

## ORIGINAL RESEARCH

# Reducing Preconception Risks Among African American Women with Conversational Agent Technology

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**Background:** Systems and tools are needed to identify and mitigate preconception health (PCH) risks, particularly for African American (AA) women, given persistent health disparities. We developed and tested “Gabby,” an online preconception conversational agent system.

**Methods:** One hundred nongravid AA women 18–34 years of age were screened for over 100 PCH risks and randomized to the Gabby or control group. The Gabby group interacted with the system for up to six months; the control group received a letter indicating their health risks with a recommendation to talk with their clinician. The numbers, proportions, and types of risks were compared between groups.

**Results:** There were 23.7 (SD 5.9) risks identified per participant. Eighty-five percent (77 of 91) provided 6 month follow up data. The Gabby group had greater reductions in the number (8.3 vs. 5.5 risks,  $P < .05$ ) and the proportion (27.8% vs 20.5%,  $P < 0.01$ ) of risks compared to controls. The Gabby group averaged 63.7 minutes of interaction time. Seventy-eight percent reported that it “was easy to talk to Gabby” and 64% used information from Gabby to improve their health.

**Conclusion:** Gabby was significantly associated with preconception risk reduction. More research is needed to determine if Gabby can benefit higher risk populations and if risk reduction is clinically significant. (J Am Board Fam Med 2015;28:441–451.)

**Keywords:** Health Care Disparities, Health Information Technology, Health Promotion, Preconception Care, Reproductive Health

Despite mounting scientific evidence that enhancing a woman’s health before pregnancy improves perinatal outcomes for her and her infant,

many women enter pregnancy in poor health and at risk for preventable adverse pregnancy outcomes. In addition, about half of pregnancies are unplanned, making it important to promote preconception health (PCH) and deliver preconception

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**Conflict of interest:** The authors are responsible for the production of Gabby, the preconception conversational agent, and retain the intellectual property rights.

**Disclaimer:** This information or content and conclusions are those of the author and should not be construed as the official position or policy of, nor should any endorsements be inferred by the Health Resources and Services Administration, the US Department of Health and Human Services, or the US government.

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care (PCC) to all women of reproductive age, regardless of pregnancy intention.<sup>1</sup> The Centers for Disease Control and Prevention (CDC) defines PCC as “interventions that aim to identify and modify biomedical, behavioral, and social risks to a woman’s health or pregnancy outcome through prevention and management by emphasizing those factors that must be acted on before conception or early in pregnancy to have maximal impact.”<sup>2</sup> PCH and PCC involve addressing a range of issues, such as family planning, specific medical conditions (eg, diabetes), exposure to teratogens, substance abuse, and preventive interventions (eg, immunization and folic acid supplementation).<sup>3</sup>

In 2008 the CDC Select Panel on Preconception Care clinical workgroup outlined those content areas that are important to identify and address to improve maternal and infant outcomes<sup>4</sup>; the workgroup identified implementation strategies as a top priority.<sup>5</sup> In 2013, the 2006 CDC preconception goals were updated to include improving the knowledge, attitudes, and behaviors of men and women related to PCC; eliminating disparities in adverse maternal, fetal, and infant outcomes; and ensuring that all US women of child-bearing age receive PCC services.<sup>6</sup> Progress toward the Healthy People 2020 goal to eliminate disparities requires that rates of adverse health outcomes fall more rapidly for African American (AA) women, which is why the Gabby system was designed for this group.

Health information technology presents opportunities to develop innovative tools that assist clinicians in delivering PCC<sup>7</sup> and to engage and empower women to improve their PCH. Among the most encouraging advances is the conversational agent, a computerized, animated character that integrates best practices from provider–patient communication theory. They emulate the face-to-face conversational behavior of an empathic clinician, including nonverbal communicative behavior such as gaze, posture, and hand gestures, to deliver tailored education, assess comprehension, and record progress.<sup>8–10</sup> Conversational agents are a logical option to deliver PCH information because they can reach a large audience while providing high user acceptability through culturally appropriate content and information appropriate to those with low health literacy.<sup>11,12</sup> AA women may benefit from conversational agents because of disparities in health literacy levels; according to a 2006 report by

the US Department of Education, 58% of AA adults possess below basic or basic health literacy compared with 28% of white adults.<sup>13</sup> There is also evidence that clinicians are more verbally dominant and less patient-centered with AA patients,<sup>14</sup> and that these systems can overcome clinician time constraints<sup>15</sup> and assist in delivering recommended preventive care.<sup>16</sup> Conversational agents also have been used in studies showing significant impact on clinical outcomes.<sup>11,17,18</sup>

Given the success of our previous conversational agent work among inner-city patients, our research team spent 5 years developing and testing the conversational agent “Gabby,” who is designed to be used by women to improve their PCH and seek PCC (Figure 1). Gabby can identify women’s individual health risks and assess their readiness for behavior change; provide information about each risk; and deliver longitudinal behavior change content to promote the adoption of healthy behaviors and risk resolution. The system helps women create a “My Health To-Do List (MHTDL),” a personal tool that can be updated throughout the intervention to track progress.

Our earlier testing of Gabby demonstrated that the system had the potential to help AA women address preconception risks over a 2-month period.<sup>19</sup> In this article we report on an enhanced version with more sophisticated elements, including tracking stages of behavioral change, which we tested in a 6-month randomized controlled trial (RCT) of nonpregnant AA women, most in college, to determine how well Gabby works and to identify additional areas for improvement. The ultimate goal is to produce an effective Gabby system for use either solely by women and/or integrated into care targeting high-risk AA women with lower education and health literacy.

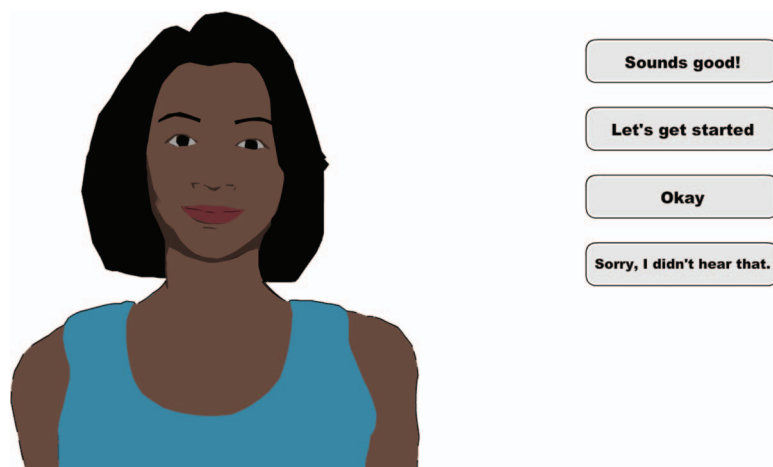
## Methods

We conducted a RCT from March 2013 to February 2014 to determine whether interacting with Gabby could reduce the proportions, numbers, and types of PCH/PCC risks compared with a control group without access to Gabby. The study was approved by the Boston University Medical Center Institutional Review Board.

## Design and Implementation

New dialog scripts and supporting media were developed for this version of Gabby, including:

**Figure 1.** An image of “Gabby,” the preconception care conversational agent.



(1) motivational interviewing dialog for those who were “precontemplative” for a specific risk; (2) dialog to simulate shared decision-making interactions with clinicians; and (3) additional longitudinal interaction using techniques such as goal setting, problem solving, tips, and homework.

### Sample

A purposeful convenience sample of 100 women who self-identified as AA or black, were 18 to 34 years of age, had access to a telephone and computer with Internet, spoke English, and self-reported as not currently pregnant were enrolled from 20 states and the District of Columbia. Participants were recruited through the US Department of Health and Human Services Office of Minority Health’s national Preconception Peer Educator (PPE) program<sup>20</sup> (n = 86), a Healthy Start site in Florida (n = 8), a Health Expo in Boston (n = 4), and word of mouth (n = 2). Recruitment materials included E-mails, flyers, and referrals.

### Baseline Data

After providing verbal informed consent by telephone, we collected contact information, demographic data, and administered the General Self Efficacy Scale,<sup>21</sup> Multidimensional Scale of Perceived Social Support,<sup>22</sup> Everyday Discrimination Scale,<sup>23</sup> and the 66-word Rapid Estimate of Adult Literacy in Medicine.<sup>24</sup>

### Randomization and Risk Assessment

Participants were randomized into the Gabby or control groups using sequentially numbered, opaque, sealed envelopes containing the random group assignment. All subjects received an E-mail with the required system log-in information and were asked to complete the risk assessment, which included 107 distinct PCH risk factors classified among 12 content areas. A full description of the content areas and risks has been published<sup>4</sup>; they are listed in Table 1 and outlined in online Appendices 1 and 2. All women received a reminder E-mail with a link to the risk assessment 1 week after enrollment, then biweekly reminders until they completed the risk assessment.

### Gabby Group

Women in the Gabby group received biweekly reminder E-mails with a link. Each interaction consisted of (1) a greeting from Gabby; (2) a review of identified health risks (“My Survey Results”); (3) discussion of risks as selected by the woman (including educational content and behavior change counseling); and (4) a review and update of the My Health To-Do List, which lists the previously discussed risks and self-reported progress (Figure 2).

### Control Group

Each control participant received a letter in the mail containing her list of PCH risks, with the suggestion to discuss her list with a health care provider.

