FEATURE ARTICLE

Association of Type 2 Diabetes Risk Perception With Interest in Diabetes Prevention Strategies Among Women With a History of Gestational Diabetes

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OBJECTIVES | The aims of this study were to identify predictors of perception of type 2 diabetes risk in women with a history of gestational diabetes mellitus (GDM) and to determine factors associated with interest in evidence-based strategies for type 2 diabetes prevention.

RESEARCH DESIGN AND METHODS | We surveyed women with a history of GDM who had not progressed to type 2 diabetes from a large academic medical center. We used multivariate logistic regression to assess predictors of high levels of perception of type 2 diabetes risk. We also tested associations between risk perception and interest in a lifestyle change program and/or metformin therapy.

RESULTS | In our diverse sample of 264 women, 28% were unaware that GDM is a risk factor for incident type 2 diabetes after pregnancy, and 48% believed their personal risk of type 2 diabetes was low. In multivariate analyses, family history of diabetes (odds ratio [OR] 2.2, 95% CI 1.2–4.4) and knowledge of GDM as a risk factor for incident type 2 diabetes (OR 4.5, 95% CI 2.1–9.8) were significant predictors of greater perception of type 2 diabetes risk. Women with higher risk perception were more likely to express interest in a lifestyle change program compared with women with lower risk perception (OR 2.4, 95% CI 1.3–4.5).

CONCLUSION | Although some women are aware that GDM is a risk factor for incident type 2 diabetes, many still perceive their own risk of developing type 2 diabetes as low. Higher risk perception predicted interest in an evidence-based diabetes prevention program, highlighting the importance of personalized risk assessment and communication about risk for women who have had GDM.

Women with a history of gestational diabetes mellitus (GDM) have up to a sevenfold higher risk of progression to incident type 2 diabetes compared with women without GDM (1). The Diabetes Prevention Program (DPP) study provides strong evidence from a randomized controlled trial for risk reduction in overweight and obese individuals with prediabetes, by either taking metformin or by following a structured lifestyle change program aiming to achieve a weight loss of 5–7% and increase physical activity (2). In women with a history of GDM, lifestyle and metformin have comparative efficacy, and both reduce the risk of developing diabetes by ~50% after 3 years of follow-up (3–5).

However, there have been challenges in translating this evidence to real-world settings. Uptake of intensive lifestyle intervention or metformin has been limited, even though these evidence-based strategies are recommended by national guidelines to prevent diabetes in higher-risk populations (6). Moreover, in one study, women with a history of GDM were 56% less likely to enroll in a DPP-based lifestyle program than women without previous GDM, and other studies have found that only 7–28% of women with a history of GDM are successfully recruited into postpartum lifestyle interventions (7–9).

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Women with prior GDM face several unique challenges to engagement in diabetes prevention strategies. First, they may underestimate their future diabetes risk. Although many women with GDM recognize that a GDM diagnosis indicates an increased risk of developing diabetes at the population level, they often downplay their personal risk (10,11). How women perceive their personal risk of incident type 2 diabetes may be an important predictor of their uptake and engagement in preventive actions, specifically lifestyle change or metformin therapy. Second, women with prior GDM may not be aware of evidence-based strategies for diabetes prevention (12,13). Preventive metformin is rarely prescribed for individuals with prediabetes (14,15), including women with prediabetes or a history of GDM (16). Although older studies have evaluated knowledge and risk perception of incident diabetes in women with GDM, none have examined these beliefs in the context of women's preferences for risk modification with a lifestyle change program and/or metformin. Finally, competing demands may affect young mothers' engagement and retention in routine care and prevention efforts. Lifestyle change programs typically require a significant time commitment that may only be feasible for a subset of highly motivated women with adequate resources (17), and commonly cited barriers to participation in diabetes prevention interventions among women with prior GDM include lack of time and child care needs (18).

The objectives of this study were to *1*) assess differences in survey responses between women with lower and higher personal risk perception of developing type 2 diabetes, including potential predictors of risk perception, and *2*) assess whether personal risk perception, among other patient characteristics, is associated with interest in engaging in evidence-based diabetes prevention strategies. Reducing the incidence of type 2 diabetes among women with a history of GDM requires a better understanding of the factors related to personal risk perception, and the role of perceived susceptibility in the adoption of preventive strategies. This information can be used to optimize the ways in which evidence-based diabetes prevention strategies are presented and implemented.

