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Women with type 1 diabetes and women with type 2 diabetes differ in knowledge and beliefs about contraception and pregnancy

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Women with diabetes beliefs about contraception and pregnancy

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Conflict of Interest

Authors have no conflicts to report

Novelty Statement (95 words)

- Despite well documented benefits of pre-pregnancy care in diabetes, women's engagement with pregnancy planning, and attendance at pre-pregnancy care, remain low.
- This may be partly related to women's knowledge and beliefs about preparing for pregnancy.
- This study showed that compared to women with type 2 diabetes, women with type 1 diabetes held stronger beliefs about the benefits of pregnancy planning, felt more confident in accessing pre-pregnancy care and delaying pregnancy until optimal glycaemia achieved.
- Evidence-based strategies are needed to raise awareness of and motivation for pregnancy planning, in particular for women with type 2 diabetes.

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Abstract (247)

Aims: To assess differences in knowledge and beliefs about pregnancy in women with diabetes.

Methods: Questions were from the Australian “*Contraception, Pregnancy & Women’s Health*” survey. Women (18 - 50 years) were eligible if pregnant or planning pregnancy. Knowledge and beliefs items were adapted from the Reproductive Health and Behaviours Questionnaire.

Results: Compared to women with type 2 diabetes (n=103), women with type 1 diabetes (n=526) had higher scores for knowledge about pregnancy in diabetes (type 1 diabetes 9.8 ± 2.4 vs type 2 diabetes 7.7 ± 3.1), beliefs about benefits (type 1 diabetes 18.4 ± 2.2 vs type 2 diabetes 17.2 ± 3.3), cues-to-action (type 1 diabetes 2.7 ± 1.4 vs type 2 diabetes 1.5 ± 1.3) and self-efficacy (type 1 diabetes 22.6 ± 5.5 vs type 2 diabetes 20.2 ± 6.1) (all $p < 0.001$) regarding preparing for pregnancy. Major knowledge gaps were the need for higher dose folate compared to women without diabetes and uncertainty about breastfeeding recommendations. Women with type 1 diabetes believed more strongly in benefits of ‘close to target’ glucose levels prior to pregnancy and using contraception to prevent unplanned pregnancy; they also felt more confident to access pre-pregnancy care and to wait for optimal glycaemia before pregnancy. Women with type 2 diabetes were less aware of contraceptive choices, and risks associated with hyperglycaemia before or early in pregnancy.

Conclusions: The findings highlighted main gaps in knowledge and beliefs about planning for pregnancy. Especially in type 2 diabetes, there is a need for evidence-based messaging and strategies addressing these gaps, to raise understanding to prepare for future pregnancies.

Keywords: diabetes, pregnancy, pre-pregnancy care, knowledge, beliefs

Introduction

Women with pre-existing diabetes can have healthy babies but pregnancies in diabetes can be challenging. Hyperglycaemia at the time of conception, and throughout pregnancy, increases the risks of adverse outcomes for both mother and unborn baby [1]. Pre-pregnancy care, with multidisciplinary support, aimed at optimising glycaemic control before pregnancy can reduce these risks [2, 3]. Despite the well documented benefits, women's engagement with pregnancy planning, and attendance for pre-pregnancy care, remain low [2, 4]. High rates of unplanned pregnancies have been reported [5], with many women seeking care only after becoming pregnant [6].

Qualitative research has shown that although women with diabetes were aware of the need to plan their pregnancy, they perceived a lack of guidance about how this can be achieved [6]. The support available for women planning pregnancy is currently insufficient and not reaching those with the highest needs. Health care system and health professional factors have a major impact on the support provided to women with diabetes of childbearing age [7].

Apart from systemic factors, individual factors could impact on women's decision about seeking pre-pregnancy care. Early, as well as recent research has shown a relationship between higher uptake of pre-pregnancy care and having type 1 diabetes (compared to type 2 diabetes), older age, higher education and socioeconomic status, being employed and in a relationship [8-10]. Knowledge about the increased risks and past preconception counselling did not encourage women to attend pre-pregnancy care [4]. Less is known about women with diabetes health beliefs regarding preparing for pregnancy. Perceived lack of self-management skills, low confidence and self-efficacy may pose barriers for pregnancy planning. The elevated risks in pregnancies of women with diabetes come with an emotional cost. Women reported feelings of anxiety, worry, uncertainty, guilt and less enjoyment of their pregnancy. Much of this stress relates to the need to obtain and maintain glucose levels close to target [11].