**Table 1. Risks Identified at the Baseline Survey and Risks Reported to be Resolved or Improved at 6 months, by Content Area and Study Group**

Risks*		Gabby Group†	Control Group‡	P Value
Emotional and mental health	Participants who triggered ≥ 1 risk (%)	21 (45.6)	19 (42.2)	.74
	Participants with at least 1 risk resolved/no. of participants reached at follow-up who had triggered at least 1 risk (%)	12/18 (66.7)	4/16 (25.0)	.02
Environmental	Risks triggered that were resolved/total no. of risks triggered (%)	15/35 (43.0)	4/32 (13.0)	.01
	Participants who triggered ≥ 1 risk (%)	44 (95.6)	43 (95.6)	1.00
Genetic health history	Participants with at least 1 risk resolved/no. of participants reached at follow-up who had triggered at least 1 risk (%)	11 (32.4)	5 (12.8)	.04
	Risks triggered that were resolved/total no. of risks triggered (%)	13/119 (10.9)	6/102 (5.9)	.18
Health care	Participants who triggered ≥ 1 risk (%)	46 (100.0)	45 (100.0)	.32
	Participants with at least 1 risk resolved/no. of participants reached at follow-up who had triggered at least 1 risk (%)	14/36 (38.9)	12/41 (29.3)	.37
Health conditions and medicines	Risks triggered that were resolved/total no. of risks triggered (%)	19/71 (26.8)	15/67 (22.4)	.55
	Participants who triggered ≥ 1 risk (%)	16 (34.8)	31 (68.9)	.01
Immunizations and vaccines	Participants with at least 1 risk resolved/no. of participants reached at follow-up who had triggered at least 1 risk (%)	5/12 (41.7)	5/27 (18.5)	.13
	Risks triggered that were resolved/total no. of risks triggered (%)	8/34 (23.5)	7/64 (10.9)	.09
Infectious diseases	Participants who triggered ≥ 1 risk (%)	28 (60.9)	28 (62.2)	.89
	Participants with at least 1 risk resolved/no. of participants reached at follow-up who had triggered at least 1 risk (%)	12/22 (54.5)	5/25 (20.0)	.01
Men and health care	Risks triggered that were resolved/total no. of risks triggered (%)	14/41 (34.1)	8/36 (22.2)	.25
	Participants who triggered ≥ 1 risk (%)	38 (82.6)	42 (93.3)	.12
Nutrition and activity	Participants with at least 1 risk resolved/no. of participants reached at follow-up who had triggered at least 1 risk (%)	17/30 (56.7)	15/38 (39.5)	.16
	Risks triggered that were resolved/total no. of risks triggered (%)	25/80 (31.3)	21/111 (18.9)	.05
Men and health care	Participants who triggered ≥ 1 risk (%)	46 (100.0)	45 (100.0)	NA
	Participants with at least 1 risk resolved/no. of participants reached at follow-up who had triggered at least 1 risk (%)	25/36 (69.4)	23/41 (56.1)	.23
Nutrition and activity	Risks triggered that were resolved/total no. of risks triggered (%)	52/172 (30.2)	44/182 (24.2)	.20
	Participants who triggered ≥ 1 risk (%)	31 (67.4)	26 (57.8)	.34
Nutrition and activity	Participants with at least 1 risk resolved/no. of participants reached at follow-up who had triggered at least 1 risk (%)	5/25 (20.0)	9/23 (39.1)	.15
	Risks triggered that were resolved/total no. of risks triggered (%)	6/49 (12.2)	4/39 (10.3)	.10
Nutrition and activity	Participants who triggered ≥ 1 risk (%)	46 (100.0)	45 (100.0)	NA
	Participants with at least 1 risk resolved/no. of participants reached at follow-up who had triggered at least 1 risk (%)	32/36 (88.9)	29/41 (70.7)	.05
Nutrition and activity	Risks triggered that were resolved/total no. of risks triggered (%)	101/292 (34.6)	67/302 (22.2)	.01

*Continued*

**Table 1. Continued**

Risks*	Gabby Group†	Control Group‡	P Value
Relationships			
Participants who triggered ≥1 risk (%)	21 (45.6)	30 (66.7)	.04
Participants with at least 1 risk resolved/no. of participants reached at follow-up who had triggered at least 1 risk (%)	5/16 (31.3)	6/27 (22.2)	.51
Reproductive health			
Risks triggered that were resolved/total no. of risks triggered (%)	10/36 (27.8)	9/53 (17.0)	.22
Participants who triggered ≥1 risk (%)	40 (87.0)	38 (84.4)	.73
Participants with at least 1 risk resolved/no. of participants reached at follow-up who had triggered at least 1 risk (%)	10/31 (32.3)	9/34 (26.5)	.61
Substance use			
Risks triggered that were resolved/total no. of risks triggered (%)	16/87 (18.4)	12/62 (19.4)	.88
Participants who triggered ≥1 risk (%)	27 (58.7)	25 (55.6)	.76
Participants with at least 1 risk resolved/no. of participants reached at follow-up who had triggered at least 1 risk (%)	10/20 (50.0)	11/22 (50.0)	1.00
Totals			
Risks triggered that were resolved/total no. of risks triggered (%)	17/36 (47.2)	17/41 (41.5)	.61
Participants with at least 1 risk resolved/no. of participants reached at follow-up who had triggered at least 1 risk (%)	36/36 (100.0)	37/41 (90.0)	
Risks triggered that were resolved/total no. of risks triggered (%)	297/1067 (27.8)	224/1091 (20.5)	<.01

\*The various risks were categorized as follows:

**Emotional and Mental Health:** history of or diagnosis of or depression, anxiety, bipolar disorder, or schizophrenia; depression (2-item Patient Health Questionnaire score  $\geq 3^25$ ); stress (4-item Perceived Stress Scale score  $\geq 8^26$ ); family history of psychiatric conditions (depression, anxiety, schizophrenia, bipolar disorder).

**Environmental Issues:** exposure to lead; at risk for toxoplasmosis; living near toxic waste or a “superfund” site; untested well water in the home; frequently drinking from plastic water bottles; frequently eating food from cans with a white plastic lining; reported workplace exposure to chemicals or dangers; reported exposure to potentially toxic household chemicals.

**Genetic Health History:** ethnicity-based genetic health risk based on ancestry; family history of a genetic health condition; personal history of a genetic health condition; need to learn family health history.

**Health Care and Programs:** inadequate financial resources; does not have health insurance; has inadequate health insurance; does not have a primary care physician; not been to a dentist in over a year.

**Health Conditions and Medicines:** history of diagnosis of diabetes, prediabetes, gestational diabetes, hyper- or hypothyroidism, phenylketonuria, seizures, hypertension, rheumatoid arthritis, lupus, renal disease, cardiovascular disease, thrombophilia, asthma; history of or diagnosis of a disability; history of or diagnosis of cancer; currently taking any prescription medications; currently taking any over-the-counter medicines.

**Immunizations and Vaccines:** need human papillomavirus vaccine; need hepatitis B vaccine; need measles, mumps, and rubella vaccine; need influenza vaccine; need tetanus vaccine; need tetanus-diphtheria-pertussis vaccine; unsure of immunization record.

**Infectious Diseases:** at risk for sexually transmitted infection; sexually active and has not been tested for sexually transmitted infections; history of or diagnosis of human immunodeficiency virus, gonorrhea/chlamydia/syphilis, herpes simplex virus; at risk for tuberculosis, malaria, cytomegalovirus hepatitis C; not born in the United States.

**Men and Health Care:** partner has not been to doctor in > 1 year; partner does not have a primary care physician; partner has not been counseled on a reproductive life plan.

**Nutrition and Activity:** bad diet or food choices (<5 daily servings of fruits and vegetables and/or regular intake of junk food); possibly taking too much vitamin A; not using a multivitamin with folic acid or a folic acid supplement; use of herbal or weight-loss supplements; not taking supplements of vitamin D, calcium, iron; need more essential fatty acids in diet; at risk for toxic concentrations of mercury; at risk for listeriosis; underweight (body mass index  $< 18.5$  kg/m<sup>2</sup>); overweight (body mass index  $\geq 30$  kg/m<sup>2</sup>); self-reported potential eating disorder; use of caffeine; not enough exercise (>30 min/d, 5 d/wk).

**Relationships:** history of or current physical or sexual abuse; history of or current emotional or verbal abuse; does not feel safe.

**Reproductive Health:** does not use withdrawal method of birth control; uses other less effective birth control method (Plan B, hyaluronidase, history of cesarean delivery, history of miscarriages; history of or diagnosis of second trimester; history of abortion; history of stillbirth; history of uterine anomalies; history of infant or child death; <3 months between past pregnancies; history of vaginal bleeding late in pregnancy; history of infant in neonatal intensive care unit; history of infant with a birth defect; participant was born before term or with a low birth weight; participant’s mother was born before term or with a low birth weight.

**Substance Use:** excessive alcohol (≥4 drinks in a day over the past year); any current tobacco use; any illicit substance use in the past year.

†At baseline, this group included 46 participants; n = 36 at 6 months.

