Risk Perception for Diabetes Among Women With Histories of Gestational Diabetes Mellitus

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OBJECTIVE — To examine risk perception for diabetes among women with histories of gestational diabetes mellitus (GDM).

RESEARCH DESIGN AND METHODS — We surveyed 217 women with histories of GDM who were enrolled in a managed-care plan and who did not currently have diabetes. In a cross-sectional design, we assessed the associations between risk perceptions and current lifestyle behavioral practices, plans to modify behaviors, and recent lifestyle behavior changes. Multivariable models included participant characteristics as well as potential modifiers of risk perception (knowledge of diabetes risk factors, optimistic bias, perceived personal control, and beliefs in the benefits and barriers of lifestyle modification).

RESULTS — Ninety percent of women recognized that GDM was a risk factor for future diabetes, but only 16% believed that they themselves had a high chance of developing diabetes; perceived risk increased to 39% when women were asked to estimate their risk assuming they maintained their current lifestyle. Women who consumed three or more but less than five servings a day of fruits and vegetables reported lower odds of moderate/high risk perception (adjusted odds ratio [OR] 0.39 [95% CI 0.16–0.92]) than women who consumed less than three servings a day, although this association was not significant after further adjustment for income. Women who perceived themselves to be at moderate/high risk more often planned to modify their future lifestyle behaviors (9.1 [0.16–0.92]).

CONCLUSIONS — Despite understanding the association between GDM and postpartum diabetes, women with histories of GDM usually do not perceive themselves to be at elevated risk.

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Gestational diabetes mellitus (GDM) is defined as glucose intolerance first identified during pregnancy (1,2). While glucose intolerance resolves with delivery ~90% of the time (3), it continues to affect women's health postpartum. Women with GDM are at increased risk for future episodes of GDM, pre-diabetes (impaired glucose tolerance and impaired fasting glucose), and type 2 diabetes (4,5). Despite these facts, women with histories of GDM may not perceive themselves to be at risk for future diabetes. Spirito et al. (6) found that among 67 women with GDM, two-thirds did not believe they would develop GDM during a future pregnancy, and one-fifth did not believe they were at risk for diabetes. Qualitative work in several high-risk groups such as the Pima Indians (7) and Mexican Americans (8) suggest that these women may believe that GDM does not pose a problem after delivery.

Theoretical models suggest that risk perception may be an important determinant of behavioral change (9). In the case of diabetes prevention, higher and more accurate perceptions of risk might encourage a healthier lifestyle, including a healthy diet and adequate physical activity. In contrast, underestimates of risk might act as a barrier to preventive behaviors and could therefore be a target for behavioral interventions. However, the association between risk perception and behavior has been inconsistent, with some studies demonstrating an association between risk perception and preventive behaviors (9) but others not demonstrating these associations (10,11). One explanation for these inconsistencies is that the links between behavior and risk perception are poorly specified (12). Another explanation is that other factors that may affect risk perception are not adequately accounted for in the analysis. These factors include knowledge of diabetes risk factors; perceived personal control, or the degree to which one believes that risk is modified by one's actions; and optimistic bias, or one's assessment of their risk compared with others like them (13).

To our knowledge, no reports have explored the ways in which diabetes risk perception is associated with preventive behaviors in women with histories of GDM, particularly after accounting for knowledge of diabetes risk factors, perceived personal control, and optimistic bias. Therefore, we tested several hypotheses: women who had poorer lifestyle behavioral practices would have greater perceptions of risk, women with greater risk perception should report plans to reduce their diabetes risk by initiating lifestyle improvements in the near future, women who recently improved their lifestyle behaviors should have lower risk perception than women who did not im-

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Abbreviations: GDM, gestational diabetes mellitus.

A table elsewhere in this issue shows conventional and Système International (SI) units and conversion factors for many substances.

prove such behaviors, and such associations would persist after adjustment for other factors that might affect risk (12).

RESEARCH DESIGN AND METHODS

— Study participants were women enrolled in an academic managed-care plan and identified as having had a GDM pregnancy within the past 5 years through a GDM delivery code (ICD-9 code 648.8) or outpatient diagnostic codes 648.83 (undelivered) or 648.84 (delivered) and with at least one outpatient or hospitalization health care utilization for any reason (GDM specific or otherwise) during the year before the survey. We conducted computer-assisted telephone interviews, and women were given the option of filling out a written survey if they chose. Women were excluded if they denied having had GDM, if they were currently pregnant with the index pregnancy, if they were unable to give informed consent, or if they had developed diabetes since their GDM delivery, for a final sample size of 217. Surveys were completed by 98% of eligible respondents who could be contacted; however, potentially eligible patients could not be reached. If patients who were unreachable had the same rate of eligibility as those successfully contacted, the survey response rate would have been 65% (14).