The Health Belief Model, which encompasses women's perception of susceptibility (i.e. perceived risk for complications), severity (of complications during pregnancies), benefits and barriers of uptake of pre-pregnancy care, and cues-to-action (e.g. triggers, exposure to information), could enhance understanding the decision about attending preconception care [10, 12]. The Social Cognitive Theory, which includes expectations of desirable action-outcomes (when attending pre-pregnancy care) and

perceived self-efficacy (belief of being able to attend pre-pregnancy care), provides further insights [10, 12]. These components could impact intentions to attend pre-pregnancy care.

Therefore, the aims of the current study were to (1) assess knowledge and beliefs about diabetes in pregnancy in a population-based sample of Australian women with type 1 diabetes or type 2 diabetes and (2) examine potential differences according to type of diabetes. Associations between knowledge and beliefs, and past attendance of pre-pregnancy care were explored.

Our previous research has examined attendance for pre-pregnancy care by sociodemographic characteristics and type of diabetes [9]. The current sub-study provides further insights into the potential role of health knowledge and beliefs in taking up pre-pregnancy care.

Methods

Participants and procedure

The current study uses data from the Australian online survey “*Contraception, Pregnancy & Women’s Health*” among women between 18 to 50 years of age with pre-existing diabetes. A detailed description of the survey design, recruitment and sample characteristics has been published [9]. The aim of this national survey was to gain a better understanding of women’s awareness, knowledge and beliefs regarding contraception and pregnancy in diabetes; to identify gaps in support prior to and during pregnancy; and to inform the development of resources for the National Diabetes Services Scheme (NDSS). Postal invitations were sent to 6000 women registered with the NDSS who met the inclusion criteria (i.e. type 1 or type 2 diabetes, consented to be contacted for research purposes, aged 18-50 years and known postal address). The NDSS is an Australian Government Initiative administered by Diabetes Australia. The NDSS provides access to information, support services and education programs as well as subsidised diabetes-related products. Registration is free to all eligible individuals diagnosed with diabetes.

A reminder postcard was sent three weeks after the initial letter. Additional survey promotion was undertaken through flyers, state and territory diabetes organisations, social media and online diabetes networks. The survey was available for 12 weeks. In total 1101 women completed the survey, of which 954 were eligible (16% response). Deakin University Human Research Ethics Committee approved the study (2014-134). Diabetes Australia conducted the NDSS database search for registrants who met the inclusion criteria.

For this sub-study, women were included if at the time of completing the survey they reported being pregnant or planning a pregnancy (currently or future) (n=629, 66%). Those who were no longer planning a pregnancy were excluded.

Survey content

The survey covered various pregnancy-related topics using open-ended questions, fixed-choice responses and Likert scales. The survey included an adaption of the Reproductive Health and Behaviours Questionnaire (RHAB) with permission of the authors [12, 13]. The RHAB includes constructs from the Health Belief Model (HBM), the Social Cognitive Theory (SCT) and Theory of Reasoned Action (TRA) and has been validated for examining preconception planning in young women with diabetes [14]. Each of these theories contributes unique constructs relevant to the decision-making process related to behavioural change [12].

The adapted questionnaire consisted of 22 items. Five HBM constructs assessed susceptibility (2 items), severity (3), benefits (4), barriers (costs) (2) and cues-to-action (5); two SCT constructs assessed self-efficacy (3) and outcome expectancy (2); one TRA construct assessed intention to attend pre-pregnancy care (1). The TRA attitude and subjective norm constructs were not included, as not deemed highly relevant for the overall aim of the project. Response options were on a 4 or 5-point scale except for self-efficacy (10-point scale) and cues-to-action (yes or no). Item scores for each construct were summed to obtain a total subscale score. Cronbach's alphas for the HBM and SCT constructs varied between 0.47 and 0.74.

Participants completed 13 knowledge statements adapted with permission from Holmes et al. [13] with three response options (true, false, not sure). Each correct answer was given a score of one to calculate a total knowledge score, ranging from 0 to 13.

Sociodemographic and clinical data (e.g. age of diagnosis, diabetes treatment) were collected. Women also indicated whether they had 'ever' attended pre-pregnancy care, and whether they had read or watched the NDSS 'Diabetes in pregnancy' resource (in book and DVD format) freely available to women with pre-existing diabetes, at the time of the survey.

Statistical analysis

Data were analysed using SPSS version 24 (IBM Corp, Somers, NY, USA). Mann-Whitney U tests and Chi-Square test were performed to compare differences in knowledge and beliefs between women with type 1 or type 2 diabetes. In all analyses missing cases were excluded test by test, resulting in different sample sizes for each test. Response options such as 'not applicable', 'don't know', were excluded when comparing

types of diabetes. Statistical significance was set at <0.01 , to adjust for multiple comparisons. A logistic regression analysis was conducted to explore the predictive value of knowledge and beliefs in past uptake of pre-pregnancy care.