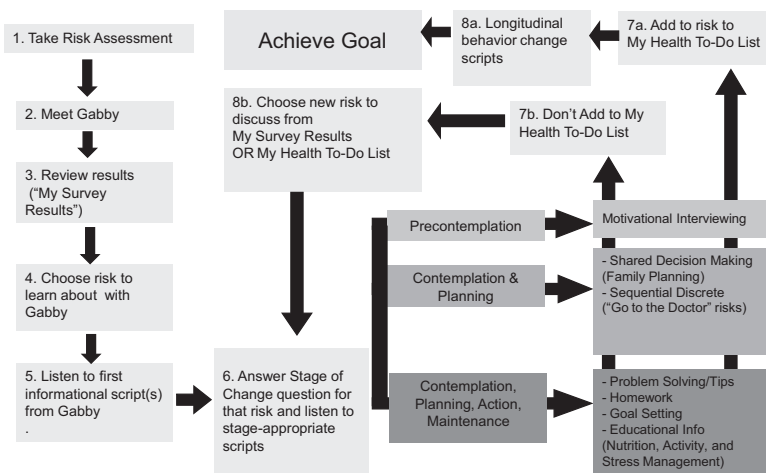
‡At baseline, this group included 45 participants; n = 41 at 6 months.

NA, not available.



**Figure 2. Diagram of a typical Gabby System interaction.**

## Gabby Version 2



### Outcome Data

Six-month outcome data were collected from all women using an online survey followed by telephone call. Questions not completed online were asked during the telephone call. Information was obtained about each baseline PCH risk to determine whether it was still “active” or “resolved.”

Additional outcome data collection included assessment of health care usage during the study period, questions about pregnancy status and outcome, system satisfaction (Gabby group), and risk letter satisfaction (control group). Number and duration of logins were documented within the system. Participants received a \$15 iTunes gift card after completing the outcome phone call.

### Statistical Analysis

Baseline demographic, clinical, and information technology usage characteristics were compared using 2-sided *t* tests for continuous variables and  $\chi^2$  tests or Fisher exact tests for categorical and dichotomous variables. Within each PCH content area, we compared the proportion of the Gabby and control participants who triggered at least 1 risk, the aggregate number of risks triggered (applying the *z* test for proportions), and the triggered risk rate using the aggregate number of risks triggered divided by the number of participants completing the risk assessment.

To assess the impact of Gabby, we first compared, using a 2-sample *t* test, the average number

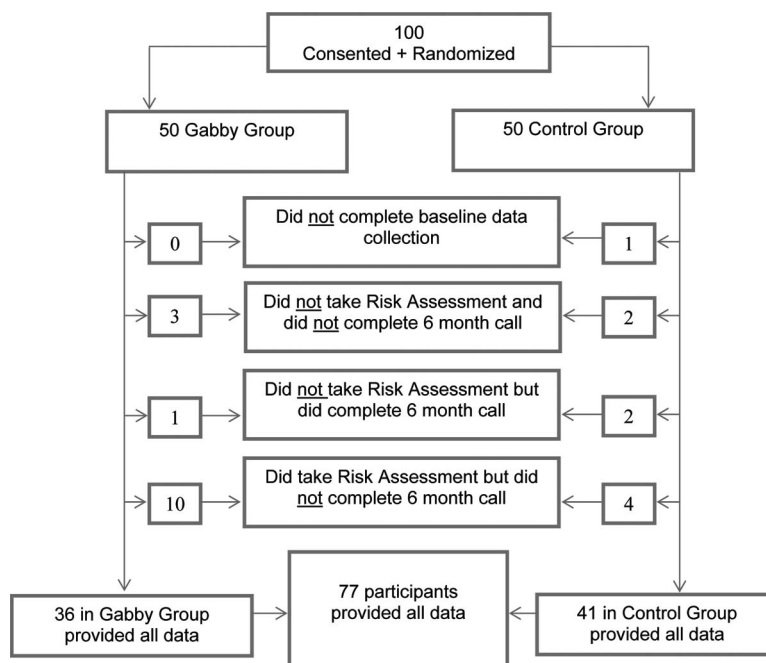
of risks resolved between the Gabby and control groups among participants who completed the risk assessment and the outcome interview. We then compared the proportion of participants who resolved at least 1 of the risks in each content area with those who triggered at least 1 risk at baseline ( $\chi^2$ /Fisher exact tests). The aggregate numbers of risks resolved were calculated by dividing the number of risks resolved by the number triggered at baseline (*z* tests for proportions). Finally, we looked at rates of risks resolved within the content areas by study group. The rates were calculated by dividing the aggregate number of risks resolved within a content area by the number of participants who triggered at least 1 risk in this domain at baseline and compared between the 2 study groups using crude Poisson regressions.

### Results

A total of 100 women who met all inclusion criteria consented and were randomized into the study. Complete baseline and 6-month outcome data were obtained from 36 women in the Gabby group and 41 in the control group (Figure 3). There was no significant difference in response rates between groups (*P* = .34).

The demographic, clinical, and information technology characteristics of the 99 women who provided baseline data are presented in Table 2. The average age was 25.5 years; about two-thirds

**Figure 3. Diagram of subject participation in study phases.**



were employed at least part time and completed at least some college, and 41% were students. Over 90% read at the high school level or better, and the majority reported high self-efficacy, high social support, and low perceived racial discrimination. More than half had computer access at home, and all used a computer regularly or considered themselves expert. Over 90% had used computers to access online health information. There were no significant differences in the demographics, clinical characteristics, or information technology literacy and availability between groups.

Table 1 shows the content areas of risks reported at baseline and those risks resolved or improved in 6 months by study group. The average number of risks triggered was 23.7 (standard deviation, 5.9) per participant, 23.2 (6.0) for the Gabby group, and 24.2 (5.8) for the control group. A total of 2158 risks were triggered by the 91 participants who completed the risk assessment (1067 by the Gabby group and 1091 by the control group). The most common content area triggered among all participants was “nutrition and activity” (27.5%), followed by “infectious disease” (16.4%), “environmental issues” (10.2%), and “immunizations and vaccines” (8.8%). The specific risks within each content area are listed at the bottom of Table 1 and in online appendix 1.

During the 6-month intervention period, 42 women interacted with Gabby at least once. There were a total of 144 interactions totaling 2676 minutes. The average session lasted 18.6 minutes (SD, 12.1 minutes), and the average interaction time with Gabby during the study was 63.7 minutes (SD, 70.4 minutes; range, 2.8–286 minutes) per woman. Of the total time interacting with Gabby, 30% was spent discussing nutrition and activity, and 10.3% was spent discussing “reproductive health.”

Significant differences in risk resolution were found between the Gabby and control groups. Among the 77 women for whom both baseline data and 6-month outcome data were available, 27.8% (297/1067) of the reported risks were resolved in the Gabby group compared with 20.5% (224/1091) in the control group ( $P < .01$ ; Table 1). At 6 months, women in the Gabby group resolved, on average, 8.3 risks (from the average 23.2 identified), compared with 5.5 risks (of 24.2 identified) in the control group ( $P < .01$ ). The risks most often resolved by those in the Gabby group were “bad diet or food choices” (18 resolved), “not using multivitamin with folic acid or folic acid supplement” (16 resolved), “at risk for sexually transmitted infection” (15 resolved), “not taking iron supplement” (13 resolved), “use of caffeine” (12 resolved), and “at risk for tuberculosis” (12 resolved). These 6

**Table 2. Participant Demographics, Clinical Characteristics, and Computer Literacy and Availability\* by Study Group (n = 99)**

	Gabby Group (n = 50)	Control Group (n = 49)
<b>Demographics</b>		
Age, mean years (SD)	25.9 (3.4)	25.1 (3.7)
Hispanic, Latino, or Spanish origin		
No	47 (94.0)	47 (95.9)
Yes	3 (6.0)	2 (4.1)
Household income (\$)		
<20,000	3 (6.0)	3 (6.1)
20,000–49,999	13 (26.0)	7 (14.3)
≥50,000	15 (30.0)	23 (46.9)
Don't know/refused	19 (38.0)	16 (32.7)
Education		
At least some college	36 (72.0)	30 (61.2)
Less than college	14 (28.0)	19 (38.8)
English as a primary language		
No	5 (10.0)	1 (2.0)
Yes	45 (90.0)	48 (98.0)
Currently a student		
No	30 (60.0)	28 (57.1)
Yes	20 (40.0)	21 (42.9)
Currently employed full time or part time		
No	16 (32.0)	12 (24.5)
Yes	34 (68.0)	37 (75.5)
<b>Clinical characteristics</b>		
REALM score, mean (SD) <sup>†‡</sup>	61.5 (11.2)	63.0 (4.8)
REALM-2 category <sup>§</sup>		
High school	42 (91.3)	40 (88.9)
Less than high school	4 (8.7)	5 (11.1)
General Self-Efficacy Scale score, mean (SD) <sup>  </sup>	33.9 (4.7)	33.8 (3.8)
Multidimensional Scale of Perceived Social Support score, mean (SD) <sup>¶</sup>	71.0 (9.4)	70.1 (9.1)
10-Item Everyday Discrimination Scale score, mean (SD) <sup>**</sup>	12.4 (8.9)	12.7 (6.8)
<b>Information technology literacy and access</b>		
Primary location of accessible computer		
Home	27 (55.1)	28 (57.1)
Work	15 (30.6)	17 (34.7)
Other	7 (14.3)	4 (8.2)
Computer experience		
I'm an expert	23 (46.0)	28 (57.1)
I use one regularly	27 (54.0)	21 (42.9)
I've never used one	0 (0)	0 (0)
I've tried one a few times	0 (0)	0 (0)
Computer attitude		
I love playing with them	45 (90.0)	42 (85.7)
They're okay	5 (10.0)	7 (14.3)
I don't like them	0 (0)	0 (0)
Do you ever read about health information online?		
No	3 (6.0)	3 (6.1)
Yes	47 (94.0)	46 (93.9)
Do you ever ask questions or share health information on social networking sites like Facebook, Twitter, or elsewhere?		
No	18 (36.0)	24 (49.0)
Yes	32 (64.0)	25 (51.0)

*Continued*



Table 2. Continued

	Gabby Group (n = 50)	Control Group (n = 49)
How frequently do you use the Internet for health information?		
Never	3 (6.0)	3 (6.1)
Rarely	2 (4.0)	1 (2.0)
Sometimes	18 (36.0)	17 (34.7)
Frequently	9 (18.0)	16 (32.7)
Very frequently	18 (36.0)	12 (24.5)

Data are n (%) unless otherwise indicated.

