Review article

A review of interventions to prevent Type 2 Diabetes after Gestational Diabetes

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ABSTRACT

Background: Gestational Diabetes Mellitus (GDM) during pregnancy is a risk factor for the development of Type 2 Diabetes (T2DM) within 15 years, and prevention programmes have been problematic.

Question: The aim of the study is to identify effective strategies and programmes to decrease the risk of T2DM in women who experience GDM, the barriers to participation, and the opportunities for midwives to assist women in prevention.

Methods: English language, peer reviewed and professional literature published between 1998 and 2013 were searched. A systematic review of the literature was undertaken, included studies were then appraised for quality and finally findings of the studies were thematically analysed.

Findings: This review identified that there are interventions that are effective, however most lifestyle changes are difficult to translate into everyday life. As the incidence of GDM is expected to rise, midwives’ role in promoting long-term health behaviours requires further review.

Conclusions: Women need to overcome barriers and be supported in making the behavioural changes necessary to prevent T2DM following GDM. Midwives as the primary carers for women in pregnancy and childbirth are ideally positioned to educate women and engage them in lifestyle and behaviour programmes that prevent the onset of Type 2 Diabetes.

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1. Introduction

Worldwide, the incidence of Gestational Diabetes Mellitus (GDM) has been increasing over the last 15 years along with increasing obesity rates. The incidence of GDM in Australia was 5% in 2008, however under new diagnostic criteria the rate could be as high as 13%. With escalating rates of diagnosis midwives will play an increasingly important role in the care of women with GDM, collaborating with the specialist care team of endocrinologists, obstetricians, diabetes educators and dietitians.

Gestational Diabetes Mellitus is carbohydrate intolerance recognised or first diagnosed during pregnancy. The original identification of GDM by O’Sullivan in the 1960s using the Oral Glucose Tolerance Test (OGTT) was the first step in recognising the importance of this condition in pregnancy. Since then the Hyperglycaemia and Adverse Pregnancy Outcome (HAPO) study has reinforced the associations between elevated maternal blood glucose control and adverse neonatal outcomes including increased birth weight, foetal adiposity and umbilical cord blood C-peptide levels. The results of this landmark study have led to a greater understanding of glucose metabolism during pregnancy and the revision of diagnostic criteria for blood glucose levels for GDM.

It is important for midwives to understand the relationship between GDM and Type 2 Diabetes Mellitus (T2DM), the impact on the index pregnancy, and the effect on future health of mothers and their infants in order to provide women with
relevant evidence-based care and advice for the long-term wellbeing of themselves and their families. The relationship between the diagnosis of GDM and the onset of T2DM has been the focus of numerous reports, studies and reviews over the last decade, and GDM has emerged as one of the strongest predictors of T2DM with the cumulative incidence of T2DM ranging from 2.6% to 70% from 6 weeks to 28 years post-partum.6-11

Documented risk factors for GDM are similar to those for T2DM, and include older maternal age (>35), obesity (BMI > 30 kg/m²), family history of Type 1 or Type 2 diabetes, and a diet high in saturated fat.12 Common risk factors in the development of GDM and T2DM underlie the temporal relationship between these two conditions, leading to a high risk of development of T2DM following the GDM pregnancy.4

The identification of women who face the consequent risk of developing T2DM during their pregnancy provides midwives with an opportunity to individually, and with other members of the multi-disciplinary team, initiate education and support women in interventions to decrease modifiable risk factors such as high BMI, excess gestational weight gain, and insufficient physical activity.13 The opportunity to intervene is not restricted to the antenatal period but extends into the postnatal period and to the pre-conception phase of a subsequent pregnancy. The Australasian Diabetes in Pregnancy Society (ADIPS) guidelines recommend follow up care in collaboration with General Practitioners, and include an OGTT at 8-12 weeks postpartum, with diagnosis of T2DM according to WHO criteria and then 1 to 2 yearly depending on risk factors.14 Women planning to conceive again should have an annual OGTT to exclude T2DM prior to conception.9 While the OGTT is an essential diagnostic and screening tool compliance with guidelines has been sporadic at best.15,16