Research Design and Methods

Study Design and Participants

This was a cross-sectional survey conducted within the University of California, Los Angeles (UCLA), health system. Using electronic health record (EHR) data, we identified potential survey participants between the ages of 18 and 50 years with a previous GDM diagnosis determined from billing codes (*International Classification of Diseases*, 9th revision, codes 648.83 and V12.21, and 10th revision, codes O24.4× and Z86.32) at any time in their medical history. We excluded women with a diagnosis of type 1 or type 2 diabetes in their medical record, an A1C >6.4% (>46 mmol/mol), or any current antihyperglycemic medication use. If BMI was known to the research team through data fields from the EHR at the time survey eligibility was assessed, women with a BMI <25 kg/m^2 (or BMI <23 kg/m^2 if Asian) were excluded because they would not meet criteria to participate in a Centers for Disease Control and Prevention (CDC)-recognized DPP-based lifestyle change program. However, missing BMI values did not preclude participation in the survey.

We used a multistep recruitment process to find survey participants. After identifying potentially eligible survey participants, we reached out to their primary care provider through the EHR to confirm that the women we identified met our study inclusion criteria. Next, eligible women were mailed recruitment letters inviting them to participate in a telephone survey, which included a prepaid postcard they could return if they preferred not to be contacted further. Between May 2019 and November 2019, research assistants fluent in English and Spanish called eligible participants to obtain informed consent and administer the survey by telephone. Participants were compensated for their time with a $40 gift card upon survey completion. The study was approved by the UCLA Institutional Review Board (No. 18-001058).

Questionnaire Items/Variables

Survey questions were developed by the study investigators after a literature review to identify beliefs and perceptions about GDM and attitudes toward uptake of type 2 diabetes prevention strategies (Supplementary Appendix S1). The study questionnaire had a single item to assess the level of agreement with the prior GDM diagnosis. ("Please rate your agreement with the statement 'I don't think I truly had gestational diabetes.'") The survey also assessed women's knowledge of the impact of GDM on type 2 diabetes risk after pregnancy ("Do you think that gestational diabetes increases, has no effect, or decreases risk of developing type 2 diabetes after pregnancy?") and perception of personal type 2 diabetes risk ("What do you think is your chance of developing type 2 diabetes over the next 10 years: high chance, moderate chance, slight chance, or almost no chance?"). We asked women about their interest in attending DPP-based lifestyle change sessions and taking metformin for diabetes prevention. Responses were recorded on a 4-point Likert scale for most questions, excluding the question on knowledge of GDM as a risk factor. Women were also asked to report the number of years since

their first diagnosis of GDM (described as "high blood sugars during pregnancy"), family history of diabetes, number of children, highest level of education, race, and ethnicity. Patient demographics collected from the EHR included age and BMI.

Statistical Analyses

A multivariate logistic regression was performed to analyze potential predictors associated with the perception of personal risk for developing type 2 diabetes. The dependent variable was a dichotomous risk perception category defined as higher ("moderate chance" or "high chance" of getting type 2 diabetes) or lower ("almost no chance" or "slight chance" of getting type 2 diabetes) risk. We adjusted for race, ethnicity, education level, time since index GDM pregnancy, agreement with GDM diagnosis, family history of diabetes, knowledge of GDM as a risk factor for diabetes, and BMI. Race and ethnicity were included to account for differences among minority groups in the rate of progression from GDM to type 2 diabetes. Education level was included in the model to control for possible differences that could be mediated by educational attainment. Time since GDM diagnosis was relevant because progression rates are estimated to be highest within the first 5–10 years after diagnosis, and recency of exposure to health care visits related to education and treatment of GDM and its long-term risks may also affect type 2 diabetes risk perception. Agreement with GDM diagnosis may directly affect a woman's views on her susceptibility to future diabetes, in conjunction with baseline knowledge of GDM as a risk factor for type 2 diabetes. Finally, the model adjusted for BMI and family history, which are salient risk factors for incident diabetes.