\*None of the data were statistically significant between the 2 groups at baseline.

<sup>†</sup>Columns do not always add up to number of participants because of missing data.

<sup>‡</sup>The Rapid Estimate of Adult Literacy Levels in Medicine (REALM) is a screening tool designed to measure adults' ability to read common medical words or lay terms that correspond to anatomy or illnesses. It is a 66-item list, with possible scores ranging from 0 to 66.<sup>24</sup>

<sup>§</sup>REALM scores are dichotomized by high school or more (score of 61 to 66) and less than high school (score  $\leq$ 60).

<sup>||</sup>The General Self-Efficacy Scale is a 10-item psychometric scale designed to assess optimistic self-beliefs related to ability to cope with difficult demands in life. Response options are never (1), sometimes (2), usually (3), or almost always (4), with possible score ranging from 10 to 40.<sup>21</sup>

<sup>¶</sup>The Multidimensional Scale of Perceived Social Support scale is a 12-item scale to measure perceived support from family, friends, and significant others. Response options ranged between strongly disagree (1), neutral (4), strongly agree (7) and were summed for a total score.<sup>22</sup>

<sup>\*\*</sup>The Everyday Discrimination Scale is a 10-item scale to measure the perceived frequency of 10 specific discriminatory experiences. Response options include never (0), less than once a year (1), a few times a year (2), a few times a month (3), at least once a week (4), and almost every day (5), with a possible total score ranging from 0 to 50.<sup>23</sup>

SD, standard deviation.

risks accounted for 29% of the risks resolved among the Gabby group. On the other hand, there were clinically important risks that were infrequently or never resolved, such as “any current tobacco use” (0 Gabby group participants resolved it of 6 identified at baseline); “currently taking any over-the-counter medicines” (1 of 13 resolved); and “no birth control” (3 of 20 resolved).

Most women in the Gabby group felt that it was easy to talk with Gabby (78%) and reported that they trusted her (59%). More than half (56%) stated that Gabby did a good job of answering their questions, almost two-thirds reported that they had used information from Gabby to improve their health, and another 22% planned to do so in the future.

## Discussion

The study findings demonstrate that among a group of mostly college-educated, computer literate AA women, the Gabby system can identify preconception risks and initiate actions to reduce the number of preconception risks. Interacting with Gabby was significantly associated with a higher proportion (28% vs 21%) and a greater average number (8.3 vs 5.5) of PCH risks being resolved within 6 months compared with women who did not interact with Gabby.

The Gabby system allows women to choose what risks to discuss and when, allowing a woman to avoid talking about risks that might be very important to her health and the health of a future baby (eg, substance use, intimate partner violence), which can lead to shortfalls where a serious risk is identified but discussion and intervention are avoided. However, our previous qualitative work supports providing autonomy and supporting a shared decision-making approach that is more empowering.<sup>19</sup>

The nutrition and physical activity content area contained the most risks triggered, discussed, and resolved. The nutrition section is unique within the Gabby program; it features a curriculum, allowing users to “browse” through a menu of topics. This approach will be applied to other content areas, such as reproductive life planning, in future versions. The system will also feature more culturally tailored content to engage young AA women from a social context.<sup>27</sup> Current development includes adding 6 narratives that provide background into Gabby's “personal life” and conversational dialog about topics such as hair care, skin care, relationships, and other topics more immediately relevant and applicable to young women's lives.

Our findings regarding participants' trust in Gabby are consistent with other studies that indi-

cate patients prefer sharing sensitive information with computerized agents whom they perceive to be less judgmental and have more time than traditional providers.<sup>28</sup> Gabby group participants also reported that it was easy to talk to Gabby, and most indicated that they had already or were planning to use information from Gabby to improve their health. They also were more likely than those in the control group (64% vs 51%;  $P = .21$ ) to report at least 1 primary care appointment within 6 months, an important but nonsignificant finding potentially resulting from the relatively short follow-up period.

We believe that women will be asking for interactive health information technology systems, and systems like Gabby will become an important part of health promotion in the future. In its current state the Gabby system is designed for use on a desktop or laptop computer; uptake of the system may have been limited because of the preference of our target population to use a telephone or tablet instead of traditional computer. The average 2.9 logins per user over 6 months fell short of our ideal goal of 1 session per week and underscores the need to plan for the future of Gabby and how women will interact with her outside of the research setting. Mobile devices are an obvious channel, but others, such as integration into clinics and community centers, offer the benefit of weaving Gabby into existing infrastructure, allowing Gabby to immediately connect to services, provide counseling, and initiate referrals. Moreover, multiple channels could be used simultaneously to reach a broader audience.

A limitation of this research is that the follow-up period was relatively short, and behavior change takes time. In addition, data are self-reported, and participants potentially could have misunderstood a question, accidentally selected the wrong response, or intentionally provided misinformation. There could also be social desirability bias when reporting risk status to staff, recall bias affecting baseline and follow-up data, and self-selection bias for study participation. Another limitation that may have led to an underestimation of Gabby's impact is that the control group also received an intervention consisting of a personalized letter listing their identified risks and suggesting that they share this information with their health care provider.

Building on the information gleaned from this RCT, we continue to enhance the Gabby system,

and in 2015 we are recruiting nationally for a much larger RCT to include women from a broader range of educational attainment and health literacy over a 12-month period to determine the impact on PCH risk mitigation. Additional research is planned to determine the impact on clinical outcomes, health care utilization, and ultimately whether Gabby—and even a parallel system for male PCH—can meaningfully affect some of the racial disparities in reproductive outcomes.

## Conclusions

This version of the Gabby system, with its personally tailored relational and comprehensive approach, holds great promise for improving access to the primary and preventive care assessments women need to prepare for pregnancy. The information gleaned has informed the next version, which is being tested in a much larger RCT. Additional research is also needed to investigate how Gabby can help AA women set their own positive reproductive health agendas, achieve meaningful health behavior changes, and engage in beneficial discourse with their health care provider, partners, and others who provide assistance and support. Gabby can potentially address problems regarding fidelity and cultural sensitivity of message, scale, ease of delivery, and clinician time constraints and can be used across a range of settings, addressing problems identified as barriers to translating PCC best practices to clinical care.<sup>29</sup>

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**Appendix 1. Baseline Risks Identified, Criteria for Identification, Goal Behavior, and Definition of Risk Resolution, by Content Area**

Risks By Preconception Care Content Area	Criteria for Identification of Risk	Goal Behavior and Definition of Risk Resolution
A. Emotional and mental health		
1. History of diagnosis of anxiety	Selection of “anxiety” in response to, “Have you been diagnosed with any of the following conditions? Check all that apply.”	Talking to a doctor about treatment for anxiety*
2. History of diagnosis of depression	Selection of “depression” in response to, “Have you been diagnosed with any of the following conditions? Check all that apply.”	Talking to a doctor about treatment for depression*
3. Potential depression	PHQ-2 score $\geq 3$	Talking with a doctor about depression*
4. History of diagnosis of bipolar disorder	Selection of “bipolar disorder” in response to, “Have you been diagnosed with any of the following conditions? Check all that apply.”	Talking to a doctor about treatment for bipolar disorder*
5. Family history psychiatric conditions (depression, anxiety, schizophrenia, bipolar disorder)	Report of family member or partner’s family member ever diagnosed with anxiety, bipolar, depression, or schizophrenia	Talking to a doctor about the history of mental illness is your family*
6. Stress	4-Item Perceived Stress Scale score $\geq 8$	Finding ways to manage your stress <sup>†</sup>
B. Environmental issues		
1. Living near toxic waste or a “superfund” site	“Yes” in response to, “Do you live near a toxic waste site or “superfund site?”	Talking to a doctor about living near a toxic waste site*
2. Exposure to lead	After indicating exposure to lead, either “no” in response to, “Have you been tested?”; or “I had too much lead in my blood” in response to, “What was the result?” and “no” in response to, “Have you been treated?”	Talking to a doctor about getting your blood lead concentrations tested*
3. Reported exposure to potentially toxic household chemicals	Selection of any chemical in response to, “In your home(s), have you or your partner been exposed to any of the following? Check all that apply: solvents (oil based paints), heavy metals (lead), paint-stripping chemicals (with methylene chloride), jewelry making or metal tempering, pesticides, herbicides, rodenticides, removal of old paint or wallpaper from walls containing lead-based paint, non-latex-based paints that are solvent based and contain metals for pigments and antifoulant agents.”	Talking to a doctor about how to make your home safer*
4. Frequently eating food from cans with a white plastic lining	“Yes” or “don’t know” in response to, “Do you frequently eat foods that come from metal cans that have a white plastic lining, like canned soup or vegetables?”	Talking to a doctor about avoiding cans with white plastic lining*
5. Frequently drinking from plastic water bottles	“Yes” in response to, “Do you frequently drink water from plastic bottles?”	Talking to a doctor about checking plastic water bottles to make sure they are safe*
6. At risk for toxoplasmosis	“Yes” in response to, “Do you ever clean a cat’s litter box?” or indicating intake of “raw or very undercooked meats or fish”	Talking to a doctor about preventing toxoplasmosis*
7. Untested well water in the home	“Yes” in response to, “Do you have well water in your home?” then “no” or “don’t know” in response to, “Has it been tested?”	Talking to a doctor about getting your well water tested*