Obesity is an independent risk factor for the development of T2DM, so the identification of women with both GDM and obesity is important to allow tailored and targeted delivery of information and programmes to support this population.17 Despite this recognition, lifestyle changes in new mothers to prevent or delay the onset of T2DM have been difficult to deliver or to engage women.18 In addition to the long-term increased risk of T2DM, the infant/child of a GDM pregnancy has a two-fold increase of being overweight.19 Animal models have also shown increased obesity and altered glucose metabolism in offspring of mothers who had GDM,20 and developing and promoting interventions to the population of mothers with young children both in the antenatal and immediate postpartum period may lead to a “whole of family” approach and to the prevention of a suite of chronic diseases.20 Midwifery intervention, referral and/or collaboration with appropriate multi-disciplinary team members during pregnancy may have a profound effect not only on the current pregnancy outcomes, but also on the future health of the mother, her infant and family.

Although women may be aware of the risks of future development of T2DM, they may not always act on this knowledge and initiate lifestyle changes suggested by health practitioners.21 Tiredness, lack of access to childcarer and work commitments are commonly cited by women as deterrents of their engagement in intervention programmes to delay or prevent T2DM after GDM.22 There are, however, strategies that midwives can initiate in the immediate post-partum that can lead to long-term health changes such as the encouragement and support of breastfeeding.

Breastfeeding is beneficial in the prevention of T2DM in obese women and in those women diagnosed with GDM.23,24 The benefits of breast-feeding depend on the length and intensity of lactation, as longer duration of lactation (up to 9 months) improves glucose metabolism and insulin sensitivity and reduces T2DM risk after GDM diagnosis.25 Difficulties surrounding the establishment of breast feeding and lactation in both obese and GDM women have been documented.23

Midwives are ideally positioned to implement strategies including promotion of early breastfeeding, maintaining supply and long term post-partum breastfeeding support25,26 that may lower a woman’s risk of T2DM and may be beneficial for long term health.26 Continuity of care by a midwifery team has also shown to enhance screening of at risk women identified while pregnant, as well as providing opportunistic education relating to long term lifestyle changes that may delay or prevent T2DM.27

Poorly managed GDM not only results in negative maternal and infant outcomes but also has future fiscal implications if it leads to T2DM. The health care cost of T2DM to society has been examined in the United States where the national economic burden in 2007 attributed to diabetes was approximately $528 billion.28 An Australian study, using a micro-simulation model, demonstrated that the most cost-effective intervention option to decrease T2DM risk is a combined diet and exercise programme aimed at high risk populations with the focus on prevention of T2DM development.29 This recommendation has been strengthened by cost benefit studies which suggest that interventions in this group to delay or prevent the development of T2DM are cost effective.30,31 In summary, the literature indicates that the prevalence of the GDM is increasing and the link between GDM and T2DM has been clearly demonstrated, and makes ethical and economic sense to pursue interventions that may decrease the risk of T2DM in women with GDM.

In order to do so we posed three research questions: How effective are interventions to delay or prevent T2DM in women previously diagnosed with GDM, what are the barriers and enablers to and predictors of women, previously diagnosed with GDM, engaging in interventions designed to delay or prevent T2DM, and what is the role of the midwife to delay or prevent T2DM following a diagnosis of GDM?

2. Methods

The aim of this review is to identify effective strategies and programmes to decrease the risk of T2DM in women who experience GDM, the barriers to participation, and the opportunities for midwives to assist women in prevention.

A three-stage approach was employed in order to answer the research questions. Firstly a systematic review of the literature was undertaken, induced studies were then appraised for quality and finally findings of the studies were thematically analysed.

Between February 2011 and November 2013 we searched CINAHL, Medline and PubMed databases. Key search terms were used, including gestational diabetes, gestational diabetes mellitus, diabetes mellitus, type 2 diabetes, epidemiology, prevalence, incidence, risk factors, barrier*, intervention*, strategy*, prevent*, program*, diet, exercise, midwives, nurse* and breastfeeding. A secondary hand search of the reference lists of retrieved articles yielded further papers for evaluation. Publications dates were limited to the previous 15 years, because this period represents the largest concentration of contemporary research.