Results

Participant characteristics

In this sub-sample, 84% (n=526) women had type 1 diabetes and 16% (n=103) had type 2 diabetes (Table 1). The majority (n=369, 59%) had not been pregnant since being diagnosed with diabetes. Seven percent (n=44) was pregnant at the time of completing the survey. Compared to women with type 1 diabetes, women with type 2 diabetes were older, more likely to be born overseas, living in rural areas, less likely to have a tertiary education or being employed (Table 1). They also had diabetes for a shorter time.

With regard to the NDSS 'Diabetes in pregnancy' resources, 176/504 (35%) women with type 1 diabetes and 14/100 (14%) of women with type 2 diabetes recalled having read the booklet, while 53/504 (11%) women with type 1 diabetes and 5/100 (5%) women with type 2 diabetes had watched the DVD.

Knowledge about diabetes and pregnancy

For 12 of the 13 statements, women with type 1 diabetes had more correct answers than women with type 2 diabetes (Table 2). Overall a large majority was well aware that women with diabetes can have healthy babies and that women should get pregnancy advice, before becoming pregnant. Participants were less aware of the risks associated with above target glucose levels early in pregnancy and recommendation to breastfeed. The number of incorrect responses was overall low, with one exception regarding folate (folic acid) dosage. One third to half of the women believed that the dosage would not be different for women with or without diabetes. Overall, women with type 2 diabetes were more likely to respond 'not sure' to knowledge questions compared to women with type 1 diabetes (Table 2).

The total knowledge score (range 0-13) was higher for women with type 1 diabetes than for women with type 2 diabetes (median type 1 diabetes 10 vs type 2 diabetes 8; $p < 0.001$) (Table 3).

Women who reported having read the NDSS 'Pregnancy in diabetes' booklet or watched the DVD scored higher on knowledge compared to those who had not/were not sure (n=604; booklet: median 11 versus 9, $p < 0.001$; DVD: median 10 versus 9, $p < 0.001$).

Beliefs about diabetes and pregnancy

Table 3 shows mean (SD) and median for the subscales of the socio-cognitive models according to type of diabetes. Women with type 1 diabetes scored significantly higher on the HBM subscales 'benefits' and 'cues-to-action' compared to women with type 2 diabetes ($p < 0.001$). There was a marginal difference for 'severity' ($p < 0.05$), and no difference for 'susceptibility' and 'barriers'. For SCT subscales, women with type 1 diabetes scored higher on 'self-efficacy' ($p < 0.001$) than women with type 2 diabetes, but not on 'outcome expectancy'. However, differences between actual scale scores for the theoretical constructs were small with the exception of 'cues-to-action' and 'self-efficacy' (Table 3). For the TRA construct 'intention', irrespective of type of diabetes, 89% of the women said they would attend pre-pregnancy care for future pregnancy.

Further exploration of 'benefits' showed that women with type 1 diabetes held strong beliefs that having glucose levels within target before pregnancy would improve their chances of having a healthy baby (type 1 diabetes 79% versus type 2 diabetes 56%); also that using contraception would prevent unplanned pregnancy (type 1 diabetes 74% vs type 2 diabetes 62%). Although the majority strongly believed in the benefit of pre-pregnancy care (type 1 diabetes 66%, type 2 diabetes 56%), 14% of women with type 1 diabetes and 19% with type 2 diabetes, believed that getting pre-pregnancy care would 'not at all' to 'somewhat' improve the chances of having a healthy baby.

For 'cues-to-action', more women with type 1 diabetes reported that their health professional had advised them to use contraception to avoid unplanned pregnancy (type 1 diabetes 59% vs type 2 diabetes 21%) and to get pre-pregnancy care when planning a pregnancy (type 1 diabetes 69% vs type 2 diabetes 35%). For only a few women, others (partner, parent, friend) had advised them to get pre-pregnancy care (type 1 diabetes 33%, type 2 diabetes 17%). Since being diagnosed with diabetes 78% of women with type 1 diabetes and 62% with type 2 diabetes reported having had a conversation with a health professional about diabetes in relation to pregnancy.

Overall, 'self-efficacy' was relatively high (Table 3). Compared to women with type 2 diabetes, those with type 1 diabetes had greater confidence that they would be able to access pre-pregnancy care (median type 1 diabetes 9 vs type 2 diabetes 7) and to wait for glucose levels to be in target before becoming pregnant (median type 1 diabetes 8 vs type 2 diabetes 6). Both groups were least confident about making changes to their diabetes management to keep glucose levels in target before pregnancy (median type 1 diabetes 7.5 vs type 2 diabetes 7).

For 'outcome expectancy', the majority believed that pre-pregnancy care would help achieve glucose levels in target range ('moderate amount' to 'a lot' type 1 diabetes 65%, type 2 diabetes 62%).