Risk perception and lifestyle modification

We assessed risk perception for developing diabetes using the item: "What do you think your risk or chance is for getting diabetes over the next 10 years?" Women could report "almost no chance," "a slight chance," "a moderate chance," or "a high chance." To account for the possibility that women who planned to make lifestyle modification changes would paradoxically have lower perceptions of risk for future diabetes (12), we also asked, "If you don't change your lifestyle behaviors, such as diet or exercise, what is your risk or chance of getting diabetes over the next 10 years?" We also inquired about changes in diabetes-related lifestyle behaviors with the question, "Have you recently made changes in any lifestyle behaviors that you believe will lower your chance of getting diabetes?" Finally, we asked about plans to modify lifestyle in the near future with the question, "Are you planning to make changes in any lifestyle behaviors in the near future that you believe will lower your chances of getting diabetes?"

Modifiers of risk perception

Measurement of optimistic bias, personal control, knowledge of diabetes risk factors, and beliefs in the benefits and barriers to lifestyle modification were adapted from the Risk Perception Survey for Developing Diabetes, a risk perception instrument used in the Diabetes Prevention Program (15) and also administered to physicians (16). The psychometric properties and scoring of these scales have been previously described (15,16). The Personal Control and Optimistic Bias subscales were graded on a scale of 1–4 and averaged so that greater scores reflected greater personal control and greater optimistic bias for not developing diabetes (15,16). Knowledge of diabetes risk factors questions were ascertained after risk factors relating to race/ethnicity, age, physical activity and diet, and family history. This subscale had a score ranging from 1 to 11, with higher scores reflecting greater knowledge of risk factors. Women's perception of the benefits of and barriers to preventive behaviors was measured using three items from the Risk Perception Survey for Developing Diabetes. These questions ask women to report their beliefs regarding the effort required to engage in a diet and exercise program, the benefits of a diet and exercise program, and specific beliefs about prevention of diabetes with exercise and diet. The responses to these items were averaged so that higher scores indicate greater belief in the benefits of preventive activity and lower scores indicate greater barriers. Since these scales were originally developed in populations without GDM, and because they were also slightly modified from their original format, we recalculated Cronbach's α coefficients for each scale. The Personal Control subscale (Cronbach's $\alpha = 0.72$ in our sample) and Knowledge of Diabetes Risk Factors subscale (Cronbach's $\alpha = 0.70$ in our sample) were not modified. We modified the Optimistic Bias subscale (Cronbach's $\alpha = 0.65$ in our sample) to reflect the fact that all of our survey respondents were women. The beliefs in the benefits and behaviors questions were not originally designed to be measurements of the same construct but rather as a summary measure for the benefits of and barriers to action, so reliability was calculated neither in the original instrument nor in our sample.

Physical activity and diet

Self-reported leisure-time physical activity was assessed using a single item adapted from the MONICA (Multinational Monitoring of Trends and Determinants in Cardiovascular Disease) physical activity instrument (17) and validated in Project DIRECT (Diabetes Intervention Reaching and Educating Communities Together) (18). Women were asked which of the following four activity levels best described their present leisure-time activity: none, only light physical activity in most weeks, vigorous activity for at least 20 min once or twice per week, and vigorous activity for at least 20 min three or more times per week. Daily consumption of fruits and vegetables was calculated from questions measuring intake of fresh, canned, frozen, or dried preparations. For this report, based on the distributions of responses, women were grouped into the following categories: consumption of less than three servings of fruits or vegetables per day, consumption of three to less than five servings of fruits or vegetables per day, and consumption of at least five servings of fruits or vegetables per day.