Two additional multivariate models were generated to test the association between personal risk perception and the level of interest in *1*) a DPP-based lifestyle change program and 2) metformin therapy. Responses to interest in a diabetes prevention strategy were classified by any level of interest ("somewhat interested," "moderately interested," or "very interested") or no interest ("not at all interested"). The covariates for these secondary models included those from the initial logistic regression, with the addition of self-reported number of children. This additional covariate was included because the number of children may affect the level of interest in options for diabetes prevention if additional parenting responsibilities and child care needs act as competing demands on time and resources. Multiple imputation (N = 20 iterations of the built-in SAS imputation procedure PROC MI) was performed for missing BMI values, and predicted probabilities were calculated for continuous variables that were statistically significant predictors in our models. All analyses were done using SAS, v. 9.3 (SAS Institute, Cary, NC), and STATA, v. 14.2 (Stata Corp., College Station, TX), statistical software.

Results

We surveyed 264 women with a history of GDM who met our eligibility criteria (Table 1). On average, participants were 37.4 years of age (SD 4.6 years), had a BMI of 30.3 kg/m^2 (SD 5.5 kg/m^2), had two children (SD 1.2) in their household, and were diagnosed with GDM 4.8 years (SD 3.8 years) before survey completion. The study sample was racially and ethnically diverse: 36.67% Hispanic, 63.4% non-Hispanic, 30.1% Asian, 54.7% non-Hispanic White, 5.5% African American, and 9.8% other race. Thirty-two percent (n = 85) of women disagreed with their past diagnosis of GDM. Twenty-eight percent (n = 75) of women were unaware that GDM is a risk factor for developing type 2 diabetes after pregnancy; 14% (n = 37) thought there was no effect on diabetes risk, 4% (n = 11) thought GDM was associated with decreased diabetes risk, and 10% (n = 27) responded "don't know." Perceptions of personal risk of incident type 2 diabetes within the next 10 years were widely distributed; 22% (n = 58) of the women believed they had almost no chance of developing diabetes, 25% (n = 65) believed they had a slight chance of developing diabetes, 30% (n = 79) believed they had a moderate chance of developing diabetes, and 20% (n = 53) believed they had a high chance of developing diabetes. Women who answered "don't know" in regard to their personal perception of type 2 diabetes risk (n = 9) were excluded from our analysis. Participants who did not have a current BMI measurement in the EHR (n = 60) were included in the analysis after multiple imputation; however, because of excessive missingness of A1C values (n = 123), we did not include A1C as a covariate. In multivariate analyses, family history of diabetes (odds ratio [OR] 2.2, 95% CI 1.2–4.1) and knowledge of GDM as a risk factor for type 2 diabetes (OR 4.5, 95% CI 2.1–9.8) were independent predictors for higher type 2 diabetes risk perception. BMI, race, ethnicity, education level, time since index GDM pregnancy, and agreement with GDM diagnosis were not significantly associated with level of risk perception (Table 2).

Perceptions Regarding CDC-Recognized Lifestyle Change Programs

Sixty percent of the women (n = 158) reported some interest in participating in a DPP-based lifestyle change program; of these, 25% were somewhat interested, 20% were moderately interested, and 15% were highly interested. Women with higher personal risk perception (OR 2.4, 95% CI 1.3–4.5), higher BMI (OR 1.1, 95% CI 1.0–1.2), and

TABLE 1 Participant Characteristics and Distribution in Perception of Type 2 Diabetes Risk