However, close to 1 out of 5 did 'not at all' or 'somewhat' believe pre-pregnancy care would help in optimizing glycaemia.

Of women with pregnancies after diabetes diagnosis, 134/244 (55%) recalled attending pre-pregnancy care. A hierarchical logistic regression identified age, self-efficacy, cues-to-action, knowledge, as significant correlates of past attendance ($X^2=68.91$, $df=10$, $n=221$, $p<0.001$, Supplementary Table 1) and explained 75% of the variance. In particular, older age, greater self-efficacy, exposure to cues-to-action and knowledge correlated with past attendance of pre-pregnancy care.

Discussion

The current study explored differences in knowledge and beliefs about planning for pregnancy between women with type 1 diabetes or type 2 diabetes, who at the time of completing the survey were pregnant or planning a pregnancy (currently or future).

For knowledge, women with type 1 diabetes had more correct answers than women with type 2 diabetes. Women with type 2 diabetes were more often unsure about the answer rather than providing incorrect responses. Irrespective of diabetes type, major knowledge gaps were the need for higher dose folate compared to women without diabetes and uncertainty about breastfeeding recommendations. The latter may be a contributing factor to low rates and shorter duration of breastfeeding by women with diabetes [15]. Women with type 2 diabetes were less aware of contraceptive choices and risks associated with hyperglycaemia before or early in pregnancy. This knowledge gap may partially explain low uptake of pre-pregnancy planning by women with type 2 diabetes [16].

Having read the NDSS 'Diabetes in pregnancy' booklet or watched the DVD were positively associated with knowledge. Although the data do not allow assuming causality, earlier findings showed that viewing an educational DVD increased knowledge about preconception care [13]. Recently, it was reported that incorporating pregnancy information into routine diabetes care was associated with improved pregnancy planning indicators [17]. Few participants in the current study recalled having accessed the NDSS 'Diabetes in pregnancy' resources. Most (79%) expressed a preference for one-on-one advice from health professionals (unpublished findings), rather than booklets or DVDs. This highlights the importance of women having access to health professionals for pregnancy planning advice and ensuring adequate reach of available support materials. Such materials could reinforce and enhance evidence-based information, but are not intended to replace the health professionals' advice.

The current findings have indicated the most important beliefs that need to be addressed in future resources and also that messages should be tailored according to diabetes type. With regard to the HBM constructs, main differences between groups were perceived benefits and cues-to-action. Compared to women with type 2 diabetes, more women with type 1 diabetes believed in the benefits of 'close to target' glucose levels prior to pregnancy and of using contraception to prevent unplanned pregnancies. There was a marginal difference according to diabetes type for perceived severity of potential health problems during pregnancy, and no difference for perceived risk for health problems or barriers to seek pre-pregnancy care. Of the two SCT constructs, perceived self-efficacy was greater among women with type 1 diabetes; they felt more confident to access pre-pregnancy care and to wait for optimal glucose levels before becoming pregnant. Women's beliefs regarding outcome expectancy or intentions to attend pre-pregnancy care did not differ according to diabetes type. The findings highlight the need for evidence-based messages and resources to promote preconception counselling and care for all women, with particular emphasis on increasing access for women with type 2 diabetes.

An early study in clinical centres in the US, found that greater knowledge and perceived benefits were associated with higher uptake of pre-pregnancy care [10]. In a clinical population of Australian women with diabetes cues-to-action was a significant predictor of pre-pregnancy care uptake [8]. The current population-based study identified self-efficacy, cues-to-action and knowledge as the strongest factors related to past attendance of pre-pregnancy care. It is of interest to note that in the current study, these were the three domains for which differences were observed between diabetes types.

Strengthening women's confidence in managing their diabetes in pregnancy with the support of diabetes health professionals and raising their awareness about the benefits of pre-pregnancy care, may be key ingredients for successful preparation of pregnancy. Based on past and current findings regarding cues-to-action [8], having a conversation with health professionals is highly influential in women's decision-making about pregnancy planning.

Observed differences according to type of diabetes could partially be explained by women with type 2 diabetes mainly accessing primary care services, where there is less awareness of the specific recommendations regarding contraception and preparation for pregnancy [3]. In the current study women with type 2 diabetes more often consulted their general practitioner for diabetes management, compared to women with type 1 diabetes who were more likely to consult a diabetes specialist. Women with type 2 diabetes were more likely to live in rural areas, where there is less access to specialist care. These may be some of the reasons that women with type 2 diabetes were

less likely to have had conversations about pregnancy with health professionals, compared to women with type 1 diabetes.

