Engaging women with an embodied conversational agent to deliver mindfulness and lifestyle recommendations: A feasibility randomized control trial

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Abstract

Objective—This randomized controlled trial evaluates the feasibility of using an Embodied Conversational Agent (ECA) to teach lifestyle modifications to urban women.

Methods—Women were randomized to either 1) an ECA (content included: mindfulness, stress management, physical activity, and healthy eating) or 2) patient education sheets mirroring same content plus a meditation CD/MP3 once a day for one month. General outcome measures included: number of stress management techniques used, physical activity levels, and eating patterns.

Results—Sixty-one women ages 18 to 50 were enrolled. On average, 51% identified as white, 26% as black, 23% as other races; and 20% as Hispanic. The major stress management techniques reported at baseline were: exercise (69%), listening to music (70%), and social support (66%). After one month, women randomized to the ECA significantly decreased alcohol consumption to reduce stress (p = 0.03) and increased daily fruit consumption by an average of 2 servings compared to the control (p = 0.04).

Conclusion—It is feasible to use an ECA to promote health behaviors on stress management and healthy eating among diverse urban women.

Practice implications—Compared to patient information sheets, ECAs provide promise as a way to teach healthy lifestyle behaviors to diverse urban women.

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1. Introduction

Clinicians often address multiple health behaviors simultaneously and supplement office visits with additional health education through written materials, such as patient information sheets or brochures [1, 2]. Although these sheets are considered standard of care, the content and readability may not necessarily benefit patients with cultural or economic differences or lower literacy [3]. Furthermore, many clinicians endorse lifestyle changes or assist in managing chronic stress related problems (e.g. obesity, alcohol, and tobacco abuse) which require patients to change several behaviors at a time [4].

Today, technology-based interventions are becoming increasingly popular for delivering health-related behavioral changes [5–7]. To date, most automated health behavior change interventions are designed to only address a single behavior [8, 9]. Little is known about the practicality of using a technology-based intervention to deliver a multi-behavioral change intervention in racially diverse women [10, 11].

Providing specifically tailored information on multiple health behaviors may prove useful for patients to improve their overall well-being. One technology, called the embodied conversational agent (ECA), shows particular promise for conveying behavioral change strategies to patients [9, 12]. This paper reports on a feasibility study that compares an ECA delivering content on mindfulness, stress management, healthy eating, and physical activity to patient education sheets with the same content.

The ECA is an animated conversational character that simulates face-to-face interaction with a patient (Fig. 1) [12–16]. The system is comprised of a networked server with a conversational database responding to patient's interactions and a patient education system. The ECA is an animated African American female character programmed to deliver culturally aware patient strategies and health information (e.g. recommending specific popular recipes or foods, mentioning prayer or spiritual traditions) to increase skills in self-management. The language used is dynamically composed, based on each patient's data (e.g. name, gender, history of past interactions and responses). The agent also answers questions and tests patient understanding of key health facts. Prior pilots have demonstrated acceptability of ECAs in both inpatient [17–19] and outpatient settings [20, 21]. Other studies have also yielded positive outcomes for ECAs to deliver health education on topics such as: exercise, eating fruits and vegetables, and preconception care [12, 16, 21–24].

Based on our previous studies, we have shown it is feasible for young African American women ages 18 to 34 years to benefit from an ECA delivering health information on dietary supplements and stress management as part of a larger preconception patient education ECA system [16, 24]. We do not know, however, whether the ECA can be used to deliver lifestyle strategies (mindfulness, stress management, healthy eating, and physical activity) in an

urban outpatient setting with racially diverse women ages 18 to 50 years. This two-arm randomized control trial (RCT) newly introduces the ECA to female patients in person and compares the acceptability and satisfaction of the ECA to patient information sheets plus a meditation CD/MP3 among peri-menopausal women recruited from Boston. The outcomes being studied are feasibility and satisfaction with the ECA versus patient information sheets (control group).