Characteristic	Total	Lower Perception of Personal Risk*	Higher Perception of Personal Risk*	*P*
Overall *n*	264†	123	132	–
Age, years, mean (SD)	37.4 (4.6)	37.2 (4.8)	37.4 (4.6)	0.724
Race, %				0.335
White	54.7	56.7	53.1	
African American	5.5	5.0	6.2	
Asian	30.1	31.7	27.3	
Other	9.8	6.7	13.3	
Ethnicity, %				0.260
Non-Hispanic	63.4	66.4	59.5	
Hispanic	36.6	33.6	40.5	
Education, %				0.512
Less than college degree	28.8	24.4	34.1	
College degree	40.5	46.3	33.3	
Post-college degree	30.7	29.3	32.6	
Years since GDM diagnosis, mean (SD)	4.8 (3.8)	4.6 (3.6)	5.0 (4.0)	0.378
Family history of diabetes, %	68.8	58.3	78.6	**<0.001**
Number of children in household, mean (SD)	2.0 (1.2)	2.0 (1.2)	1.9 (1.1)	0.722
Disagreement with GDM diagnosis, %	32.2	35.8	28.0	0.184
Baseline knowledge of GDM as a risk factor for type 2 diabetes, %	71.6	61.0	82.6	**<0.001**
BMI, kg/m^2, mean (SD)	30.3 (5.5)	30.1 (5.5)	30.6 (5.6)	0.465
A1C, %, mean (SD)‡	5.7 (0.3)	5.7 (0.3)	5.7 (0.4)	0.162
Any interest in DPP, %	60.3	46.7	73.3	**<0.001**
Any interest in metformin, %	39.4	32.0	48.1	**0.009**

Bold type indicates statistical significance. *Personal perception of type 2 diabetes risk was categorized as lower ("slight chance" or "almost no chance") or higher ("moderate chance" or "high chance"). †Nine participants did not answer the survey question on risk perception. ‡A1C values were missing from the EHR for 123 participants, so A1C was not included as a covariate in our model.

Hispanic ethnicity (OR 2.3, 95% CI 1.0–5.3) had statistically significant higher odds of having any interest in joining a lifestyle change program (Table 3). The significance of BMI as a predictor suggests that, as BMI increases, there are increased odds of interest in participating in a lifestyle change intervention. A patient with a BMI of 25 kg/m^2 had a 54% predicted probability of interest in participating in a lifestyle change program. At a BMI of 35 kg/m^2, this probability increased to 68%.

Perceptions Regarding Metformin for Diabetes Prevention

Thirty-nine percent (n = 102) of the women reported some interest in taking metformin for diabetes prevention; of these, 19% reported being somewhat interested, 9% moderately interested, and 12% very interested. In adjusted multivariate models, only BMI was found to be a statistically significant predictor of interest in preventative metformin (OR 1.1, 95% CI 1.0–1.2) (Table 3). The predicted probability of having interest in metformin therapy was 29% for women with a BMI of 25 kg/m^2 compared with 46% for women with a BMI of 35 kg/m^2.

Discussion

Although GDM is one of the strongest population-level risk factors for incident type 2 diabetes, our study found that many women with prior GDM underestimate their personal risk of developing diabetes. This finding highlights the need for efforts to increase awareness that GDM is an important risk factor for incident type 2 diabetes and to encourage women with GDM to engage in individual diabetes prevention efforts. In fact, 28% of the women in our study were not aware of an association between GDM and future diabetes risk, further underscoring the importance of work that remains to be done in this area. Many of the women in our study were overweight or obese in addition to having a history of GDM, and yet almost half still believed they had a less than moderate risk of developing type 2 diabetes. Women who had baseline knowledge that GDM is a risk factor for type 2 diabetes and women with a family history of diabetes were more likely to have a higher perceived personal risk of developing diabetes.

In addition, higher risk perception was associated with greater interest in a DPP-based lifestyle change program

TABLE 2 ORs of Higher Perception of Type 2 Diabetes Risk

Variable	Higher Perception of Type 2 Diabetes Risk, OR (95% CI)	*P*
Race		0.486
White (reference)		
African American	1.6 (0.4–5.8)	
Asian	1.1 (0.5–2.3)	
Other	2.2 (0.8–6.1)	
Ethnicity		0.580
Non-Hispanic (reference)		
Hispanic	1.2 (0.6–2.7)	
Education level		0.150
Less than college degree (reference)		
College degree	0.5 (0.2–1.1)	
Post-college degree	0.9 (0.4–2.1)	
Years since GDM diagnosis	1.0 (0.9–1.1)	0.639
Agreement with GDM diagnosis		0.811
No (reference)		
Yes	1.1 (0.6–2.1)	
Family history of diabetes		**0.017**
No (reference)		
Yes	2.2 (1.2–4.1)	
Baseline knowledge of GDM as a risk factor for type 2 diabetes		**<0.001**
No (reference)		
Yes	4.5 (2.1–9.8)	
BMI	1.0 (0.9–1.1)	0.520