Inclusion criteria were: women previously diagnosed with GDM (population), behavioural and pharmacological interventions intended to reduce maternal risk of T2DM (interventions), delay or prevention of development of T2DM (outcomes), English (language), peer reviewed publications or professional publications (source), and 1998 to 2013 (publication time period).

The preliminary search, based on title and abstract, yielded 122 articles. The first author (AP) then reviewed these articles and discarded commentaries, reviews and research that focused on populations other than women who had been diagnosed with GDM. Full text articles were then assessed for eligibility, and included reviews were then assessed by FB (second author). Following this, 30 articles remained (Fig.1). The reporting quality
of the RCTs was assessed using the CONSORT algorithm, to which a numerical score was assigned and those articles having a score of 90% or better were included in further analysis. Because the included studies lacked homogeneity we could not justify a meta-analysis and undertook a thematic approach to data synthesis. Analysis of studies was based on the research questions namely, interventions to prevent or delay T2DM in women previously diagnosed with GDM – summarised in Table 1, barriers, enablers to and predictors of women engaging in interventions to delay or prevent T2DM summarised in Table 2, and the role of the midwife in care of a woman with GDM in Table 3.

3. Results

3.1. Interventions to delay or prevent T2DM in women previously diagnosed with GDM

Of the 30 publications selected for review, 13 studies included interventions to delay or prevent T2DM (Table 1). Of these, eight were Randomised Controlled Trials (RCTs) and five were observational studies. Three RCTs and one observational study also involved a pharmacological intervention. Of the 13 studies, the effectiveness of the interventions varied, and outcomes measured included dietary behaviour change, weight loss and increased physical activity.

The Diabetes Prevention Programme (DPP) RCT studies, with n = 3234 and n = 1776, demonstrated the effectiveness of a lifestyle intervention in preventing the development of T2DM. In 2002, the DPP Research Group used a three arm trial to compare participation in a lifestyle intervention programme (intervention 1) or the use of Metformin (intervention 2) with standard care (control group) to reduce the incidence of T2DM in high risk populations, where a history of GDM was one risk factor. The control group received general written information, highlighting the importance of the US Food Guide Pyramid, and general advice to increase physical activity. The lifestyle intervention, which included a 16-lesson curriculum covering diet, exercise, and behaviour modification was found to be more effective than Metformin in reducing the risk of developing T2DM. When outcomes for women with a history of GDM were compared with those who did not it was found that both the lifestyle and Metformin intervention reduced the incidence of T2DM by approximately 50% compared with the placebo group. The intensive lifestyle intervention was more effective in the non-GDM group and the GDM group were not able to sustain the lifestyle changes over time. A smaller study (n = 17) that delivered the DPP dietary-principles via telephone counselling demonstrated success with weight loss in a high-risk population. The combination of increased risk, less physical activity and consistent weight gain in the GDM group highlights the importance of an intense intervention and long-term follow-up in this group of women.

Smaller RCTs with between 20 and 40 women have demonstrated success with weight loss and dietary change and mixed success with changing physical activity levels. McIntyre and colleagues’ evaluation of developing an individualised physical activity programme for women following a GDM pregnancy found that the average physical activity time increased by 60 min/week when women undertook a programme that mainly comprised of walking, when compared with standard care. While neither Cheung, nor Kim were able to demonstrate increases in physical activity levels in their interventions.
Table 1
Summary of identified studies of effective interventions to delay or prevent Type 2 Diabetes.

