up OGTT at 6-8 weeks if they received postnatal written information or individualised risk reduction advice from a health professional. These findings are similar to those reported by Kim et al (2007) who demonstrated that recall of postnatal screening advice and provision of laboratory slips were associated with return for postnatal screening confirmed by health care claims data [208]. Likewise, in other studies, rates of follow-up testing have been reported to be up to three fold higher in those who attended a postnatal health professional visit [202, 205].

Non-tertiary educated women in this sample were almost twice as likely to return for testing if they saw an endocrinologist. This was also the case for women who saw a diabetes educator as well as an obstetrician, suggesting that diabetes specific education and advice may act to reinforce the importance of appropriate postnatal testing and that specialist advice may prompt women with a lower level of education to seek follow-up testing.

Contrary to expectations, previous GDM was not associated with return for 6-8 week OGTT in univariate analyses. Likewise, a family history of diabetes did not increase the likelihood of returning for follow-up testing in LR analyses, suggesting that prior personal or family experience with diabetes was not necessarily a motivating factor for re-evaluation of postnatal glucose tolerance. Unlike other studies, where insulin use has been associated with return for follow-up testing [205], this was not a predictor of postnatal testing in our LR analyses. The likelihood of returning for OGTT at 6-8 weeks also decreased with age in this sample, with every five year increase in age women were only 83% as likely to return for an OGTT at the recommend time.

Despite the well-established risks of future type 2 diabetes, and the potential benefits of early diagnosis and intervention, this study suggests that appropriate follow-up diabetes testing may not always be sought by women with prior GDM. While Rumbold and Crowther (2001) found that the majority (72%) of Australian hospitals

with maternity services were recommending postnatal testing [204], it has been suggested that factors such as fragmentation between pre and postnatal health care and limited interaction with the health care system after delivery may contribute to poor follow-up [209]. With much of the emphasis during a GDM pregnancy focused on perinatal outcomes, it is possible that a low level of perceived risk for future diabetes may contribute to a lack of appropriate postnatal testing [260], while the pressures of child-care, time and social support may also present barriers to follow-up.

5.4.1 Limitations

Our study has several limitations, the chief of which is the low (36%) response rate. The women in this survey differed somewhat to the NDSS population with GDM, in that they were slightly older and more likely to be Australian born. As the survey was administered in English, it is also likely that women with poor or limited English skills were under-represented.

Based on the results of the sensitivity analysis, it is also possible that a response bias towards potentially more motivated women may have actually overestimated the rate of return for follow-up testing after a GDM pregnancy.

Our data were obtained from a cross-sectional survey of women with previous GDM. We did not have access to any longitudinal data or clinical information to ascertain the appropriateness of any subsequent maternal follow-up after the initial 6-8 week OGTT. We did not examine factors associated with return for further screening in women with a longer duration since delivery. These factors may be more important as time since delivery has been shown to increase risk for development of type 2 diabetes [53].

The data collected relied on recall of type of test and time frame for postnatal testing and an understanding of blood glucose testing methods. The previous experience of blood glucose testing during the women's GDM pregnancy and a description of tests in lay terms would have reduced the possibility of respondent error.

5.5 Conclusions

Our study suggests that specialist diabetes care in women in non-tertiary educated women, or a team approach to management with diabetes education as well as obstetric care may act to reinforce the need for postnatal diabetes testing in accordance with the ADIPS guidelines. Individualised follow-up from a health professional and the provision of written information following a GDM pregnancy may also be effective in increasing return for appropriate postnatal testing in this high risk group.

This highlights the importance of consistent, unambiguous postnatal testing advice from health care providers and suggests a case for structured follow-up, or as a minimum, the provision of written information and postnatal testing reminders. A national recall system, like that currently in place for cervical screening, would provide an ideal opportunity for the delivery of postnatal information regarding risk reduction, including advice on subsequent testing for diabetes following a GDM pregnancy.

Chapter 6 Postpartum diet quality in Australian women following a gestational diabetes pregnancy

This chapter was published in 2012.

Morrison, M.K, Koh, D, Lowe, J.M, Miller, Y.D, Marshall, A.L, Colyvas, K and Collins, C.E. Postpartum† diet quality in Australian women following a gestational diabetes pregnancy. *European Journal of Clinical Nutrition* 2012; 66:1160–1165.

The work presented in the manuscript was completed in collaboration with the co-authors (Appendix A). Permission to reproduce the text and figures from the manuscript has been granted by the publishers (Appendix E)..

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† *The term 'postpartum' has been used to replace 'postnatal' for submission to the European Journal of Clinical Nutrition*

6.1 Introduction

Gestational diabetes mellitus (GDM) is a form of glucose intolerance diagnosed during pregnancy [2]. It affects an estimated 5% of Australian women, increasing up to 14% in some high risk groups [7]. GDM is associated with increased perinatal risks, while longer term consequences include development of type 2 diabetes and increased cardiovascular risk [46]. Although research to date has varied in estimates of future type 2 diabetes risk, one recent Australian study reported a 9.6 times greater risk of type 2 diabetes in women with previous GDM and a cumulative risk of 25% after 15 years [53].

Research demonstrates that intensive lifestyle interventions are effective in the prevention of type 2 diabetes [78], hence, the diagnosis of GDM provides an opportunity for early intervention in an at-risk group. Despite this, there is some evidence to suggest that women diagnosed with GDM have postpartum lifestyle behaviours that are not consistent with guidelines for prevention of type 2 diabetes, including suboptimal physical activity levels [309, 310], poor intake of fruit and vegetables and high fat diets [87, 88, 243]. However, to date there has been little published data on the postpartum dietary intakes of Australian women with prior GDM.

Recent studies examining whole diets, as opposed to single nutrients or dietary components, have highlighted the important role of dietary patterns and overall diet quality in the prevention of type 2 diabetes [236, 237, 239, 241]. Healthful dietary patterns characterised by high consumption of fruit and vegetables, whole grains, fish, and poultry may delay the progression to type 2 [228, 241] while Western dietary patterns have been demonstrated to increase risk [311]. Likewise a variety of diet quality tools that measure adherence to dietary guidelines have demonstrated that a high-diet quality, representing alignment with national dietary guidelines, is inversely associated with obesity, blood lipids, hyperglycaemia and hyperinsulinaemia, as well as all-cause mortality and indices of self-rated health [232, 312]. In prospective studies, overall diet quality has also been inversely associated with type 2 diabetes risk in

women, independent of body mass index (BMI) [313]. Diet quality may therefore have an important role in mediating the development of chronic disease in a group known to be at high risk of type 2 diabetes.

The aim of this study was to describe the diet quality of a national sample of Australian women with a recent history of GDM and determine factors associated with adherence to national dietary recommendations.

6.2 Materials and methods

This was a cross-sectional study of Australian women with a recent history of GDM. Participants were recruited from the National Diabetes Service Scheme (NDSS) database. The NDSS is an initiative of the Australian Government that provides subsidised blood glucose testing strips and free syringes to residents diagnosed with diabetes. Registrants also have the option of nominating whether or not they consent to being contacted for research purposes. Study inclusion criteria were: diagnosed with GDM ≤3 years previously, registered with the NDSS and consented to be contacted for research purposes. Women were excluded if they were aged <18 years at time of registration. Eligible women were invited to participate by mail. Additional women were recruited from two major maternity clinics in Brisbane, Australia. Women from the clinics were pregnant at time of recruitment, but surveyed 6-months postpartum. This additional sampling was to recruit women with very recent GDM, who may be missed in the NDSS database due to status update delay. The University of Newcastle Human Research Ethics Committee, The University of Queensland, Royal Brisbane Women's Hospital and Mater Health Services approved the study and Diabetes Australia Ltd. approved the NDSS database search.

6.2.1 Survey design

The survey was administered by two methods. First, a self-administered written questionnaire and second, a telephone interview conducted in parallel by trained interviewers using Computer-Assisted-Telephone-Interviewing for Windows (WinCati, Version 4.2; Sawtooth Technologies, Northbrook, IL, USA) full details of which have been described elsewhere [292, 309]. Briefly, the survey questions

addressed demographics, educational attainment, language spoken at home and occupation using standard items from the 2001 Australian census [314]. Information regarding GDM management, lifestyle related risk factors, family and medical history and postpartum follow-up were collected by self-report. Data on respondent's height and pre and postpartum weight were self-reported and used to calculate BMI as weight (kg)/height (m)^2. Physical activity was assessed using the validated Active Australia Questionnaire (AAQ) which involves recall of frequency and duration of physical activity in the past week. The AAQ is a widely used reliable and valid measure of physical activity [315, 316]. Physical activity levels were defined according to AAQ criteria [317], whereby 'sufficient' physical activity was defined as the accumulation of at least 150 min of moderate or equivalent weighted vigorous activity over at least five sessions in the past week. Physical activity over-reporters were re-coded according to AAQ guidelines [317]. The self-administered questionnaire was pilot tested with a convenience sample of women (n=23) from the Diabetes Australia-NSW membership database. The telephone questionnaire was pilot tested with six women who had a recent GDM (<3 years) pregnancy using a snowball sampling method.

6.2.2 Australian Recommended Food Score (ARFS)

Diet quality was assessed using the ARFS. The ARFS is a diet quality score modelled on the Recommended Food Score developed by Kant and Thompson [318] and derived from the Victorian Cancer Council's Dietary Questionnaire for Epidemiological Studies (DQES) food frequency questionnaire (FFQ) [319]. The DQES was originally developed for use in an ethnically diverse cohort [319], and has been validated against 7 day weighed food records in young Australian women and found to be an accurate estimate of usual dietary intake [320]. The ARFS is an index of dietary variety and nutritional quality with higher scores reflecting greater adherence to the *Dietary Guidelines for Australians* [321] and food variety within core food groups of the *Australian Guide to Healthy Eating (AGHE)* [322]. It has been validated in a nationally representative sample of Australian women [312], with a higher ARFS associated with

a lower percentage of energy from total and saturated fat, a higher percentage of energy from carbohydrates and protein, and higher intake of micronutrients.

The ARFS requires respondents to report their usual consumption of foods over the preceding 12 months. It includes nine questions regarding frequency of consumption of core foods and details of usual food choices within each group. These questions are closed ended with multiple response categories. This is followed by a 48 item FFQ with dichotomised response categories. The FFQ includes only foods from the original DQES FFQ that make a healthful contribution to dietary intake. The ARFS scoring is mostly independent of reported quantities of food, rather is based on frequency of consumption of core food items. Items from the 48 question FFQ consumed less than once a week scored zero and those consumed once a week or more scored one. An additional score of one was allocated for each of the following: consuming two or more fruit serves per day, four or more vegetables per day, the use of reduced fat or skim milk or soy milk, consuming at least 500mL of milk per day, using high fibre, wholemeal, rye or multigrain breads, consuming at least four slices of bread per day, using polyunsaturated or monounsaturated spreads or no fat spread, having one or two eggs per week, using ricotta or cottage cheese and using low fat cheese, consuming ice cream and cheese each less than once a week, yoghurt more than once a week. Frequency of alcohol consumption between 1-2 days/month and 4 days per week was allocated one point and one point was allocated for quantity of between one or two standard drinks. Zero points were added for alcohol consumed outside of these ranges. Further details are provided in Table 6.1. The maximum ARFS that indicates greater adherence to the recommendations in both the Dietary Guidelines for Australians and the AGHE is 74.

For analysis, ARFS was divided into quintiles to create a categorical variable with quintile one representing the lowest category of dietary quality and quintile five the highest dietary quality. Those with more than four missing items were excluded from analysis and missing values were re-coded as zero for those with up to four items missing.

6.2.3 Statistical analysis

To correct for potential sampling bias, descriptive statistics, ARFS and component scores were adjusted for age, country of birth, state of residence and insulin usage using weights from 15880 women with complete data in the NDSS dataset. Unweighted analyses were used to examine the predictors of ARFS. Univariate chi-square analyses were performed to determine variables associated with ARFS quintiles. Statistically significant variables ($p \leq 0.05$), as well as age and BMI, were included in a multiple variable multinominal logistic regression analysis. Likelihood ratio tests were used to assess significance of effects in the logistic regression model and used as the basis for retaining a variable in the model. The Pearson Chi-Square was used to check the goodness of fit of the model. The multiple variable model provides odds ratio (OR) estimates adjusted for other variables in the model. ORs for quintiles 2-5 were referenced to quintile 1 and 95% confidence intervals were calculated for each of these quintiles. Analyses were completed using SPSS version 18.0 (IBM Corp., Somers, NY, USA).

6.3 Results

Of the 15893 women registered on the NDSS with gestational diabetes, invitations were sent to 5147 women who met the inclusion criteria, with 302 women unable to be contacted. Of those invited, 1736 women consented to participate (36% response rate). Ineligible respondents who were currently pregnant (n=189), diagnosed with other forms of diabetes (n=9) or those with missing demographic data required for sample weighting (n=39) were excluded from analyses. Final data were available for 1499 respondents.

Using weighted data the mean age ± SD was 34.2±5.1. Approximately two thirds were Australian born (64.5%) or currently employed (67.4%). Less than half (40.1%) were tertiary educated, 22.6% spoke a language other than English, and 1.7% were from an Aboriginal or Torres Strait Islander background. A previous diagnosis of GDM (before the index pregnancy) was reported by 13.1% of respondents, 25.7% used insulin during

the index pregnancy, 29.0% were overweight and 26.3% were obese with a mean (±SD) self-reported BMI of 27.1±6.5.

The ARFS was calculated for 1447 women (52 women had more than four missing items, so were excluded from the analyses). Mean (±SD) diet quality score was 30.9±8.1 from a possible maximum score of 74. Subscale component scores are reported in Table 6.1 and demonstrate that the meat, alcohol and vegetable components were the most highly scored groups relative to the other components with nuts/legumes, grains and fruits the most poorly scored.

Table 6.1: The Australian Recommended Food Score (ARFS): Scoring method, component scores (mean and standard deviation (SD)) and total ARFS for women with previous GDM

Food Group	Items allocated one point	Maximum Score	Mean	SD
Vegetables	≥4 vegetables/day; potatoes; tomato sauce/paste/dried; tomatoes fresh/canned; capsicum; lettuce/endive/salad greens; cucumber; celery; beetroot; carrots; cabbage/brussels sprouts; cauliflower; broccoli; silverbeet/spinach; peas; green beans; bean/alfalfa sprouts; pumpkin; onions/leeks; garlic; mushrooms; zucchini	22	11.7	4.4
Fruit	≥2 serves fruit/day; ≥1/week of each fruit or vegetable juice; canned or frozen fruit; oranges or other citrus; apples; pears; bananas; melons; pineapple; strawberries; apricots; peach/nectarine; mango/pawpaw; avocado	14	4.8	3.1
Grains	≥4 slices bread/day; ≥1/week of each bread type – white high fibre; wholemeal; rye; multigrain; wholemeal; ≥1/week Allbran; Sultana Bran/Fibre Plus/Branflakes; Weet-Bix/VitaBrits/Weeties; rice; pasta/noodles; vegemite/marmite/promite; porridge; muesli; Cornflakes/Nutrigrain/Special K;	14	4.3	1.7
Dairy	>500ml milk/day; reduced fat or skim; ≤1/week cheese, ice cream; ≥ 1 week yoghurt; ricotta/ cottage cheese; low fat cheese	7	2.7	1.1
Nuts/legumes	Nuts; peanut butter; ≥1/week of each baked beans; soy beans/tofu; soya milk; other beans (chickpeas, lentils)	7	1.7	1.1
Meat, eggs, poultry	1-4/week of beef; veal; lamb; pork; chicken; up to 2 eggs/week	5	2.8	1.2
Fish	1-4/week of fish (steamed, baked, grilled); canned fish (salmon, tuna, sardines)	2	1.0	0.8
Fats	Use polyunsaturated/monounsaturated spread or nil margarine	1	0.5	0.5
Alcohol	<1/month up to 4 days/week beer/wine/spirits; maximum/day 1-2 standard drinks	2	1.1	0.8
Total ARFS		74	30.9	8.1

Table 6.2 reports the demographic characteristics, health seeking behaviours and diabetes related risk factors of women with GDM by ARFS quintile. Independent variables found to be significant ($p \leq 0.05$) in univariate analyses included region of birth, speaking only English, being tertiary educated, returning for postpartum follow-up blood glucose testing, being sufficiently physically active and receiving risk reduction advice from a health professional. When these variables (as well as age and BMI) were included in multinominal logistic regression analyses, they remained significant, with the exception of region of birth that was excluded from the final model, see Table 6.3. The Pearson Chi-Square was not significant (ChiSq (5116)=5116, p=0.499) indicating a satisfactory fit of the model to the data.

Table 6.2: Percentage (%) of Women in Each Quintile of the Australian Recommended Food Score (ARFS) by demographic characteristics, health seeking behaviours and diabetes related risk factors

| | Unweighted Mean±SD ARFS | Quintiles of ARFS 1=lowest, 5= highest (ARFS score) | | | | | χ2 |
		1 (≤24) n=312	2 (25-29) n=304	3 (30-33) n=256	4 (34-38) n=321	5 (39+) n=254	
Region of birth		%	%	%	%	%	
Australia	31.1±8.0	20.6	22.0	18.9	21.5	17.0	χ2 (20) =30.32, p=0.07*
Asia	29.7±9.0	31.3	17.4	16.7	16.7	18.1	
Pacific Islands	33.0±6.9	10.2	22.0	15.3	35.6	16.9	
Europe	31.4±8.5	24.1	18.0	12.8	24.8	20.3	
Middle East	29.0±9.3	35.0	20.0	5.0	20.0	20.0	
Other	33.1±7.8	14.6	17.1	17.1	31.7	19.5	
Language							
English only	31.3±8.1	19.7	21.7	18.4	22.4	17.9	χ2 (4) =14.38, p=0.006*
Other	30.1±8.5	30.6	17.5	14.4	21.4	16.2	
Tertiary educated							
Yes	32.3±7.8	16.0	21.0	17.2	24.6	21.2	χ2 (4) =22.22, p <0.001*
No	30.3±8.3	25.0	21.0	18.0	20.6	15.3	
Employed							
Yes	31.3±8.1	20.6	21.0	18.2	22.7	17.5	χ2 (4) =1.91, p=0.75
No	30.8±8.3	23.5	21.0	16.8	21.2	17.5	
Insulin requiring							
Yes	31.1±7.9	22.3	21.6	18.0	19.2	18.9	χ2 (4) =3.29, p =0.51
No	31.0±8.7	21.3	20.8	17.6	23.4	17.0	
Previous GDM							
Yes	31.0±8.1	19.2	17.7	19.2	25.1	18.7	χ2 (4) =3.29, p =0.51
No	31.7±8.2	22.0	21.6	17.5	21.7	17.3	
Return for follow-up BGL							
Yes	31.9±8.4	18.5	20.5	17.5	23.3	20.2	χ2 (4) =13.52, p=0.009*
No	30.3±7.8	24.7	21.5	17.9	21.1	14.8	
Sufficiently active							
Yes	32.6±8.1	16.6	18.4	18.2	24.2	22.8	χ2 (4) =23.64, p<0.001*
No	30.4±8.1	23.7	22.9	17.6	20.9	14.9	
Risk reduction advice							
Yes	31.7±8.0	19.4	21.0	16.9	23.2	19.4	χ2 (4) =12.41, p=0.02*
No	30.0±8.3	25.3	20.9	19.1	20.4	14.3	
Hyperlipidaemia							
Yes	31.5±8.0	17.9	21.4	17.9	27.9	15.0	χ2 (4) =3.83, p=0.43
No	31.1±8.2	22.0	21.0	17.7	21.6	17.8	
Hypertension							
Yes	30.5±8.8	25.4	21.8	16.2	18.8	17.8	χ2 (4) =3.08, p=0.54
No	31.2±8.1	21.0	20.9	17.9	22.7	17.5	
Type 2 diabetes							
Yes	31.1±7.2	12.1	30.3	21.2	18.2	18.2	χ2 (4) =3.72, p=0.51
No	30.1±8.2	21.8	20.8	17.6	22.3	17.5	

Statistically significant at p≤0.05

Table 6.3 contains all the significant effects in the multiple variable multinomial logistic regression model expressed as OR and 95% CIs for ARFS quintiles 2 to 5, using the lowest quintile as the reference group for each OR. The reference groups for the categorical explanatory variables are indicated by OR = 1. Interpretation of the effects is similar for all variables in the model as they have a positive relationship with dietary score. The relative impact of the six significant factors can be assessed by comparing the OR's for ARFS quintile 5. Factors associated with being in the highest compared with the lowest ARFS quintile included age (OR 5-year increase 1.40; 95% CI 1.16, 1.68), tertiary education (OR 2.19; 95% CI 1.52, 3.17), speaking only English (OR 1.92; 95% CI 1.19, 3.08), being sufficiently physically active (OR 2.11; 95% CI 1.46, 3.05), returning for postpartum blood glucose testing (OR 1.75; 95% CI 1.23, 2.50) and receiving risk reduction advice from a health professional (OR 1.80; 95% CI 1.24, 2.60). There was a trend such that as BMI increased women were less likely to be in the highest compared with the lowest ARFS quintile (reference group). However this failed to reach significance in the likelihood ratio test (p=0.078) and was excluded from the final model. Table 6.3 also provides OR estimates for the other three quintiles of diet quality to show the overall pattern across quintiles.