Women with type 1 diabetes had been living with diabetes for nearly twice as long as women with type 2 diabetes and therefore had longer exposure to information and experiences in managing diabetes. These factors may contribute to feeling more confident in managing diabetes, and in their awareness and ability to attend pre-pregnancy care. If they had pre-pregnancy care in the past, they may not feel the need to attend for future pregnancies [8].

Currently, pre-pregnancy care is not high on the clinical agenda in primary care or integrated into structured education programs for type 2 diabetes [3]. When discussed, clinical conversations largely focus on achieving optimal glucose levels in preparation for and during pregnancy. As shown in this study, many reported feeling not confident that they could achieve these targets. The difficulty in achieving optimal glycaemia and knowledge of potential adverse effects for the baby, could lead to anxiety and concerns [11, 18]. These feelings are often unrecognised in clinics. Women have reported missing out on the positive experience of 'normal' pregnancies because of preoccupation with diabetes and glucose levels [11]. Therefore, a shift is needed towards an encouraging, positive and supportive attitude from health professionals with opportunities to enable women to psychologically and physically prepare for their pregnancies [11].

General practitioners and practice nurses have a central role in supporting women with type 2 diabetes. Diabetes guidelines recommend preconception counselling to be incorporated into routine diabetes care, from puberty onwards [19]. However, health professionals' beliefs and attitudes regarding pregnancy in diabetes could hinder or facilitate this dialogue taking place. It has been shown that health professionals in primary care lack training and confidence in providing pre-pregnancy counselling [20]. Also negative beliefs and stereotypes about type 2 diabetes and pregnancy hinder the conversation [18]. Therefore there is a need for targeted interventions to upskill health professionals on diabetes in pregnancy, and critically in primary care. A multifaceted approach with programs for women with diabetes and health professionals has been shown to be beneficial for increased contraception uptake and reduced adverse pregnancy outcomes [21]. Therefore and in response to the survey findings, NDSS resources have been developed for women with diabetes, including a pregnancy and diabetes website (ndss.com.au/pregnancy), a dedicated pregnancy and diabetes e-newsletter, and a pregnancy planning checklist [22]. This information is tailored according to diabetes type and reinforces the key messages about planning for pregnancy and diabetes. However further work is needed to develop resources for women of culturally and linguistically diverse background. In addition, e-Learning modules for Australian health professionals have been

developed with a specific focus on pre-pregnancy planning and care for women with diabetes [23]. These modules refer health professionals to the existing resources for women with diabetes as mentioned above, which could facilitate the conversation.

A major strength of this study is that findings are from a large population-based registry of women with pre-existing diabetes, of childbearing age and who were pregnant or planning a future pregnancy. Limitations include cross-sectional study design, low response rate and underrepresentation of women with type 2 diabetes, despite oversampling of women with low socioeconomic status to overcome these limitations [9]. Compared to the NDSS database of women with diabetes (18-50 years), women who responded to the survey were less likely to have type 2 diabetes (16% vs 75%), more likely to be aged 18-35 years (46% vs 23%) and less likely to be in the 46-50 year age group (5% vs 36%). These differences may reflect the stage of life in which women are more likely to be interested in becoming pregnant. There were no differences in state of residence between women in the survey and NDSS registrants. The survey was conducted online in English which may have impacted participation of those without internet access or not fluent in English. Paper versions could be requested but required contacting the research team. These limitations may have contributed to participation of women who are already engaged in and better informed about the importance of contraception and pre-pregnancy care.

The key findings of the first Australian survey about pregnancy and diabetes demonstrate a difference in knowledge and beliefs between women with type 1 diabetes and type 2 diabetes. There is a need, especially in type 2 diabetes, for evidence-based messaging and strategies to inform and motivate women to plan and prepare for pregnancy and to seek diabetes specific pre-pregnancy care before conceiving. Special attention is required to engage with women who were not represented in this online survey and who may have limited access to available resources.