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Study design</th>
<th>Setting</th>
<th>Sample studies</th>
<th>Intervention</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buchanen, T.A., Xiang, A.H., Peters, R.K., Kjos, S.L., Marroquin, A., Goico, J., Ochoa, C., Tan, S., Berkowitz, K., Hodis, H.N., Azen, S.P. (2002)</td>
<td>RCT</td>
<td>USA</td>
<td>n = 266</td>
<td>Randomised to receive Troglitazone 400 mg/day or placebo</td>
<td>Diabetes incidence rate was decreased in the intervention group (5.4%) compared with the placebo group (12.1%) (p = 0.001)</td>
</tr>
<tr>
<td>Cheung, N., Smith, B., van der Ploeg, H., Cinnado, N., Bauman, A. (2011)</td>
<td>RCT</td>
<td>Australia</td>
<td>n = 43</td>
<td>12 month patient centred counselling self-management education techniques to change physical activity behaviour</td>
<td>Primary target of 10,000 steps on 5 or more days was not reached (p = 0.34)</td>
</tr>
<tr>
<td>Ferrara, A., Hedderson, M., Albright, C., Ehrlich, S., Quesenberry, C. (2011)</td>
<td>RCT</td>
<td>USA</td>
<td>n = 17</td>
<td>Dietary intervention by phone based on the DPP guidelines</td>
<td>Primary target of returning to pre-pregnant weight – Intervention group higher but not significant (p = 0.07). Intervention more effective in women without excessive gestational weight gain (p = 0.04)</td>
</tr>
<tr>
<td>Kim, C., Draska, M., Hess, M.L., Wilson, E.J., Richardson, C.R. (2012)</td>
<td>RCT</td>
<td>USA</td>
<td>n = 49</td>
<td>13 week walking programme that provided web-based education, pedometer, text message reminders, and an internet forum</td>
<td>There were no significant differences in physical activity (p = 0.20) and weight loss (p = 0.81)</td>
</tr>
<tr>
<td>Knowler, W.C., Barrett-Connor, M., Fowler, S., Hamman, R.F., Lachin, J., Walker, A., Nathan, D.M. (2002)</td>
<td>RCT</td>
<td>USA</td>
<td>n = 3234</td>
<td>Randomised to placebo, Metformin, and lifestyle modification primary-diagnoses of diabetes, secondary-level of physical activity, caloric intake</td>
<td>Lifestyle change (58% [48–66, 95%CI]) and Metformin (31% [17–43, 95%CI]) reduced the incidence of diabetes</td>
</tr>
<tr>
<td>McIntyre, H.D., Peacock, A., Miller, Y.D., Koh, D., Marshall, A.L. (2012)</td>
<td>RCT</td>
<td>Australia</td>
<td>n = 28</td>
<td>Individualised exercise plan with an exercise physiologist</td>
<td>Average time of physical activity (60 [0–540] min/week) increased in the intervention group (p = 0.234)</td>
</tr>
<tr>
<td>Ratner, R.E., Christophi, C.A., Metzger, B.E., Dabelea, D., Bennett, P.H., Pi-Sunyer, X., Fowler, S., Kahn, S.E. (2008).</td>
<td>RCT</td>
<td>USA</td>
<td>n = 1776</td>
<td>Compared outcomes of women who had GDM who had participation in (DPP) lifestyle intervention programme, the use of Metformin, or standard care</td>
<td>Lifestyle intervention (p = 0.002) and Metformin (p = 0.006) reduce the risk of T2DM compared to placebo and control</td>
</tr>
<tr>
<td>Reinhardt, J., van der Ploeg, H., Gregzulka, R., Timperley, J. (2012)</td>
<td>RCT</td>
<td>USA</td>
<td>n = 38</td>
<td>6 month phone based motivational interviewing programme aimed at positive lifestyle change</td>
<td>Weight reduction in the intervention group (95% CI: –7.6 to –0.5) changes in dietary intake</td>
</tr>
<tr>
<td>Cheung, N.W., Smith, B.J., Henriksen, H., Tapsell, L.C., McLean, M., Bauman, A. (2007)</td>
<td>Observational</td>
<td>Australia</td>
<td>n = 20</td>
<td>One year group based lifestyle behaviour change programme</td>
<td>Reduction in weight in participants (p = 0.03)</td>
</tr>
<tr>
<td>Fehler, K.L., Kennedy, L.E., McCargar, L.J., Bell, R.C., Ryan, E.A. (2007)</td>
<td>Observational</td>
<td>Canada</td>
<td>n = 11</td>
<td>Dietary intervention</td>
<td>Eating patterns were changed during the index GDM pregnancy ([1 protein p = 0.01, fibre p = 0.002] but not sustained postpartum</td>
</tr>
<tr>
<td>Gates, D.J., Mick, D. (2010)</td>
<td>Observational</td>
<td>USA</td>
<td>n = 7</td>
<td>Assessing participants perceptions of healthness through the exercise Qiong</td>
<td>Group sessions demonstrated a potential to improve perceptions of healthness in women but not stat significant (p = 0.100)</td>
</tr>
<tr>
<td>Retnakaran, R., Qi, Y., Sermer, M., Connelly, P.W., Ziman, B., Hanley, A.J. (2010)</td>
<td>Observational</td>
<td>Canada</td>
<td>n = 238</td>
<td>Assessing behaviour change post GDM</td>
<td>Leisure time activity was increased in first year in women post GDM (p = 0.002)</td>
</tr>
<tr>
<td>Xiang, A.H., Peters, R.K., Kjos, S.L., Marroquin, A., Goico, J., Ochoa, C., Buchanan, T.A. (2006)</td>
<td>Observational</td>
<td>USA</td>
<td>n = 89</td>
<td>3 years administration of Pioglitazone</td>
<td>The results supported a class effect of Thiazolidinedione drugs to enhance insulin sensitivity, reduce insulin secretory demands and preserve pancreatic β-cell function in intervention group (p = 0.01)</td>
</tr>
</tbody>
</table>