Table 6.3: Effect sizes for the multinomial logistic regression model of variables associated with diet quality^

| | Quintiles of ARFS
1=lowest#, 5= highest (ARFS score) | | | | |
| | Quintile 2
(25-29) | Quintile 3
(30-33) | Quintile 4
(34-38) | Quintile 5
(39+) | |
	Adjusted OR 95%CI	Adjusted OR 95%CI	Adjusted OR 95%CI	Adjusted OR 95%CI	p*
Age (5 year increase)	0.91(0.77-1.08)	1.15(0.96-1.37)	1.29(1.09-1.53)	1.40(1.16-1.68)	<.001
Tertiary educated Yes No	1.74(1.22-2.47) 1	1.55(1.07-2.24) 1	1.93(1.36-2.74) 1	2.19(1.52-3.17) 1	<.001
Sufficiently active Yes No	1.12(0.78-1.61) 1	1.43(0.99-2.07) 1	1.60(1.12-2.27) 1	2.11(1.46-3.05) 1	<.001
Follow-up BG testing Yes No	1.24(0.89-1.72) 1	1.31(0.93-1.85) 1	1.44(1.03-1.99) 1	1.75(1.23-2.50) 1	0.03
Language English only Other	2.11(1.35-3.32) 1	2.10(1.30-3.38) 1	1.67(1.09-2.57) 1	1.92(1.19-3.08) 1	0.005
Risk reduction advice Yes No	1.31(0.93-1.83) 1	1.19(0.84-1.70) 1	1.55(1.10-2.18) 1	1.80(1.24-2.60) 1	0.02

^ Diet quality was the response variable in the model and was measured using ARFS quintiles, the significant effects related to diet quality are the six variables listed in the table; #Quintile 1 is the reference group (scores ≤ 24)*; Significance of the effect of each variable by the Likelihood Ratio Test

6.4 Discussion

This is the first Australian study to date investigating diet quality in a national sample of women with a history of GDM. Despite their increased risk of developing type 2 diabetes, women in this study had an overall poor diet quality as measured by the ARFS, indicating suboptimal intake of key food groups and eating patterns not aligned with national guidelines [321]. These findings are consistent with research done with representative samples of young and mid-aged Australian women whereby poor diet quality and disparities between national food group recommendations and dietary intakes have been reported [312, 323, 324].

Analysis by component sub-scores indicated that nuts/legumes, fruit and grains were the food groups most poorly scored by women with previous GDM. To achieve a higher score in these food categories women would need to consume a variety of high fibre and whole grain breads and cereals, legumes and increase the amount and variety of fruit consumed each week. Despite an already elevated risk of type 2 diabetes in this group, it is plausible that poor diet quality as found in this study, may further increase their risk for longer term chronic disease including both type 2 diabetes [220, 237, 325] and cardiovascular disease [326]. This highlights a need to target specific dietary changes for women with previous GDM to prevent subsequent chronic disease.

Consistent with other studies, we found that tertiary educated [327] and older women had better diet quality. These results are consistent with the findings of Collins et al (2008) who found the same relationship in a nationally representative sample of mid-aged Australian women [312]. In the current study we also found that those who spoke only English were almost twice as likely to have an ARFS in the upper quintile after adjustment for education and other significant variables, indicating that language or cultural barriers influence an individual's ability to achieve a high quality diet. Considering that the risk of developing GDM in Australia is greater among women from non-English speaking backgrounds [7, 328], this is an important finding and indicates that this group may require additional support and/or targeted interventions.

As may be expected, the current study confirms that women who practise other preventive health behaviours are more likely to report better quality dietary intakes. In the present study, women who met the guidelines for physical activity were more than twice as likely to be in the upper compared to the lower quintile for diet quality. Women who sought postpartum testing for diabetes also reported better diet quality. Although previous studies have shown low rates of postpartum testing for diabetes following a GDM pregnancy [291, 329, 330], this finding suggests that either they are the more motivated group to improve their lifestyle following GDM or that being advised to return for follow-up acts as a motivating factor for improved diet quality.

The finding that women who received risk reduction advice from a health professional were more likely to have better diet quality highlights the importance of providing lifestyle interventions targeting postpartum risk reduction. Despite this, we have previously demonstrated poor follow-up and limited provision of postpartum dietary advice for this high-risk group [331]. With diabetes prevention studies providing evidence of the benefit of intensive lifestyle interventions for reducing the incidence of type 2 diabetes in those at highest risk [76, 78, 332], these results support the need for additional resources to address postpartum lifestyle management.

The association between BMI and diet quality has been reported in previous studies [333, 334]. Although we found a trend towards women with a lower BMI having better diet quality, these results did not reach statistical significance in logistic regression analysis. Postpartum weight retention may have confounded this relationship between weight and diet quality. The use of self-reported weight may also have biased BMI calculations. Studies using postal survey methodology have demonstrated that self-report underestimates weight in women by an average of 0.95kg, with those in overweight and obese categories underestimating by up to 2.5kg [335]. With both body weight and dietary patterns being important determinants of type 2 diabetes risk [313], this trend warrants further investigation, in particular with women with a longer postpartum duration.

This study has several limitations; most notable is the low (36%) response rate. It is also possible that a response bias towards potentially more health conscious women may present an optimistic assessment of postpartum diet quality. As with any tool used to measure dietary intake, the ARFS has a number of limitations. Respondents are asked to report their usual consumption of foods over the preceding 12 months, therefore results may be influenced by the season in which the questionnaire was administered or be more likely to emphasise recently consumed foods. It is possible that our findings are also influenced by under or over-reporting. However, as the ARFS focuses on frequency of consumption of core foods and the variety of food choices within those groups, the scoring is independent of reported amounts of food items that would have limited the associated measurement error. Further, we did not collect longitudinal data to determine associations between diet quality and long-term chronic disease risk. Despite these limitations, our study did have a large sample size drawn from a population-based registry as opposed to a hospital or insurance-based data set, strengthening the applicability of the study to a larger population of women with prior GDM.

6.5 Conclusion

Women with previous GDM should be targeted for dietary interventions aimed at improving overall diet quality in the postpartum period. In particular, barriers to healthy eating may need to be addressed in those at highest risk of poor diet quality including younger women, those with a lower level of education, women who speak a language other than English and those who do not seek postpartum follow-up. Our study suggests that health professionals could have an important role in providing postpartum risk reduction advice that may improve overall diet quality, and further research is needed to assess the impact of health professional advice on preventive behaviours and subsequent chronic disease risk among women with GDM. A systematic approach to follow-up is urgently needed to ensure that all women diagnosed with GDM receive adequate information and support to achieve a diet consistent with the guidelines for chronic disease prevention.

Chapter 7   Perceived risk of type 2 diabetes in Australian women with a recent history of gestational diabetes mellitus

This chapter was published in 2010.

Morrison, M.K., Lowe, J.M. and Collins, C.E. Perceived risk of type 2 diabetes in Australian women with a recent history of gestational diabetes mellitus. *Diabetic Medicine* 2010; 27:882–886.

The work presented in the manuscript was completed in collaboration with the co-authors (Appendix A). Permission to reproduce the text and figures from the manuscript has been granted by the publishers (Appendix E)

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7.1 Introduction

Gestational diabetes mellitus is estimated to affect approximately 5% of Australian women during pregnancy, increasing up to 14% in some high risk groups [7]. Aside from the risk of antenatal complications, gestational diabetes has also been demonstrated to pose significant long-term adverse health consequences, including an increased risk of type 2 diabetes [46]. Although research to date has varied in estimates of type 2 diabetes risk, one recent Australian study reported a 9.6 times greater risk in women with previous gestational diabetes with a cumulative risk of 25% fifteen years [53]. Some studies have suggested a marked increase in cumulative incidence in the first five years postpartum‡, although this has not been consistently demonstrated across all ethnic groups [11].

Despite the well documented risks of type 2 diabetes, there is evidence to suggest that women do not necessarily perceive themselves to be at increased risk. Spirito et al (1990) reported that among women with prior gestational diabetes two thirds did not believe they would develop it again in a subsequent pregnancy and one-fifth did not believe they were at increased risk of diabetes [259]. Likewise Kim et al (2007) found that among 217 well educated, Caucasian, Asian and Pacific Islander women with previous gestational diabetes, only 16% believed that they had a high chance of developing diabetes in the future [260].

With evidence supporting the benefits of lifestyle changes in the prevention of type 2 diabetes [78], risk perceptions may be an important determinant of intention to modify health behaviours [336]. Therefore the aim of this study was to describe the risk perceptions of a sample of Australian women with a recent history of gestational diabetes and determine factors associated with a high level of perceived risk for the development of type 2 diabetes. This provides a better understanding of the

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‡ *The term 'postpartum' has been used to replace 'postnatal' for submission to Diabetic Medicine.*

effectiveness of current diabetes risk communications and important information to facilitate the development of targeted awareness and prevention strategies.

7.2 Subjects and methods

This study was a cross-sectional survey of Australian women with a recent history of gestational diabetes. Participants were recruited from the Australian National Diabetes Service Scheme (NDSS) database. This is an initiative of the Commonwealth Government that provides subsidised diabetes self-management products and free syringes to Australian residents diagnosed with diabetes who register with the scheme. All registrants have the option of consenting to being contacted for research purposes. Inclusion criteria were those registered with gestational diabetes on the database between June 2003 and June 2005 and who consented to being contacted for further research. Women were excluded if they were aged <18 years at time of registration in the database or resided in a Queensland postcode because of a concurrent study being undertaken in that state. The University of Newcastle Human Research Ethics Committee approved the study and Diabetes Australia Ltd. approved the NDSS database search.

All potential participants were contacted by mail in 2006, with eligible women sent a letter of invitation, a participant information package, a postnatal health and lifestyle survey, a reply paid envelope and a pen. A reminder postcard was sent to all eligible women one month after the initial mail-out. Data from the whole NDSS data set from 2003-2005 were used to determine whether survey respondents differed from those who did not consent to be contacted for research purposes or did not complete the survey.

7.2.1 Survey design

The survey was a self-administered written survey with 69 predominately closed questions addressing demographics, educational attainment, language spoken at home, occupation, gestational diabetes management, family and medical history. Data on breastfeeding were collected using standard World Health Organisation definitions [89]. Height and weight and weight history was self reported and body mass index

was calculated. Risk perception was assessed by asking respondents to indicate what they currently believed to be their risk of developing type 2 diabetes, with 5 response categories ranging from "very low risk" to "very high risk". For data analysis, responses were collapsed into two categories with those responding "high risk" or "very high risk" categorised as having a *high level* of perceived risk of type 2 diabetes.

Self-reported physical activity was collected using the *Active Australia Questionnaire* which involves recall of frequency and duration of physical activity in the past week. This physical activity questionnaire has been reported to have reliability and validity comparable with other widely utilised measures of physical activity [337]. Physical activity levels were defined according to criteria established for the 1999 *Active Australia Survey* [315] whereby "sufficient" physical activity was considered as the accumulation of at least 150 minutes of moderate or equivalent weighted vigorous activity over five sessions in the past week.

Information on dietary intake was collected using the Australian Recommended Food Score (ARFS), which has been described in detail elsewhere [312] and indicates adherence to the *Dietary Guidelines for Australian Adults* and *Australian Guide to Healthy Eating* [321]. This score has been used to evaluate the quality and nutrient profiles of intakes of young Australian women and validated in mid-aged women [312, 323]. The food scores were converted into quintiles with the upper two quintiles determined as those dietary intakes most closely aligned with healthy eating guidelines based on the findings of previous studies with mid-aged and young women [312, 323].

The survey was pilot tested with a sub-group of women (n=23) from the Diabetes Australia-NSW membership database. This pilot was approved by the Diabetes Australia-NSW Research Advisory Committee.

7.2.2 Statistical analyses

Univariate logistic regression analyses were performed to determine variables associated with a high level of perceived risk. Statistically significant variables ($p<0.05$) were included in multiple variable logistic regression analyses using both stepwise and backward elimination variable selection methods to check both methods gave the same

list of significant variables. All 2 way interactions between the surviving main effects were examined. Likelihood ratio tests were used to assess significance of effects in the logistic regression models. The Hosmer and Lemeshow goodness of fit test was used to determine if there was a satisfactory fit of the model to the data. Odds ratios and 95% confidence intervals were calculated for each of the model effects. Analyses were completed using SPSS version 15.0 (SPSS Inc, Chicago, Ill, USA).

7.3 Results

Of 15893 women registered on the NDSS with gestational diabetes, 5576 had consented to be contacted for research purposes. Invitations were sent to 4098 women who met the inclusion criteria, with 249 women unable to be contacted. Of those invited, 1381 women returned surveys, indicating consent to participate (36% response rate). Nine ineligible surveys were excluded, resulting in 1372 eligible respondents. A further 196 respondents who were currently pregnant or subsequently diagnosed with type 2 diabetes were excluded from risk perception analyses. Hence, data analysis was completed for 1176 respondents. The women in the sample were significant older (34.9±4.9 vs. 34.0±5.2), more likely to be Australian born (72.4% vs. 64.2%) than NDSS registrants (p<0.001). There was no significant difference in use of insulin (p=0.452) or the proportion of Aboriginal and Torres Strait Islander women (p=0.469) in the sample compared with the NDSS population.

The mean±SD age was 34.9±4.9 years and time since gestational diabetes index pregnancy was 21.1±8.6months. The majority (72.4%) of respondents were Australian born, 38.6% were tertiary educated, 18.9% spoke a language other than English and 1.1% were from an Aboriginal or Torres Strait Islander background. A previous diagnosis of gestational diabetes (prior to the index pregnancy) was reported by 13.4% of women and 53.6% reported a family history of type 2 diabetes. Of the respondents 26.4% used insulin during the index pregnancy and 56.5% were currently overweight or obese with a mean (±SD) self-reported body mass index of 27.1±6.4kg/m². Mean (±SD) diet quality score was 30.1±8.3 out of a possible maximum score of 74 and 34.8% of women were sufficiently physically active. Nine percent (9%) of women perceived

that they were very low risk for developing type 2 diabetes, 23% low risk, 42% moderate risk, 20% high risk and 6% very high risk. Ninety three percent (93%) of women recalled being advised that gestational diabetes was a risk factor for type 2 diabetes.

Independent variables found to be significant (p<0.05) in univariate analyses included region of birth; being overweight (BMI>25kg/m^2); having a family history of type 2 diabetes; using insulin during the index pregnancy and previous gestational diabetes. As shown in table 7.1 when these variables, as well as age, were included in multiple variable logistic regression analyses, all variables remained significant with the exceptions of region of birth (p=0.074) and previous gestational diabetes (p=0.064). There were no two-way interactions between the surviving main effects and the model was a good fit using Hosmer and Lemeshow test.

Table 7.1: Univariate and multiple variable logistic regression analysis of factors associated with a high level of type 2 diabetes risk perception.

		Univariate Analysis			Multivariable Model		
		High level perceived risk (%)	Unadjusted OR	P	Adjusted OR	95%CI	P
Region of birth				*0.007*			*0.074*
Asia		15.5	0.45		0.84	0.45,1.56	
Pacific Islands		14.3	0.41		0.35	0.09,1.27	
Europe		21.8	0.69		0.81	0.46,1.43	
Middle East		10.5	0.29		0.19	0.04,0.86	
Other		23.5	0.76		0.81	0.33,2.04	
Australia		28.8	1.00		1.00		
Tertiary educated	Yes	26.3	1.02	*0.91*			
	No	25.9					
Employed	Yes	25.6	0.95	*0.72*			
	No	26.6					
English speaking only	Yes	27.1	1.34	*0.11*			
	No	21.7					
Insulin requiring	Yes	37.0	2.06	*<0.001*	1.92	1.31,2.61	*<0.001*
	No	22.2					
Family history diabetes	Yes	36.8	3.86	*<0.001*	3.80	2.67,5.33	*<0.001*
	No	13.1					
Previous GDM	Yes	36.8	1.80	*0.003*	1.52	0.98,2.38	*0.064*
	No	24.5					
Overweight (BMI>25kg/m^2)	Yes	38.1	4.96	*<0.001*	4.50	3.12,6.51	*<0.001*
	No	11.0					
Sufficiently active	Yes	26.0	0.97	*0.848*			
	No	26.5					
Upper quintile diet quality	Yes	23.9	0.82	*0.166*			
	No	27.8					
Ever breastfed	Yes	26.0	0.96	*0.856*			
	No	26.9					

In univariate sensitivity analyses, when data was re-dichotomised to combine moderate, high and very high risk perception, this yielded the same set of significant variables, with the exception of tertiary education becoming significant (p<0.05). Assuming that women who responded to this survey may have been potentially more motivated and realistic about health risks, we also determined that if none of the 14717 non-responders believed that they were at high risk, then the proportion of women reporting a high or very high perceived risk for type 2 diabetes may actually be as low as 2%.

7.4 Discussion

The diagnosis of gestational diabetes provides an ideal opportunity to convey messages about future health risks and preventive strategies targeted for a group of women known to be at high risk of developing diabetes. However, we found that awareness of gestational diabetes as a risk factor may not be sufficient to increase personal risk perceptions. Despite the fact that the majority of women in this study recalled being advised of an increased risk of type 2 diabetes, we found that one third still considered themselves to be low or very low risk up to 3 years after the gestational diabetes pregnancy. The findings from our study expand those of Kim et al (2007)who found that the majority of women did not believe that they were high risk, because they intended to modify their behaviour in the future [260]. They also reported an optimistic bias in women with gestational diabetes, which although we did not identify it in our study, would provide one plausible explanation as to why some women did not perceive themselves to be at high risk.