Bold type indicates statistical significance.

but not metformin therapy, although these prevention options have similar effectiveness in preventing or delaying diabetes in this patient population. Interest in diabetes prevention strategies varied widely; the majority of women were interested in a lifestyle change program, with fewer interested in taking metformin. Our study demonstrates existing gaps in risk awareness and provides additional context for discussions of risk and preferences for type 2 diabetes preventive care among women with prior GDM.

The DPP study provided the strongest evidence base supporting prevention of type 2 diabetes with lifestyle change or metformin in women with a history of GDM. In the subgroup of 350 women with a history of GDM who were enrolled in the DPP study, relative risk reduction of incident type 2 diabetes was 53% for the lifestyle treatment group and 50% for the metformin treatment group after 3 years of follow-up (3). At 10 years of follow-up, relative type 2 diabetes risk reduction was 35% for lifestyle treatment and 40% for metformin (4). The number needed to treat to prevent an incident case of type 2 diabetes is 5–7 for treatment with either lifestyle intervention or metformin, depending on the time horizon.

Despite the comparative efficacy of both choices, we found that more women were interested in a lifestyle change program than in starting metformin to lower their type 2 diabetes risk. In a nationally representative population of men and women with prediabetes, about one-fourth of survey participants reported interest in a DPP-based lifestyle change program (19). A much larger proportion (60%) of women in our study expressed such interest, which is notable because women with GDM do not frequently engage in postpartum lifestyle interventions (7,8).

Conveniently, DPP-based lifestyle change programs are now widely available in virtual formats (i.e., online or through smartphone apps), and some studies support that participation and attendance is enhanced in a virtual format, while producing clinically significant weight loss outcomes (20,21). However, current estimates of DPP-based lifestyle change program participation among a nationally representative population with prediabetes are as low as 2.4% (19). Because many women express interest in participating when they are made aware of the benefits of such programs, information about why and how to participate in one should be more widely disseminated to women with prior GDM to increase reach. Women with GDM undergo medical nutrition therapy and lifestyle counseling during pregnancy, so baseline familiarity with receiving health education content similar to that provided by a DPP-based lifestyle change program may also help to

TABLE 3 ORs for Interest in Diabetes Prevention Strategies

Variable	Any Interest in DPP-Based Lifestyle Change Program, OR (95% CI)	*P*	Any Interest in Metformin Therapy, OR (95% CI)	*P*
Race		0.220		0.146
White (reference)				
African American	1.9 (0.5–7.1)		0.3 (0.1–1.5)	
Asian	2.3 (1.0–5.3)		1.8 (0.8–4.0)	
Other	1.3 (0.4–4.1)		0.8 (0.3–2.3)	
Ethnicity		**0.042**		0.337
Non-Hispanic (reference)				
Hispanic	2.3 (1.0–5.3)		1.5 (0.7–3.3)	
Education level		0.420		0.607
Less than college degree (reference)				
College degree	0.6 (0.3–1.3)		0.9 (0.4–2.0)	
Post-college degree	0.7 (0.3–1.7)		1.3 (0.6–3.0)	
Personal risk perception		**0.006**		0.136
Low risk (reference)				
High risk	2.4 (1.3–4.5)		1.6 (0.9–3.0)	
Agreement with GDM diagnosis		0.344		0.700
No (reference)				
Yes	1.4 (0.7–2.7)		1.1 (0.6–2.2)	
Family history of diabetes		0.566		0.759
No (reference)				
Yes	1.2 (0.6–2.3)		1.1 (0.6–2.1)	
Baseline knowledge of GDM as a risk factor of type 2 diabetes		0.084		0.285
No (reference)				
Yes	0.9 (0.9–4.1)		1.5 (0.7–3.4)	
Years since GDM diagnosis	1.0 (0.9–1.1)	0.654	1.1 (1.0–1.1)	0.182
Number of children in household	0.9 (0.7–1.2)	0.475	0.9 (0.7–1.2)	0.668
BMI	1.1 (1.0–1.2)	**0.024**	1.1 (1.0–1.2)	**0.009**

Bold type indicates statistical significance.

increase interest and participation in such programs. Additionally, a lifestyle change program may be more acceptable or desirable in general given the collateral health benefits of diabetes prevention that are associated with weight change through lifestyle modification.