Despite Cheung et al.’s success in increasing physical activity through walking in an observational study delivering a group-based healthy lifestyle programme to women previously diagnosed with GDM, the group’s subsequent RCT based on a structured, behavioural physical activity intervention in women with recent GDM found a small increase in physical activity in the intervention group, but the aim of reaching the target of 10,000 steps/day was not met by the majority of women in the study.
Kim and colleagues’ study examining a programme designed to increase physical activity using a web-based pedometer programme in women recently diagnosed with GDM detected little difference in clinical measurements between the two groups.
However, it was noted by the authors that the addition of a dietary intervention to their programme might have been more effective.41

Observational studies add further support to these findings. In addition to Cheung’s study,42 Gates et al. introduced Qigong, an oriental movement exercise, to a group of woman (with young children) at risk of T2DM,43 and Retnakaran et al. investigated the maintenance of women’s pre-pregnancy leisure time activity and dietary patterns in the year immediately post-partum following the diagnosis of GDM.44 Gates et al. showed participants reported increased time at the Qigong sessions beneficial, increasing their perception of healthiness,45 and Retnakaran et al. had success with increasing their leisure time activity in the year after pregnancy compared with women who did not have GDM. However, the definition of leisure-time activities was limited to walking and television watching, so the inclusion of sedentary activities does not provide clear evidence of the effectiveness of physical activity.46

In contrast, the problem with sustaining dietary changes made during pregnancy into the post-partum period was highlighted by Fehler et al.45 Lifestyle advice, including dietary and physical activity recommendations provided at the time of diagnoses of GDM, were not continued into the postpartum period in a study where 60% of participants failed to return to their pre-pregnant weight, with physical activity levels low or unchanged.45

Studies that primarily looked at pharmacological treatments evaluated in their effectiveness at preventing the development of, or progression to, T2DM were also considered. In 1998, the TRIPOD study recruited high risk Hispanic women with prior history of GDM and demonstrated a significant decrease in T2DM incidence (12.1% in the intervention group compared with 5.4% in the placebo group) following the use of Troglitazone.47 However the drug was removed from use due to adverse hepatic effects.46 In the follow up study (PIPOD), researchers used Pioglitazone to evaluate β-cell function, insulin resistance and the incidence of T2DM in women who had completed the TRIPOD study. The researchers found that Pioglitazone stopped the decline of β-cell function and concluded that Thiazolidinedione drugs could enhance insulin sensitivity, reduce insulin secretory demands, and preserve pancreatic β-cell function, all in association with a reduced rate of progression to T2DM, in Hispanic women with prior GDM.36

In summary, from the 8 RCTs, 5 (Buchanan et al., Ferrara et al., Knowler et al., Ratner et al., and Reinhardt et al.) reported positive results in the intervention groups, and within the 5 observational studies, 3 (Fehler et al., Retnakaran et al., and Xiang et al.), reported positive changes.