*Continued*

**Appendix 1. Continued**

Risks By Preconception Care Content Area	Criteria for Identification of Risk	Goal Behavior and Definition of Risk Resolution
8. Reported workplace exposure to chemicals or dangers	Selection of any job listed in response to, "Does your job or your partner's job fall into any of the following categories? Check all that apply: lab and clinical health care work, printing, dry-cleaning, jewelry making or metal tempering, jobs that use pesticides, herbicides, rodenticides, solvents (oil-based paints), heavy metals (lead), paint-stripping agents, lead-based paints or non-latex-based paints that are solvent based and contain metals for pigments"	Talking to a doctor about how to be safer at work*
C. Genetic health history	Selection of any ethnicity listed in response to, "What is your blood ancestors' ethnic/racial/geographic background? Please check all that apply: White, European, Ashkenazi Jewish, French Canadian, Cajun, African, Mediterranean, Asian"	Talking with a doctor about health problems based on your ethnicity*
2. Family history of a genetic health condition	Selection of any of the health conditions listed in response to, "Has anyone in your family or your partner's family ever had (including parents, grandparents, siblings, aunts, uncles, cousins) any of the following?: Chromosomal disorders, deafness, facial clefts (cleft palate), sickle cell disease or trait, thalassemia, developmental delay/mental retardation, blood clots, cancer, neural tube defects (eg, spina bifida), heart disease, vision loss inherited from family member, sudden infant death syndrome, early infant death, muscular dystrophy, cystic fibrosis, family history of other congenital malformations or birth defects"	Talking with a doctor about your family's health history*
3. Personal history of a genetic health condition	Selection of any of the health conditions listed in response to, "Have you or your partner ever had any of the following conditions? Check all that apply: Chromosomal disorders, deafness, facial clefts (cleft palate), sickle cell disease or trait, thalassemia, developmental delay/mental retardation, blood clots, cancer, neural tube defects (eg, spina bifida), heart disease, vision loss, inherited from family member, family history of other congenital malformations or birth defects"	Talking with a doctor about your health history or your partner's health history*
4. Need to learn family health history	Selection of "don't know" in response to, "Has anyone in your family or your partner's family ever had (including parents, grandparents, siblings, aunts, uncles, cousins) any of the following? (See list of conditions listed under "Family history of genetic health condition")"	Talking with a doctor about your family's health history*
D. Health care and programs	1. Does not have primary care physician No response to, "Do you have a primary care provider? (PCP being a general doctor that you would see once a year for checkups and for illness); or selection of "emergency room" in response to, "When you do need medical care, do you usually go to your PCP or to the emergency room?"	Choosing a PCP*
2. Inadequate health insurance	No response to, "Does your health insurance get you the health care you need?"	Getting better health insurance*

*Continued*



**Appendix 1. Continued**

Risks By Preconception Care Content Area	Criteria for Identification of Risk	Goal Behavior and Definition of Risk Resolution
3. Does not have health insurance	No” in response to, “Do you have health insurance?”	Getting health insurance*
4. Not been to dentist in over a year	“No” in response to, “Have you been to the dentist in the past year?”	Going to the dentist*
5. Inadequate financial resources	“Yes” in response to, “Is it difficult to pay bills, like rent, water, heat, or electricity?” <i>or</i> selecting any of the following programs in response to, “Do you use any of these assistance programs?”: Medicaid (including Mass Health), health safety net or free care, Temporary assistance to needy families (welfare), food stamps, housing assistance, energy assistance, Women Infants and Children	Applying for programs to help pay your bills*
E. Health conditions and medicines		
1. History of diagnosis of asthma	Selection of “asthma” as a diagnosed health issue	Talking to a doctor about your asthma*
2. History of diagnosis of disability	“Yes” in response to, “Do you have a disability?” (Disability specified as a physical or intellectual disability in which case extra care from a doctor is required.)	Talking with a doctor about your disability*
3. History of diagnosis of hypertension (high blood pressure)	Selection of “hypertension (high blood pressure)” as a diagnosed health issue	Following your treatment plan for your blood pressure <sup>†</sup>
4. Currently taking any over-the-counter medicines	“Yes” in response to, “Do you take any ‘over-the-counter’ medications?”	Talking to a doctor about your “over-the-counter” medicines*
5. History of diagnosis of prediabetes	Selection of “prediabetes” as a diagnosed health issue	Following your treatment plan for pre diabetes <sup>†</sup>
6. Currently taking a prescription medication	“Yes” in response to, “Do you take any medicines prescribed by a doctor?”	Telling a doctor about your prescription medications*
7. History of diagnosis of rheumatoid arthritis	Selection of “rheumatoid arthritis” as a diagnosed health issue	Talking to a doctor about your RA*
F. Immunizations and vaccines		
1. Need hepatitis B vaccine	Selection of “no” or “don’t know” to, “Have you received a vaccination for hepatitis B?”	Talking with a doctor about getting the hepatitis B vaccine*
2. Unsure of immunization record	“No” in response to, “Do you know about any of the immunizations you have gotten in the past?”	Talking with a doctor about getting the immunizations you need*
3. Need varicella vaccine	Selection of “no” or “don’t know” to, “Have you received a vaccination for varicella (2 doses) or ever had the chicken pox?”	Talking with a doctor about getting the varicella, or chicken pox, vaccine*
4. Need influenza vaccine	Selection of “no” or “don’t know” to, “Have you received a vaccination for influenza (flu) this year for flu season (October through April)?”	Talking with a doctor about getting the flu vaccine*
5. Need human papillomavirus vaccine	Selection of “No” or “Don’t Know” to, “Have you received a vaccination for HPV in 3 doses (ever)?”	Talking with a doctor about getting the HPV vaccine ±
6. Need measles, mumps, and rubella vaccine	Selection of “no” or “don’t know” to, “Have you received a vaccination for measles, mumps and rubella (i) in childhood)?”	Talking with a doctor about getting the MMR vaccine*

*Continued*

**Appendix 1. Continued**

Risks By Preconception Care Content Area	Criteria for Identification of Risk	Goal Behavior and Definition of Risk Resolution
7. Need tetanus-diphtheria-pertussis vaccine	Selection of "no" or "don't know" to, "Have you received a vaccination for tetanus, diphtheria, and pertussis once when you were 11 to 12 years old and/or another after you turned 18 years old?"	Talking with a doctor about getting the Tdap vaccine*
8. Need tetanus vaccine	Selection of "no" or "don't know" to, "Have you received a tetanus booster vaccination within the past 10 years?"	Talking with a doctor about getting the tetanus vaccine*
G. Infectious diseases		
1. At risk for hepatitis C	"Yes" in response to any of the following: "Have you received blood products or organs before 1992?"; "Are you a health care worker?"; "Do you work in a correctional institution, like a jail?"; "Have you ever stayed overnight in a jail?"; "Do you have a tattoo or body piercing that you got in your home or someone else's home?"; "Yes" or "don't know" in response to, "Have any of your sexual partners had hepatitis C?"	Talking with a doctor about getting tested for hepatitis C*
2. At risk for malaria	"No" in response to, "If you traveled to Central America, South America, Africa, Asia, Eastern Europe, the South Pacific, or the Caribbean in the future, would you take antimalarial medicine?"	Talking with a doctor about how to prevent malaria*
3. At risk for sexually transmitted infection	"Yes" in response to any of the following: "Do you work in a correctional institution, like a jail?"; "Have you ever stayed overnight in a jail?"; "Has a doctor or nurse ever told you that you have gonorrhea?"; "Have you ever been paid for sex, or had sex for drugs?"; "Have you ever used illicit drugs (street drugs), including marijuana?"; "Yes" or "don't know" in response to, "Have you ever had unprotected sex? (meaning vaginal intercourse without a condom, oral sex without a condom, or anal sex without a condom)"; "Have any of your sexual partners been diagnosed with an STI?"; "Have any of your sexual partners had syphilis or herpes?"; "Have any of your male sexual partners had sex with men?"	Talking with a doctor about getting tested for STIs and finding out how to prevent them*
4. At risk for TB	"Yes" in response to, "Are you a healthcare worker?"; "Do you work in a correctional institution, like a jail?"; "Have you ever stayed overnight in a jail?"; "Were you born in Latin America, Caribbean, Africa, Asia, Eastern Europe, or Russia?"; "Yes" or "don't know" in response to, "Have you been in contact with someone who has tuberculosis (TB)?"	Talking with a doctor about getting tested for TB*
5. At risk for cytomegalovirus	"Yes" in response to, "Do you work in a daycare, nursery school, or kindergarten?"; "Are you often in contact with children under 6 years old?"	Talking to a doctor about how to prevent cytomegalovirus*
6. Sexually active and not been tested for sexually transmitted infections	"No" (and still sexually active) in response to, "Have you ever been tested for an STI, including chlamydia, syphilis, HIV, and others?"	Talking with a doctor about getting tested for STIs*
7. Not born in the United States	"Yes" in response to, "Were you born in a country other than the United States?"	Talking with a doctor about being born in another country*