Statistical analysis

In the first stage of our analysis, we examined whether women who engaged in "riskier" behaviors had higher perceived risk by examining the association between current physical activity and diet (independent variable) and risk perception (dependent variable). For the purposes of this analysis, "no chance" and "slight chance" were categorized as "low" risk perception, and "moderate chance" and "high chance" were categorized as "high" risk perception. Using multivariate logistic regression models, we adjusted for participant characteristics associated with the primary dependent and independent variables, as well as personal control, optimistic bias, knowledge of diabetes risk factors, and beliefs in the benefits of and barriers to lifestyle modification. Candidate participant characteristics included demographic variables (age, race, education, and income), cardiovascular risk factors (family history of diabetes and current diabetes, history of dyslipidemia, history of hypertension outside of pregnancy, or cigarette smoking), current BMI, and pregnancy characteristics (breast-feeding, insulin use during pregnancy, and type of prenatal care provider) (Table 1). None of the covariates were highly correlated with each

Table 1—*Distribution of perception of risk or chance for future diabetes and association with participant characteristics*

	Total	Almost no chance	Slight chance	Moderate chance	High chance
n	217	16	76	88	35
Age (years)	35.7 ± 5.4	34.5 ± 5.7	36.4 ± 5.5	35.7 ± 5.1	34.9 ± 5.6
Race					
Non-Hispanic white	71	69	68	71	74
Asian/Pacific Islander	13	13	16	15	3
African American	7	6	4	8	9
Other	10	13	12	6	15
Education					
Less than high school or high school	7	**25**	**3**	**8**	**9**
Some college	29	**19**	**25**	**26**	**44**
College graduate or more	64	**56**	**72**	**66**	**47**
Annual household income					
<$15,000 per year	4	0	5	5	0
$15,000 to <$40,000	12	21	7	12	21
$40,000 to <$75,0000	32	36	23	35	39
≥$75,000	52	43	64	48	39
Family history of diabetes*	52	**31**	**43**	**66**	**50**
History of dyslipidemia	23	6	25	24	23
History of hypertension outside of pregnancy	9	0	9	13	6
Current cigarette smoking	11	6	7	15	14
Duration of breast-feeding without formula					
0 to <3 months	53	**44**	**46**	**63**	**47**
3 months to <1 year	33	**25**	**45**	**23**	**35**
≥1 year	14	**31**	**9**	**14**	**18**
Current BMI (kg/m^2)	30.1 ± 7.7	**24.7 ± 3.8**	**27.3 ± 6.5**	**32.4 ± 8.1**	**32.6 ± 7.2**
Time since delivery (months)	27.0 ± 17.8	**37.4 ± 19.2**	**28.1 ± 19.6**	**26.2 ± 16.4**	**22.5 ± 15.4**
Prenatal provider type†					
Obstetrician/gynecologist	90	88	89	93	86
Family practitioner	14	**31**	**20**	**9**	**9**
Endocrinologist	42	25	43	41	51
Midwife	6	0	11	2	9
Dietician	60	56	55	60	71
Other	5	0	7	3	9
Insulin use during pregnancy	42	19	38	44	57
Personal control (possible range 1–4)	3.24 ± 0.49	3.42 ± 0.55	3.31 ± 0.46	3.20 ± 0.43	3.13 ± 0.61
Optimistic bias (possible range 1–4)	2.12 ± 0.50	**2.66 ± 0.68**	**2.24 ± 0.43**	**1.99 ± 0.41**	**1.91 ± 0.54**
Knowledge of diabetes risk factors (possible range 1–11)	6.9 ± 1.8	6.6 ± 2.2	6.9 ± 1.6	7.0 ± 1.6	7.0 ± 1.6
Benefits/barriers (possible range 1–4)	3.43 ± 0.46	3.63 ± 0.57	3.46 ± 0.46	3.39 ± 0.40	3.40 ± 0.52

Data are means ± SD or percent. Column headings indicate responses to the question, "What do you think your risk or chance is of getting diabetes over the next 10 years?" Bold type indicates associations at $P \leq 0.05$. *First-degree relative with diabetes. †Women could see multiple provider types during pregnancy, so percentages do not sum to 100.

other, and so none were excluded for this reason. Since women could have multiple provider types during pregnancy, prenatal provider contact was characterized as six indicator variables: contact with an obstetrician/gynecologist (yes/no), family practitioner (yes/no), endocrinologist (yes/no), midwife (yes/no), dietitian (yes/no), and other provider type (yes/no). In a similar set of models, we substituted the "modified" risk perception question with similar dichotomization (moderate/high risk versus no risk/slight risk) as the dependent variable.