We found that women who considered themselves to be at high or very high risk for type 2 diabetes were more likely to report known diabetes risk factors. The size of the effect was greatest in women with a BMI>25kg/m^2 who were more than four times more likely to perceive that they were at high risk of diabetes compared with women in the healthy weight range. Likewise women with a known family history of type 2 diabetes were also more likely to perceive their own diabetes risk as high. While these risk perceptions may be the result of having had a gestational diabetes pregnancy, they

may also reflect general awareness of diabetes risk factors in the community. With evidence suggesting that increasing body mass index is associated with increased diabetes risk [53], and the well documented familial risks of type 2 diabetes [338] this finding is somewhat reassuring.

We also found that women who required insulin during a gestational diabetes pregnancy to be almost twice as likely to perceive that they were high or very high risk for the development of diabetes. This finding is supported by some evidence suggesting that insulin use is a predictor for the long-term development of type 2 diabetes [53]. As suggested by Kim et al (2007), it is possible that prior experience with insulin may increase perceptions of disease severity, as may the intensive diabetes education received during insulin initiation and stabilisation [260]. While there was also a trend for previous gestational diabetes to increase risk perception, the results of multiple variable logistic regression analysis demonstrated that the strength of the effect was smaller than that of the other variables and it failed to reach statistical significance.

Interestingly, in unadjusted analyses we also found differences in risk perception depending on region of birth. However, in multiple variable analyses while there remained a trend for overseas born women to be less likely to perceive that they were at high risk of diabetes, these differences failed to reach statistical significance. With previous studies demonstrating differences in self care behaviours and beliefs regarding future health consequences in different cultural groups [263]and the trend towards those in the highest risk groups to be less likely to perceive an increased risk, these findings warrant further investigation [53, 54].

Despite the fact that both physical activity and diet quality have been associated with type 2 diabetes risk [78, 239], contrary to expectations, there was no association in univariate analyses between these lifestyle behaviours and risk perceptions in this study. While this may suggest that risk perceptions do not always translate into preventive behaviours, it may also relate to readiness to change. That is, risk perceptions may influence the contemplation phase of behaviours change but alone

may be insufficient to motivate preventive health behaviours [339]. This is supported by findings from qualitative research suggesting that concerns regarding developing type 2 diabetes did not motivate women with prior gestational diabetes to engage in physical activity [264]. However, it may be that the women in our study had intentions to modify behaviour in the future or instigated other preventive behaviours not measured in this study. It is also plausible that advice regarding diabetes risk did not sufficiently emphasise the preventable nature of type 2 diabetes or include adequate information on risk reduction strategies. Perhaps this finding may also be explained by the level of health professional expertise in delivering risk reduction advice [263] or it is possible that the timing of information delivery regarding prevention was not appropriate. Alternatively, the lack of association with these variables may also reflect the complex relationship between risk perception and preventive behaviours and the shortcomings of cross sectional data in examining such associations [340].

7.4.1 Limitations

Our study has several limitations, the chief of which is the low (36%) response rate. The women in this survey differed somewhat to the NDSS population with gestational diabetes, in that they were slightly older and more likely to be Australian born. As the survey was administered in English, it is also likely that women with poor or limited English skills were under-represented.

Our data were obtained from a cross-sectional survey of women with previous gestational diabetes. We did not have access to clinical data to determine actual risk nor utilise longitudinal measures such as those required to accurately test a behaviour motivation hypothesis [340]. This study was also undertaken prior to the *Risk perception for the development of diabetes* tool being adapted for this group [258, 260]. As a result, the chosen risk perception questions did not encompass the multiple dimensions of risk assessment such as optimistic bias and personal control measures [258]. However, despite our somewhat simplistic measures of risk perception, our findings regarding risk perceptions concur with those reported elsewhere [259, 260].

As suggested by our sensitivity analysis it is also possible that a response bias towards potentially more health conscious women may have also overestimated the number of respondents who believed they were at high risk. The risk perceptions reported in this paper therefore probably represent a 'best case' scenario.

Despite these limitations, this study had a large sample size drawn from a population based registry as opposed to a hospital or insurance based data set, strengthening the applicability of the study to a larger population of women with prior gestational diabetes.

7.5 Conclusions

Awareness of gestational diabetes as a risk factor may not be sufficient to increase personal risk perceptions; however women with known diabetes risk factors including obesity, family history and insulin use during pregnancy may be more likely to perceive that they are at high risk of type 2 diabetes. Risk perceptions may not necessarily translate into healthy behaviours with our study failing to show any association between the perception of being at high risk of developing diabetes and sufficient physical activity or diet quality.

While the emphasis of a gestational diabetes pregnancy is very much focused on antenatal outcomes, it also provides an ideal opportunity to alert women to future risk of type 2 diabetes and promote positive messages about the potential for its prevention. The challenge for health care providers lies in the ability to make tangible the potential risk for all women with gestational diabetes. Health professional discussions regarding 'future risk' may also benefit from a greater sense of immediacy regarding postnatal lifestyle changes to mitigate risk. Finally, motivating women to make appropriate long term lifestyle changes may require changes to current models of care from those focused predominately on short-term obstetric outcomes to a continuum of care which includes the delivery of evidence based behaviour change interventions which take into account social and cultural context and barriers to change for this group of high risk women.

Chapter 8 Australian women's experiences of living with gestational diabetes

This chapter was submitted for publication in 2013.

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The work presented in the manuscript was completed in collaboration with the co-authors (Appendix A).

8.1 Introduction

Gestational diabetes mellitus (GDM) is a form of diabetes with onset or first recognition during pregnancy [2]. GDM affects approximately 5% of pregnancies in Australia, increasing up to 14% in some high risk groups [7]. With evidence suggesting that rates of GDM are currently increasing in Australia [7], an understanding of the impact of the GDM diagnosis and the experiences of Australian women can help identify priorities for health care provision and inform interventions to meet the needs of women with GDM.

GDM has been demonstrated to pose perinatal risks [284] as well as adverse maternal health consequences including an increased risk of future type 2 diabetes [46] Treatment of GDM may lower the risk of birth complications [62], however this requires intensive antenatal interventions and day to day self-management to achieve optimal glycaemic control [2].

Some evidence suggests that a diagnosis of GDM may increase a woman's anxiety [271], result in poorer health perceptions and a less positive pregnancy experience when compared to women without a GDM diagnosis [341]. A Canadian study described the experiences of women diagnosed with GDM as living a controlled pregnancy, followed by a process of adaptation to the diagnosis, while burdened by the moral obligation to be a responsible mother and being worried about potential impact on future health [278]. Similarly, Nolan et al (2011) in research with US women with GDM and type 2 diabetes identified three primary themes related to concern for the infant, concern for self and sensing a loss of personal control over their health [342]. Research with Swedish women described the diagnosis as a process of 'stun to gradual balance', where both positive and negative elements were reported [274].

Several Australian studies to date have provided some insight into the experiences of women with GDM. Carolan (2013) using focus groups and semi-structured interviews with 15 women with GDM, examined women's experiences with diabetes self-management [343]. In the process of adjusting to GDM, they described four discrete

themes, relating to the shock of diagnosis, coming to terms with GDM, working it out/learning new strategies and looking to the future. Each adjustment phase was underpinned by the fifth theme of having a supportive environment. Adherence to the GDM management plan was reported to be motivated by thinking about the baby. In a study examining factors that facilitate or inhibit GDM self management in Australian women, time pressures, physical and social constraints, comprehension difficulties, and insulin as an easier option were described as barriers to self management. Thinking about the baby and psychological support from partners and families were facilitators [277]. In telephone interviews with 57 women with previous GDM, Razee et al (2010) highlighted a number of social and cultural barriers influencing their ability to follow a healthy lifestyle in the postnatal period [276]. Doran (2008) examining perspectives on lifestyle changes in interviews with eight Australian women also reported a lack of support for postnatal risk reduction [264]. While these studies provide an insight into women's experiences, the samples were drawn from health service based data sets which may limit the generalisability of the results.

 The aim of our study was to build on these findings by describing Australian women's reflections on the experience of having a pregnancy affected by GDM in a large sample of women from a national gestational diabetes register. A secondary aim was to describe associations between the characteristics of respondents and their GDM pregnancy experience.

8.2 Subjects and methods

This study was a cross sectional survey of Australian women with a recent history of GDM. Participants were recruited from the National Diabetes Service Scheme (NDSS) database. The NDSS is an initiative of the Commonwealth Government providing subsidised diabetes self-management products to Australian residents with diabetes registered with the scheme. All registrants have the option of consenting to being contacted for research purposes. Study inclusion criteria were: diagnosed with GDM ≤3 years previously, registered with the NDSS and consented to be contacted for research purposes. Women were excluded if they were aged <18 years at the time of registration

database or resided in a Queensland postcode because of a concurrent study of gestational diabetes being undertaken in that state. The University of Newcastle Human Research Ethics Committee approved the study and Diabetes Australia Ltd. approved and conducted the NDSS database search. All potential participants were contacted by mail, with eligible women sent a letter of invitation, a participant information package, a written survey, a reply paid envelope and a pen. A reminder postcard was sent to all eligible women 1 month after the initial mail-out. Data from the 15893 women registered on the NDSS during the same period was used to determine whether respondents differed from those who did not consent to be contacted for research purposes or did not participate.

The survey was a self-administered written questionnaire with 69 predominantly closed questions. Briefly, survey questions addressed demographics, educational attainment, language spoken at home and occupation using standard items from the 2001 Australian census [314].Information regarding GDM management, lifestyle-related risk factors, family and medical history, and postnatal follow-up were collected by self-report. Respondent's height and pre and postnatal weight were self-reported. Physical activity and diet quality were assessed using validated tools. The self-administered questionnaire was pilot tested with a convenience sample of women (n=23) from the Diabetes Australia-NSW membership database. At completion of the closed questions, women were provided with an optional open ended question allowing them to document their experiences of living with GDM using free text narrative. This text provided the qualitative component of the survey and an 'open forum' for women to describe their unique experience in the absence of structured or pre-determined questions.

8.2.1 Data analysis

The analysis of open ended responses content involved systematically classifying narrative into themes. The framework approach was the method chosen to underpin data analysis because of its suitability for analysis of cross sectional data and because of the systematic approach it provided for the analysis of a large number of written responses [344]. Analysis involved a deductive approach which included initial

familiarisation with the data by reading and transcribing narrative. Notes were made during the transcription process as key concepts emerged. This was followed by a preliminary analysis of the entire set of transcribed responses, identification of concepts and a literature review to establish a thematic framework. Thematic categories were developed by considering each sentence, phrase or paragraph of transcripts in an attempt to summarise key concepts. The key issues and concepts expressed by the participants formed the basis of a thematic framework. Emerging themes were then discussed and agreed. Responses were indexed according to the established framework, then mapped and interpreted. The mapping was a manual process used to determine linkages between themes and overlapping concepts, which refined the framework and determined the final eight key themes. To establish rigor in this approach, all responses were initially analysed by one researcher, then independently categorised by a second researcher. Discrepancies were discussed with a third reviewer until consensus was achieved. Privacy rules governing the use of the NDSS dataset for participant recruitment, did not allow for respondent validation.

Data from the survey was coded and entered into SPSS version 15.0. Univariate chi-squared analyses were performed to determine variables associated with each theme. This quantitative component of the analysis was conducted by age group (above and below the mean), whether a language other than English was spoken at home, previous diagnosis of GDM, use of insulin, being Australian born, having a tertiary education & being overweight.

8.3 Results

Of women registered on the National Diabetes Services Scheme (NDSS) with GDM, 5576 had consented to be contacted for research purposes. Invitations were sent to 4098 women who met the inclusion criteria, with 249 women unable to be contacted. Of those invited, 1381 women returned surveys, indicating consent to participate (36% response rate). Nine ineligible surveys were excluded, resulting in 1372 eligible respondents. Of those, 393 (29% of respondents) completed the optional question about

sharing their experiences with GDM. Free text comments ranged in length from a few sentences to several pages of narrative.

The demographics of question respondents was compared to those available for the entire NDSS dataset (n=15893) (Table 8.1). The women providing details of their experiences with GDM were slightly older (p<0.001), more likely to be Australian born (p<0.001) and less likely to have used insulin (p=0.009) when compared to women registered on the NDSS.

Table 8.1: Selected demographics of question respondents

	Question respondents n=393 % (n)
Australian born	77.1 (300)
Aboriginal or Torres Strait Islander	0.8 (3)
Insulin usage	20.8 (81)
Tertiary educated	47.1 (185)
Employed	66.1(257)
Previous GDM	14.0 (55)
Other language	15.3 (60)
Family history of diabetes	58.8 (231)
Age, years median (range)	35.1(24.4-47.6)
Time since index pregnancy, months ± SD	21.5±8.4
Pre-pregnancy BMI (kg/m2) ± SD	26.8±6.3

From the narrative provided, eight key themes emerged from the data when women described their experiences with GDM with an additional cross-cutting theme of either giving or seeking information. Some comments expressed more than one theme and 8.4% of women provided other general comments that were not included in the qualitative analysis. The proportion of women providing comments in each theme is shown in Table 8.2. No association was found between any of the themes and being Australian born, employed, tertiary educated, having a family history of diabetes or being overweight.

Table 8.2: Themes described by women reflecting on their experiences with GDM.

Theme	Frequency[a] *n* (%)
Shock, fear and anxiety	35 (8.9)
Uncertainty and scepticism	37 (9.4)
An opportunity to improve one's health	38 (9.6)
Adapting to life with GDM	46 (11.6)
The need for support	68(17.2)
Better awareness	14 (3.5)
Abandoned	59 (14.9)
Staying healthy and preventing diabetes	54 (13.7)
Information	31 (7.8)
Other	33 (8.4)

[a]Results do not tally to 100% because of multiple themes described by respondents.

Shock, fear and anxiety

Women expressed shock, fear and anxiety associated with diagnosis of GDM. Some women described being shocked that they would be a candidate for the condition. Others reported fearing what the diagnosis would mean for themselves and their baby, with feelings of being "*scared*" and "*worried*" commonly described. For others it elicited anxiety, some of which was described for the duration of the pregnancy.

"When told I had GDM, my level of stress and anxiety increased. I felt extra pressure and responsibility that every single thing I did (especially eating) had a huge impact on my unborn

child. And I became scared about hurting her if I didn't manage to control my levels <u>constantly</u>. Each fluctuation of my levels scared me"

"…I truly found my pregnancy, in particular the diabetes quite traumatic and I still feel the fear today".

"It is one of the main reasons I am scared of falling pregnant again even though I want another child"

Women taking insulin were more likely to experience shock, fear or anxiety (p=0.001). There was also a trend towards women who spoke another language being more likely to report this experience (p=0.061).

Uncertainty and scepticism

Disbelief regarding the diagnosis, uncertainty and differing perceptions about the seriousness of GDM emerged from the data. There was some scepticism regarding the accuracy of the testing with some women believing that their diagnosis had been misclassified as their diabetes was easily managed.

"I don't believe I had diabetes, if I did it was very borderline. Every time I tested myself, I was well within normal range even after eating junk"

"I thought the test was a joke, I was borderline but was still subject to rigmarole, even during labour they made me do a fingerprick test. It seemed to me an excuse for unwanted intervention"

Others believed that previous pregnancies were possibly missed cases of GDM, with women describing large babies in prior pregnancies or birth complications that they attributed to undiagnosed GDM.

An opportunity to improve one's health

While many women described the stress associated with the diagnosis, others viewed it as an opportunity to improve their health. Some described it as a '*wake up call*' and reported using the diagnosis as a catalyst for lifestyle change.

"In a way I am glad I was diagnosed with GDM - I have had to make changes to my diet and lifestyle and as a result managed to lose 16kg after my last birth, I feel and look much healthier"

A number of women also saw the chance to improve their understanding about nutrition and healthy eating as a positive aspect of the diagnosis.

"The diet plan that I used with GDM has benefited me now as I still follow it. I felt very healthy when I was pregnant due to the good foods that I had to eat for the wellbeing of both my baby and myself"

Women who had GDM previously (p=0.034) and younger women (below the mean age) (p=0.054) were less likely to view the diagnosis of GDM as an opportunity to improve their health.

Adapting to life with GDM

There were a variable range of experiences described by women in regards to living with GDM. Some women appeared to easily adapt their lifestyle once they had sufficient knowledge and skills for self management.

"I found GDM was extremely easy to handle through diet. Once I was diagnosed and my diet was controlled, my energy levels were great. All I needed was a kick start doing this".

Others described the difficulties or frustration that they faced with dietary management.

"I was always hungry no matter how many vegies I ate. It was very hard to get used to eating food I was not used to".

I found that the diet did not help with the diabetes. On days when I ate well my levels were still high and when I ate bad my levels were not too bad!!

"I stuck to my diet religiously while pregnant. But some people assumed that I was going off it because I needed insulin later in the pregnancy"

Women also described different experiences with other aspects of management, in particular, insulin administration. Some reported anxiety associated with insulin

injections, while others viewed the positive aspects in relation to glycaemic control and increased dietary flexibility.

"Thank God I only had it when I was pregnant. It was a challenge having to keep check on my food intake and take insulin."

"I found it very hard to manage by diet alone. I was much happier being on insulin".

The need for support

The need for health professional support was highlighted in this study. Many women praised their obstetricians and diabetes health professionals for the intense education and support provided. Some viewed the constant contact and *'surveillance'* by health professionals as a positive experience; others believed that health professionals instilled *'guilt'* and *'fear'* in them during their pregnancy. Some women did not feel well supported by health professionals during their GDM pregnancy.

"I found that during pregnancy there was really a lack of support. I was pretty much yelled at rather than supported. I was then referred once for a quick one day training on how to use the machine, inject insulin and a dietitian that went through a pamphlet. There was a sense that it's your fault, your fat and at risk of diabetes! They really point the finger and put blame - there was really no empathy"

Others reported feeling isolated by the diagnosis and lack of information and support from health professionals.

I did not feel I was given adequate information to really understand diabetes and felt the need to purchase books to obtain satisfactory answers to my questions. The health professionals gave only very basic information.

You did feel left on your own much of the time and that it really wasn't "too much to worry about" I remember I started off being really good but getting slacker towards the end of the pregnancy.

I was given barely enough info from the diabetes educator, who was rarely available.

Inconsistencies in advice and information provided by health professionals were also a source of frustration for some women. These women expressed the need for the information and support provided by health professionals to be comprehensive, consistent and unambiguous.

Better awareness

The need for better awareness about GDM both in the community, and amongst health professional was identified. Some women wrote about their very limited knowledge of GDM prior to the diagnosis, prompting suggestions for more information for pregnant women about the risks.

"I believe there should be more information prior to the 26-28 week test about GDM, given so as not to cause such alarm. The community also needs to be educated about GDM"

"It is something that should be more widely known about. I had never heard of it until I was diagnosed with it and it really frightened me because I knew nothing about it"

Concern was also expressed about the lack of awareness amongst some health professionals in regards to the diagnosis and management of GDM.

"GPs are very outdated with this area. The GPs I saw gave me completely opposing information to the diabetes educator. At the time I was pregnant there was no obstetrician in town so I had to use who was available".

Abandoned

The lack of postnatal care following the intensive management of GDM was highlighted by respondents. Women described feeling abandoned by the health professionals who had monitored and supported them throughout their GDM pregnancy and some felt unsure about what happened next in regards to postnatal testing and management.

"There's a lot of support while you are pregnant. No-one cares once you're not pregnant. No-one follows up or checks if you still need help"

Some believed that their GDM was too readily dismissed once the baby was born. The need for better postnatal follow-up and information was also frequently suggested.

"I was surprised that there was very little follow-up after the birth of my baby. It was basically ignored after staff at the hospital placed this as a priority during pregnancy. I may still have it for all I know!"

