Screening Measure to Assess Knowledge of Diabetes in Pregnancy

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The purpose of this study was to develop a brief measure to assess knowledge regarding diabetes in pregnancy (Diabetes in Pregnancy Knowledge Screen [DPKS]). A test-retest design was used for subjects enrolled in a diabetes in pregnancy program at a university hospital. There were 58 women with overt diabetes (OD; insulin dependent and non–insulin dependent) and 67 women with gestational diabetes (GD). Three forms of the DPKS scale were developed for use with women with OD and women with GD treated or not treated with insulin. Adequate readability, internal consistency (r = 0.71), and test-retest reliability (r = 0.76) were demonstrated with the DPKS. Initial support for the validity of the measure is suggested by its ability to differentiate women with GD versus OD, women on insulin versus those who are diet controlled, and women with shorter versus longer duration of illness. The DPKS may prove a useful clinical tool for diabetes educators working with pregnant women. *Diabetes Care* 13:712–18, 1990

Effective medical management of diabetes relies on patient adherence to the daily diabetic regimen prescribed by the physician. For the patient to care for his/her diabetes on a day-to-day basis, an adequate understanding of the disease and the daily requirements for managing diabetes are necessary.

Much work has been done to develop instruments to measure knowledge of diabetes and its management in children and adults with type I (insulin-dependent) or type II (non-insulin-dependent) diabetes mellitus (1–3). However, one high-risk group, pregnant women with diabetes, has been essentially overlooked in the development of these instruments. It is particularly important to assess the knowledge of these individuals, because adequate management of their disease affects not only their own health but also the health of their unborn babies (4).

Iyer (5) has developed a structured teaching plan for pregnant women with diabetes that emphasizes that pregnancy is the most cost-beneficial period in which to provide education and effect behavioral change, because pregnant diabetic subjects are more motivated to protect not only their own health but that of their babies. However, no standardized method has been developed to assess the baseline knowledge of the pregnant woman with diabetes or to assess the outcome of an educational intervention. This study describes the development of a brief standardized knowledge screening questionnaire specifically designed for pregnant women with diabetes.

RESEARCH DESIGN AND METHODS

Fifty-eight pregnant women with overt diabetes (OD) were participants in this study. Forty-eight women had type I diabetes and 10 had type II diabetes. Women with OD were diagnosed 1–24 yr before their pregnancy and controlled by insulin and/or diet. Once pregnant, all women with OD were treated by diet and insulin.

Sixty-seven women with gestational diabetes (GD) were also participants in the study. Criteria used for the diagnosis of GD were based on a standardized 3-h oral glucose tolerance test (OGTT) administered at ~28 wk

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TABLE 1
Demographics

	Women with overt diabetes	Women with gestational diabetes	Statistical test of differences
n	58	67	
Age (mean ± SD)	27.6 ± 6.0	26.6 ± 5.6	t(df 123) = 0.96
Education (%)			
College graduate plus graduate studies	8	2	
College graduate	10	6	
Some college	22	21	
High school graduate	29	40	
Some high school	31	31	χ^2(df 4) = 2.15
Race (%)			
White	84	88	
Non-White	16	12	χ^2(df 1) = 0.71
Marital status (%)			
Married	80	56	
Single	20	44	χ^2(df 1) = 5.63*
Primigravida (%)	42	36	χ^2(df 1) = 0.41
Socioeconomic status (%)			
I	14	25	
II	8	16	
III (Hollingshead classes)	44	35	
IV	26	22	
V	8	2	χ^2(df 4) = 6.61

*$P < 0.05$.

gestation (6). In a few cases, glucose screening was conducted after 28 wk gestation. Women identified as having two or more abnormal OGTT values were enrolled in the program for additional prenatal care. All women were treated by diet, with a subset of the women also controlled by insulin (n = 21).

Demographic characteristics of the subjects can be seen in Table 1. The two groups differed only in that more women with OD were married than women with GD. All women were English speaking.

Participants in the study were recruited from the Diabetes in Pregnancy Program at the Women and Infants Hospital of Rhode Island. The patients were approached during regular clinic visits while they were waiting to be seen by the physician and were asked to complete a questionnaire designed to measure knowledge of diabetes during pregnancy. Eighty-five percent of the women agreed to participate in the study. A subgroup of the patients were retested ~4 wk after the initial test administration. Forty-two women with OD and 20 women with GD completed the test a second time. Due to the many medical demands (e.g., appointments with dietitian, nurse educator) on women with OD during clinic visits, not all subjects were retested within 4 wk. An even smaller sample of women with GD was retested because many delivered within 4 wk before they were scheduled to be retested.