3.2. Barriers and enablers to and predictors of women engaging in interventions to prevent or delay the onset of T2DM

Of the total 30 publications selected for review, 14 studies identified barriers to women who have had GDM taking up interventions to prevent or delay T2DM, particularly in relation to instigating and sustaining programmes designed for lifestyle change, such as those presented above. Researchers have examined behaviours, beliefs and issues that may prevent or support this cohort maintaining long term lifestyle changes to prevent or delay the onset of T2DM.

Women described in the studies (Table 2), who have had GDM in a previous pregnancy, were more likely to be overweight, not meeting recommended fruit and vegetables intake, smokers and have low levels of physical activity47,48 compared with women who did not have a diagnosis of GDM. These findings suggest women may not be successful in changing their lifestyles despite the increased risk of T2DM and may need greater assistance in changing these specific behaviours.

A woman’s ability to follow a healthy lifestyle is dependent on her psychological wellbeing, as well as social and cultural support. The difficulty balancing household expectations and leading a healthy lifestyle49 and the complexities of women’s motivations behind these decisions are highlighted in the studies in Table 2. Evans et al. studied women with a history of GDM to explore their health behaviours and their perceived health status compared with their actual experiences in healthy lifestyle changes.30 Important issues to the mother such as ‘the feeling of abandonment’ by health care providers and the hospital following the birth of their baby in contrast to the intensive monitoring during their pregnancy, and the recognition that lifestyle changes are difficult were noted.50 Zehle et al. examined psychosocial factors related to diet, concluding that most women felt that a healthy diet (more vegetables and fewer fried foods) was too great a change from their current behaviours to maintain.51 In a study investigating postnatal lifestyle changes following GDM, despite reporting their concern about progression to T2DM women were not observed to increase their levels of physical activity or lose weight as advised during their pregnancies.52

Symons Downs and Ulbricht noted that most women they surveyed exercised in pregnancy to control their blood glucose levels, whereas during the post-partum period exercise was perceived as important only to assist weight loss. Only 7% of women believed that exercising post-partum would decrease their risk of T2DM despite the education provided during pregnancy.53 A proportion of women in this population group were in the “pre-action” phase for both undertaking sufficient levels of physical activity and taking steps to lose weight. Many reported readiness-to-change behaviour to prevent T2DM; however the majority remained overweight or obese,54,55 indicating that further assistance is required to motivate women to achieve healthier, chronic disease preventing behaviours and lifestyles.

Factors that negatively influence initiation and engagement in physical activity, follow up care following GDM, and specific approaches to encourage women adopt healthy lifestyle changes have been reported by numerous authors (Table 2).22,25,57 Studies report barriers to physical activity including lack of assistance with child care, insufficient time, financial constraints, fatigue, work issues, and lack of social support, all of which prevented women undertaking sufficient physical activity.22,51,57–59

Women also expressed their preference for a programme of support that allowed access from home (e.g. internet based) and/or support from ‘lifestyle coach’.22 Studies targeting women with GDM in the immediate postpartum period using a telephone intervention have attempted to overcome accessibility issues, have been effective, and well received.38,39 Women in both of these studies experienced a greater percentage of weight loss and lifestyle behaviour changes in the intervention group (when compared with usual care). Increased social support and facilitating increased physical activity self-efficacy, as well as a “family friendly” approach, may help increase the proportion of women meeting lifestyle recommendations in this population.53,59

3.3. The role of the Midwife in the care of women with GDM

Of the 30 articles selected for review, 3 articles explored the role of the midwife (Table 3), in particular the need to enhance the role in order to improve the quality of care for women with GDM. The cornerstone of midwifery care has always been women-centred, holistic delivery of safe, evidence-based care, regardless of the individual woman’s level of risk. However, following a diagnosis of GDM, women transition to a “high risk” model of care involving the multidisciplinary team.60 Women newly diagnosed with GDM have described their frustration with the transition to the multidisciplinary team approach, finding the care fragmented
and little psychological support from the different healthcare providers. The positive effects of continuity-of-care during the childbirth journey have been well described, and women identify that they prefer that their pregnancy is 'normalised' after the diagnoses of GDM was made, which may be achieved with a collaborative midwifery and multidisciplinary team approach.