Staying healthy and preventing diabetes

An understanding of the need to stay healthy to prevent future diabetes, as well as difficulties encountered to try and combat future diabetes was described in the narrative. While some women recognised their future risk of diabetes, they detailed the barriers to achieving a healthy lifestyle such as a lack of motivation, time, work commitments and competing family priorities. Long-term weight management difficulties were also a barrier for some. The required lifestyle changes were often described as *"challenging"* and *"difficult"*.

Although I am aware of the dangers of developing type 2 diabetes due to GDM, it is easy to make excuses whilst working with a small child - I need to exercise and eat healthier ASAP!!

"It was scary and I don't ever want to get it back. I find myself struggling with two kids and winter and find I'm kidding myself that I'm healthy and eating correctly as I know I'm not. I plan to try harder in the future for my children as well as myself".

Some felt that the lifestyle changes were something that they were contemplating or would adopt later in life and others viewed a future with diabetes as somewhat unavoidable.

"Thinking about getting type 2 it seems a long way off. I feel like I still have time to make changes down the track. An excuse I know, but it doesn't seem real, maybe I should be testing my sugars now?"

In contrast, a number of women outlined the positive steps they had taken to improve their health and manage their weight following the diagnosis.

I now try to live and eat healthier to decrease my chances of developing type 2 diabetes.

8.4 Discussion

Women's experiences of having a pregnancy affected by GDM were diverse. While some women in this study provided narrative of a neutral emotive tone, for others the memory was of a predominantly negative experience or in contrast, an opportunity to use the diagnosis as a positive health learning event.

The shock, fear and anxiety described by many women in regards to the diagnosis and subsequent management of GDM provide an insight into the emotional impact and the burden that many women felt. While some women described the impact on their entire pregnancy and future pregnancy plans, others were able to more readily adapt to the diagnosis. These findings are consistent with research suggesting that the experience of at-risk pregnancy is associated with feelings of heightened vulnerability, lack of control and increased stress [345, 346]. Other researchers have suggested however that while there is a higher level of anxiety (state rather than trait) in women with GDM at the time of the first assessment, this anxiety may be transient [347]. In our study this appeared to be the case for some but not all women reflecting on their feelings about being diagnosed with GDM. We identified women requiring insulin to manage GDM as one group who may need additional support in adjusting to the diagnosis.

The finding that some women were uncertain and sceptical regarding the diagnosis has not been previously well described in the GDM literature, with only one study reporting that women found the diagnosis of GDM difficult to accept [348]. While research with adults with type 2 diabetes have reported that denial in relation to diagnosis is associated with poorer metabolic control [349], this was not examined in our study. Uncertainty has also been reported to affect the psychological well-being and coping strategies of high-risk pregnant women [350], with those having high levels of uncertainty reporting greater distress and emotion-focused rather than problem-focused coping. However further research is required to understand the impact of these beliefs on maternal health and wellbeing and outcomes in a GDM pregnancy.

Some women in the present study were able to view the diagnosis of GDM as a positive health learning event. This supports the work of Evans & O'Brien (2005) who

reported that for some women the knowledge acquired about diabetes while pregnant served to enhance motivation and self-efficacy to make lifestyle alterations [273]. In the present study reported lifestyle changes included weight loss, increased physical activity and healthy eating resulting from the desire to prevent progression to diabetes. This suggests that for some women with GDM, the ante-natal period may present an opportunity for promoting lifestyle changes that would also address future risk reduction. Other women described the difficulties in maintaining lifestyle changes in the postnatal period. In particular, younger women and those with a previous GDM diagnosis may require more support to improve their lifestyles in order to reduce their subsequent risk of diabetes.

The perceived importance of the health professional in providing information, awareness and supporting the woman with GDM was evident in this study. The impact of healthcare provider patient relationship resonated throughout the narrative and is supported by qualitative research describing the importance of health professional support and patient provider interactions in high risk pregnancies [351]. With the Australian Carbohydrate Intolerance Study providing evidence of the benefits of treating GDM on postnatal quality of life, health professional support may also be an important determinant of longer term health status [62]. In light of increasing rates of GDM this will pose a challenge for health care providers to adequately support all women diagnosed with GDM both now and in the future.

While the Australasian Diabetes in Pregnancy Society guidelines recommend postnatal counselling on lifestyle for future risk reduction [2], women reported that this was one of the most neglected areas of their diabetes care. GDM has been demonstrated to pose significant long-term adverse health consequences, including an increased risk of type 2 diabetes [46]. Despite the well-documented risks and the profound effect of lifestyle interventions on type 2 diabetes prevention, health care systems have not adapted to provide ongoing systematic postnatal review of women who have had GDM [201, 352]. These findings highlight the need for such system changes.

Overall, our findings concur with the other Australian studies [264, 276, 343] which identified issues such as shock, concern, coping and adjustment, prevention of future diabetes, mental health and information needs in women with prior GDM. While our study suggests that similar themes apply in a national sample of Australian women, our thematic analysis also raised issues of uncertainty and scepticism, and the need for better awareness of GDM, which have not been previously reported.

8.4.1 Limitations

Our study has several limitations, the chief of which is the low response rate. However, considering the scope of the study, the amount of information obtained per response and quality of the narrative, the sample size would be considered to be sufficient for this type of qualitative analysis [353]. The women who chose to share their personal experiences were older than women registered on the NDSS, however the size of the age difference is not considered to be practically significant. Women born outside Australia were under represented in this study. Despite this, the themes that emerged in this study are similar to those found by Razee et al (2010) two thirds of whom were Arabic or Cantonese/Mandarin speaking [276]. However, our study design meant that we could not explore societal and cultural nuances in the same manner as the in-depth interviews used in their study. Women using insulin were also under-represented in this study and the finding that this group were more likely to report shock, fear and anxiety, may also have impacted on the results. Similar demographic differences between responders and non-responders have been reported in other studies using this methodology [354]. Despite these limitations, this study had a large sample size, drawn from a national diabetes register as opposed to a hospital or insurance based data set, suggesting that the results may represent a spectrum of GDM experiences of Australian women.

8.5 Conclusion

This study provides an insight into the experience of the pregnant woman faced with a diagnosis of GDM and the process of adapting to a GDM pregnancy. It emphasises the important role of the health professional in providing information and support and

provides some insight into the challenges and opportunities for future diabetes risk reduction. As health care systems adopt the new International Association of the Diabetes and Pregnancy Study Groups diagnostic criteria (IADGSP), rates of GDM are predicted to increase in the context of limited health care resources [33]. The results of this study may therefore help inform health care providers, including midwives, obstetricians and diabetes health professionals on how to best meet the needs of this diverse group of women.

Chapter 9   Conclusion

9.1 Overview

This chapter summarises the key findings from the body of research conducted in this thesis and the implications of the findings for current practice in the management of GDM (Section 9.2). This includes the findings in relation to current dietetic practice in GDM (Section 9.2.1), postnatal health and lifestyle (Section 9.2.2) and factors influencing preventive health behaviours (Section 9.2.3). The strengths and limitations of the research are then discussed (Section 9.3) and recommendations made for future research (Section 9.4). This chapter concludes with a summary of the findings and key recommendations from this body of work (Section 9.5).

9.2 Summary and implications for practice

9.2.1 Dietary management of gestational diabetes

The survey on current dietetic practice in GDM (Chapter 3) was conducted to examine current dietetic practice in the management of GDM, describe the dietary interventions provided to women with GDM that may influence antenatal and postnatal health and lifestyle behaviours, and determine the need for national evidence-based GDM dietetic practice guidelines and nutrition recommendations.

This study demonstrated that while there was consistency in many key components of nutrition education provided by Australian dietitians, it also highlighted differences in the implementation of MNT and some discrepancies with international evidence-based guidelines for GDM management. Encouragingly, more than three quarters of respondents reported that all women with GDM attending their service were referred to see a dietitian. This is consistent with recommendations from ADIPS [2] and international dietetic practice guidelines [106] that management should be provided by a multidisciplinary health care team, including a dietitian.

Variations in the frequency, duration and type of dietetic interventions provided were evident in this study. Two-thirds of dietitians reported that they were only able to

provide one to two consults per client, which is less than the minimum of three visits recommended by the ADA evidence-based GDM practice guidelines [106]. Services were provided as individual consults or group education with some variations in the length of consultation. Dietitians described glycaemic targets and clinical judgement as the major factors determining frequency of interventions with half of all respondents also citing dietetic staffing levels to be a factor influencing the level of service provided. With dietetic services already being provided in the context of limited health care resources and the increasing rates of GDM diagnosis [7], there is a need for evidence of the effectiveness of dietetic interventions in an Australian setting and the potential cost effectiveness to the health care system.

Overall, the results of this survey highlight a number of variations in usual practice among Australian dietitians in the implementation of MNT for the management of GDM. This included inconsistencies in the dietetic process in particular in the areas of nutrition assessment and macronutrient targets. The overall content of nutrition education however, was reported to be more consistent among the dietitians surveyed. There is currently limited evidence of the outcomes of dietetic interventions in an Australian context, hence the impact of the different approaches to dietary management have not been investigated.

Differences in GDM management amongst dietitians were also noted in relation to targets for fasting and postprandial BGLs and monitoring of weight. Since this study was conducted, ADIPS have released revised guidelines for the testing and diagnosis of GDM [30]. These guidelines also provide suggested glycaemic treatment targets, which if adopted nationally could assist with improving consistency in treatment of GDM. These guidelines do not however, provide recommendations for GDM pregnancy weight gain.

The survey also demonstrated that dietitians were able to provide limited postnatal dietetic follow-up, with more than half of the dietitians surveyed not providing any postnatal dietetic care and only 10% routinely providing follow-up in the postnatal period. Although the majority of dietitians (93%) recognised that women were at

moderate to high risk of future diabetes, this finding highlights the limitations of current models of GDM care which are focused very much on antenatal service provision. This finding is also important in the context of the postnatal health and lifestyle component of this thesis. With the results presented in Chapter 5 suggesting poor diet quality in women with GDM in the postnatal period as well as evidence suggesting that antenatal dietary changes, which may have a positive impact on longer term health, are not sustained in the postnatal period [244, 246], there is an urgent need to better support women in adopting lifestyle behaviours consistent with type 2 diabetes prevention.

While many dietitians reported that their service had developed their own nutrient recommendations or practice guidelines, there was strong support for the development of national DAA endorsed dietetic practice guidelines. This is supported by international research demonstrating beneficial outcomes as a result of systematic and consistent care when MNT practice guidelines are implemented in GDM [67], as well as other forms of diabetes [92]. Guidelines should also include nutrition recommendations to guide appropriate nutrient prescription and support dietitians in clinical decision making. Evaluation of the outcomes of dietetic interventions would be a key component of guideline validation. This would be necessary to justify funding of dietetic services to support best practice. Consideration would also need to be given to barriers to the implementation of guidelines in the context of different GDM services, such as maternal health clinics, diabetes centres and private practice. Promotion to other health professionals who provide GDM care would be needed to ensure appropriate referral pathways and processes as well as provision of consistent advice. Opportunities for professional development in the area of GDM would also be beneficial in supporting dietitians in best practice.

9.2.2 Postnatal health and lifestyle

Until recently, evidence for the benefits of breastfeeding following a GDM pregnancy on future diabetes risk has been limited. However with two large prospective studies demonstrating long term benefits of breastfeeding in reducing cardiovascular risk factors and the development of type 2 diabetes [51, 175], breastfeeding may be an

important additional strategy to help reduce the risk of future type 2 diabetes in women with GDM.

The results of the breastfeeding study presented in Chapter 4 of this thesis suggested high rates of breastfeeding initiation in this group. However, the respondents were not representative of the entire NDSS dataset in regards to a number of demographics and were more highly educated, suggesting that the results need to be interpreted with caution, and may not reflect actual breastfeeding rates in Australian women with GDM.

However, the study still identified a number of factors influencing early cessation of breastfeeding in this group. These include breastfeeding problems at home, higher BMI, caesarean section, lower SEIFA, not being married, early postnatal return to work and inadequate breastfeeding support. While similar findings have been reported in population based studies, compared to women without GDM, these risk factors for early cessation are likely to be more important in those with GDM due to a disproportionate number with a higher BMI, delivering via caesarean section and from lower socioeconomic groups [10]. These results provide important information about the need to address breastfeeding problems in the early postnatal period and better support women with GDM to ensure breastfeeding success.

As some of these risk factors are potentially modifiable, this study also identified those who would benefit most from interventions to support women to achieve successful breastfeeding initiation and optimal duration. Ideally, additional breastfeeding support should be offered to all women with GDM, with specific support targeting those most at risk of early breastfeeding cessation. Breastfeeding interventions in women with GDM have the potential to make a considerable difference to breastfeeding rates and duration of breastfeeding in this group, and as a result may be an effective diabetes risk reduction strategy.

9.2.2.1 Postnatal follow-up

Despite international recommendations highlighting the importance of postnatal follow-up screening for type 2 diabetes [46], the data presented in Chapter 5 of this

thesis demonstrated that only 27% of Australian women surveyed returned for follow-OGTT at 6-8 weeks post-GDM pregnancy according to ADIPS guidelines. Given the high risk for the development of type 2 diabetes [11] in women with GDM, as well as the potential for subsequent pregnancies in women of child bearing age, strategies for encouraging return for postnatal screening are needed.

A number of factors were positively associated with postnatal follow-up testing in women with GDM. Women were more likely to return for follow-up OGTT at six to eight weeks if they received postnatal written information or individualised risk reduction advice from a health professional. These findings mirror those reported elsewhere [209] and highlight the benefits of postnatal follow-up with a health professional or at a minimum, the need for risk reduction advice during antenatal care. The benefit of postnatal written information was also encouraging as a simple strategy for reminding women of the need for follow-up testing. Since the publication of this paper, a national recall and reminder system for women with GDM has been established through the NDSS. This reminder system provides a schedule of follow-up reminders in the immediate postnatal period and then annually for five years and biannually until the age of 60 years. Follow-up letters and information are also sent to a nominated health professional as a component of the reminder system. This is a positive step towards improving rates of follow-up screening in Australian women with GDM.

The important role of diabetes health professionals as advocates for postnatal screening was another important finding in this study. Women with a lower level of education were more likely to seek follow-up testing if they were under the care of an endocrinologist, while women who saw a diabetes educator in conjunction with an obstetrician were also more likely to return for testing according to ADIPS guidelines. The fact that the type of care provided during a GDM pregnancy has such an influence on return for postnatal screening highlights both the need for specialised diabetes care, as well improved communication with primary care providers who predominately care for women in the postnatal period. It would be of interest to evaluate whether notifying nominated health care providers in the NDSS recall and reminder system

will also encourage general practitioners to be increasingly involved with postnatal follow-up of women with GDM.

Barriers to postnatal follow-up were not examined in this study, however qualitative research has suggested that emotional factors such as adjusting to a new baby and the fear of a diabetes diagnosis, as well as issues such as child care availability influence whether or not women seek postnatal follow-up [197]. There is much debate in the literature [73, 200] about the efficacy of different testing methods for re-evaluation of glucose tolerance in the postnatal period. The argument for simplifying testing procedures to encourage adherence has been made, however the benefits of an OGTT in detecting abnormalities in fasting and postprandial BGLs have also been demonstrated in the literature [200]. The challenge for health care providers is finding the balance between the best test for diagnosing postnatal glucose abnormalities and simplifying the process to encourage women to participate in postnatal screening.

9.2.2.2 Diet quality

The study presented in Chapter 6 of this thesis examined the diet quality of a national sample of Australian women with a recent history of GDM and factors associated with adherence to national dietary recommendations using a diet quality index, the Australian Recommended Food Score (ARFS). The findings revealed overall poor dietary patterns in this group at high risk of future diabetes. In particular, foods which have been shown to be protective in relation to chronic disease risk including nuts/legumes [221] and grains [219] had the lowest sub-scale scores in the ARFS. This suggests that women with GDM need to be targeted to improve postnatal diet in order to reduce future lifestyle related disease risk. In particular, food based advice which promotes the benefits of low energy density, low glycemic index, nutrient rich foods and addresses overall diet quality is needed.

When women in the highest ARFS quintile were compared with those in the lowest quintile, a number of factors were found to be associated with higher diet quality in the postnatal period. Consistent with other research, this study showed that women with a higher level of education [323] and older women were more likely to have better diet

quality compared with their younger or non-tertiary educated counterparts. Likewise, women who spoke only English were more likely to have a higher diet quality score suggesting that language or cultural barriers may have some influence on diet quality following a GDM pregnancy. An alternative explanation may be that the tool used for measuring diet quality did not capture culturally relevant usual food choices. While the specific needs of women who speak a language other than English were not examined in this study, further investigation is clearly warranted. In particular, whether the information provided regarding postnatal lifestyle is culturally appropriate and meets the needs of women from these groups. As expected, those who practised other preventive health measures such as returning for follow-up blood glucose testing and being physically active were more likely to have better diet quality. Not only do these results support the need for improved access to postnatal dietary interventions, they also suggest that additional support may be needed for some high risk groups.

Women in this study who reported receiving risk reduction advice from a health professional were almost twice as likely to be in the highest compared with lowest quintile for diet quality. This suggests that health professionals can play an important role in providing postnatal risk reduction advice in relation to adherence with dietary guidelines. The most appropriate timing and delivery of interventions were not examined in this study. However, due to the poor return for follow-up reported in the Chapter 4 of this thesis, there may be benefits for postnatal dietary interventions beginning in the antenatal period. These results also provide a case for systematic postnatal follow-up of women by a health professional.

Overall, consistent with international findings [246], women with a recent history of GDM in this study were found to have poor diet quality. Interventions are therefore clearly needed to ensure that women diagnosed with GDM receive adequate information and support to achieve a diet consistent with the guidelines for chronic disease prevention.

9.2.3 Factors influencing preventive health behaviours

9.2.3.1 Risk perceptions

Perceptions of risk are hypothesised to be an important component of preventive health behaviour, with higher and more accurate risk perceptions thought to encourage healthier lifestyle behaviours and underestimates of risk being potential barriers to change [336]. Risk perceptions for developing diabetes in Australian women with GDM were examined in Chapter 7 of this thesis, the findings of which provide some insight into the effectiveness of current risk communications and factors associated with increased awareness of the risk of developing diabetes.

Although there was a high level of awareness of GDM as a type 2 diabetes risk factor among respondents, one third of women still considered themselves to be low or very low risk for type 2 diabetes up to three years after a GDM pregnancy. Our findings suggest that although the link between GDM and postnatal diabetes risk is being clearly communicated to women, it is evident that knowledge of GDM as a risk factor for diabetes does not necessarily translate to increased personal risk perception or perception of any immediate risk following a GDM pregnancy.

Interestingly, women with known diabetes risk factors including obesity, family history and insulin use during pregnancy were more likely to perceive that they were at high risk of type 2 diabetes up to 3 years post GDM pregnancy. Considering these women are more likely to be high risk in the early postnatal period [11, 53], these findings are reassuring. They are also consistent with those reported elsewhere [260] and suggest a high level of awareness regarding risk factors for type 2 diabetes, such as obesity and family history. These results are also indicative of a need for increased awareness of GDM as a strong predictor of type 2 diabetes risk.

In this study, a high level of perceived risk for diabetes was not associated with sufficient physical activity or higher diet quality. However, the use of cross-sectional methodology to capture such associations has limitations. For example, women who thought they were at high risk of diabetes may have improved their lifestyle to try and reduce risk or alternatively some women may have believed that they were high risk

because of poor lifestyle patterns. Intention to change behaviour, which may influence risk perception, was not examined in this study. Longitudinal data would be needed to provide a better understanding of the association between perceptions of risk and behaviour change.