References

1. Inkster ME, Fahey TP, Donnan PT, Leese GP, Mires GJ, Murphy DJ. Poor glycated haemoglobin control and adverse pregnancy outcomes in type 1 and type 2 diabetes mellitus: systematic review of observational studies. *BMC pregnancy and childbirth* 2006; **6**:30.
2. Wahabi HA, Alzeidan RA, Bawazeer GA, Alansari LA, Esmaeil SA. Preconception care for diabetic women for improving maternal and fetal outcomes: a systematic review and meta-analysis. *BMC pregnancy and childbirth* 2010; **10**:63.
3. Murphy HR, Bell R, Dornhorst A, Forde R, Lewis-Barned N. Pregnancy in Diabetes: challenges and opportunities for improving pregnancy outcomes. *Diabetic Medicine* 2018; **35**:292-299.
4. Murphy HR, Temple RC, Ball VE, Roland JM, Steel S, Zill EHR, *et al*. Personal experiences of women with diabetes who do not attend pre-pregnancy care. *Diabetic Medicine* 2010; **27**:92-100.
5. Zhu H, Graham D, Teh RW, Hornbuckle J. Utilisation of preconception care in women with pregestational diabetes in Western Australia. *Australian and New Zealand Journal of Obstetrics and Gynaecology* 2012; **52**:593-596.
6. Spence M, Alderdice FA, Harper R, McCance DR, Holmes VA. An exploration of knowledge and attitudes related to pre-pregnancy care in women with diabetes. *Diabetic Medicine* 2010; **27**:1385-1391.
7. Forde R, Collin J, Brackenridge A, Chamley M, Hunt K, Forbes A. A qualitative study exploring the factors that influence the uptake of pre-pregnancy care among women with Type 2 diabetes. *Diabetic Medicine* 2020; **37**:1038-1048.
8. Komiti A, Jackson HJ, Nankervis A, Conn J, Allan C, Judd F. An investigation of psycho-social factors associated with the uptake of pre-pregnancy care in Australian women with type 1 and type 2 diabetes. *J Psychosom Obstet Gynaecol* 2013; **34**:75-81.
9. Morrison M, Hendrieckx C, Nankervis A, Audehm R, Farrell K, Houvardas E, *et al*. Factors associated with attendance for pre-pregnancy care and reasons for non-attendance among women with diabetes. *Diabetes Research and Clinical Practice* 2018; **142**:269-275.
10. Janz NK, Herman WH, Becker MP, Charron-Prochownik D, Shayna VL, Lesnick TG, *et al*. Diabetes and pregnancy: factors associated with seeking pre-conception care. *Diabetes Care* 1995; **18**:157-165.
11. Singh H, Murphy HR, Hendrieckx C, Ritterband L, Speight J. The challenges and future considerations regarding pregnancy-related outcomes in women with pre-existing diabetes. *Current Diabetes Reports* 2013; **13**:869-876.

12. Charron-Prochownik D, Wang S-L, Sereika SM, Kim Y, Janz NK. A theory-based reproductive health and diabetes instrument. *American Journal of Health Behavior* 2006; **30**:208-220.
13. Holmes VA, Spence M, McCance DR, Patterson CC, Harper R, Alderdice FA. Evaluation of a DVD for women with diabetes: impact on knowledge and attitudes to preconception care. *Diabetic Medicine* 2012; **29**:950-956.
14. Wang SL, Charron-Prochownik D, Sereika SM, Siminerio L, Kim Y. Comparing three theories in predicting reproductive health behavioral intention in adolescent women with diabetes. *Pediatric Diabetes* 2006; **7**:108-115.
15. Rasmussen B, Nankervis A, Skouteris H, McNamara C, Nagle C, Steele C, *et al.* Factors associated with breastfeeding to 3 months postpartum among women with type 1 and type 2 diabetes mellitus: An exploratory study. *Women and Birth* 2020; **33**.
16. Cheung NW, Mcelduff A, Ross GP. Type 2 diabetes in pregnancy: a wolf in sheep's clothing. *Australian and New Zealand Journal of Obstetrics and Gynaecology* 2005; **45**:479-483.
17. Holmes V, Hamill L, Alderdice F, Spence M, Harper R, Patterson C, *et al.* Effect of implementation of a preconception counselling resource for women with diabetes: a population based study. *Primary Care Diabetes* 2017; **11**:37-45.
18. Forde R, Patelarou EE, Forbes A. The experiences of prepregnancy care for women with type 2 diabetes mellitus: a meta-synthesis. *Int J Womens Health* 2016; **8**:691-703.
19. American Diabetes Association. 14. Management of Diabetes in Pregnancy: Standards of Medical Care in Diabetes—2020. *Diabetes Care* 2020; **43**:S183-S192.
20. Magdaleno AL, Venkataraman S, Dion M, Rochon M, Perilli G, Vengrove MA. Preconception counseling in women with diabetes by primary care providers and perceived barriers to initiating this discussion. *Endocrine Practice* 2020; **26**:226-234.
21. Sina M, MacMillan F, Dune T, Balasuriya N, Khouri N, Nguyen N, *et al.* Development of an integrated, district-wide approach to pre-pregnancy management for women with pre-existing diabetes in a multi-ethnic population. *BMC pregnancy and childbirth* 2018; **18**:402.
22. Morrison M, Audehm R, Barry A, Hendrieckx C, Nankervis A, Porter C, *et al.* Resources to support preconception care for women with diabetes. *Diabetes & Primary Care Australia* 2017; **2**:1-5.
23. Morrison M, Audehm R, Barry A, Hendrieckx C, Nankervis A, Porter C, *et al.* NDSS Pregnancy information to support women living with diabetes. *The Australian Diabetes Educator* 2018; **21**.