*Continued*

**Appendix 1. Continued**

Risks By Preconception Care Content Area	Criteria for Identification of Risk	Goal Behavior and Definition of Risk Resolution
8. History of diagnosis of gonorrhea, chlamydia, or syphilis	“Yes” in response to, “Has a doctor or nurse ever told you that you have (any) STIs?” (selection of gonorrhea, chlamydia, or syphilis)	Talking to a doctor about getting treated for chlamydia, syphilis, or gonorrhea*
9. History of diagnosis of HIV	“Yes” in response to, “Has a doctor or nurse ever told you that you have HIV?”	Talking to a doctor about getting treated for HIV*
10. History of diagnosis of herpes	“Yes” in response to, “Has a doctor or nurse ever told you that you have genital herpes?”	Talking to a doctor about getting treated for herpes*
11. Tuberculosis	“Yes” in response to, “Has a doctor or nurse ever told you that you have tuberculosis (TB)?”	Talking to a doctor about getting treated for TB*
H. Men and health care		
1. Partner does not have a primary care physician	“No” or “don’t know” to, “Does your partner have a primary care doctor (PCP), which is a doctor he would see for checkups or if he was sick?”	Telling your partner that he should choose a PCP*
2. Partner has not been to a doctor in >=1 year	“No” or “don’t know” to, “Has your partner been to the doctor in the past year?”	Telling your partner that he should go to the doctor*
3. Partner not counseled on reproductive life plan	“No” or “don’t know” to, “Has your partner been counseled on his reproductive life plan (plan about birth control and when he wants to have children in the future)?”	Telling your partner to talk to his doctor about his reproductive life plan (like birth control)*
I. Nutrition and activity		
1. Bad diet or food choices	Response of <5 daily servings of fruits and vegetables; “yes” in response to, “Do you tend to snack on junk food (chips, soda, candy, desserts) most days?”	Eating a healthier diet ( $\geq 5$ servings of fruits and veggies each day and/or less junk food) <sup>†</sup>
2. Use of caffeine	“Yes” to, “Do you drink caffeinated drinks like coffee, tea, soda, or energy drinks?”	Cutting back to a safe amount of caffeine (<200 mg a day) <sup>†</sup>
3. Self-reported potential eating disorder	“Yes” to, “Do you think you might have an eating disorder, like anorexia or bulimia?”	Talking to a doctor about your eating disorder*
4. Not enough exercise (<30 min/d, 5 d/wk)	“No” in response to, “Do you exercise or take part in regular activity, like walking or biking, 5 days a week for a minimum of 30 minutes?”	Getting the recommended amount of exercise (30 minutes, 5 days a week) <sup>†</sup>
5. At risk for toxic concentrations of mercury	“Yes” to, “Do you eat fish more than twice a week? (Certain types of fish may have high levels of mercury, which could cause health problems.)”	Talking to a doctor about limiting the amount of fish you eat to the safe amount*
6. Use of herbal or weight-loss supplements	“Have you ever taken herbs (like chamomile or ginseng), herbal teas, home remedies, or weight-loss products for your health?”	Talking to a doctor about your herbal medicines*
7. At risk for listeriosis	“Yes” to, “Do you eat unpasteurized dairy products or cheese; soft cheeses like feta, blue cheese, brie, goat cheese, or queso fresco?”; “Do you eat hot dogs or deli meat?”	Talking to a doctor about preventing listeriosis*
8. Not using multivitamin with folic acid or folic acid supplement	Selection of “none,” “don’t know,” or “foods with folic acid” (without also selecting “folic acid pill” or “multivitamin with folic acid”) in response to, “What way(s) do you get folic acid?”	Taking a multivitamin or folic acid pill daily <sup>†</sup>

*Continued*

**Appendix 1. Continued**

Risks By Preconception Care Content Area	Criteria for Identification of Risk	Goal Behavior and Definition of Risk Resolution
9. Not taking calcium supplement	Not selecting "calcium" in response to, "Do you take any of the following vitamins or minerals?"	Getting more calcium <sup>†</sup>
10. Not taking iron supplement	Not selecting "iron" in response to, "Do you take any of the following vitamins or minerals?"	Getting more iron <sup>†</sup>
11. Need more omega-3 fatty acids in diet	Indicating no intake of walnuts, olive oil, or fatty fish	Eating more foods with omega-3 fatty acids <sup>†</sup>
12. Not taking supplement of vitamin D	Not selecting "vitamin D" in response to, "Do you take any of the following vitamins or minerals?"	Getting more vitamin D <sup>†</sup>
13. Overweight (BMI $\geq 30$ kg/m <sup>2</sup> )	BMI $\geq 30$ kg/m <sup>2</sup> , based on self-reported height and weight	Starting a healthy eating and exercise plan to manage your weight <sup>†</sup>
14. Possibly taking too much vitamin A	Selection of vitamin A in response to, "Do you take any of the following vitamins or minerals?"	Talking to a doctor about getting a safe amount of vitamin A*
J. Relationships		
Interpartner violence	(Any below)	
1. Does not feel safe	"Yes" in response to, "Are you afraid that someone you know may hurt you?"; "Are you ever afraid or nervous to go home?"	Taking action to feel safer <sup>†</sup>
2. History or current emotional or verbal abuse	"Yes" in response to, "Have you ever felt nervous or scared because of the things that someone said to you?"; "Has anyone ever told you that you are a bad person, that you are useless or that you are worth nothing?"	Preparing to get out of an emotionally or verbally abusive relationship <sup>†</sup>
3. History or current physical or sexual abuse	"Yes" in response to, "Have you ever been hit, slapped, kicked, or physically hurt in any way?"; "Has anyone ever made you do something sexual that you didn't want to do?"	Preparing to get out of a physically or sexually abusive relationship <sup>†</sup>
K. Reproductive health		
1. History of abortion	Selecting " $\geq 1$ " in response to, "How many abortions (elective termination of pregnancy) have you had?"	Talking with a doctor about your experience with abortion*
2. Prior cesarean deliveries	Selecting " $\geq 1$ " in response to, "How many cesarean sections (c-sections) have you had?"	Talking with a doctor about your experience with cesarean delivery*
3. Less than 3 months between past pregnancies	"Yes" to, "Have you ever gotten pregnant less than 3 months after the end of another pregnancy?"	Talking with a doctor about the short time between your pregnancies*
4. Participant was born preterm or low birth weight	"Yes" or "don't know" to, "Were you born very early or very small?"	Telling a doctor that you were born with low birth weight or before term*
5. Participant's mother born before term or with a low birth weight	"Yes" or "don't know" to, "When your mother was born, was she born very early or very small?"	Telling a doctor that your mother was born with a low birth weight or before term*

*Continued*

## Appendix 1. Continued

Risks By Preconception Care Content Area	Criteria for Identification of Risk	Goal Behavior and Definition of Risk Resolution
No/ineffective birth control		
6. No birth control	“No” in response to, “Do you use birth control on a regular basis?”	Using birth control <sup>†</sup>
7. Withdrawal method	Selection of “withdrawal” as birth control method used	Using a more reliable type of birth control <sup>†</sup>
8. Other less effective birth control	Selection of Plan B (morning after pill), rhythm/natural family planning, or “other” as birth control method used (Any below)	Using a more reliable type of birth control <sup>†</sup>
Poor birth outcome		
9. History includes 1 or 2 miscarriage(s)	Indicating 1 or 2 in response to, “How many miscarriages have you had?”	Talking with a doctor about your experience with miscarriage*
10. History of infant born with a low birth weight	“Yes” or “don’t know” to, “Have you ever had a baby weighing 5.5 lb or less (or <2500 g) at birth?”	Talking with a doctor about your baby born with a low birth weight*
11. History of preterm birth	“Yes” or “don’t know” to, “Have you ever had a premature or preterm baby (born at least 3 weeks early)?”	Talking with a doctor about your preterm baby*
12. History of infant in NICU	“Yes” to, “Have you ever had a baby that had to stay in an intensive care nursery (NICU)?”	Talking with a doctor about your child who was in the NICU*
13. History of infant with a birth defect	“Yes” or “don’t know” to, “Have you ever had a baby with a birth defect?”	Talking with a doctor about your child’s birth defect*
14. History of infant or child death	“Yes” to, “Have you ever had a child who died after he or she was born?”	Talking with a doctor about your child’s death*
15. History of stillbirth	Selecting “ $\geq 1$ ” in response to, “How many stillbirths have you had?”	Talking with a doctor about your experience with stillbirth*
16. Prenatal appointments	Not asked at time of baseline risk assessment; triggered during interactions with Gabby	Starting prenatal care*
17. History of uterine anomalies	“Yes” or “don’t know” to, “Have you ever had a problem(s) with your uterus (womb)?”	Talking with a doctor about the problems with your uterus*
18. History of vaginal bleeding late in pregnancy	“Yes” to, “Have you ever had vaginal bleeding late in pregnancy?”	Talking with a doctor about your history of vaginal bleeding during pregnancy*
L. Substance Use		
1. Any illicit substance use in the last year	Selecting “ $\geq 1$ ” in response to, “How many times in the past year have you used an illegal drug or used a prescription medication for non-medical reasons?”	Talking to a doctor about quitting drugs <sup>†</sup>
2. Excessive alcohol ( $\geq 4$ drinks in a day over the past year)	Selecting “ $\geq 4$ ” in response to, “During the past 12 months, what was the largest number of alcoholic drinks that you drank in a single day?”	Cutting back to no more than 3 drinks at a time <i>and</i> cutting back to drinking no more than twice a week <sup>†</sup>