Although there was less interest in metformin therapy among our study population, it remains an important pharmacologic option for type 2 diabetes prevention. Qualitative studies suggest that people with prediabetes may view metformin as a second-line option if they do not achieve the behavioral goals of a lifestyle change program or are not able to participate in such a program because of competing demands (12).

In parallel, nutrition therapy is the initial management at the onset of GDM, and it is estimated that only up to 30% of these women will require pharmacologic intervention to control hyperglycemia during their pregnancy (22). Because the majority of women with GDM are able to achieve optimal glucose control with lifestyle change during pregnancy, they may also believe that metformin treatment is not warranted unless a lifestyle change program is inadequate. In general, most individuals acknowledge that taking preventive medicine requires less effort than participating in a lifestyle change program, which demands time and effort to exercise and follow a healthy diet (23,24); thus, for some women, metformin may be the easier of the two options to adhere to if the medication is well tolerated.

Although personal risk perception was not associated with interest in using metformin for diabetes prevention, higher perception of risk for incident type 2 diabetes was a significant predictor of a woman's interest in participating in a DPP-based lifestyle change program. The divergence in the association between risk perception and preference for preventive options may reflect differences in familiarity with and knowledge of the two options.

When treatment choices have clinical equipoise, patients can make a preference-driven decision based on their personal values and goals. Shared decision-making (SDM),

defined as a process in which clinicians and patients work together to make decisions based on clinical evidence that balances risks and expected outcomes with patient preferences and values, can provide the framework needed to educate women about their risk, explore options for risk reduction, and promote uptake of both lifestyle change programs and metformin therapy. Using SDM to engage patients with prediabetes in diabetes prevention is an effective approach to increase adoption of both interventions (23). Patient-centered discussions may increase understanding of risk perception and/or general prediabetes knowledge to support behavior change. Patients can also receive more personalized risk communication and health information that is tailored to their background and health literacy.

We believe that a patient-centered SDM approach can be used to increase knowledge, risk perception, and behavior change among women with a history of GDM. An SDM intervention for prediabetes demonstrated that three-fourths of participants with prediabetes chose to engage in a diabetes prevention intervention after participating in SDM and also showed that greater BMI was a predictor of uptake of both lifestyle change and metformin (14,23). In concordance with those findings, the current study shows that, among women with a history of GDM, higher BMI is associated with interest in both prevention options.

Clinicians can use decision aids to engage patients in conversations about prediabetes criteria and type 2 diabetes susceptibility and facilitate the development of patients' preferred prevention plans. Education tools designed specifically for prediabetes treatment choices can be integrated into clinicians' workflows, or other patient care team members such as primary care pharmacists can deliver this type of education (25,26). It is important to address history of GDM as a risk factor for future diabetes often and consistently during follow-up care after a GDM-complicated pregnancy, and the first opportunity may be at the time of the first recommended postpartum glucose tolerance test, 4–12 weeks after delivery (6). However, rates of type 2 diabetes screening can be as low as 20% within the first year after delivery (27–29). Although appropriate follow-up visits to screen for type 2 diabetes after GDM are crucial for reinforcing risk awareness through patient education, a woman's engagement with her health care provider may drop off in the postnatal period, so it is prudent to consider multiple opportunities to intervene in raising awareness of diabetes risk in this high-risk population.

Offering SDM for diabetes prevention throughout the life span to women with a history of GDM can re-engage women who otherwise may not have had ongoing support for diabetes prevention. Multilevel approaches that target patient education within the health care system and also through other sources in the home or community will ensure that women with prior GDM can receive consistent communication about and assessment of their diabetes risk to bolster accurate risk perceptions. Other potential informal sources of knowledge that contribute to GDM awareness and perception of type 2 diabetes risk (e.g., learning from family members and networks, including social media) should be examined in future studies to identify additional ways to improve risk communication for this population.