Subsequent to the publication of this paper on risk perceptions, the NDSS GDM recall and reminder system was established in Australia. This program reminds women of the need for postnatal follow-up and also includes a healthy lifestyle component called "Life after GDM"[265]. All women with GDM registered with the NDSS who sign up to reminder system receive a copy of the "Life after GDM" booklet in the postnatal period. This resource provides information on the risk of type 2 diabetes and lifestyle changes to reduce risk after a pregnancy affected by GDM. An electronic version is also available on the NDSS website www.ndss.com.au/GD. This coordinated approach to increasing awareness through the use of a national GDM database ensures consistency in the information provided to women across Australia. The inclusion of practical strategies to reduce risk may also address the problem of simplistic or brief communications about the risk of type 2 diabetes without adequate follow-up or concrete risk reduction advice. However, evaluation of the effectiveness of this program is yet to be reported.

Although the emphasis of a GDM pregnancy is very much focused on antenatal outcomes, it also provides an ideal opportunity to alert women to postnatal health risks and promote positive messages about the potential for diabetes prevention. This includes raising awareness of the potential risk for all women with gestational diabetes and increasing acceptance of personal risk. Discussions regarding 'future risk' may also benefit from a greater sense of immediacy about the need for postnatal lifestyle changes. Addressing inadequacies in current models of GDM care to ensure systematic review of women in the postnatal period would also give a strong message to women about the importance of a GDM diagnosis to their long term health.

9.2.3.2 Women's experiences with GDM

The objective of the study presented in Chapter 8 of this thesis was to gain a better understanding of the impact of the GDM diagnosis, as well as the antenatal and postnatal experiences of Australian women with GDM. These experiences may be important determinants of GDM self-management as well as influencing longer term preventive health behaviours.

This study provided the qualitative component of this body of work and gave the women with GDM a 'voice'. Thematic analysis of women's experiences from free text narrative identified eight key themes describing women's experiences with GDM. The findings from this research provide an insight into key issues for this group and build on the quantitative data collected in this thesis.

Key themes emerging from the data included (1) shock, fear and anxiety, (2) uncertainty and scepticism, (3) an opportunity to improve one's health, (4) adapting to life with GDM, (5) the need for support, (6) better awareness, (7) feeling abandoned and (8) staying healthy and preventing diabetes. While some of these findings were consistent with other studies describing women's experiences [348], there were some novel findings in this study. Firstly, the issues of uncertainty and scepticism regarding the GDM diagnosis and the need for better awareness prior to diagnosis have not been previously reported. These experiences may be important in the context of the new ADIPS diagnostic criteria which are expected to result in increasing the rate of diagnosis of Australian women [33]. They also suggest that health professionals may need to improve communications with pregnant women to increase awareness of GDM and the importance of diagnosis and management for the best pregnancy outcomes.

In examining associations between the characteristics of respondents and their GDM pregnancy experience, women requiring insulin to manage GDM were more likely to experience shock, fear or anxiety and there was a trend towards women who spoke another language also being more likely to report this experience. This suggests that women from these groups may need additional support to adjust to the diagnosis of

GDM. Those diagnosed with GDM in a previous pregnancy and younger women were less likely to view the diagnosis as an opportunity to improve their health suggesting that positive messages about the potential for diabetes prevention may need to target these women and address their specific barriers and enablers.

This study also provides insight into the challenges and opportunities for future diabetes risk reduction. The theme of feeling *abandoned* highlighted that many women did not believe that they had received adequate postnatal support and emphasised the limitations of current models of GDM care focused on antenatal management. Likewise, the theme of *staying healthy and preventing diabetes* described a number of barriers to achieving a healthy lifestyle while that of a*n opportunity to improve one's health* illustrated the potential for the diagnosis of GDM to have a positive impact on subsequent lifestyle patterns. This suggests that for some women, the diagnosis of GDM can be used as a motivator for preventive health behaviours. Further investigation into how this translates into the adoption of long term healthy lifestyle patterns would be worthwhile.

9.3 Research strengths and limitations

Specific strengths and limitations have been outlined in each of the papers presented within the preceding chapters of this thesis. Further to this, a brief discussion of these in relation to each of the studies is outlined below.

9.3.1 Study One: Postnatal health and lifestyle study

The gestational diabetes postnatal lifestyle survey was used to gather data presented in chapters 5, 6, 7 and 8. Aside from the response rate of 36%, one of the main limitations of this study was that the women who responded to the survey differed somewhat from the entire NDSS dataset in regards to a number of demographics. The survey was only administered in English; therefore women from non-English speaking groups, who are known to disproportionately be affected by GDM, were likely to be underrepresented in this study. The results in relation to postnatal screening, diet quality, risk perceptions and women's experiences of living with GDM therefore cannot be considered to represent that of all Australian women with GDM.

There are inherent limitations with any tool used to collect dietary intake data. Limitations of the ARFS have been discussed in Chapter 5; however it is worth noting that while a higher ARFS has been associated with a lower fat, saturated fat and higher intakes of micronutrients, it has not been prospectively studied to determine the association with risk of type 2 diabetes.

There were also limitations in the methods used for the collection of qualitative data to describe women's experiences with GDM (Chapter 8). Women who provided written documentation of their experiences were more likely to be Australian born, indicating that the results may not represent those of overseas born women. Collecting data via written feedback also limited the opportunity for women with a lower level of literacy to describe their experiences.

Furthermore, the use of cross sectional methods for data collection in this survey is limited by the fact that the results only provide a 'snapshot' of the health and lifestyle patterns of women with GDM and although useful in examining associations, cannot determine cause and effect. Longitudinal, prospective studies would be useful to further examine some of the findings in this study. Finally, this survey also relied on the use of self-reported data which could not be validated due to privacy rules governing the use of the NDSS database.

The strengths of this study include the large sample size (>1300) and the use of a national diabetes database for participant recruitment. This is the first Australian study to describe postnatal health and lifestyle patterns in a national sample of women and makes an important contribution to determining the uptake of preventive health behaviours in women with recent GDM.

9.3.2 Study Two: Dietetic practice survey

The dietetic practice study presented in Chapter 3 was conducted using online survey methodology with recruitment via the Dietitians Association of Australia national member database, dietitians in public and private hospitals with maternity services as well as diabetes services across Australia. A potential limitation of this method recruitment was the fact that the process of inviting dietitians to participate included

multiple methods of approaching potential respondents. It was therefore not possible to accurately estimate the response rate. With the use of an online survey, data entry errors are another possible limitation of this study.

In addition, more than half of respondents saw less than five clients with GDM per month, suggesting that this may not have captured current practice of all dietitians who see clients with diabetes as the major part of their practice. However, one potential advantage of this is that the survey included the current practice of dietitians who see a range of clients including women with GDM as part of their practice, as well as dietitians less experienced in GDM for whom dietetic practice guidelines and nutrition recommendations may be most beneficial.

Despite these limitations, this is the only study to date to examine dietetic practice in Australian dietitians in the area of GDM management.

9.3.3 Study Three: Breastfeeding mixed methods study

The breastfeeding mixed methods study was primarily quantitative, using online survey methodology, followed by a qualitative phase using semi-structured telephone interviews. The data presented in Chapter 4 regarding early cessation of breastfeeding was collected only using the quantitative data collected in this study. The results of the qualitative data component are yet to be published and will be provide information on the breastfeeding experiences of women with GDM. However, these findings have not been included within this thesis.

In regards to the online survey component of this study, the main limitation was the low response rate (15%). While this response rate is comparable to that of other online surveys using the NDSS database for recruitment [306], it is less than that achieved with postal survey methodology used in the postnatal health and lifestyle study. In addition, there may have been a bias towards women with positive attitudes towards breastfeeding being more likely to participate in the study. The demographic characteristics of respondents also suggest that highly educated, older women were more likely to participate which may have influenced the findings.

Despite these limitations, this study is the first to report on factors associated with early breastfeeding cessation in Australian women with GDM and examine the breastfeeding experiences of women with GDM. Given the growing body of evidence about the potential benefits of breastfeeding in women with GDM, this study will also help inform strategies to improve breastfeeding support.

9.4 Future research

In concluding this body of work, recommendations for future research are presented in order to optimise dietetic interventions in GDM and promote and support preventive health behaviours for postnatal diabetes risk reduction.

Firstly, further research is required into the development and testing of best practice guidelines for dietetic care of women with GDM in an Australian context. Specifically, this research should examine models of dietetic care, cost effectiveness, the optimal frequency of visits and examine outcomes of MNT. Determination of the minimum level of dietetic intervention required to produce the best outcomes in GDM would be an important aspect of this research. A variety of approaches to nutrition education should also be tested to ensure that guidelines are appropriate to different models of service provision.

In addition, as discussed in Chapter 2, there are also gaps in the evidence regarding nutrition recommendations for women with GDM. Further research regarding optimal nutrient prescription is recommended, with particular focus on areas of inconsistencies in dietetic practice. Testing of the IOM weight gain guidelines in Australian women with GDM would also provide guidance on monitoring of weight gain and appropriate targets during pregnancy.

In regards to postnatal care of women, there are a number of areas highlighted in this thesis requiring further investigation. Firstly, intervention studies examining the effectiveness of targeted postnatal breastfeeding support in women with GDM are warranted. Identifying effective strategies to assist with the management of breastfeeding problems would be useful for translating such research into practice. While research into improving breastfeeding initiation and duration in women with

GDM should focus on women at greatest risk of early cessation including those who deliver via caesarean section, those from lower socioeconomic groups and women who are overweight or obese.

With the development of a national GDM recall and reminder system through the NDSS, it is also recommended that future work be done to evaluate the effectiveness of the reminder system in regard to rates of postnatal screening. Additional research in this area should focus on reducing barriers to follow-up screening for women in the early postnatal period. Examining the outcomes of the NDSS recall and reminder system in regards to postnatal lifestyle changes and perceptions of risk would also be important in determining the effectiveness of such a program.

The findings regarding poor diet quality in women with GDM suggest that further research is needed to determine the most effective interventions to improve adherence with dietary recommendations. Randomised control trials examining different models of postnatal care in an Australian context are needed. This should include research specifically looking at the timing, method and delivery of interventions, as well as testing the effectiveness of targeted postnatal dietary interventions delivered during pregnancy. With a number of barriers to postnatal follow-up identified in other studies [207]further research into novel dietary interventions such as web based or telephone counselling are also warranted. Longitudinal studies are needed to determine the association between diet quality, as measured by the ARFS and the development of type 2 diabetes in Australian women with a history of GDM.

As women from non-English speaking backgrounds were under-represented in the studies presented in this thesis, research into the lifestyle patterns of women from culturally and linguistically diverse (CALD) groups is needed. Considering that women from CALD groups are at high risk for the development of GDM and type 2 diabetes, research providing a better understanding of lifestyle related risk factors and culturally appropriate postnatal interventions is recommended.

9.5 Summary and key recommendations

The care of women with GDM in the antenatal and postnatal period is of vital importance for both maternal and infant health. This thesis has examined a number of key issues which may influence health outcomes for women with GDM, with the overall goal of advancing knowledge in the area of dietary management of GDM and prevention of future type 2 diabetes. The findings presented as a series of research papers in Chapters 3, 4, 5, 6, 7 and 8 of this thesis, while largely descriptive in nature, highlight some of key issues in the dietary management of GDM, provide important insights into the postnatal health and lifestyle patterns of Australian women with recent GDM and identify the current challenges for chronic disease prevention in a group at high risk of type 2 diabetes.

The key findings arising from this thesis and recommendations are summarised below:

1. There are inconsistencies in the nutrition recommendations, the dietetic care processes for women with GDM and the provision of follow-up care post-GDM

This was evidenced by the findings of Chapter 3 examining current dietetic practice in GDM. Chapter 5 highlighted dietary patterns of overall poor quality in women with previous GDM, providing some evidence of the need for improved postnatal nutrition care.

Recommendation: There is a need for Australian dietetic practice guidelines and nutrition recommendations to guide dietitians in clinical decision making and ensure evidence based nutrition care. Guidelines should be evaluated to determine the impact on GDM management and pregnancy outcomes. Dissemination and implementation issues are additional important consideration. The provision of postnatal nutrition advice needs to be addressed within dietetic practice guidelines to ensure that women are adequately supported to make long term lifestyle changes for type 2 diabetes risk reduction.

2. There is a need for a systematic approach to address postnatal follow-up care for Australian women with GDM.

This was demonstrated across a number of studies, in particular Chapter 5 showing poor return for follow-up for postnatal diabetes screening in women with previous GDM, with the positive effects of receiving individualised risk reduction advice and written information also being demonstrated. Chapter 6 highlighted the need for strategies to achieve improved postnatal diet quality for future diabetes prevention and in Chapter 8 women described their experiences with a lack of postnatal care and feeling *abandoned* by health care providers.

Recommendation: There is a need for systematic postnatal review of women with GDM to be incorporated into current models of GDM service provision. This requires a shift in focus from short-term obstetric outcomes to a coordinated approach that acknowledges the need for a longer-term continuum of care, and may require considerable changes to health care policies and have a substantial impact of service planning. Clear pathways for GDM management that continue beyond the postnatal period and that involve multiple health care providers such as diabetes and obstetric services, as well as primary care providers would be critical to the success of improving postnatal follow-up. In addition, promotion of ADIPS postnatal management recommendations to health professionals should be a priority, as should evaluating the impact of the NDSS GDM recall and reminder system on rates of postnatal diabetes screening.

3. There is a need to increase awareness of the risk of type 2 diabetes following a GDM pregnancy and appropriate lifestyle changes for risk reduction.

This was shown in Chapter 7 which described diabetes risk perceptions in the early postnatal period, as well as Chapter 6 indicating the need for strategies to improve diet quality to address postnatal diabetes risk reduction. In Chapter 8 women also described the challenges of staying healthy and preventing diabetes.

Recommendation: Effective diabetes risk communications strategies need to be developed for women with GDM and included in diabetes prevention campaigns. Awareness of risk may not be sufficient to change behaviour, so strategies to increase diabetes risk perceptions also need to bridge the gap between risk awareness and

lifestyle change. Recent initiatives implemented by the NDSS to increase awareness of the risk of type 2 diabetes and lifestyle changes for diabetes prevention should be tested for their effectiveness in making a real difference to health outcomes for women with GDM. Health professionals involved in the care of women with GDM need to provide consistent messages about the subsequent risk of type 2 diabetes, including positive messages about the potential for prevention. Considering that GDM care is often shared among multiple health care providers, health professionals may need professional development programs in this area. As these women are a heterogeneous group, a one size fits all approach to lifestyle interventions is unlikely to be effective, so consideration needs to be given to social and cultural context and barriers to change.

4. There is a need for additional support for preventive health behaviours in women with a history of GDM

A lack of support for type 2 diabetes prevention was particularly evident in Chapter 3 where very limited postnatal dietetic care was available to Australian women with GDM, Chapter 4 where the need for additional breastfeeding support was identified and Chapter 8 where women described the need for support both during their GDM pregnancy and in the postnatal period. On a positive note, Chapter 6 highlighted the potential role for health professional support in promoting healthy eating behaviours, while Chapter 5 demonstrated that health professionals can improve the uptake of postnatal diabetes screening.

Recommendation: Additional support should be provided to women with GDM to assist with meeting current recommendations for diabetes prevention. This support needs to be provided throughout both the antenatal and postnatal periods and in the longer term, in the primary health care setting. Although interactions between women with GDM and health care providers may be of a relatively short duration, there are critical points in time where support for preventive behaviours could be optimised. In the antenatal period, adequate support to manage GDM should be provided to ensure that changes to diet and physical activity level set the scene for lifelong lifestyle changes. In the early postnatal period, additional breastfeeding support to increase

duration of breastfeeding may be an effective future diabetes risk reduction strategy. While improved support to implement postnatal lifestyle changes to address longer term diabetes prevention is vital.

In summary, women with GDM are a group at high risk for adverse pregnancy outcomes and future chronic disease. Management of GDM should ideally occur within the framework of a multidisciplinary team which includes a dietitian. To optimise the outcomes of dietary management an evidence based approach and support for dietitians to provide high level care to women with GDM is required. A diagnosis of GDM also provides an ideal opportunity for early interventions to promote future health. Despite this, the findings presented in this body of work highlight that the postnatal health and lifestyle behaviours of Australian women with GDM are not conducive to chronic disease prevention. This research demonstrates that strategies to promote and support preventive health behaviours are urgently needed.

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Appendix A: Statement of contribution of others

I attest that Research Higher Degree candidate Melinda K Morrison contributed to the following paper through the development of the research question, methodology design, participant recruitment, data analysis and interpretation (with statistical assistance) and writing of the manuscript.

Morrison, M.K., Collins, C.E. and Lowe, J.M. Postnatal testing for diabetes in Australian women following gestational diabetes mellitus. *Australian and New Zealand Journal of Obstetrics & Gynaecology* 2009; 49:494–498.

Professor Clare E Collins

Date   9/7/2013

Associate Professor Julia Lowe

Date   9/7/2013

Melinda K Morrison

Date   9/7/2013

Professor John Rostas

Assistant Dean Research Training

Date   11/7/2013

I attest that Research Higher Degree candidate Melinda K Morrison contributed to the following paper through the development of the research question, methodology design, participant recruitment, data analysis and interpretation (with statistical assistance) and writing of the manuscript.

Morrison, M.K., Lowe, J.M. and Collins, C.E. Perceived risk of type 2 diabetes in Australian women with a recent history of gestational diabetes mellitus. *Diabetic Medicine* 2010; 27:882–886.

Professor Clare E Collins

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Melinda K Morrison

Date   9/7/2013

Professor John Rostas

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Date   11/7/2013

I attest that Research Higher Degree candidate Melinda K Morrison contributed to the following paper through the development of the research question, methodology design, participant recruitment, data analysis and interpretation and writing of the manuscript.

Morrison, M.K., Collins, C.E. and Lowe, J.M. Dietetic practice in the management of gestational diabetes mellitus: A survey of Australian dietitians. *Nutrition & Dietetics* 2011; 68:189–194

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Melinda K Morrison

Date   9/7/2013

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Assistant Dean Research Training

Date   11/7/2013

I attest that Research Higher Degree candidate Melinda K Morrison contributed to the following paper through the development of the research question, methodology design, participant recruitment, assisting with data analysis and interpretation and writing of the manuscript.

The study was conducted in conjunction with Dr Denise Koh, Dr Yvette Miller and Associate Professor Alison Marshall at the University of Queensland, who were involved with methodological design, participant recruitment for QLD, data entry, data interpretation and review of the manuscript. Statistical assistance and advice was provided by Mr Kim Colyvas.

Morrison, M.K, Koh, D, Lowe, J.M, Miller, Y.D, Marshall, A.L, Colyvas, K and Collins,

C.E. Postpartum diet quality in Australian women following a gestational diabetes

pregnancy. *European Journal of Clinical Nutrition* 2012; 66:1160–1165.

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Date   9/7/2013

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Date   21/6/2013

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Date   11/7/2013

I attest that Research Higher Degree candidate Melinda K Morrison contributed to the following paper through the development of the research question, methodology design, participant recruitment, data analysis and interpretation and writing of the manuscript.

Morrison, M.K., Lowe, J.M. and Collins, C.E. Australian women's experiences of living with gestational diabetes, currently under review in *Women and Birth*.