Continued



**Appendix 1. Continued**

Risks By Preconception Care Content Area	Criteria for Identification of Risk	Goal Behavior and Definition of Risk Resolution
3. Any current tobacco use	Selecting "I smoke, or use tobacco, regularly now"; "I smoke, or use tobacco, regularly now, but I've cut down"; or "I smoke, or use tobacco, every once in a while" in response to, "Which of the following best describes your tobacco use?"	Quitting tobacco <sup>†</sup>

<sup>†</sup>Risk resolution was defined as the woman indicating that, "I've already talked to a doctor about it" (if risk was discussed with Gabby during the intervention) or "I have been working on this separately from Gabby" (if the risk was *not* discussed with Gabby during the intervention) when the risk-specific behavior was provided, after the following explanation: "Now we are going to go through the list of risks that were based on the health survey you took 6 months ago. I'll go through each item and please let me know if you: don't plan to talk to a doctor about it: anytime soon, plan to talk to a doctor about it in the next 6 months, plan to talk to a doctor about it in the next month, have already talked to a doctor about it, or tell me if you don't think this risk should have been put on your list 6 months ago."

<sup>†</sup>Risk resolution was defined as the woman indicating that, "I've done that at least once" or "I've been doing that for more than 6 months" (if risk was discussed with Gabby during the intervention) or "I have been working on this separately from Gabby" (if the risk was not discussed with Gabby during the intervention) when the risk-specific behavior was provided, after the following explanation: "Now we are going to go through the list of risks that were based on the health survey you took 6 months ago. I'll go through each item and please let me know if you don't plan to do it anytime soon, plan to do it in the next 6 months, plan to do it in the next month, have done it at least once, have been doing it for more than 6 months, or let me know if you don't think this risk should have been put on your list 6 months ago."

BMI, body mass index; HIV, human immunodeficiency virus; MMR, measles, mumps, rubella; NICU, neonatal intensive care unit; PCP, primary care physician; PHQ-2, 2-item Patient Health Questionnaire; STI, sexually transmitted infection; TB, tuberculosis.

**Appendix 2. Risks Identified at Baseline and Resolved within 6 Months, By Study Group and Content Area**

Preconception Care Risks	Gabby Group		Control Group		P Value
	Baseline (n = 46)	Resolved* (n = 36)	Baseline (n = 45)	Resolved* (n = 41)	
<b>Emotional and mental health</b>					
History of diagnosis of anxiety	4 (8.7)	0 (0.0)	3 (6.7)	0 (0.0)	NA
History of diagnosis of depression	5 (10.9)	2 (50.0)	2 (4.4)	0 (0.0)	.47
Potential depression	6 (13.0)	2 (40.0)	5 (11.1)	0 (0.0)	.44
History of diagnosis of bipolar disorder	1 (2.2)	0 (0.0)	2 (4.4)	0 (0.0)	NA
Family history psychiatric conditions (depression, anxiety, schizophrenia, bipolar disorder)	12 (26.1)	5 (55.6)	15 (33.3)	1 (7.7)	.02
Stress	7 (15.2)	6 (100.0)	5 (11.1)	3 (60.0)	.18
Total participants, Emotional and mental health	21 (45.6)	12 (66.7)	19 (42.2)	4 (25.0)	.02
Total emotional and mental health risks (n)	35	15	32	4	
<b>Environmental issues</b>					
Living near toxic waste or a “superfund” site	1 (2.2)	0 (0.0)	1 (2.2)	0 (0.0)	NA
Exposure to lead	24 (52.2)	3 (16.7)	21 (46.7)	3 (15.8)	1.00
Reported exposure to potentially toxic household chemicals	6 (13.0)	2 (40.0)	5 (11.1)	0 (0.0)	.44
Frequently eating food from cans with a white plastic lining	14 (30.4)	0 (0.0)	13 (28.9)	1 (9.1)	.44
Frequently drinking from plastic water bottles	36 (78.3)	5 (17.2)	38 (84.4)	2 (5.9)	.23
At risk for toxoplasmosis	18 (39.1)	0 (0.0)	10 (22.2)	0 (0.0)	NA
Untested well water in the home	11 (23.9)	0 (0.0)	7 (15.6)	0 (0.0)	NA
Reported workplace exposure to chemicals or dangers	9 (19.6)	3 (50.0)	7 (15.6)	0 (0.0)	.07
Total participants, environmental issues	44 (95.6)	11 (32.4)	43 (95.6)	5 (12.8)	.05
Total environmental issues risks (n)	119	13	102	6	
<b>Genetic health history</b>					
Ethnicity-based genetic health risk based on ancestry	44 (95.6)	10 (28.6)	44 (97.8)	9 (22.5)	.55
Family history of a genetic health condition	18 (39.1)	6 (42.9)	15 (33.3)	4 (33.3)	.70
Personal history of a genetic health condition	5 (10.9)	2 (66.7)	3 (6.7)	0 (0.0)	.40
Need to learn family health history	4 (8.7)	1 (50.0)	5 (11.1)	2 (40.0)	1.00
Total participants, genetic health history	96 (100.0)	41 (38.9)	45 (100.0)	11 (29.3)	.37
Total genetic health history risks (n)	17	19	67	15	
<b>Health care and programs</b>					
Does not have a primary care physician	13 (28.3)	4 (44.4)	12 (26.7)	3 (33.3)	1.00
Inadequate health insurance	0 (0.0)	0 (0.0)	6 (13.3)	0 (0.0)	NA
Does not have health insurance	2 (4.4)	0 (0.0)	6 (13.3)	0 (0.0)	NA

Continued

**Appendix 2. Continued**

Preconception Care Risks	Gabby Group		Control Group		P Value
	Baseline (n = 46)	Resolved* (n = 36)	Baseline (n = 45)	Resolved* (n = 41)	
Not been to dentist in over a year	15 (32.6)	4 (30.8)	16 (35.6)	4 (28.6)	1.00
Inadequate financial resources	4 (8.7)	0 (0.0)	24 (53.3)	0 (0.0)	NA
Total participants, health care and programs	16 (34.8)	5 (41.7)	31 (68.9)	5 (18.5)	.23
Total health care and programs risks (n)	34	8	64	7	
<b>Health conditions and medicines</b>					
History of diagnosis of asthma	7 (15.2)	2 (50.0)	9 (20.0)	3 (42.9)	1.00
History of diagnosis of disability	3 (6.5)	1 (33.3)	1 (2.2)	0 (0.0)	1.00
History of diagnosis of hypertension (high blood pressure)	2 (4.4)	1 (50.0)	1 (2.2)	0 (0.0)	1.00
Currently taking any over-the-counter medicines	13 (28.3)	1 (11.1)	10 (22.2)	2 (20.0)	1.00
History of diagnosis of prediabetes	2 (4.3)	2 (100.0)	1 (2.2)	0 (0.0)	.33
Currently taking any prescription medications	14 (30.4)	7 (58.3)	13 (28.9)	3 (27.3)	.21
History of diagnosis of rheumatoid arthritis	0 (0.0)	0 (0.0)	1 (2.2)	0 (0.0)	NA
Total participants, health condition and medicines	28 (60.9)	12 (54.5)	28 (62.2)	5 (20.0)	.02
Total health condition and medicines risks (n)	41	14	36	8	
<b>Immunizations and vaccines</b>					
Need hepatitis B vaccine	9 (19.6)	2 (28.6)	16 (35.6)	2 (14.3)	.57
Unsure of immunization record	8 (17.4)	1 (4.3)	1 (2.2)	0 (0.0)	1.00
Need varicella vaccine	6 (13.0)	1 (20.0)	12 (26.7)	2 (20.0)	1.00
Need influenza vaccine	22 (47.8)	8 (47.1)	26 (57.8)	9 (40.9)	.70
Need human papillomavirus vaccine	21 (45.6)	7 (41.2)	25 (55.6)	3 (13.0)	.07
Need measles, mumps, and rubella vaccine	1 (2.2)	0 (0.0)	9 (20.0)	1 (12.5)	NA
Need tetanus-diphtheria-pertussis vaccine	2 (4.3)	1 (100.0)	11 (24.4)	2 (22.2)	.30
Need tetanus vaccine	11 (23.9)	5 (71.4)	11 (24.4)	2 (22.2)	.13
Total participants, immunizations and vaccines	38 (82.6)	17 (56.7)	42 (93.3)	15 (39.5)	.22
Total immunizations and vaccines risks (n)	80	25	111	21	
<b>Infectious diseases</b>					
At risk for hepatitis C	7 (52.2)	3 (6.7)	28 (29.2)	6 (24.0)	.17
At risk for malaria	22 (47.8)	2 (11.1)	28 (29.2)	3 (11.1)	1.00
At risk for sexually transmitted infection	40 (87.0)	15 (48.4)	43 (95.56)	18 (46.2)	.85
At risk for tuberculosis	23 (50.0)	12 (75.0)	23 (51.1)	6 (30.0)	.02
At risk for cytomegalovirus	7 (15.2)	0 (0.0)	8 (17.8)	0 (0.0)	NA