2. Methods

2.1. Design and implementation

2.1.1. The Gabby System—The ECA system for this study was adapted from the Gabby Preconception Health Care system's dialogue scripts and media (Version 2); the detailed curriculum is in Table 1 [16]. The scripts included motivational interviewing dialogue, dialogue to simulate shared decision making interactions, and additional longitudinal interaction using techniques such as goal setting, problem solving, tips, and homework (Appendix A).

The healthy eating promotion dialogue was based on previous ECA studies engaging women in preconception care [16, 24], the Five Fruit and Vegetables recommendation [25], the Harvard School of Public Health's healthy eating plate [26], and the principles of the Diabetes Prevention Program [27]. Information on stress management was adapted from principles of Mindfulness Based Stress Reduction (MBSR) [16], a promising mind-body intervention [28–31]. The major techniques included were: being present in the moment, responding and not reacting to stress, awareness of breath meditations (two versions: short 10 min; long 25 min), body scan, mindful eating, and mindful yoga. A recent systematic review identified 21 RCTs of MBSR: eleven of these studies showed improvement in mental health measures compared to waitlist or standard care controls, and improved pain scores and mental health status for patients with chronic pain [32]; other studies have also shown similar results [33–36]. Additional stress management exercises included progressive muscle relaxation and guided imagery. Finally, physical activity recommendations were based on governmental guidelines for physical activity [20, 21, 37, 38].

The ECA system is accessed over the web in a standard browser through a username and secure password login. Each interaction with the system consisted of a personal greeting from Gabby, an ECA, followed by educational content and behavior change counseling related to stress management, healthy eating, and physical activity, any or all of which could be selected by the participant (Fig. 1). The system also contains an auto logout feature after a period of user inactivity.

If participants were randomized to the intervention, the research assistant (RA) enrolled them into the ECA system, specifying baseline information (e.g. name, age), and then taught them how to use the system for 60 min. Participants were asked to log on once a day for 30 days and to interact with Gabby for as long as they wished.

2.1.2. Patient information sheets and meditation CD/MP3—If participants were randomized to the control, the RA reviewed patient information sheets in person for 60 min,

which mirrored the content from the Gabby system. These sheets were written at a fifth grade level to accommodate a spectrum of health literacy. We also prepared a CD/MP3 with the same meditations and exercises offered by the ECA. Control group meditations were recorded by a live meditation teacher in contrast to Gabby's electronic voice. Women were encouraged to listen to the recordings once a day for 30 days and to read the sheets as many times as they wished.

2.2. Recruitment, enrollment and randomization

Participants were recruited from primary care outpatient clinics at Boston Medical Center (BMC). Recruitment flyers were placed in clinical exam rooms, and recruitment materials were available to clinicians to hand out as appropriate. We also posted in the weekly BMC online newsletter. Patients self-referred themselves to the study by calling the study phone number listed on flyers within clinics. We included participants who self-identified as women, were 18–50 years of age, had access to a telephone and computer with internet, were English-speaking, and were not pregnant, to enroll in the study. We excluded participants who refused to consent, were not able to complete the study due to health reasons, including mental health or substance abuse problems, or did not speak English.

All participants completed enrollment with a trained RA, which took 30 min to complete. The RA explained the study, including the purpose, risks, and benefits, and asked each potential participant a question about each of those points to confirm that she was capable of providing informed consent. Participants gave verbal informed consent, since the enrollment process was completed. Data were collected by the RA for all participants at baseline and at one month follow-up. Participants were enrolled into the study on a rolling basis and as such, participant study durations were tracked individually based upon the date of baseline completion. After obtaining baseline information, participants were randomized to either the intervention or control using a computer-generated permuted block method. The RA was not blinded to group allocation.