Professor Clare E Collins

Date   9/7/2013

Associate Professor Julia Lowe

Date   9/7/2013

Melinda K Morrison

Date   9/7/2013

Professor John Rostas

Assistant Dean Research Training

Date   11/7/2013

I attest that Research Higher Degree candidate Melinda K Morrison contributed to the following paper through the development of the research question, methodology design, participant recruitment, data analysis and interpretation (with statistical assistance)and writing of the manuscript.

The study was conducted in conjunction with Dr Roslyn Giglia, Curtin University, who provided advice on methodology, data interpretation and review of the manuscript.

Morrison, M, Collins, C, Lowe, J, Giglia, R. Factors associated with early cessation of breastfeeding in women with gestational diabetes mellitus, currently under review in *Diabetic Medicine.*

Professor Clare E Collins

Date   9/7/2013

Associate Professor Julia Lowe

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Dr Roslyn Giglia

Date: 19/6/2013

Melinda K Morrison

Date   9/7/2013

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Assistant Dean Research Training

Date   11/7/2013

Appendix B: Postnatal health and lifestyle survey

gestational diabetes

POST-NATAL HEALTH AND LIFESTYLE SURVEY

DIABETES
AUSTRALIA
New South Wales

The UNIVERSITY
of NEWCASTLE
AUSTRALIA

Gestational Diabetes
Post-Natal Health and Lifestyle Survey

About this survey...

This survey is a lifestyle questionnaire for women with previous gestational diabetes who registered with the National Diabetes Services Scheme (NDSS) between the years 2003 & 2005.

The survey is designed to find out more about the diabetes information and advice provided to Australian women with gestational diabetes and the lifestyle of women with a history of gestational diabetes in the post-natal period. The survey consists of 68 questions and should take approximately 30 minutes to complete.

How to complete this survey...

Please answer every question you can. If you are unsure about how to answer a question, mark the response that you think is most appropriate for you.

Please read the instructions carefully. Some questions require you to write answers in a box, others require you to fill in a circle. Please select underline answer only in each question unless otherwise specified. You will find tips on how to answer the questions in shaded boxes throughout the survey.

If you need any help to answer any of the questions, please contact: Melinda Morrison at Diabetes Australia - NSW at melindam@diabetesnsw.com.au or on (02) 9552 9968.

Thank you for taking the time to complete this survey. Once you have completed it, please return it to us in the reply paid envelope provided.

> **Look for tips on how to answer questions in shaded boxes like this.**

Use a blue or black pen.   **Do not use a pencil.**

If you make a mistake, cross out your first answer and mark your new answer as shown below:

○ a   ○ b   ✕ c   ○ d   ● e   ○ f

Part A: About you...

These questions are about where you live and what you do.

A1... What is your date of birth?

| | | / | | | / | | | | |

Day / Month / Year

A2... What is the postcode of where you live at the moment?

| | | | | |

A3... In what country or region were you born?

O Australia

O United Kingdom / Ireland

O New Zealand

O Southern or South Eastern Europe (e.g. Greece, Italy, Spain, Portugal)

O Northern or Western Europe (e.g. France, Germany, Netherlands)

O Eastern Europe (e.g. Poland, Russian Federation, Hungary)

O Middle East or North Africa (e.g. Lebanon, Egypt, Iraq, Turkey)

O South Asia (e.g. India, Sri Lanka)

O North Asia (e.g. China, Korea, Japan, Taiwan)

O South East Asia (e.g. Vietnam, Indonesia, Philippines, Singapore, Malaysia)

O South Pacific Islands (e.g. Samoa, Fiji)

O Other, please specify: _____

A4... Do you usually speak another language other than English at home?

○ No, I only speak English at home   (GO TO Question A6)

○ Yes, Italian

○ Yes, Greek

○ Yes, Spanish

○ Yes, Cantonese

○ Yes, Mandarin

○ Yes, Arabic

○ Yes, Hindi

○ Yes, Sinhalese

○ Yes, Tamil

○ Yes, Tagalog

○ Yes, Vietnamese

○ Yes, Samoan

○ Yes, other, please specify: _____

A5... How well do you speak English?

○ Very well

○ Well

○ Not well

○ Not at all

A6... Are you of Aboriginal or Torres Strait Islander origin?

○ No

○ Yes, Aboriginal origin

○ Yes, Torres Strait Islander origin

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A7... What is the highest educational qualification that you have achieved?

○ No formal qualification

○ Year 10 or equivalent (e.g. school certificate)

○ Year 12 or equivalent (e.g. higher school certificate)

○ Trade/apprenticeship (e.g. hairdresser/chef)

○ Certificate or diploma (e.g. child care/technician)

○ University degree (e.g. bachelor degree)

○ Higher University Degree (e.g. Grad Dip/Honours/Masters/PhD)

A8... What is your main occupation now? (include full time or part time or your *usual* occupation if on maternity leave)

○ Manager or administrator
(e.g. magistrate, farm manager, general manager, director of nursing, school principal)

○ Professional
(e.g. scientist, doctor, registered nurse, allied health professional, teacher, artist)

○ Associate professional
(e.g. technician, manager, youth worker, police officer)

○ Tradesperson or related worker
(e.g. hairdresser, florist, gardener)

○ Advanced clerical or service worker
(e.g. secretary, personal assistant, flight attendant, law clerk)

○ Intermediate clerical, sales or service worker
(e.g. typist, word processor, data entry operator, receptionist, child care worker, nursing assistant, hospitality worker)

○ Intermediate production or transport worker
(e.g. sewing machinist, machine operator, bus driver)

○ Elementary clerical, sales or service worker
(e.g. filing, mail clerk, parking inspector, sales assistant, telemarketer, housekeeper)

○ Labourer or related worker
(e.g. cleaner, factory worker, general farm hand, kitchen hand)

○ No paid job

> **Thank you for completing these questions, please move on to the next set of questions which ask you more about being diagnosed with gestational diabetes.**

Part B: About Gestational Diabetes...

These questions ask you about being diagnosed with gestational diabetes during any of your pregnancies.

B1... In what year were you FIRST diagnosed with gestational diabetes?

○ 1998 or before   ○ 2000   ○ 2002   ○ 2004

○ 1999   ○ 2001   ○ 2003   ○ 2005

For question B2, select as many answers as apply to you.

B2... In which pregnancy or pregnancies was gestational diabetes diagnosed?

○ 1st pregnancy   ○ 3rd pregnancy   ○ 5th pregnancy   ○ other - please specify below

○ 2nd pregnancy   ○ 4th pregnancy   ○ 6th pregnancy   _____

B3... If you were diagnosed with gestational diabetes in more than one pregnancy, when was your most recent diagnosis?

○ Not applicable - only diagnosed with gestational diabetes once

○ 2002 or before   ○ 2003   ○ 2004   ○ 2005   ○ 2006*

If you are currently pregnant and have gestational diabetes, please answer the rest of these questions referring to the pregnancy in which you were diagnosed with diabetes between 2003 & 2006.

The remaining questions in this section relate to your **most recent** pregnancy with gestational diabetes.

B4... At what stage during your most recent pregnancy with gestational diabetes were you diagnosed with this condition?

○ Before 26 weeks

○ During gestational diabetes screening at 26-28 weeks

○ After 28 weeks

B5... What was the outcome of this pregnancy?

○ Live birth (more than 36 weeks)

○ Premature birth (36 weeks or less)

○ Stillbirth or miscarriage

226

B6... What was the birth weight of your baby from your most recent pregnancy with gestational diabetes ?

| | | | | grams   **OR** | | pounds | | ounces

B7... What was the birth length of your baby from your most recent pregnancy with gestational diabetes ?

| | centimetres   **OR** | | inches

B8... What was the date of birth of your baby from your most recent pregnancy with gestational diabetes ?

| | / | | / | | | |
Day / Month / Year

B9... Are you currently pregnant?

○ Yes

○ No

○ Unsure

Thank you for completing these questions, please move on to the next set of questions which ask you more about your weight.

227

Part C: About your weight...

These questions relate to your weight before, during and after your <u>most recent</u> pregnancy with gestational diabetes.

For questions C1, C2 and C4, write one number in each square, like this:

| 1 | 6 | 5 |

C1... How tall are you (without shoes) ?

[ ][ ][ ] centimetres   **OR**   [ ] feet [ ][ ] inches

C2... What was your weight (without clothes or shoes) <u>before</u> your <u>most recent</u> pregnancy with gestational diabetes?

[ ][ ][ ] kilograms   **OR**   [ ][ ] pounds [ ][ ] ounces

C3... Approximately how much weight did you <u>gain</u> during your <u>most recent</u> pregnancy with gestational diabetes?

- O 0 - 5 kilograms
- O 6 - 10 kilograms
- O 11 - 15 kilograms
- O 16 - 20 kilograms
- O More than 20 kilograms
- O Lost weight

C4... What is your current weight?

[ ][ ][ ] kilograms   **OR**   [ ][ ] pounds [ ][ ] ounces

C5... How would you describe your <u>current</u> weight?

- O Underweight
- O Healthy weight
- O Overweight
- O Obese

228

C6... Since the birth of this baby, have you gained any weight?

○ Yes
○ No   (GO TO Question C8)
○ Unsure   (GO TO Question C8)

C7... If YES, how much have you gained?

○ 1 - 5 kilograms
○ 6 - 10 kilograms
○ 11 - 15 kilograms
○ 16 - 20 kilograms
○ More than 20 kilograms

C8... Since the birth of this baby, have you returned to your pre-pregnancy weight or below?

○ Yes - I have returned to my pre-pregnancy weight
○ Yes - I am below my pre-pregnancy weight
○ No - I have not returned to my pre-pregnancy weight or below
○ Unsure

Thank you for completing these questions, please move on to the next set of questions which ask you more about breastfeeding.

229

Part D: About breastfeeding...

These questions relate to breastfeeding your baby following your <u>most recent</u> pregnancy with gestational diabetes.

D1... Has your baby from your <u>most recent</u> pregnancy with gestational diabetes <u>ever</u>* been breastfed?

○ Yes

○ No   (GO TO Question D3)

*"Ever' been breastfed means that the baby at some point in time received breast milk by breastfeeding or as expressed breast milk through a bottle.

D2... If YES, for how long did you breastfeed your baby from your <u>most recent</u> pregnancy with gestational diabetes?

○ Less than 1 month

○ 1 - 3 months

○ 4 - 6 months

○ 7 - 12 months

○ More than 12 months

○ Still breastfeeding this baby

D3... Are you <u>currently</u> breastfeeding?

○ Yes

○ No

> **Thank you for completing these questions, please move on to the next set of questions which ask you more about your gestational diabetes health care.**

230

Part E: About your gestational diabetes health care...

These questions relate to the health professionals you saw, the information you received DURING your most recent pregnancy with gestational diabetes.

E1... Which health / medical professionals did you see during your most recent pregnancy with gestational diabetes?

○ General practitioner
○ Obstetrician
○ Endocrinologist / Diabetes Specialist Doctor
○ Diabetes Educator / Diabetes Nurse
○ Dietitian
○ Psychologist
○ Midwife
○ Other - please specify _____

E2... How many times did you see a dietitian during your most recent pregnancy with gestational diabetes?

○ None
○ Once
○ Twice
○ Three times
○ Four times
○ Five or more times

E3... How was your gestational diabetes managed during your most recent pregnancy with gestational diabetes?

○ Diet controlled
○ Diet + insulin injections
○ No management
○ Other - please specify _____

E4... Were you advised by health professional(s) during / after your most recent pregnancy with gestational diabetes that you were at increased risk of developing type 2 diabetes later in life?

○ Yes
○ No
○ Unsure

231

These questions relate to the health professionals you saw, the information you received AFTER your most recent pregnancy with gestational diabetes.

E5... Did you receive any advice from health professional(s) about reducing your risk of type 2 diabetes after the birth of your baby from your most recent pregnancy with gestational diabetes?

○ Yes

○ No   (GO TO Question E7)

○ Unsure (GO TO Question E7)

E6... If YES, who gave you advice about reducing your future risk of diabetes after the birth?

○ General practitioner

○ Obstetrician

○ Endocrinologist / Diabetes Specialist Doctor

○ Diabetes Educator / Diabetes Nurse

○ Dietitian

○ Psychologist

○ Midwife

○ Diabetes Australia

○ Other - please specify _____

E7... How many times did you see a dietitian after the birth of your baby from your most recent pregnancy with gestational diabetes?

○ None

○ Once

○ Twice

○ Three times

○ Four times

○ Five or more times

E8... What type of information or advice did you receive about diabetes after the birth of your baby from your most recent pregnancy with gestational diabetes?

○ No information or advice (GO TO Question E10)

○ Nutrition information or advice

○ Exercise / physical activity information or advice

○ Diabetes prevention information or advice

○ Other - please specify _____

232

E9... If you received information about diabetes after the birth, in what format did you receive this information?

○ Pamphlet/brochure

○ Group education session

○ Individualised advice - one on one with a health professional

○ Other - please specify _____

E10... Do you believe that you received enough information about a healthy lifestyle to help you reduce the risk of type 2 diabetes _after_ the birth of your baby?

○ Yes (GO TO Question E12)

○ No

E11... If NO, what additional information would you have liked to receive about a healthy lifestyle to help reduce your risk of type 2 diabetes?

○ Additional information about nutrition

○ Additional information about exercise/physical activity

○ Additional general diabetes prevention information

○ Other - please specify _____

E12... What do you believe is the _best way_ for you to receive information or advice about reducing your risk of diabetes _after_ the birth of your baby?

○ Pamphlet/brochure

○ Group education session

○ Individualised advice - one on one with a health professional

○ Internet/website

○ DVD or CD Rom

○ Telephone follow-up with a health professional

○ Other - please specify _____

E13... Did you have a test for diabetes _after_ the birth of your baby?

○ Yes

○ No   (GO TO Question F1)

○ Not yet, but am scheduled to have test   (GO TO Question F1)

○ Unsure   (GO TO Question F1)

233

E14... If YES, how were you notified that you were due to have a diabetes test _after_ the birth of your baby?

○ Advised by diabetes doctor/educator or dietitian at follow up visit

○ Advised by general practitioner (GP)

○ Sent a reminder notice by health care provider / hospital / Diabetes Australia

○ Other - please specify _____

E15... If YES, what type of diabetes test did you have _after_ the birth?

○ Non-fasting finger prick blood glucose test

○ Fasting finger prick blood glucose test

○ Non-fasting blood glucose test with blood taken from your arm

○ Fasting blood glucose test with blood taken from your arm

○ A glucose tolerance test "

○ Haemoglobin A1c (HbA1c)

○ Unsure

" A Glucose Tolerance Test is a fasting blood test which involves drinking a glucose drink and have blood taken from the arm to check fasting blood glucose levels and levels at 1 and 2 hours after the glucose drink. This test is usually done in a pathology or blood collection lab.

E16... If YES, when did you have this test done _after_ the birth?

○ 6-8 weeks after the birth

○ 3-6 months after the birth

○ 7-12 months after the birth

○ 2 years after the birth

○ 3 years after the birth

○ Other - please specify _____

Thank you for completing these questions, you are now over half way!
Please take a short break before moving on to the next set of questions, which ask you more about your medical history.

234

Part F: About your medical history...

These questions ask about <u>your</u> medical history.

F1... Have you ever been told that you have any of the following conditions?

○ High blood cholesterol or triglyceride levels
○ High blood pressure (hypertension)
○ Polycystic Ovarian Syndrome (PCOS)
○ Obesity
○ Type 2 diabetes (NIDDM or adult onset diabetes)
○ Pre-diabetes or Impaired Glucose Tolerance or Impaired Fasting Glucose
○ Heart disease
○ None of these conditions

F2... Do you currently have type 2 diabetes (NIDDM or adult onset diabetes)?

○ Yes   (GO TO Question G1)
○ No
○ Unsure

F3... If NO, please indicate what you believe to be your current risk of developing type 2 diabetes?

○ Very low risk
○ Low risk
○ Moderate risk
○ High risk
○ Very high risk

Thank you for completing these questions, please move on to the next set of questions which ask you about your family history.

235

Part G: About your family history...

These questions ask about <u>your</u> family history of health conditions and medical problems.

G1... Do any of your blood relatives (e.g. parents, brothers, sisters or grandparents) have any of the following conditions?

○ Type 2 diabetes (NIDDM or adult onset diabetes)

○ Pre-diabetes or Impaired Glucose Tolerance or Impaired Fasting Glucose

○ Heart disease

○ High blood cholesterol or triglyceride levels

○ High blood pressure (hypertension)

○ Obesity

○ None of my blood relatives have been diagnosed with these conditions

○ Unsure

Thank you for completing these questions, please move on to the next set of questions which ask you more about your lifestyle.

236

Part H: About smoking...

These questions ask about smoking.

H1... Do you currently smoke?

O Yes

O No   (GO TO Question I1)

H2... If YES, how regularly do you currently smoke?

O Daily

O At least weekly (but not daily)

O Less than weekly

> **Thank you for completing these questions, please move on to the next set of questions which ask you about the physical activity you did last week.**

237

Part I: About physical activity...

These questions ask you about the amount of physical activity <u>you</u> did <u>last week</u>. Only count the number of times when the activity lasted for 10 minutes or more.

I1... How many times did you do each type of activity <u>last week</u>?

a... Walking briskly (for recreation or exercise, or to get from place to place)

☐☐ times

b... Moderate leisure activity (like social tennis, moderate exercise classes, recreational swimming, dancing)

☐☐ times

c... Vigorous leisure activity (that makes you breathe harder or puff and pant like aerobics, competitive aerobics, competitive sport, vigorous running, cycling, swimming)

☐☐ times

d... Vigorous household or garden chores (that make you breathe harder of puff and pant)

☐☐ times

I2... If you add up all the times you spent in each activity last week, how much time did you spend all together doing each type of activity?

a... Walking briskly (for recreation or exercise, or to get from place to place)

☐☐ hours ☐☐ minutes

b... Moderate leisure activity (like social tennis, moderate exercise classes, recreational swimming, dancing)

☐☐ hours ☐☐ minutes

c... Vigorous leisure activity (that makes you breathe harder or puff and pant like aerobics, competitive aerobics, competitive sport, vigorous running, cycling, swimming)

☐☐ hours ☐☐ minutes

d... Vigorous household or garden chores (that make you breathe harder of puff and pant)

☐☐ hours ☐☐ minutes

Now think about all of the time you spend <u>sitting</u> during EACH DAY while at home, at work, while getting from place to place or during your spare time.

I3... How many hours in total do you typically spend sitting down while doing things like visiting friends, driving, reading, watching television or working at a desk or computer?

a... On a usual <u>week day</u> ☐☐ hours   b... On a usual <u>weekend day</u> ☐☐ hours

> **Thank you for completing these questions, please move on to the next set of questions which ask you more about your eating patterns over the last 12 months.**

238

Part J: About your eating patterns...

These questions ask you about your **usual** eating patterns over the last **12 months**.

> Where possible give only one answer per question for the type of food you eat most often. (If you can't decide which type you have most often, answer for the types you usually eat).

J1... How many pieces of fresh fruit do you **usually** eat **per day**? *(count 1/2 cup diced fruit, berries or grapes as one piece)*

○ I don't eat fruit

○ Less than 1 piece of fruit per day

○ 1 piece of fruit per day

○ 2 pieces of fruit per day

○ 3 pieces of fruit per day

○ 4 or more pieces of fruit per day

J2... How many different vegetables do you **usually** eat **per day**? *(count all types fresh, frozen or tinned)*

○ Less than 1 vegetable per day

○ 1 vegetable per day

○ 2 vegetables per day

○ 3 vegetables per day

○ 4 vegetables per day

○ 5 vegetables per day

○ 6 or more vegetables per day

J3... What **type** of milk do you **usually** use?