On the first clinic visit, women in the program meet with an obstetrician, a nurse educator, and a dietitian to review the management and effects of diabetes during pregnancy. They also receive various reading materials on the topic. Thereafter, women attend the clinic on a weekly basis, have their blood glucose levels monitored, and receive feedback about their pregnancy and diabetes from clinic staff.

The Diabetes in Pregnancy Knowledge Screen (DPKS) has three versions devised for women with OD (14 items), women with GD who are diet controlled (14 items), and women with GD who are treated by diet and insulin (18 items). There are 8 items in common for all three forms. There are 11 items in common for the forms for women with OD and women with GD who use insulin. There are 14 items in common for the forms for women with GD who are diet controlled versus women with GD who use insulin. The items are shown in Table 2. The version of the DPKS designed for women with OD can be seen in the Appendix.* Multiple-choice items were developed by psychologists, nurse educators, and an obstetrician. The items were devised to cover the specific teaching tasks recommended for diabetes educators working with pregnant women including diet, blood glucose testing, insulin administration and reactions, exercise, and sick day management. Three of the items related to diet and one item on the normal blood glucose range in pregnancy were taken from an existing scale (1). Like other scales, every item also has "I don't know" as a possible answer to discourage guessing (1). The items were revised several times on the basis of pilot testing before reaching the

*Copies of the other forms of the DPKS are available from the authors on request.

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TABLE 2
Item-total correlations and item difficulty on Diabetes in Pregnancy Knowledge Screen (DPKS) for women with overt and gestational diabetes

DPKS item	Item–total-score correlation coefficient	Item difficulty (% correct)*
1. When planning vigorous exercise, what changes should you make in your daily diabetes routine (n = 125)?	0.59	64
2. On days when you are sick, what steps should you take to control your diabetes (n = 125)?	0.35	81
3. The normal range for blood sugar during pregnancy is (n = 125)	0.46	82
4. Circle all true statements about your specific meal plan devised by the dietitian (n = 125).	0.51	55
5. Margarine is mainly (n = 125)	0.48	88
6. Rice is mainly (n = 125)	0.47	80
7. If you don't feel like eating the egg in your diet for breakfast, you can (n = 125)	0.60	86
8. If you have problems controlling your blood sugar during pregnancy, what are some of the possible effects on your baby after birth (n = 125)?	0.56	85
9. Which of the following feelings may result from a reaction (n = 79)?	0.58	32
10. What should you do if you have a reaction (n = 79)?	0.36	30
11. Bedtime snacks are an important part of your meal plan because they help you avoid reactions overnight (true/false; n = 79).	0.24	94
12. Another name for gestational diabetes is (n = 67)	0.26	65
13. Why does gestational diabetes occur in some pregnant women (n = 67)?	0.62	85
14. Blood sugar is tested during clinic visits in order to (n = 67)	0.48	78
15. The majority of women with gestational diabetes have blood sugar problems one month after the birth of their child (true/false; n = 67).	0.35	91
16. Gestational diabetes can be a risk factor for developing diabetes later on. After your delivery you should (n = 67)	0.53	82
17. If you become pregnant in the future, it is not likely that you will develop gestational diabetes during that pregnancy (true/false; n = 67).	0.30	67
18. Why are glycosylated hemoglobin levels drawn once per month during pregnancy (n = 51)?	0.52	71
19. What does glucagon do (n = 51)?	0.58	61
20. After using glucagon, it is most important to (n = 51)	0.23	69
21. You should decrease your insulin before vigorous exercise (true/false; n = 22).	0.33	18

Items 1–8 were designed for all women with diabetes, 9–11 were designed for women who were insulin treated, 12–17 were designed for women with gestational diabetes, 18–20 were designed for women with overt diabetes, and item 21 was designed for women with gestational diabetes treated with insulin.
*Percentages reported for items 2–6, 9–11, 14, 15, and 17–21 represent proportion of women who got item totally correct; percentages for items 1, 7, 8, 12, 13, and 16 represent partially correct answers.

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final form. True/false items and several of the multiple-choice items are scored as either 0 (incorrect) or 1 (correct). Many of the items have several applicable answers (see Appendix). These multiple-choice questions are scored 0 (incorrect), 1 (partially correct), or 2 (completely correct). Due to variation in number of items across different versions of the DPKS, scores are reported as percentage of items correct for each of the forms.