Table 1: Demographic and clinical characteristics of selected sample (n = 629)

Characteristics	Type 1 Diabetes	Type 2 Diabetes	p-value
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	N=526		N=103		
	N		N		
Age (years) M(SD)	525	29.8 (6.8)	103	39.5 (6.3)	< 0.001
Country of birth (n, %)	525		103		0.033
Australia		441 (84.0)		77 (74.8)	
Other		84 (16.0)		26 (25.2)	
Geographical location (n, %)	526		101		0.003
Metropolitan area		328 (62.4)		48 (47.5)	
Regional area		148 (28.1)		33 (32.7)	
Rural area		50 (9.5)		20 (19.8)	
Language spoken at home (n, %)	525		103		0.063
English		511 (97.3)		96 (93.2)	
Other		14 (2.7)		7 (6.8)	
Aboriginal or Torres Strait Islander (n, %)	525		103		0.089
Yes		7 (1.3)		4 (3.9)	
No		518 (98.7)		99 (96.1)	
Tertiary education (n, %)	525		103		0.002
Yes		254 (48.4)		32 (31.1)	
No		271 (51.6)		71 (68.9)	
Marital status (n, %)	526		103		0.238
Single (never married, separated, divorced, not living together)		160 (30.4)		25 (24.3)	
Married or defacto		366 (69.6)		78 (75.7)	
Employment (n, %)	525		103		<0.001
Employed		402 (76.6)		57 (55.3)	
Not currently employed		123 (23.4)		46 (44.7)	
Diabetes duration (years) M(SD)	522	13.7 (8.4)	101	7.1 (7.3)	<0.001
Average visits in past 12 months for diabetes management M(SD) with					
General practitioner	524	2.2 (2.8)	103	3.8 (3.9)	<.001
Endocrinologist	523	2.6 (2.3)	99	1.1 (2.1)	<.001
Primary diabetes treatment (n, %)	525		103		
Insulin injections		272 (51.8)		26 (25.2)	
Insulin pump		253 (48.2)			
Oral hypoglycemic agents				63 (61.2)	
Diet and lifestyle				14 (13.6)	
Number of pregnancies since diabetes diagnoses (n, %)	514		100		0.106

None	302 (58.8)	67 (67.0)
1	92 (17.9)	14 (14.0)
2	57 (11.1)	12 (12.0)
3	41 (8.0)	6 (6.0)
4 or more	22 (4.3)	1 (1.0)

p-value based on Student's test or Chi-square tests

Table 2: Knowledge about pregnancy and diabetes according to type of diabetes

	N	% Correct*	% Incorrect	% Not sure	P-value
1. Women with diabetes cannot take the contraceptive pill		False	True	Not sure	<.001
Type 1	523	96.4	1.7	1.9	
Type 2	101	71.3	5.0	23.8	
2. Women with diabetes have very limited (few) choices of contraception		False	True	Not sure	<.001
Type 1	525	87.8	3.8	8.4	
Type 2	101	60.4	11.9	27.7	
3. Women with diabetes can have a healthy baby		True	False	Not sure	.041
Type 1	525	97.0	1.1	1.9	
Type 2	101	93.1	2.0	5.0	
4. Women with diabetes should get diabetes-specific advice from a health professional before falling pregnant		True	False	Not sure	=.001
Type 1	524	96.2	0.8	3.1	
Type 2	100	88.0	4.0	8.0	
5. Women with diabetes should take the same amount of folate as all other women planning a pregnancy		False	True	Not sure	<.001
Type 1	525	30.5	33.0	36.6	
Type 2	101	11.9	49.5	38.6	
6. Blood glucose levels around the time you fall pregnant can affect the health of a baby		True	False	Not sure	<.001
Type 1	524	83.2	3.6	13.2	