In order to normalise care for women diagnosed with GDM, midwives require specialist knowledge. A review has suggested the option of a diabetes specialist midwife, who has the qualifications and experience to incorporate both diabetes and midwifery care. Such a role could have an impact on improving care during both the antenatal and postnatal periods and support

<table>
<thead>
<tr>
<th>Author and year</th>
<th>Study design</th>
<th>Setting</th>
<th>Sample studied</th>
<th>Method</th>
<th>Thematic findings</th>
</tr>
</thead>
<tbody>
<tr>
<td>Doran, F., Davis, K. (2011)</td>
<td>Quantitative</td>
<td>Australia</td>
<td>n = 72</td>
<td>Surveys reporting surveys to identify barriers and enablers to physical activity</td>
<td>Themes; lack of child care, time constraints, illness, lack of family support; enjoyment and perception of health promotion enhanced activity</td>
</tr>
<tr>
<td>Evans, M., Patrick, L., Wellington, C.M. (2010)</td>
<td>Descriptive, interpretive analysis</td>
<td>Canada</td>
<td>n = 16</td>
<td>Semi-structured interviews and surveys to elicit information regarding general health and health behaviours</td>
<td>Themes; being on one's own, feeling uncertain/not off the hook, staying healthy/making changes, moving on. Sustaining lifestyle changes described as difficult</td>
</tr>
<tr>
<td>Kieffer, E.C., Sinco, B., Kim, C. (2006)</td>
<td>Cross sectional; quantitative</td>
<td>USA</td>
<td>n = 177,420</td>
<td>Telephone surveys assessing physical activity, fruit and vegetable intake, and smoking</td>
<td>Women with a history of GDM were less likely to meet fruit and vegetable guidelines (p &gt; 0.05) and more likely to smoke (p = 0.05)</td>
</tr>
<tr>
<td>Koh, D., Miller, Y.D., Marshall, A.L., Brown, W.J., McIntyre, D. (2008)</td>
<td>Cross sectional; quantitative</td>
<td>Australia</td>
<td>n = 331</td>
<td>Telephone survey assessing physical activity, psychosocial correlates of physical activity</td>
<td>Health enhancing physical activity was low, suggests increasing social support and self-efficacy</td>
</tr>
<tr>
<td>Razeé, H., van der Ploeg, H.P., Blignault, I., Smith, B.J., Bauman, A.E., McLean, M., Wah Cheung, N. (2010)</td>
<td>Thematic analysis</td>
<td>Australia</td>
<td>n = 57</td>
<td>Semi structured telephone interviews on women's experiences and perceptions of GDM and risk of developing T2DM</td>
<td>Themes; differing cultural needs, mental health, social support</td>
</tr>
<tr>
<td>Smith, B.J., Cheung, N.W., Bauman, A.E., Zehle, K., McLean, M. (2005)</td>
<td>Cross sectional; quantitative</td>
<td>Australia</td>
<td>n = 226</td>
<td>Telephone surveys assessing physical activity, self-efficacy, social support and barriers to participation in interventions</td>
<td>Barriers identified; lack of child care, insufficient time, and lack of encouragement</td>
</tr>
<tr>
<td>Stage, E., Ronneby, H., Damm, P. (2004)</td>
<td>Cross sectional; quantitative</td>
<td>Denmark</td>
<td>n = 121</td>
<td>Mailed survey with structured questions on diet, weight loss and exercise</td>
<td>Theme; not able to change lifestyle following GDM</td>
</tr>
<tr>
<td>Swan, W.E., Liaw, S., Dunning, T., Pallant, J.F., Kilmartin, G. (2010)</td>
<td>Cross sectional; quantitative</td>
<td>Australia</td>
<td>n = 77</td>
<td>Mailed questionnaire on stage of behaviour change, physical activity level, and dietary fat intake</td>
<td>Reported readiness for change, weight remained increased</td>
</tr>
<tr>
<td>Symons Downs, D., Ullbrecht, J.S. (2006)</td>
<td>Cross sectional; quantitative</td>
<td>USA</td>
<td>n = 28</td>
<td>Mailed survey on self-reported exercise beliefs and behaviours</td>
<td>Themes; initial feelings of abandonment postpartum, lifestyle changes are difficult</td>
</tr>
<tr>
<td>Zehle, K., Smith, B.J., Chey, T., McLean, M., Bauman, A.E., Cheung, N.W. (2008)</td>
<td>Cross sectional; quantitative</td>
<td>Australia</td>
<td>n = 226</td>
<td>Telephone surveys on dietary behaviours, self-efficacy, social support, preferred methods of lifestyle support</td>
<td>Barriers identified; education. Preferred method; telephone advice from dietitians and health care educator</td>
</tr>
</tbody>
</table>