RESULTS

To measure the readability of the DPKS, the Dale-Chall formula was used (7). This method uses a formula that uses the total number of words, the number of words not on a standard word list, and the number of sentences. When the Dale-Chall formula was applied to the three forms of the DPKS, overall test readability levels between the 9th and 10th grade were found on the form for women with GD, between 9th and 10th grade level for women with GD on insulin, and between 7th and 8th grade level for women with OD. None of the diabetes terms, e.g., *glucose*, *reaction*, or *hemoglobin*, are included on the standard word list, and they increased the reading levels substantially. However, they are routinely used terms for all the patients in the clinic. When the Dale-Chall formula was recalculated without including some of the diabetes terminology, the overall grade level for all three forms of the DPKS was 7th–8th grade. On the form for women with GD, five of the items were at the 5th–6th grade level, five at the 7th–8th grade level, three at the 9th–10th grade level, and two at college level. For the DPKS form used for women with GD on insulin, seven of the items were at the 5th–6th grade level, five at the 7th–8th grade level, four at the 9th–10th grade level, one at the 11th–12th grade level, and two at college level. On the form for women with OD, one item was at the 4th grade level, five at the 5th–6th grade level, three at the 7th grade level, one at the 9th–10th grade level, two at the 11th–12th grade level, and two at college level. The two items at the college level were the same on all three forms (items 9 and 10 in Appendix). These are dietary terms routinely used by the dietitian and nurse educator in the clinic but they are not on the standard word list and thus scored at a very high reading level.

A moderate correlation between educational level and the total score of the DPKS was obtained for women with OD ($r = 0.39$, $P < 0.001$) and women with GD ($r = 0.45$, $P < 0.001$). The relationship between socioeconomic status and the DPKS was less pronounced than that for educational level (women with OD $r = 0.04$, $P > 0.10$ and women with GD $r = 0.25$, $P > 0.05$).

To better understand what the women did or did not know about diabetes during pregnancy, we calculated individual item difficulties. They ranged from 18 to 94% and are reported in Table 2.

The internal consistency of the DPKS was assessed with Cronbach's α. To have a sufficiently large sample available, a coefficient α was calculated for the entire sample of women ($n = 125$) on the 8 items in common for the three forms of the DPKS. A coefficient of 0.71 was obtained, which meets the minimal standard for internal consistency (8). With the use of the 14 items completed by 67 women with GD, a coefficient α of 0.78 was obtained. With the 14-item form of the DPKS for women with OD, the coefficient α was 0.62. An examination of individual item-total scores for women with OD and GD are presented in Table 2. All items exceeded the correlation coefficient (0.20) recommended as the minimum acceptable standard (9). The mean item-total correlation was 0.45. Test-retest reliability coefficients were also calculated for the entire sample ($r = 0.76$), for women with OD ($r = 0.80$), and for women with GD ($r = 0.75$).

Validity studies. Because knowledge was presumed to be related to duration of illness, the relationship between DPKS and duration of illness for women with type I diabetes was investigated; a correlation of $r = 0.37$ was calculated. The women were also divided into those who had been diagnosed more recently (i.e., ≤9 yr; $n = 22$) versus those diagnosed ≥10 yr earlier ($n = 26$). Women who had been diagnosed >10 yr earlier (77.9 ± 8.6) obtained higher scores on the DPKS than those who had been diagnosed <10 yr earlier (70.7 ± 12.1, t[df 46] = 2.34, $P < 0.05$).

Because women with OD had diabetes before their pregnancy, it was hypothesized that they would score higher than women with GD. Consequently, discriminant (construct) validity was assessed by examining whether women with OD had higher mean scores than women with GD at the baseline assessment. Women with OD ($n = 58$) obtained a mean percent correct score of 73.3 ± 13.5, whereas women with GD ($n = 67$) obtained a mean percent correct score of 55.2 ± 17.3. This difference was statistically significant (t[df 123] = 6.43, $P < 0.001$). Because the forms for women with OD and GD had only eight items in common, the obtained difference might reflect differential difficulty of the test forms. Consequently, the two groups were compared on the eight items they had in common. The women with OD obtained a mean total score (percent correct) of 80.2 ± 15.0, whereas the women with GD obtained a mean total score of 59.3 ± 20.9. This difference was statistically significant (t[df 123] = 6.31, $P < 0.001$).