○ None

○ Full cream milk

○ Reduced fat milk

○ Skim milk

○ Soya milk

J4... How much milk do you **usually** use **per day**? *(include flavoured milk and milk added to tea, coffee, cereal etc.)*

○ None

○ Less than 250ml (1 large cup or mug)

○ Between 250ml and 500ml (1-2 cups)

○ Between 500ml and 750ml (2-3 cups)

○ 750ml (3 cups) or more

239

J5... What type of bread do you usually eat?

○ I don't eat bread

○ High fibre or low GI white bread

○ White bread

○ Wholemeal bread

○ Rye bread

○ Multigrain / mixed grain / grain & seed bread

J6... How many slices of bread do you usually eat per day? *(Include all types, fresh or toasted and count one bread roll as 2 slices)*

○ Less than 1 slice per day

○ 1 slice per day

○ 2 slices per day

○ 3 slices per day

○ 4 slices per day

○ 5-7 slices per day

○ 8 or more slices per day

J7... Which spread do you usually put on bread?

○ I don't use any fat spread

○ Margarine of any kind

○ Polyunsaturated margarine (e.g. sunflower)

○ Monounsaturated margarine (e.g. canola, olive)

○ Butter and margarine blends

○ Butter

J8... On average how many teaspoons of sugar do you usually use per day? *(Include sugar taken with tea and coffee and on breakfast cereal etc.*

○ None

○ 1 to 4 teaspoons per day

○ 5 to 8 teaspoons per day

○ 9 to 12 teaspoons per day

○ More than 12 teaspoons per day

240

J9... On average, how many eggs do you usually eat per week?

○ I don't eat eggs

○ Less than 1 egg per week

○ 1 to 2 eggs per week

○ 3 to 5 eggs per week

○ 6 or more eggs per week

J10... What type of cheese do you _usually_ eat?

○ I don't eat cheese

○ Hard cheeses e.g. parmesan, romano

○ Firm cheeses e.g. cheddar, edam

○ Soft cheeses e.g. camembert, brie

○ Ricotta or cottage cheese

○ Cream cheese

○ Low fat cheese

J11... On average, _how often_ do you _usually_ drink sweet / sugar containing drinks including fizzy soft drink, cordials, fruit juice or sports drinks? Do _not_ include diet drinks.

○ Never

○ Less than once a month

○ 1 - 3 times per month

○ 1 time per week

○ 2 times per week

○ 3 - 4 times per week

○ 5 - 6 times per week

○ 1 time per day

○ 2 times per day

○ 3 or more times per day

241

J12... Over the past 12 months on average, how often did you eat the following foods?
(please mark one answer for each food)

	Never	Less than once a week	Once a week or more
All Bran	O	O	O
Sultana Bran or Fibre Plus or Branflakes	O	O	O
Weet Bix or Vita Brits	O	O	O
Cornflakes or Nutrigrain or Special K	O	O	O
Porridge	O	O	O
Muesli	O	O	O
Rice	O	O	O
Pasta or noodles (including lasagne)	O	O	O
Nuts	O	O	O
Peanut Butter or peanut paste	O	O	O
Vegemite or Marmite or Promite	O	O	O
Tinned or frozen fruit (any kind)	O	O	O
Oranges or other citrus fruit	O	O	O
Apples	O	O	O
Pears	O	O	O
Bananas	O	O	O
Watermelon, rockmelon, honeydew etc	O	O	O
Pineapple	O	O	O
Strawberries	O	O	O
Apricots	O	O	O
Peaches or nectarines	O	O	O
Mango or paw paw	O	O	O
Avocado	O	O	O
Fruit or vegetable juice	O	O	O
Potatoes cooked without fat	O	O	O
Tomato sauce, tomato paste or dried tomatoes	O	O	O
Fresh or tinned tomatoes	O	O	O
Peppers (capsicum)	O	O	O
Lettuce, endive or other salad greens	O	O	O
Cucumber	O	O	O
Celery	O	O	O
Beetroot	O	O	O
Carrots	O	O	O
Cabbage or brussels sprouts	O	O	O
Cauliflower	O	O	O
Broccoli	O	O	O
Silverbeet or spinach	O	O	O
Peas	O	O	O

242

J12 (continued)... Over the past 12 months on average, how often did you eat the following foods? (please mark one answer for each food)

	Never	Less than once a week	Once a week or more
Green beans	O	O	O
Bean sprouts or alfalfa sprouts	O	O	O
Baked beans	O	O	O
Soy beans, soy bean curd or tofu	O	O	O
Other beans (include chick peas, lentils etc)	O	O	O
Pumpkin	O	O	O
Onions or leeks	O	O	O
Garlic (not garlic tablets)	O	O	O
Mushrooms	O	O	O
Zucchini	O	O	O

J13... Over the past 12 months on average, how often did you eat the following foods? (please mark one answer for each food)

	Never	Less than once a week	Once a week	2-4 times a week	5-8 times a week or more
Beef	O	O	O	O	O
Veal	O	O	O	O	O
Lamb	O	O	O	O	O
Pork	O	O	O	O	O
Chicken	O	O	O	O	O
Fish - steamed, baked or grilled	O	O	O	O	O
Canned fish (salmon, tuna etc)	O	O	O	O	O
Cheese	O	O	O	O	O
Yoghurt	O	O	O	O	O
Ice cream	O	O	O	O	O

J14... Over the past 12 months, how often did you drink beer, wine and/or spirits?

O Never

O Less than once a month

O 1 - 3 days per month

O 1 day per week

O 2 days per week

O 3 days per week

O 4 days per week

O 5 days per week

O 6 days per week

O Every day

243

J15... Over the past 12 months on days when you were drinking, how many glasses of beer, wine or spirits altogether did you usually drink?

O Nil - don't drink   O 1   O 2   O 3   O 4   O 5   O 6   O 7   O 8   O 9   O 10 or more

---

Thank you for answering these questions, you have now finished!

Are there any other comments you would like to make about your experiences with gestational diabetes?

_____

_____

_____

BEFORE YOU RETURN THIS SURVEY TO US, PLEASE:

☐ Check that you have answered all questions that relate to you in this survey.

☐ Read the additional information request form on the next page and complete it if you would like any information sent to you.

☐ Place the completed survey in the reply paid envelope provided & place in an Australian Post box. A stamp is NOT required. Please do **NOT** fold the survey.

THANK YOU once again for taking the time to complete this survey.

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Appendix C: Dietetic practice survey

GESTATIONAL DIABETES DIETETIC PRACTICE SURVEY

DEMOGRAPHIC DATA

In which state do you currently practice as a dietitian?

- o NSW

- o ACT

- o VIC

- o QLD

- o NT

- o TAS

- o SA

- o WA

- o Overseas

In what setting do you currently work as a dietitian?

- o Public hospital

- o Specialised diabetes centre / service

- o Community health centre

- o Private practice

- o Private hospital

- o Non-government organisation

- o Other – please specify_____

What is your primary area of dietetic practice?

- o Diabetes

- o Ante-natal / Obstetrics

- o General clinical

- o Community nutrition

- o Other - please specify _____

How would you describe your work geographic location?

- o Metropolitan or large urban (>100,000)

- o Regional

- o Rural / remote

- o Other - please specify _____

Do you currently work?

- o Full-time

- o Part-time

- o Consultancy / contract

- o Other – please specify _____

How many years in total have you worked as a dietitian?

- o <1 year

- o 1-3 years

- o 3-5 years

- o 5-10 years

- o >10 years

How many years experience do you have in the dietary management of diabetes?

- o <1 year

- o 1-3 years

- o 3-5 years

- o 5-10 years

- o >10 years

Are you a current member of the Dietitians Association of Australia (DAA)?

- o Yes

- o No

Are you an Accredited Practising Dietitian (APD)?

- o Yes

- o No

Are you a member of the national DAA Diabetes Interest Group?

- o Yes

- o No

Do you have any additional post-graduate diabetes education qualifications?

- o Yes

- o No

- o Currently enrolled

Are you a Credentialled Diabetes Educator (CDE)?

- o Yes

- o No

Are you (or is your service) a member of any of the following organisations?

- o   Australasian Diabetes in Pregnancy Society (ADIPS)

- o   Australian Diabetes Educators Association (ADEA)

- o   Diabetes Australia (professional member)

GESTATIONAL DIABETES SERVICES

How many women on average would you see with GDM each month?

- o   5 or less

- o   6-10

- o   11-20

- o   20 or more

Does your service include other members of a multidisciplinary team?

- o   Yes

- o   No

If YES, please indicate which team members:

- o   Diabetes Educator

- o   Endocrinologist / Diabetes Specialist

- o   Obstetrician

- o   Midwife

- o   Psychologist

- o   Exercise physiologist / physiotherapist

- o   Other – please specify _____

If NO, do your clients with GDM have access to other members of the multidisciplinary team through another service?

- o Yes

- o No

- o Unsure

Comment:

_____

_____

What type of dietetic services do you provide for women with GDM? ((Select any that are applicable)

- o Individualised appointments

- o Group education

- o Telephone, email or fax follow-up

- o Other – please specify _____

How soon after referral are women with GDM usually seen by a dietitian?

- o <1 week

- o 1-2 weeks

- o 3-4 weeks

- o >1 month

Are women with GDM provided with any initial nutrition information (e.g. written information, meal plan) prior to their first dietetic appointment?

- o Yes

- o No

- o Unsure

Comment:

_____

_____

On average how many face-to-face visits (including individualised appointments & group education) would each client have with a dietitian during their GDM pregnancy? (exclude telephone, email or fax follow-up)

- o One

- o Two

- o Three

- o Four

- o Five or more

Comment:

_____

_____

What influences the decision on the frequency of dietitian visits? (Select any that are applicable)

- o Dietetic staffing levels

- o Service protocols or guidelines

- o Glycemic control

- o Use of insulin

- o Cultural background / language

- o Client literacy levels

- o Dietitian's clinical judgement

- o Schedule of appointments with other team members (e.g. Diabetes Educator)

- o Other – please specify_____

How much time is allocated for?

Initial dietitian assessment & advice   _ minutes

Follow-up dietitian appointments   _ minutes

Group education   _ minutes

Follow-up group education   _ minutes

Are all women with GDM who attend your service (or sent by referring doctor) referred to see a dietitian?

- o   Yes

- o   No

- o   Unsure

If NO, under what circumstance are women with GDM usually referred for dietetic advice? (You may select more than one)

- o   Commencement of insulin

- o   Poor glycemic control

- o   Weight related issues

- o   Pregnancy related issues (e.g. hyperemesis)

- o   Language difficulties

- o   Other – please specify_____

DIETETIC EDUCATION & ADVICE

Please indicate which of the following topics are covered in your dietetic education of clients with GDM? (Select any that are applicable)

- o   Core food group requirements

- o   Sources of carbohydrate, protein and fat

- o   Carbohydrate quantity

- o   Carbohydrate distribution & frequency

- o   Sugar

- o   Glycemic Index

- o   Fat

- o   Saturated fat

- o   Fibre

- o   Free foods

- o   Pregnancy specific micronutrients

- o   Artificial sweeteners

- o   Label reading

- o   Alcohol

- o   Eating out

- o   Hypoglycaemia (where appropriate)

- o   Physical activity

- o   Pregnancy weight gain

- o   Food safety (listeriosis, mercury & fish)

- o   Breastfeeding

- o   Post-natal diet & risk reduction

- o   Other – please specify _____

What macronutrient targets do you aim for in your dietetic interventions with

women with GDM?

Carbohydrate   _____ %

Protein   _____ %

Fat   _____ %

Saturated fat   _____ %

What daily fibre target would you aim for (in grams)?   _____

Do you recommend that women include a minimum amount of carbohydrate per day?

- o Yes

- o No

If YES, please indicate the minimum amount of carbohydrate recommended (in grams per day) _____

What teaching tools do you use in education regarding carbohydrate distribution for women with GDM? (Select any that are appropriate)

- o Fixed carbohydrate portions or exchanges (prescribed amounts of carbohydrate at meals and snacks)

- o Flexible carbohydrate portions or exchanges (range of portions or exchanges at meals and snacks)

- o Australian Guide to Healthy Eating carbohydrate serves

- o General information regarding small meals and snacks spread out over the day

- o Plate model

- o Not applicable – carbohydrate distribution not discussed

- o Other - please specify _____

For what reasons are these your chosen teaching tools with women with GDM?

_____

_____

_____

Under what circumstances would you teach carbohydrate portions or exchanges in the dietary management of GDM?

- o Used for all women with GDM

- o Used for women requiring insulin only

- o Used as appropriate (dependent on language skills, level of education etc)

- o Not applicable – carbohydrate portions or exchange not used

Comment:

_____

_____

What advice do you provide to women with GDM regarding the use of artificial (non-nutritive) sweeteners?

- o Use any sweeteners as desired

- o Avoid saccharin (954) and cyclamate (952), and use other sweeteners as desired

- o Avoid saccharin (954) and cyclamate (952), and use other sweeteners in small amounts only

- o Use any sweeteners in small amounts only

- o Avoid all sweeteners

- o No advice regarding artificial sweeteners provided

- o Other – please specify _____

What advice do you provide to women with GDM regarding the glycemic index (GI)?

- o Include at least <u>one</u> low GI carbohydrate at each meal

- o Include at least <u>one</u> low GI carbohydrate at each meal <u>and</u> snack

- o <u>All</u> carbohydrate foods should be low GI

- o Avoid high GI foods

- o No advice regarding GI provided

- o Other – please specify _____

Do you provide specific advice about appropriate weight gain for pregnancy to women with GDM as part of your dietetic practice?

- o Yes

- o No

- o Sometimes

If YES, what weight gain targets do you recommend?

_____

_____

Overall how confident do you feel providing dietary advice for the management of GDM?

Very confident   Confident   Somewhat confident   Not confident

Comment:

_____

_____

Do you believe that your service/centre currently offers adequate dietetic services for women with GDM?

- o   Yes

- o   No

- o   Unsure

Comment:

_____

_____

POST-NATAL LIFESTYLE

Does your service provide a post-natal glucose tolerance test reminder or notification program for women with GDM?

- o   Yes

- o   No

- o   Unsure

Comment:

_____

_____

Do you see women with GDM for type 2 diabetes prevention AFTER their GDM pregnancy?

- o   Yes

- o   No

- o   Sometimes

If NO, do you refer these women to another service (e.g. general dietetic clinic, community prevention program) after their GDM pregnancy?

- o   Yes

- o   No

- o   Sometimes

Comment:

_____

_____

Do you provide any information or advice during ante-natal dietitian visits regarding lifestyles changes for future type 2 diabetes prevention?

- o   Yes

- o   No

- o   Sometimes

Comment:

_____

_____

Do you provide any specific advice about post-natal weight management as part of your dietetic practice?

- o Yes

- o No

- o Sometimes

Comment:

_____

_____

Do you provide any specific advice about breastfeeding to women with GDM as part of your dietetic practice?

- o Yes

- o No

- o Sometimes

Comment:

_____

_____

How would you describe risk or chance of a woman developing type 2 diabetes within 10 years of a pregnancy affected by GDM?

- o Low risk (<10%)

- o Moderate risk (10-30%)

- o High risk (>50%)

- o Other – please specify _____

Do you believe that your service/centre currently offers adequate post-natal lifestyle interventions (or referrals) for the prevention of future diabetes in women with GDM?

- o   Yes

- o   No

- o   Unsure

Comment:

_____

_____

SCREENING & MANAGEMENT GUIDELINES

Does your service (or area health service) recommend routine GDM screening for <u>all</u> pregnant women?

- o   Yes

- o   No

- o   Unsure

- o   Not applicable

Comment:

_____

_____

Are clients with GDM routinely weighed during visits to your service?

- o Yes

- o No

- o Unsure

Comment:

_____

_____

Does your service recommend self-blood glucose monitoring for women with

GDM?

- o Yes

- o No

- o Unsure

Comment:

_____

_____

If YES, please specify the blood glucose testing <u>times</u> recommended by your service

(Select any that are applicable)

- o Fasting

- o 1 hour post-prandial

- o 2 hour post-prandial

- o Unsure

Other – please specify _____

What recommendations does your service currently make for <u>target</u> blood glucose levels (mmol/L)? (Indicate any that are applicable)

Fasting _____ _ mmol/L

1 hour post-prandial _____ _ mmol/L

2 hour post-prandial _____ _ mmol/L

Other – please specify _____ _ mmol/L

PRACTICE GUIDELINES & NUTRITION RECOMMENDATIONS

Does your service have written nutrition recommendations (e.g. specifying the macro and micronutrient content of the diet) for the management of GDM?

o   Yes

o   No

o   Unsure

If YES, how were these nutrition recommendations developed?

o   Health professional consensus

o   Published nutrition recommendations (e.g. American Diabetes Association)

o   Other - please specify _____

Does your service have written dietetic practice guidelines or protocols (e.g. specifying the frequency of visits, information to be covered in each session etc) for the management of GDM?

- o Yes

- o No

- o Unsure

If YES, how were these guidelines developed?

- o Health professional consensus

- o US or international guidelines

- o Other – please specify _____

Do you believe that there is a need for DAA endorsed evidence based GDM nutrition recommendations or dietetic practice guidelines?

| Nutrition Recommendations | YES | NO | UNSURE |
| Dietetic Practice Guidelines | YES | NO | UNSURE |

Would you like to make any additional comments in regards to your current dietetic practice in GDM?

_____

_____

_____

_____

_____

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS SURVEY!

If you would like to receive a complimentary copy of the Diabetes Australia *Healthy*

***Shopping Guide* 2008 edition, please complete you details below (your personal**

details will not be linked to your survey responses):

Name:

Organisation:

Department:

Address:

City/Town:

State:

Postcode:

Appendix D: Breastfeeding survey

GDM Infant Feeding Survey

Introduction

Thank you for your interest in participating in the Gestational Diabetes Infant Feeding Survey.

Please click "Next" to provide consent to participate and start the survey.

THANK YOU...

Consent to participate

Please select your choice below.

Clicking on the "agree" button below indicates that:
* you have read the participant information statement
* you voluntarily agree to participate
* you are at least 18 years of age

If you do not wish to participate in the research study, please click on the "disagree" button.

1. I give my consent to participate in this survey.

◯ Agree

◯ Disagree

Consent to participate

You have decided not to participate in this research.

Should you wish to participate, please click "previous" and click "agree", otherwise thank you for your time.

Instructions for completing survey

Completion of the survey will take approximately 15 minutes. There are no right or wrong answers to the questions.

Please respond to each question by either:
- using your mouse to click on the response that is most applicable to you
- clicking on the answer box & typing in the required information (you can also tab between boxes)
- selecting from the drop down menu

At the end of each page click "Next". To change or review an answer click "Previous".

When you have finished the survey click "Done".

About you...

These questions are about where you live and what you do. We recognise that some of the questions are very personal. Please remember that your responses will remain strictly confidential.

GDM Infant Feeding Survey

2. What is your date of birth?

DD   MM   YYYY

Please enter your date of birth   [ ] / [ ] / [ ]

3. What is the postcode of where you live at the moment?

Please enter postcode   [ ]

About you...