*Continued*

**Appendix 2. Continued**

	Gabby Group		Control Group		P Value
	Baseline (n = 46)	Resolved* (n = 36)	Baseline (n = 45)	Resolved* (n = 41)	
<b>Preconception Care Risks</b>					
Sexually active and not been tested for sexually transmitted infections	27 (58.7)	5 (22.7)	32 (71.11)	7 (23.3)	.96
Not born in the United States	6 (13.0)	3 (60.0)	3 (6.67)	0 (0.0)	.20*
History of diagnosis of gonorrhea, chlamydia, or syphilis	16 (34.8)	9 (69.2)	13 (28.89)	3 (33.3)	.19
History of diagnosis of human immunodeficiency virus	1 (2.2)	0 (0.0)	0 (0.0)	0 (0.0)	NA
History of diagnosis of herpes	5 (10.9)	3 (75.0)	4 (8.89)	1 (25.0)	.49
History of diagnosis of tuberculosis	1 (2.2)	0 (0.0)	0 (0.0)	0 (0.0)	NA
Total participants, infectious diseases	46 (100.0)	25 (69.4)	45 (100.0)	23 (56.1)	.25
Total infectious disease risks (n)	172	52	182	44	
<b>Men and health care</b>					
Partner does not have primary care physician	21 (45.6)	2 (13.3)	9 (20.0)	4 (50.0)	.13
Partner has not been to doctor in >1 year	13 (28.3)	1 (10.0)	8 (17.8)	3 (42.9)	.25
Partner has not been counseled on reproductive life plan	30 (65.2)	4 (16.7)	22 (48.9)	7 (36.84)	.17
Total participants, men and health care	31 (67.4)	5 (20.0)	26 (57.8)	9 (39.1)	.21
Total men and health care risks (n)	64	7	39	14	
<b>Nutrition and activity</b>					
Bad diet or food choices (<5 daily servings of fruits and vegetables and/or regular intake of junk food)	35 (76.1)	18 (64.3)	34 (75.6)	9 (30.0)	<.01
Use of caffeine	41 (89.1)	12 (38.7)	32 (71.1)	10 (35.7)	.81
Self-reported potential eating disorder	0 (0.0)	0 (0.0)	1 (2.2)	0 (0.0)	NA
Not enough exercise (< 30 min/d, 5 d/wk)	23 (50.0)	8 (50.0)	21 (46.7)	7 (26.8)	.43
At risk for toxic concentrations of mercury	12 (26.1)	2 (20.0)	8 (17.8)	3 (50.0)	.30
Use of herbal or weight-loss supplements	17 (37.0)	4 (30.8)	33 (73.3)	3 (9.7)	.17
At risk for listeriosis	42 (91.3)	1 (3.1)	37 (82.2)	3 (9.1)	.91
Not using a multivitamin with folic acid or a folic acid supplement	23 (50.0)	16 (80.0)	28 (62.2)	12 (50.0)	.06
Not taking a calcium supplement	22 (47.8)	10 (50.0)	25 (55.6)	5 (23.8)	.08
Not taking an iron supplement	29 (63.0)	13 (54.2)	37 (82.2)	6 (18.3)	.004
Need more omega-3 fatty acids in diet	6 (91.6)	2 (28.6)	8 (17.8)	1 (16.7)	1.00
Not taking a vitamin D supplement	18 (39.1)	6 (37.5)	24 (53.3)	5 (25.0)	.42
Overweight (BMI $\geq$ 30 kg/m <sup>2</sup> )	10 (21.7)	7 (100.0)	9 (20.0)	3 (42.9)	.07
Possibly taking too much vitamin A	11 (23.9)	2 (33.3)	5 (11.1)	0 (0.0)	.45
Total participants, nutrition and activity	46 (100.0)	32 (88.9)	45 (100.0)	29 (70.7)	.09
Total nutrition and activity risks (n)	292	101	302	67	

*Continued*

**Appendix 2. Continued**

	Gabby Group		Control Group		P Value
	Baseline (n = 46)	Resolved* (n = 36)	Baseline (n = 45)	Resolved* (n = 41)	
<b>Preconception Care Risks</b>					
<b>Relationships</b>					
Interpartner violence (any below)	21 (23.3)	5 (31.3)	30 (66.7)	6 (22.2)	.72
Does not feel safe	5 (5.6)	3 (60.0)	4 (8.9)	0 (0.0)	.20
History or current emotional or verbal abuse	20 (22.2)	4 (26.7)	27 (60.0)	5 (20.8)	.71
History or current physical or sexual abuse	11 (12.2)	3 (37.5)	22 (48.9)	4 (21.1)	.63
Total participants, relationships	21 (45.6)	5 (31.3)	30 (66.7)	6 (22.2)	.72
Total relationship risks (n)	36	10	53	9	
<b>Reproductive health</b>					
History of abortion	9 (19.6)	3 (37.5)	6 (13.3)	3 (50.0)	1.00
Prior cesarean delivery	2 (4.3)	1 (100.0)	1 (2.2)	0 (0.0)	1.00
<3 Months between past pregnancies	0 (0.0)	0 (0.0)	2 (4.4)	0 (0.0)	NA
Participant was born before term or with low birth weight	14 (30.4)	2 (18.2)	7 (15.6)	1 (20.0)	1.00
Participant's mother was born before term or with low birth weight	18 (39.1)	1 (6.7)	20 (44.4)	1 (5.6)	1.00
No/ineffective birth control	24 (52.2)	4 (23.5)	19 (42.2)	6 (35.3)	.71
No birth control	20 (43.5)	3 (18.7)	18 (40.0)	6 (37.5)	.43
Withdrawal method	4 (8.7)	0 (0.0)	1 (2.2)	0 (0.0)	NA
Other less effective birth control	2 (4.3)	1 (5.9)	0 (0.0)	0 (0.0)	1.00
Poor birth outcome	7 (15.2)	1 (25.0)	4 (8.9)	0 (0.0)	1.00
History includes 1 or 2 miscarriage(s)	5 (10.9)	1 (50.0)	3 (6.7)	0 (0.0)	1.00
History of infant born with a low or high birth weight	1 (2.2)	0 (0.0)	0 (0.0)	0 (0.0)	NA
History of preterm birth	2 (4.3)	0 (0.0)	0 (0.0)	0 (0.0)	NA
History of infant in the NICU	1 (2.2)	1 (100.0)	0 (0.0)	0 (0.0)	NA
History of infant with a birth defect	1 (2.2)	1 (100.0)	0 (0.0)	0 (0.0)	NA
History of infant or child death	2 (4.3)	0 (0.0)	0 (0.0)	0 (0.0)	NA
History of stillbirth	2 (4.3)	1 (50.0)	1 (2.2)	0 (0.0)	1.00
Prenatal appointments	2 (4.3)	0 (0.0)	1 (2.2)	0 (0.0)	NA
History of uterine anomalies	2 (4.3)	0 (0.0)	0 (0.0)	0 (0.0)	NA
History of vaginal bleeding late in pregnancy	2 (4.3)	0 (0.0)	0 (0.0)	0 (0.0)	NA
Total participants, reproductive health	40 (87.0)	10 (32.3)	38 (84.4)	9 (26.5)	.91
Total reproductive health risks (n)	87	16	62	12	

*Continued*



**Appendix 2. Continued**

Preconception Care Risks	Gabby Group		Control Group		P Value
	Baseline (n = 46)	Resolved* (n = 36)	Baseline (n = 45)	Resolved* (n = 41)	
<b>Substance use</b>					
Any illicit substance use in the last year	9 (19.6)	0 (0.0)	11 (24.4)	0 (0.0)	NA
Excessive alcohol ( $\geq 4$ drinks in a day over the past year)	21 (45.6)	10 (62.5)	23 (51.1)	9 (42.9)	.24
Cutting back to drinking alcohol on no more than 2 occasions per week	Unknown	9 (56.3)	Unknown	7 (33.3)	.16
Eliminating binge-drinking ( $\geq 4$ drinks in a day)	Unknown	8 (50.0)	Unknown	8 (38.1)	.47
Any current tobacco use	6 (13.0)	0 (0.0)	7 (15.6)	2 (40.0)	.44
Total participants, substance use	27 (58.7)	10 (50.0)	25 (55.6%)	11 (50.0%)	1.00
Total substance use risks (n)	36	17	14	17	

Data are n (%) unless otherwise indicated.

\*Percentage resolved calculated based on those participants who originally identified the risk *and* were reached at the 6-month follow-up.

NA, not available; NICU, neonatal intensive care unit.