Because previous research has demonstrated that patients who are treated with insulin demonstrate more knowledge of their diabetes than those who are diet controlled, concurrent validity was assessed by comparing women with GD who use or do not use insulin (1). The two groups were compared on the 14 items they had in common, eliminating the 4 items designed for women with GD who use insulin. The mean total score (percent correct) for women who were diet controlled ($n = 46$) was 55.5 ± 16.8, whereas the mean

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total score for women treated with insulin in addition to diet (n = 21) was 62.6 ± 16.3. The difference between the two groups was in the expected direction but was not statistically significant (t[df 65] = 1.62, $P > 0.10$).

Patients are likely to improve their knowledge about diabetes during pregnancy by taking part in the clinic program. Consequently, it was hypothesized that scores would improve somewhat on the DPKS at retesting due to this informal education. For the sample of 62 subjects, the group received a mean score of 69.5 ± 14.4. At follow-up, the mean score was 74.2 ± 15.4 at baseline. A paired t test revealed this change to be statistically significant (t[df 61] = 3.52, $P < 0.001$). When the results were compared for women with OD separately, there was a significant difference between the original test administration (72.5 ± 14.3) and retesting (79.7 ± 10.0, t[df 41] = 5.39, $P < 0.001$). For the women with GD, their mean score on original testing was 63.2 ± 12.6, whereas the repeat test score was 62.7 ± 18.5. This difference was not statistically significant (t[df 19] = 0.18, $P = 0.86$).

DISCUSSION

The DPKS was designed as a brief screening test about diabetes during pregnancy, with several items devised to assess discrete areas of diabetes knowledge, e.g., diet, blood glucose testing, and insulin reactions. Overall results of our preliminary studies are promising. The readability of the scale is comparable to other scales in the literature (1,2). The necessity of the use of diabetes, pregnancy, and dietary terminology raises the grade level and reading difficulty of some items but cannot be avoided. Similarly, there was a small but significant correlation with educational level, suggesting that understanding of diabetes in general, and item content on the DPKS in particular, is related to educational level. Thus, although the overall low reading level of the DPKS should facilitate use of the scale in routine clinical care, as with other scales, care should be taken to ensure that patients adequately understand some of the more difficult items.

The test-retest and internal consistency coefficients obtained in the study appear adequate. Internal consistency increases with the length of a test. Thus, although the internal consistency of the DPKS was somewhat lower than that found for other diabetes knowledge tests for adults and children, it is reasonably high for such a brief measure (1,10). The addition of items would increase the internal consistency of the measure, but we elected to keep the measure brief to ensure its practicality. For example, the diabetes educator can review the answers with the patient, discuss areas where knowledge is deficient, and readminister the scale on later clinic visits if necessary to gauge the success of educational efforts.

The validity of the measure was supported by the following findings. First, the duration of illness has been suggested as an important variable related to knowledge among individuals with diabetes (1,11). This was found to be true for women with type I diabetes in this sample. In addition, the group of women with OD (type I and type II) were expected to have higher scores than women recently diagnosed with GD, and this was also found to be true. Second, because women in the Diabetes in Pregnancy Program spoke with the nurse educator and their physician on a weekly basis, they were receiving some education throughout the retest period. Thus, it was expected that over the course of treatment in the program women would gain some additional knowledge about diabetes in pregnancy and their scores might improve slightly on retesting. A modest improvement was found in this study for the sample as a whole and for women with GD. However, because we did not retest all subjects and there was no control group in this design, the improvement in scores is only suggestive evidence because the improvement could be due to practice effects of repeated testing. There was no change for the women with GD, which might be a function of the small number available for analyses and the brief period these women had to assimilate information about GD.

Other studies have suggested that patients who were taking insulin are more knowledgeable about their diabetes than those not treated with insulin (1,11,12). Because all women with OD were on insulin, women diagnosed with GD who were placed on insulin were compared with those who were diet controlled. Women with GD on insulin obtained higher scores than those who were diet controlled, but this difference was not statistically significant. Many subjects are needed to have the power necessary to obtain statistically significant results on this particular comparison. In addition, because most of the women with GD who were placed on insulin had only been on insulin for 1–2 wk at the time of the screening with our knowledge measure, this may not have been an adequate length of time to have significantly affected the level of knowledge.