	Type 2	101	47.5	11.9	40.6	
7.	High blood glucose levels early in pregnancy do not increase the risk of birth defects		False	True	Not sure	<.001
	Type 1	524	69.7	11.5	18.9	
	Type 2	100	46.0	8.0	46.0	
8.	High blood glucose levels early in pregnancy increase the risk of miscarriage		True	False	Not sure	<.001
	Type 1	524	68.3	4.6	27.1	
	Type 2	101	44.6	6.9	48.5	
9.	High blood glucose levels during pregnancy do not increase the risk of problems for the mother		False	True	Not sure	.046
	Type 1	524	83.6	5.5	10.9	
	Type 2	100	75.0	8.0	17.0	
10.	High blood glucose levels during pregnancy do not increase the risk of problems for the baby		False	True	Not sure	<.001
	Type 1	524	87.2	3.6	9.2	
	Type 2	100	71.0	8.0	21.0	
11.	Women with diabetes have an increased risk of having a large baby, making delivery more difficult		True	False	Not sure	.164
	Type 1	524	82.3	3.4	14.3	
	Type 2	101	76.2	5.0	18.8	
12.	Women with diabetes are recommended to breastfeed		True	False	Not sure	.012
	Type 1	524	49.2	5.5	45.2	
	Type 2	101	35.6	5.9	58.4	
13.	Type 2 diabetes is a less serious form of diabetes in pregnancy		False	True	Not sure	.036
	Type 1	523	55.6	9.4	35.0	
	Type 2	100	67.0	6.0	27.0	

* Correct response to the statement being 'False' or 'True'; p-value based on Chi-Square test comparing Correct with merged Incorrect/Not sure replies.

Table 3: Descriptive Statistics for Knowledge and RHAB subscales in those planning a pregnancy according to type of diabetes

Theory and subscales	# items	Range	Type 1 diabetes					Type 2 diabetes					IQR	Mean diff	p-value ^e
			N	Mean or N	SD or %	Median	IQR	N	Mean or N	SD or %	Median				
Total Knowledge	13	0-13 ^a	526	9.8	2.4	10	9,12	103	7.7	3.1	8	6,11	2.1	<.001	
Health Belief Model	Susceptibility	2	2-9 ^b	476	7.6	1.2	8	7,9	91	7.6	1.2	8	7,9	0.0	.825
	Severity	3	3-15 ^b	506	11.2	2.5	11	10,13	99	10.6	2.5	10	9,13	0.6	.014
	Benefit	4	4-20 ^c	513	18.4	2.2	19	17,20	100	17.2	3.3	18	16,20	1.2	<.001
	Barrier	2	2-10 ^b	481	4.4	1.9	4	3,6	94	4.2	1.8	4	3,5	0.2	.511
	Cues-to-action	5	0-5 ^d	519	2.7	1.4	3	2,4	100	1.5	1.3	1	0,2	1.4	<.001
Social Cognitive Theory	Self-efficacy	3	0-30 ^c	510	22.6	5.5	23	19,27	97	20.2	6.1	20	15,5,24.5	2.4	<.001
	Outcome expectancy	2	2-10 ^c	509	8.3	1.6	8	7,10	101	8.1	1.8	8	7,10	0.2	.685
Theory of Reasoned Intentions	1		521	463	89			103	92	89				1.00	

Action	
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^a total knowledge = sum of all correct responses; ^b higher score = more susceptible/ serious/difficult; ^c higher score=more benefits/confident/expectations; ^d cues-to-action is dichotomous (yes, no). ^e Based on Mann-Whitney test or Chi-square for Intentions

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Supplementary Table 1: Final model of hierarchical logistic regression exploring associations between knowledge/beliefs (significant in univariate analysis) and past attendance of pre-pregnancy care (n=221, type 1 diabetes=193, type 2 diabetes=28)

	B	SE	Wald test	df	p	Exp(B)*	95% CI (lower- upper)	
Age	.121	.035	12.107	1	.001	1.129	1.054	1.208
Diabetes type	.422	.542	.607	1	.436	1.525	.527	4.408
Diabetes duration	-.023	.020	1.362	1	.243	.977	.940	1.016
Tertiary educated	-.311	.343	.822	1	.365	.733	.374	1.435
Pregnancies#	.110	.148	.551	1	.458	1.116	.835	1.493
Knowledge	.269	.098	7.577	1	.006	1.309	1.081	1.586
Benefit	.123	.084	2.144	1	.143	1.131	.959	1.333
Cues-to-action	.361	.144	6.256	1	.012	1.434	1.081	1.903
Self-efficacy	.097	.031	9.723	1	.002	1.102	1.037	1.172
Outcome expectancy	-.045	.117	.146	1	.702	.956	.760	1.203
Constant	-11.752	2.159	29.640	1	.000	.000		

number of pregnancies after diabetes diagnosis.

A hierarchical logistic regression was conducted to determine significant correlates of past pre-pregnancy care (dependent variable). Bivariate analysis was conducted to identify significant factors associated between past attendance of pre-pregnancy care in the past and sociodemographic, knowledge and cognitive constructs. Sociodemographic factors were entered in a first block, knowledge and cognitive constructs in the second block. The final model (Suppl Table 1) identified four significant factors; indicating that the odds to have attended pre-pregnancy care in the past was positively related with age, knowledge, cues-to-action and self-efficacy.

*Exp(B) is an indicator of change in the odds resulting from one unit change in the subscales.