Table 2
Summary of thematic findings of studies regarding barriers, enablers and predictors to women previously diagnosed with GDM participating in effective interventions to delay or prevent T2DM.
will become more important as more women who are diagnosed with GDM seek midwifery combined with medical care.\textsuperscript{27,62} A cohort study demonstrated the benefits of caring for women post-partum using a midwife-led GDM care clinic in London, particularly in overcoming the poor uptake of postnatal follow up. The postpartum screening clinic increased the number of women who attended for their post GDM screening test, as well as providing opportunistic discussions on long term lifestyle changes to delay or prevent T2DM.\textsuperscript{27}

4. Discussion

This literature review identified thirty studies that varied in their methodological approaches, rigour and findings, thus it is not possible to draw firm conclusions about interventions to prevent Type 2 Diabetes following Gestational Diabetes. Our synthesis of the findings suggests that lifestyle interventions including behaviour modification programmes directed towards weight loss and physical activity may be effective delay or prevention of T2DM following in women previously diagnosed with GDM.\textsuperscript{34} However, there are barriers to the uptake and adherence to lifestyle advice and midwives may be ideally placed to assist with resolving this disconnect.

This population group have risk factors for the development of T2DM, and further research is required to evaluate how these risks can be decreased long term. It makes sense both clinically and financially to explore options that prevents T2DM, rather than treat the disease later in life. If the new diagnostic guidelines are introduced\textsuperscript{14} (and it is beyond the scope of this paper to examine their sensitivity and specificity) this may increase the rate of GDM diagnosis and treatment and have a profound effect on the number of women identified as ‘at risk’ of developing T2DM.

Although this review has shown there are barriers to recruit, retain and engage women in interventions relating to lifestyle and behaviour change, this target cohort is considered ‘high risk’ for development of T2DM within 10–15 years.\textsuperscript{7} The birth of a new baby is a profoundly life changing experience. Issues such as home responsibilities, work and lack of time were cited as reasons for non-participation and further pregnancies, lack of childcare, work, cultural considerations, and family obligations were common themes and resulted in difficulty in recruitment and engagement. Health care programmes aimed at this group need to find a “common ground” where behaviour change to delay or prevent T2DM can be achieved without women feeling that their family life or responsibilities are compromised.

Discussion and education of women regarding the long-term risks by midwives, dietitians and diabetes educators during the antenatal period may encourage women with GDM to consider continuing the lifestyle changes suggested. However, to ensure women remain aware of the ongoing increased risk of T2DM, postnatal programmes need to be developed. These should include reminders and a specified follow up schedule and the design of accessible, preventative health, evidence-based programmes that are systematically delivered to support women in attaining these health goals. An effective behaviour change programme for women who have had GDM should be easily accessible, engaging, and provide, social and institutional support to recruit and maintain this group of the population who are at very high risk of developing T2DM without appropriate health care support.

5. Conclusion

Although the literature relating to the role of the midwife in the care of women with GDM is limited it is clear that this is an emerging role that will be required increasingly in the future, and adapting to a changing maternity care landscape has been the mainstay of the midwifery profession. Midwives are in the unique position of caring for women when risk factors for T2DM are often first recognised. Although the midwives role is completed following the birth and immediate post-partum period, reinforcement of the relationship between GDM and T2DM during the childbirth journey may encourage women to engage in lifestyle changes post-partum that support long term health. Education programmes for midwives that expand their knowledge on the prevention, diagnoses, treatment and management of diabetes will support midwives to provide women in their care with evidence-based information to encourage long term lifestyle changes to delay or prevent T2DM.

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