One important finding from this study is the low correct scores obtained on the knowledge questionnaire by women with GD. The average woman with GD got ~50% of the items on the DPKS correct. Women with OD obtained a higher percentage correct (in the 70% range) than women with GD, which was commensurate with other studies of knowledge of diabetes (1). These results suggest, as do other studies (2), that most patients have rudimentary knowledge of their diabetes. This may be particularly true of women with GD who were asked to integrate a substantial amount of knowledge in a relatively short period. In addition, variability on the measure suggests that there are some patients who have greater difficulty learning about diabetes during pregnancy and therefore should be targeted for extra educational efforts during their pregnancy.

Further refinement of item wording and scale content will be a goal of future research. Nonetheless, the DPKS can provide a general index of knowledge for clinical

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purposes and a cost-efficient method of pinpointing a patient's specific educational deficits quickly. By so doing, the knowledge areas most important in enhancing management of diabetes during pregnancy and minimizing potential complications with the pregnancy can be more easily reviewed with the patient. Further development of the scale will also help in future studies examining the relationship between compliance and knowledge or between metabolic control and knowledge among this high-risk group.

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APPENDIX: DIABETES IN PREGNANCY KNOWLEDGE SCREEN

Below are questions about diabetes during pregnancy. Answering these questions will help us determine your current knowledge about diabetes during pregnancy and enable us to provide the best care possible during your pregnancy. Many questions have more than one answer, therefore circle "I don't know" rather than guessing. By answering to the best of your knowledge, we will be able to counsel you most effectively about diabetes during your pregnancy.

1. Which of the following feelings may result from a reaction? (Circle all that might happen, not just those that have happened to you)
   A. Difficulty thinking
   B. Blurred vision
   C. Nervousness or shaky
   D. Numbness
   E. Sweating
   F. I don't know
2. What should you do if you have a reaction? (Circle all that apply)
   A. Walk it off
   B. Sit down and rest
   C. Eat crackers or cheese
   D. Drink milk
   E. I don't know
3. Glycosylated hemoglobin levels are drawn about once per month during pregnancy. Why are these levels taken?
   A. They measure previous blood sugar control
   B. They measure the amount of iron in your blood
   C. They measure how helpful your diet is in controlling your blood sugar
   D. I don't know
4. When planning vigorous exercise (e.g., swimming, playing tennis), what changes should you make in your daily diabetes routine? (Circle all that apply)
   A. Decrease insulin
   B. Carefully time when to do your exercising
   C. Increase amount of carbohydrates (e.g., bread, fruits) you eat
   D. Increase the amount of protein (e.g., meat, cheese) you eat
   E. I don't know
5. On days when you are sick, what steps should you take to control your diabetes?
   A. Increase the amount of water or other fluids
   B. Stop your insulin
   C. Call your doctor
   D. I don't know
6. The normal range for blood sugar during pregnancy is:
   A. 40–150 mg/dl
   B. 60–120 mg/dl
   C. 100–200 mg/dl
   D. I don't know
7. A specific meal plan has been devised for you by the dietitian. Which of the following statements about your meal plan are correct. (Circle all that apply)
   A. You should eat everything on your meal plan
   B. You can reduce the amount of food you eat if you're not hungry
   C. You should control the amount of food you eat all the time
   D. You can eat your meals any time during the day as long as you eat everything on your plan
   E. I don't know
8. Bedtime snacks are an important part of your meal plan because they help you avoid having reactions overnight. (Circle one)
   True or False
9. Margarine is mainly:
   A. Protein
   B. Carbohydrate
   C. Fat
   D. Mineral and vitamin
   E. I don't know
10. Rice is mainly:
    A. Protein
    B. Carbohydrate
    C. Fat
    D. Mineral and vitamin
    E. I don't know
11. If you don't feel like having the egg on your diet for breakfast, you can: (Circle two)
    A. Have extra toast
    B. Substitute one small chop
    C. Have an ounce of cheese instead
    D. Skip the egg, and don't eat anything else
    E. I don't know
12. If you have problems controlling your blood sugar during pregnancy, what are some of the possible effects on your baby after birth? (Circle all that apply)
    A. Could be born with low blood sugar (hypoglycemia)
    B. Could be a large baby making delivery more difficult
    C. Could have breathing problems after birth
    D. I don't know
13. What does glucagon do?
    A. It helps the liver release more sugar into the blood
    B. It makes the liver stop releasing sugar into the blood
    C. It helps the pancreas release more insulin
    D. It stops the pancreas from releasing insulin
    E. I don't know
14. After using glucagon, it's most important to:
    A. Drink plenty of fluids
    B. Get plenty of rest

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C. Eat a meal so your blood sugar doesn't drop
D. None of the above
E. I don't know

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