We found that women with a family history of type 2 diabetes were more likely to perceive a higher personal risk of incident diabetes after GDM. Our study reinforces a well-supported finding that family history of diabetes is a salient risk factor for incident type 2 diabetes, including among women with prior GDM (11,21,30,31). Family members who have experience with related health conditions often play a central role in sharing health information and perspectives on disease vulnerability that cannot be overlooked.

Interestingly, however, Harwell et al. (31) found that, although family history was most strongly associated with perceived risk of type 2 diabetes in both men and women with prediabetes, individuals with a family history of type 2 diabetes were also more likely to believe that diabetes cannot be prevented. Fatalism regarding the ability to modify mutable risk factors may be a barrier in some women with prior GDM (32), especially if they are unaware of the benefits of both DPP-based lifestyle change programs and metformin therapy for delaying or preventing type 2 diabetes. Knowledge and beliefs interact in complex ways to influence intentions or motivations to engage in individual prevention efforts, but all women with prior GDM can benefit from a patient-centered approach to consider the ways to reduce their risk of type 2 diabetes. CDC-recognized, DPP-based lifestyle change programs are offered by many health plans as a free preventive benefit, and metformin is a low-cost generic medication, so both of these resources are widely accessible. There remains an important opportunity to increase accurate risk assessments and offer both options to women at the greatest risk of developing diabetes.

Although our study included a large and diverse sample of women with prior GDM, there were several limitations. In our multivariate analysis, higher perception of personal risk for type 2 diabetes was associated with a higher level of interest in a lifestyle change intervention; however, we asked women to report their interest in either metformin

or lifestyle change at a single point in time, so we are unable to report actual uptake or adherence to prevention strategies. We asked women about their knowledge of GDM and their level of agreement with their diagnosis, but because there was variation in the duration of time since their GDM-complicated pregnancy and because women could have been treated for GDM at any facility before establishing care in our medical center, we did not determine the specific sources from which women learned about GDM or track their adherence to GDM care and subsequent follow-up. We also did not survey women about their income, so we could not assess the impact of socioeconomic status on our findings. Additionally, our models did not adjust for A1C because of a high rate of data missingness, so we were unable to account for its effect. Finally, our study was conducted within one large health system serving mostly a commercially insured population, so results may not be generalizable to all women with GDM.

Conclusion

A history of GDM is considered to be one of the strongest independent risk factors for development of type 2 diabetes. Intensive lifestyle change through a DPP-based program and metformin therapy are similarly effective strategies to prevent or delay incident type 2 diabetes, and both should be part of ongoing discussions among women with prior GDM and overweight/obese BMI in order to recognize measures to reduce their diabetes risk. The proportion of women in our study who expressed interest in either option far exceeded estimates of the proportion of women currently engaged in these options. Given the very low levels of uptake of evidence-based strategies for diabetes prevention, SDM is one approach to potentially encourage adoption of these strategies. In the setting of GDM and prediabetes, SDM must first help patients assess their personal risk, because accurate risk perception may significantly affect a person's likelihood of participating in prevention strategies. Using SDM as a framework can ensure that clinicians and patients will have patient-centered discussions about the evidence-based treatment options for diabetes prevention. This effort will help women with prior GDM develop a clear interpretation of their personal risk and make fully informed choices regarding prevention strategies that align with their preferences, goals, and needs.

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DUALITY OF INTEREST

No potential conflicts of interest relevant to this article were reported.

AUTHOR CONTRIBUTIONS

A.V. and O.K.D. designed the study. A.V., N.T., O.K.D., and T.M. performed the analyses. A.V., O.K.D., and T.M. wrote the manuscript. C.M.M., H.P., S.A., Y.C.-L., and K.N. reviewed and edited the manuscript. A.V., O.K.D., and T.M. are the guarantors of this work and, as such, had full access to all the data in the study and take responsibility for the integrity of the data and the accuracy of the data analysis.

PRIOR PRESENTATION

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