In the next stage of the analysis, we examined whether current perception of elevated risk led to plans to improve behavior in the future. Specifically, we examined the association between risk perception (independent variable) and plans to modify lifestyle in the near future (dependent variable). For these analyses, multivariate logistic regression models were constructed in a manner similar to that outlined above.

In the final stage of the analysis, we examined whether recent improvements in behavior led to lower perceived risk by examining the association between report of recent lifestyle improvements to reduce diabetes risk (independent variable) and risk perception for diabetes (dependent variable). Multivariate logistic regression models were constructed in a manner similar to that outlined above; risk perception was again examined as a dichotomous variable.

In sensitivity analyses, we examined alternate measures of physical activity aside from leisure-time physical activity. These measures included self-reported hours per week spent walking and walk-

Table 2—*Association between lifestyle behaviors and moderate/high risk perception (dependent variable)*

	Unadjusted odds ratio (95% CI)	Unadjusted odds ratio (95% CI) Modified risk perception*	Adjusted odds ratio (95% CI)	Adjusted odds ratio (95% CI) Modified risk perception*
Leisure-time vigorous activity (reference = no activity)†				
Only light physical activity	0.64 (0.16–2.65)	1.43 (0.27–7.56)	0.42 (0.05–3.33)	2.61 (0.41–16.5)
Vigorous activity for 20 min, one to two times per week	0.67 (0.15–2.92)	1.00 (0.18–5.59)	0.84 (0.10–7.01)	2.04 (0.30–13.9)
Vigorous activity for 20 min, three times per week	0.42 (0.10–1.75)	0.61 (0.12–3.20)	0.33 (0.04–2.66)	1.08 (0.17–6.80)
Consumption of fruits and vegetables (reference = less than three servings per day)‡				
Three to less than five servings per day	0.54 (0.27–1.05)	0.50 (0.22–1.17)	**0.39 (0.16–0.92)**	**0.35 (0.19–0.95)**
Five or more servings per day	0.57 (0.30–1.08)	**0.37 (0.17–0.83)**	0.93 (0.38–2.29)	0.43 (0.16–1.14)

An OR ratio >1 indicates that the measure of lifestyle is associated with moderate to high perception of risk. Bolded type indicates associations at $P < 0.05$. *"If you don't change your lifestyle behaviors, such as diet or exercise, what is your risk or chance of getting diabetes over the next 10 years?" †Adjusted for education, race, smoking, family history of diabetes, duration of breast-feeding, current BMI, months since delivery, prenatal care by a family practitioner, optimistic bias score, diabetes knowledge score, personal control score, and benefits and barriers score. ‡Adjusted for age, education, history of hypertension, smoking, history of dyslipidemia, optimistic bias score, diabetes knowledge score, personal control score, and benefits and barriers score.

ing intensity (19). The results of these analyses were similar and are not presented here. We also examined whether recent behavioral modification was associated with risk perception among the subset of women who engaged in healthy behaviors. Since income could theoretically affect food choices, we constructed alternate models where we also adjusted for income. Analyses were conducted with SAS version 9.0 software.

RESULTS — In general, study participants were white, relatively affluent, and well educated (Table 1, *column 1*). The mean age of the women was 35.7 ± 5.4 years. Women were predominantly non-Hispanic white or Asian/Pacific Islanders. Only 17% self-identified as Hispanic, African American, or Native American. Fewer than 10% had less than some college education, and most reported ≥$75,000 in annual income per year. While most women reported breast-feeding, less than half did so for >3 months without formula supplementation. Most had received prenatal care from an obstetrician during pregnancy, with lower percentages also reporting care by an endocrinologist or dietitian. The mean Knowledge of Diabetes Risk Factors score was only 7 out of a possible 11, reflecting that >90% of our sample was aware of the roles of activity, diet, and decreased weight in preventing diabetes and of the increased risk for diabetes conferred by GDM. Fewer women were aware about the role of race, ethnicity, and age in diabetes risk.

Regarding risk perception, 7% of women believed that they had almost no chance of developing diabetes in the future, 35% believed that they had a slight chance of developing diabetes, 41% believed they had a moderate chance of developing diabetes, and only 16% believed they had a high chance of developing diabetes. Of note, when women were asked about their risk perception if they did not improve their current lifestyle, the percent of women who believed they had a high chance of developing diabetes increased to 39%. Regarding current behaviors, performance of leisure-time physical activity and consumption of fruits and vegetables was suboptimal. Only 31% reported engaging in the recommended amount of vigorous activity (i.e., 20 min three times per week). Only 22% reported vigorous activity for 20 min one to two times per week, 43% reported light physical activity, and 5% reported no activity. Only 32% of women reported consuming the recommended five or more servings a day of fruits and vegetables, while 40% reported consuming less than three servings per day. Sixty-eight percent of women reported recently implementing risk-reducing behaviors, while 85% of women reported plans to implement risk-reducing behavior in the future.