4. In what country or region were you born?

- ◯ Australia
- ◯ United Kingdom / Ireland
- ◯ New Zealand
- ◯ Southern or South Eastern Europe (e.g. Greece, Italy, Spain, Portugal)
- ◯ Northern or Western Europe (e.g. France, Germany, Netherlands)
- ◯ Eastern Europe (e.g. Poland, Russian Federation, Hungary)
- ◯ Middle East or North Africa (e.g. Lebanon, Egypt, Iraq, Turkey)
- ◯ South Asia (e.g. India, Sri Lanka)
- ◯ North Asia (e.g. China, Korea, Japan, Taiwan)
- ◯ South East Asia (e.g. Vietnam, Indonesia, Philippines, Singapore, Malaysia)
- ◯ South Pacific Islands (e.g. Samoa, Fiji)
- ◯ Other (please specify)

  [ ]

About you...

5. What is the main language that you speak at home?

- ◯ English
- ◯ Italian
- ◯ Greek
- ◯ Spanish
- ◯ Cantonese
- ◯ Other (please specify)

- ◯ Mandarin
- ◯ Arabic
- ◯ Hindi
- ◯ Sinhalese
- ◯ Tamil

- ◯ Tagalog
- ◯ Vietnamese
- ◯ Samoan

[ ]

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6. How well do you speak English?

○ Very well

○ Well

○ Not well

○ Not at all

About you...

7. Are you of Aboriginal or Torres Strait Islander origin?

○ No

○ Aboriginal origin

○ Torres Strait Islander origin

8. What is the highest educational qualification that you have achieved?

○ No formal qualification

○ Year 10 or equivalent (e.g. school certificate)

○ Year 12 or equivalent (e.g. higher school certificate)

○ Trade/apprenticeship (e.g. hairdresser/chef)

○ Certificate or diploma (e.g. child care/technician)

○ University degree (e.g. bachelor degree)

○ Higher university degree (e.g. Grad Dip/Honours/Masters/PhD)

About you...

9. What is your present marital status?

○ Married

○ Defacto

○ Separated

○ Divorced

○ Widowed

○ Never married

10. Were you employed outside the home or studying during your gestational diabetes pregnancy in 2010? (Answer YES if you were employed but on leave)

○ Yes

○ No

GDM Infant Feeding Survey

About you...

11. If you went back to work/study after this baby was born, how old was this baby when you returned to work?

○ Less than 1 month

○ 2 months

○ 3 months

○ 4 months

○ 5 months

○ 6 months

○ 7 months

○ 8 months

○ 9 months

○ 10 months

○ 11 months

○ 12 months

○ More than 12 months

○ Did not return to work

Comment (optional)

About you...

12. Did you return to work/study full-time or part-time after the birth of this baby?

○ Full-time

○ Part-time

○ Other (please specify)

13. Did you receive paid maternity leave after the birth of this baby?

○ Yes

○ No

About you...

14. What is your occupation? (If currently unemployed, please give your occupation or job title prior to leaving the workforce. If you were self-employed, please give your occupation or job title e.g. hairdresser.)

15. What is your partner's occupation? (If self-employed, please give your partner's occupation or job title e.g. plumber, electrician. If your partner is currently unemployed, please give your partner's occupation when working.)

GDM Infant Feeding Survey

16. What is your annual gross (before tax) household income?

○ less than $18,200

○ $18,200 to 25,999

○ $26,000 to $33,799

○ $33,800 to $41,599

○ $41,600 to $51,999

○ $52,000 to $62,399

○ $62,400 to $72,799

○ $72,800 to $88,399

○ $88,400 to $103,999

○ $104,000 to $129,999

○ $130,000 or more

Your health and lifestyle...

These questions ask you about your lifestyle habits BEFORE you were diagnosed with gestational diabetes in 2010.

17. Did you smoke before your 2010 gestational diabetes pregnancy?

○ Yes

○ No

Your health and lifestyle...

18. How often did you smoke?

○ Less than 10 cigarettes per day

○ 10 or more cigarettes per day

Your health and lifestyle...

19. What was your weight (without clothes or shoes) before your 2010 gestational diabetes pregnancy?

Weight in kilograms

20. How tall are you (without shoes)?

Centimetres e.g. 165 cm enter as 165

OR Feet and inches e.g 5 foot 2 inches enter as 5ft 2

About gestational diabetes...

The remaining questions relate to previous pregnancies and your diagnosis of gestational diabetes in 2010.

The following question is of a sensitive nature and may be distressing for some people. If you need support because of miscarriage, stillbirth or neonatal death, please contact the Miscarriage, Stillbirth & Neonatal Death support network SANDS on 13 000 SANDS 13 000 72637. Sands support is provided by trained parent supporters who have themselves experienced the loss of a baby.

GDM Infant Feeding Survey

21. What was the outcome of the pregnancy in 2010 in which you were diagnosed with gestational diabetes?

○ Live birth (more than 36 weeks)

○ Premature live birth (36 weeks or less)

○ Stillbirth, miscarriage or neonatal death

Thank you...

Thank you for your time in completing this survey.

If you need support in relation to miscarriage, stillbirth or neonatal death, please call SANDS on 1300072637 to talk to another parent who has also experienced the loss of a baby.

About gestational diabetes...

These questions ask you about previous pregnancies and being diagnosed with gestational diabetes in 2010.

The following question is of a sensitive nature and may be distressing for some people. Should you choose not to answer this question please select NEXT. If you need support in relation to having previously experienced miscarriage, stillbirth or neonatal death, please call SANDS, the Miscarriage, Stillbirth & Neonatal Death support network on 13 000 SANDS 13 000 72637. Sands support is provided by trained parent supporters who have themselves experienced the loss of a baby.

22. How many times have you had each of the following?

	None	One	Two	Three	Four	Five or more
Live birth (more than 36 weeks)	○	○	○	○	○	○
Premature live birth (36 weeks or less)	○	○	○	○	○	○
Miscarriage, stillbirth or neonatal death	○	○	○	○	○	○

About gestational diabetes...

23. How many times have you been diagnosed with gestational diabetes?

○ Once

○ Twice

○ Three times

○ Four times

○ Five or more times

GDM Infant Feeding Survey

24. In what year(s) were you diagnosed with gestational diabetes?

☐ 2002 or before ☐ 2003 ☐ 2004 ☐ 2005 ☐ 2006 ☐ 2007 ☐ 2008 ☐ 2009 ☐ 2010 ☐ 2011 ☐

About gestational diabetes...

25. How was your gestational diabetes managed during your pregnancy in 2010?

☐ Diet controlled

☐ Diabetes tablets (e.g. metformin, diaformin, diabex)

☐ Insulin injections

26. What was the date of birth of your baby from your 2010 pregnancy with gestational diabetes ?

	DD	MM	YYYY
Please enter baby's date of birth	☐ /	☐ /	☐

27. Was this pregnancy a twin or multiple birth pregnancy?

○ Yes

○ No

About gestational diabetes...

28. Please enter the weights of each baby from this multiple birth pregnancy. Please enter weight in grams e.g. enter a 2.8kg baby as 2800.

Baby 1 weight in grams	☐
Baby 2 weight in grams	☐
Baby 3 weight in grams	☐
Baby 4 weight in grams	☐

About gestational diabetes...

29. What was the birth weight of this baby?

Please enter weight in grams e.g. enter a 3.2kg baby as 3200   ☐

About gestational diabetes...

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GDM Infant Feeding Survey

30. What was the method of delivery for this baby?

◯ Caesarean delivery

◯ Unassisted vaginal delivery

◯ Assisted vaginal delivery (e.g. forceps, vacuum extraction)

31. Were there any birth complications for this baby (e.g. low blood sugar levels, respiratory problems)?

◯ Yes

◯ No

Comment (optional)

32. Was this baby admitted to a special care nursery?

◯ Yes

◯ No

Comment (optional)

About infant feeding...

The questions relate to feeding your baby from your 2010 pregnancy with gestational diabetes.

33. Before this pregnancy did you plan on breastfeeding this baby?

◯ Yes

◯ No

◯ Unsure

About infant feeding...

34. For how long did you plan on breastfeeding this baby?

◯ Less than 3 months

◯ 3-6 months

◯ 6 months or more

About infant feeding...

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GDM Infant Feeding Survey

35. Was this baby 'ever' breastfed? ('Ever' breastfed means that the baby at some point in time received breast milk by breastfeeding or as expressed breast milk through a bottle).

○ Yes

○ No

About infant feeding...

36. Did you ever try to breastfeed this baby?

○ Yes

○ No

About infant feeding...

37. What were the reasons that you decided to bottle feed from the start? (You may select more than one reason)

☐ Infant formula is better for the baby

☐ Bottle feeding is easier

☐ I don't like breastfeeding

☐ I was going back to work soon after the birth of this baby

☐ Breastfeeding affects how your breasts look

☐ The baby's father preferred bottle feeding

☐ Formula is just as good as breast milk

☐ The baby's father can help with bottle-feeding

☐ To know how much milk the baby gets at each feed

☐ I wanted to continue smoking

☐ I wanted to continue drinking alcohol

☐ I was playing a lot of sport

☐ Breastfeeding is too embarrassing

☐ My mother suggested bottle feeding

☐ A friend / relative suggested bottle feeding

☐ A health professional (e.g. doctor, nurse) suggested bottle feeding

☐ Other (please specify)

About infant feeding...

38. What was the first feed that your baby received?

○ Breastmilk (or colostrum)

○ Infant formula

○ Other (please specify)

39. Was this baby put to the breast to feed within 30 minutes of birth?

○ Yes

○ No

40. Did you have any problems breastfeeding this baby in hospital?

○ Yes

○ No

About infant feeding...

41. What breastfeeding problems did you have in hospital?

☐ Cracked or sore nipples   ☐ Baby had problems sucking

☐ Baby got too much milk   ☐ Breasts engorged (too full)

☐ Baby got milk too fast   ☐ Mastitis

☐ Took a long time before milk started flowing at start of feed   ☐ Not enough milk

☐ Baby too tired to feed / not waking up for feeds   ☐ Felt that I wasn't doing very well breast-feeding

☐ Difficulty expressing milk   ☐ Trouble positioning and/or attaching the baby to the breast

☐ Baby lost or did not gain enough weight

☐ Other (please specify)

About infant feeding...

42. Did this baby receive any infant formula while in hospital?

○ Yes

○ No

43. Was this baby breastfed (or having expressed breast milk) when you first came home from hospital?

○ Yes

○ No

44. Did you have any problems breastfeeding this baby when you came home?

○ Yes

○ No

GDM Infant Feeding Survey

About infant feeding...

45. What breastfeeding problems did you have at home?

- [ ] Cracked or sore nipples
- [ ] Baby got too much milk
- [ ] Baby got milk too fast
- [ ] Took a long time before milk started flowing at start of feed
- [ ] Baby too tired to feed / not waking up for feeds
- [ ] Difficulty expressing milk
- [ ] Baby lost or didn't gaining enough weight
- [ ] Other (please specify)

- [ ] Baby had problems sucking
- [ ] Breasts engorged (too full)
- [ ] Mastitis
- [ ] Not enough milk
- [ ] Felt that I wasn't doing very well at breast-feeding
- [ ] Trouble positioning and/or attaching the baby to the breast

About infant feeding...

46. How old was this baby when you stopped breastfeeding (or giving expressed breastmilk) COMPLETELY?

- ( ) Baby was never breastfed
- ( ) Less than one week
- ( ) 1-3 weeks
- ( ) 1 month
- ( ) 2 months
- ( ) 3 months
- ( ) 4 months
- ( ) 5 months

- ( ) 6 months
- ( ) 7 months
- ( ) 8 months
- ( ) 9 months
- ( ) 10 months
- ( ) 11 months
- ( ) 12 months or more
- ( ) Still breastfeeding this baby

About infant feeding...

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47. What was the main reason you stopped breastfeeding this child?

○ Felt it was time to stop

○ Teething

○ Baby decided to wean

○ Returned to work

○ Pregnant

○ Not producing any/enough milk

○ Other problems with breastfeeding eg cracked nipples

○ Other (please specify)

About infant feeding...

48. Was this baby supplemented with infant formula regularly at any time while you were breastfeeding?

○ Yes

○ No

Comment (optional)

About infant feeding...

49. From what age was this baby regularly given infant formula as well as breastmilk?

○ Less than 1 month

○ 1 month

○ 2 months

○ 3 months

○ 4 months

○ 5 months

○ 6 months

○ 7 months

○ 8 months

○ 9 months

○ 10 months

○ 11 months

○ 12 months or more

About infant feeding...

GDM Infant Feeding Survey

50. In the first six months was this baby regularly given any other liquids (e.g. water, juice or other drinks) or solids while you were breastfeeding?

○ Yes

○ No

51. Were you given any information or advice about breastfeeding from your diabetes educator, dietitian, nurse/midwife or the doctor looking after your gestational diabetes?

○ Yes

○ No

○ Unsure

About infant feeding...

52. What kind of information were you given? (select any that apply)

☐ Pamphlets or booklets on breastfeeding your baby

☐ Lectures or classes (with or without a demonstration) on breastfeeding your baby

☐ Video / DVD on how to breastfeed your baby

☐ Individual consultation, discussion or demonstration about breastfeeding your baby

☐ Other (please specify)

About infant feeding...

53. Did you suffer from post-natal depression after the birth of this baby?

○ Yes

○ No

54. Prior to this pregnancy had you ever breastfed ANOTHER baby?

○ Yes

○ No

55. What do you understand to be the recommended age to which a baby should be "EXCLUSIVELY" breastfed?(Exclusively breastfed means that the baby only receives breastmilk, and is not given infant formula or other food/drinks)

Months (please click on the box and select an answer)

About infant feeding...

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GDM Infant Feeding Survey

56. Do you believe that you received enough breastfeeding support from health professionals?

○ Yes

○ No

○ Unsure

57. Did you access any of the following breastfeeding support services for this baby?

☐ Lactation consultant or breastfeeding clinic

☐ Midwife or baby health nurse home visit

☐ Australian Breastfeeding Association services

☐ Family care cottage / Tresillian / Karitane services

☐ Did not access any of these services.

☐ Other (please specify)

_____

About breastfeeding...

These questions ask you your feelings about breastfeeding. You will need to use the scroll bar on your computer to scroll down and see all of the statements.

GDM Infant Feeding Survey

58. For each of the following statements, please indicate how much you agree or disagree
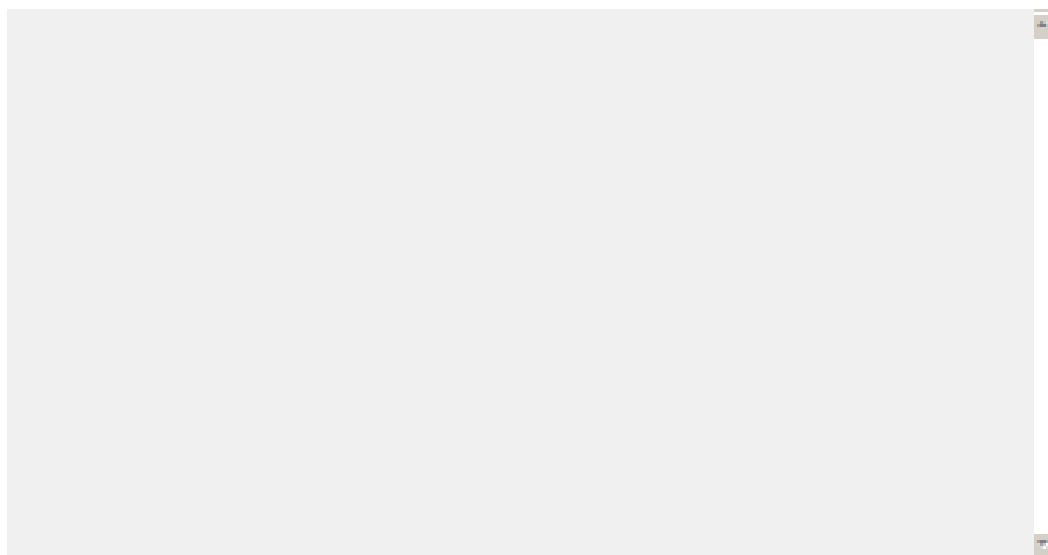
	Strongly disagree	Disagree	Neutral	Agree	Strongly agree
It is more difficult for a woman with gestational diabetes to breastfeed when compared to a woman without gestational diabetes	○	○	○	○	○
The benefits of breastfeeding last only until the baby is weaned from breast milk	○	○	○	○	○
Formula feeding is more convenient than breastfeeding	○	○	○	○	○
Breastfeeding increases mother-infant bonding	○	○	○	○	○
Breast milk is lacking in iron	○	○	○	○	○
Formula feeding is a better choice if a mother plans to go back to work	○	○	○	○	○
Mothers who formula feed miss one of the great joys of motherhood	○	○	○	○	○
Women should not breastfeed in public places such as restaurants	○	○	○	○	○
Babies fed breast milk are healthier than babies who are formula fed	○	○	○	○	○
Formula fed babies are more likely to be overfed than are breastfed babies	○	○	○	○	○
Fathers feel left out if a mother breastfeeds	○	○	○	○	○
Breast milk is the ideal food for babies	○	○	○	○	○
Breast milk is more easily digested than formula	○	○	○	○	○
Formula is as healthy for an infant as breast milk	○	○	○	○	○
Breastfeeding is more convenient than formula feeding	○	○	○	○	○
Breast milk is less expensive than formula	○	○	○	○	○
A mother who occasionally drinks alcohol should not breastfeed her baby	○	○	○	○	○

Your experiences...

Please feel free to share your breastfeeding experiences (positive or negative).

59. Are there any other comments that you would like to share about your experiences breastfeeding after a gestational diabetes pregnancy?

Would you like to enter the prize draw?

60. Would you like to enter the draw to win one of 5 x $50 Coles Myer Gift Vouchers?

○ Yes

○ No

To enter the prize draw...

61. To enter the draw, please provide your contact details below. Any information that you provide is confidential and will not be shared with any other party or linked to your survey responses.

Name:

Email Address:

Phone Number:

Further research...

THANK YOU FOR TAKING THE TIME TO COMPLETE THIS SURVEY.

Are you interested in participating in further research?

We are seeking women who are interested in participating in telephone interviews to further describe their infant feeding experiences following a gestational diabetes pregnancy.

If you are interested in participating, please complete the contact form below and we will email you to arrange a suitable time for a short (20 minute) telephone interview.

GDM Infant Feeding Survey

To thank you for your time all participants who complete the telephone interviews will be eligible to receive a complimentary "Healthy Lifestyle Package" consisting of a pedometer, the latest version of the Diabetes Australia "Healthy Shopping Guide" and a copy of the Australian Diabetes Council "Invigorate" magazine.

62. If you are interested in participating, please select "Yes" below. If you would prefer not to participate, please select "No"

◯ Yes

◯ No

63. If you are interested in participating in a follow-up telephone interview, please provide your details below. The information you provide will not be used for any other purposes and you are free to decline participating at any time.

Name:

Address:

Suburb:

State:

Post Code:

Email Address:

Phone Number:

64. Please indicate the best day(s) for contacting you.

☐ Monday ☐ Tuesday ☐ Wednesday ☐ Thursday ☐ Friday ☐ Saturday ☐ Any day

65. Please indicate the best time for contacting you.

☐ Morning ☐ Afternoon ☐ Evening

Thank you, we will be in contact with you soon to arrange a telephone interview.

You have now completed the survey.

Thank you for your assistance with this research.

Appendix E: Permission letters regarding copyright

DATE: July 4, 2013

SPRINGER REFERENCE

2011 Gestational Diabetes During and After Pregnancy

Editors: Catherine Kim, Assiamira Ferrara

ISBN: 978-1-84882-119-4

Fig. 9.1 on page 127

YOUR thesis:

University:	University of Newcastle Australia
Title:	"An investigation into the dietary management of gestational diabetes in Australian women and postnatal health and lifestyle behaviours for future diabetes risk reduction"

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