Women who had a moderate or high diabetes risk perception more often had a family history of diabetes and breastfed for a shorter period of time (Table 1). Women with moderate/high risk perception had less education and were also more often obese, less often had a family practitioner involved in their prenatal care, and were less optimistic or more realistic about developing diabetes than women with lower perceptions of risk. While insulin use was not associated with risk perception in a general χ^2 test ($P = 0.059$), the test for trend was positive ($P = 0.009$).

In unadjusted analyses, neither greater leisure-time activity nor fruit and vegetable consumption was significantly associated with moderate/high risk perception (Table 2, *column 1*). In unadjusted analyses, greater leisure-time activity was not associated with modified risk perception (i.e., risk perception if women did not modify their current lifestyle practices); however, greater fruit and vegetable consumption was associated with lower modified risk perception (Table 2, *column 2*). After adjustment for covariates, leisure-time activity was still not significantly associated with risk perception (Table 2, *column 3*), although greater fruit and vegetable consumption was associated with lower perception of risk (Table 2, *columns 3 and 4*). In sensitivity analyses, we found that adjustment for income slightly changed our estimates, rendering the association between fruit and vegetable consumption and risk perception nonsignificant (adjusted OR 0.45 [95% CI 0.18–1.09]), suggesting that income might be a partial confounder of the association between risk perception and dietary habits.

In unadjusted analyses, greater risk perception was associated with more frequent plans to modify future behavior. Of those who believed they had almost no chance of developing diabetes, 56% reported plans to modify their future behavior, compared with 78% of women who perceived slight risk, 93% of women who perceived moderate risk, and 94% of

women who perceived high risk for diabetes. This pattern persisted after adjustment for covariates used in testing for the accuracy hypothesis. After adjustment for covariates, women who perceived a slight risk reported plans to modify their behavior more frequently than women who reported almost no risk (OR 5.42 [95% CI 1.01–29.2]); women who perceived moderate/high risk were more likely to report plans to modify future behavior (9.1 [1.5–57.0]).

Finally, in unadjusted analyses, recent improvement in behavior was not associated with lower risk perception. Of the women who reported recently modifying their behavior, 58% reported moderate/high risk perception, and of women who did not report recent modifications in their behavior, 54% reported moderate/high risk perception—which is a nonsignificant difference. In analyses that adjusted for covariates mentioned earlier, women who reported recent modifications in their behavior to reduce diabetes risk were more likely to report moderate/high risk perception compared with women who had not recently modified their behavior (OR 1.02 [95% CI 0.49–2.14]). In sensitivity analyses, we limited the sample to women who reported optimal levels of physical activity and fruit and vegetable consumption. In this sample, of women who recently modified their behavior, 41% reported high risk perception compared with 25% of those who had not recently modified their behavior, contrary to the hypothesis. Results were not significantly different with adjustment (not shown).

CONCLUSIONS — The traditional paradigm for the GDM pregnancy focuses on perinatal outcomes. Yet GDM may also serve as an indicator of future maternal glucose intolerance and a "teachable moment" during which women may be alerted to their increased risk. In turn, this increased risk perception could potentially encourage the adoption of preventive behaviors. In this report, >90% of women with histories of GDM recognized that GDM was a risk factor for future diabetes, but less than one-fifth of women believed they themselves were at high risk for diabetes because they intended to improve their behavior in the near future. Even when assuming their lifestyle would not change, only a little more than one-third of women believed themselves to be at high risk. In accord with theoretical models of risk perception, we found that women who had greater perceptions of risk more often intended to improve their behavior in the future. Our study is unique in that no previous reports have examined these associations in women with histories of GDM, particularly with grounding in risk perception theory and with adjustment for potential biases including women's perception of personal control, optimistic bias, and knowledge of diabetes risk factors.

We also found that women with histories of GDM who had greater perceptions of diabetes risk more often had risk factors associated with diabetes, such as family history, greater BMI, and shorter durations of breast-feeding (20). While insulin use during pregnancy did not meet criteria for significance ($P < 0.05$) for its association with risk perception, there was a trend toward significance (i.e., more than half of women who perceived that they had a high chance for developing future diabetes used insulin, whereas only ~20% of women who perceived that they had a low chance for developing future diabetes used insulin). We speculate that the use of subcutaneous injections for greater glucose levels may have increased women's impressions of their disease severity during pregnancy. In addition, the additional teaching and monitoring that may accompany insulin use may have also contributed to greater risk perception. These women had less optimistic bias (i.e., they were more pessimistic or more realistic about their chances of getting disease in general and diabetes specifically compared with others like them). However, while greater risk perception was associated with lesser fruit and vegetable consumption, we did not find any associations between self-reported physical activity and risk perception. More comprehensive measures of activity may have captured an association, although we examined alternate measures of activity such as number of hours walking, and no association was observed. Women may not perceive activity to be as strong a risk factor for diabetes as weight or family history, although we did not ask about their perceptions of the strength of risk factors for diabetes, only if women believed it was a risk factor. We did not observe an association between recent modification of behavior and risk perception. It is possible that any improvements may have been inadequate to lead to any real or perceived risk reduction. Although three-quarters of women stated that they had recently improved their physical activity and dietary practices, less than one-third reported the recommended levels of vigorous physical activity and less than one-third reported optimal fruit and vegetable consumption. Also, women who already practiced healthy behaviors would not necessarily report recent behavior modification, but they would report lower risk perception, thus minimizing any associations. Among women who had optimal behavioral practices, recent modification of behavior was still not associated with lower perceptions of risk.

Previous studies of the associations between risk perception and behaviors in other populations have been inconsistent, potentially due to inconsistencies in risk theories and/or lack of adequate adjustment for risk modifiers (9–11). In particular, in cross-sectional analyses, it is difficult to interpret an association between risk perception and behavior because poorer behaviors may increase risk perception or increased risk perception may negatively impact behavior. While our data were collected at a single point in time, we took care to distinguish between past behavior, current behavior and risk perception, and plans to change future behavior. Ideally, perceptions of risk and reports of behavior would be collected longitudinally. Such analyses would reduce biases associated with social desirability and allow for determination of whether actual behaviors improved or deteriorated over time, rather than just plans to improve behaviors or recall of recent behavior changes. Such analysis would also allow more comprehensive models rather than separate testing of multiple hypotheses.

Our study is also limited in that we examined a select and, in several ways, advantaged population, which is uncharacteristic of the national population of women with histories of GDM. Women in our sample were predominantly white or Asian/Pacific Islanders, well educated, affluent, and insured. In the Women and Infants Staying Healthy Study, a cohort of urban and racially and ethnically diverse pregnant women from the San Francisco Bay area, 23% of women with GDM had less than a high school education (21), compared with the <1% in our sample. In the Behavioral Risk Factor Surveillance System, 16% of women with histories of GDM had less than a high school education, and 27% had only a high school education (22). Both studies noted the high prevalence of a GDM history among Latinas, who were rare in our study. It is pos-

sible that key modifiers, such as knowledge of diabetes risk factors and, particularly, knowledge that GDM is a risk factor for future diabetes, are different in the general population of women with GDM. It is also possible that plans to improve future behaviors are less common in this population. Of note, despite our women's sociodemographic advantages, they still reported suboptimal levels of physical activity and diet and in that way are similar to the national population of women with histories of GDM.

This report has several implications for the translation of diabetes prevention interventions to women with histories of GDM. By supporting the connection between risk perception and behavior, our work suggests that using risk perception may provide a point of intervention to help women modify their behavior and thereby reduce their incidence of future diabetes. However, our work also notes that knowledge of GDM as a risk factor for diabetes is not necessarily sufficient to increase risk perception. Rather, realistic assessments of behavioral implementation in the near future may help women to gauge their risk more accurately. Our results also suggest that the decision to initiate insulin during pregnancy might have implications for future diabetes prevention, in that insulin use may make postpartum interventions more attractive, and that the relationship between prenatal treatments and postpartum risk perception should be studied in greater detail.

Further longitudinal research is needed to determine whether intentions to improve behavior in this population are significantly associated with actual behavioral changes, whether risk perception is responsive to these changes, and whether (as well as which) interventions that modify risk perception translate to actual improvements in behavior.

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