All participants received a reminder phone call/e-mail at 14 days after enrollment to assess for safety and address any questions. After one month from baseline, the RA conducted post-study interviews in person or by phone. Participants received a gift card for their participation in the study and reimbursement for transportation and were also entered into a raffle.

2.3. Outcome measures

2.3.1. Primary outcomes—A primary goal of this study was to gather feasibility data on ECA utilization among multiracial women ages 18 to 50 years within an outpatient setting in order to design a larger fully powered RCT. The primary outcomes were as follows: number of recruited participants in a 12-month period; proportion of participants who were racial minorities (non-white); number of participants who completed the study from baseline to follow-up; number of participants for whom outcome data can be collected; and participants' satisfaction with the intervention or control.

2.3.2. Demographic and secondary outcomes—The following information was collected by the RA through an interview both at baseline and post-study: demographics (including age, race, ethnicity, education, work status, income, self-reported height and weight, BMI; clinical factors such as health conditions, medication use, smoking status, alcohol use, and pain levels); physical and mental health statuses by the Short Form Health Survey (SF-12) [39] and depression levels by the Patient Health Questionnaire (PHQ-9) [40]. We asked questions assessing eating patterns, physical activity routines, and stress management levels at baseline and post-intervention.

Adapting questions from the National Health and Nutrition Examination Survey (NHANES), participants reported the total number of fruit and vegetable servings they consumed daily; the frequency of consuming regular soda/sugary drinks, caffeinated drinks, snack foods, calcium and dairy, whole grains, red meat, and fish per week; the frequency of eating breakfast per week; and intake of vitamins or minerals, folic acid, and herbal supplements [41]. We showed an image of a food label and asked participants if they read Nutrition Fact labels on grocery items regularly. We assessed their nutrition knowledge (Appendix B), and inquired about food access and assistance programs using the Household Food Insecurity Access Scale (HFIAS) [42].

Based on the Stanford Patient Education Research Center's Exercise Behaviors Questionnaire, we compiled the total amount of time, in minutes, participants reported engaging in physical activity during a typical week [43]. Specific activity routines included stretching, strengthening and aerobic activities (e.g. walking, running or jogging, aquatics, and other). We also collected information on participants' self-efficacy to participate in physical activity with the Self-Efficacy for Exercise Scale (SEE) [44].

For stress management, we asked participants to report self-perceived stress levels using the Perceived Stress Scale (PSS-4) [45]. For types of stress management, we asked: "in the past week, how many times did you do stress management or relaxation techniques?" Then we asked them to describe techniques they utilized to manage their stress on a weekly basis (see Section 3.2.2).

For all three overarching topics, we asked participants to rate their confidence in their ability to eat healthy, to exercise at least an hour per week, or to manage stress. Higher scores indicated greater confidence to perform such activities.

At the end of the study, participants were also asked to provide feedback on their assigned intervention. Questions included incorporation and relevance of suggestions on diet and nutrition; effects of the intervention on stress; exercise; benefits and difficulties of interacting with the intervention; and any other feedback they wished to share.

Specifically for ECA users, we collected system utilization data including number of logins, duration of use (in min), and user satisfaction after one month. Following a semi-structured interview guide, we also asked open ended questions regarding participants' impressions of an ECA delivering health information.

2.4. Data analysis

2.4.1. Preliminary analysis—Effectiveness of randomization was assessed by comparing sociodemographic factors between the intervention and control using Chi-square tests for dichotomous and categorical variables and two-sample *t*-tests for continuous variables.

2.4.2. Primary and secondary analyses—Descriptive statistics were used to analyze primary outcome measures. This feasibility study lacked the statistical power to measure the difference in adherence to plan between intervention and control patients. An exploratory analysis using a Chi-square test was conducted to compare the adherence to plan (e.g. increase in stress management techniques used, increase in healthy eating, and increase in activity) between intervention and control patients. Two sample *t*-tests were used to compare satisfaction scores between the two groups. Normally distributed data were analyzed using two sample *t*-tests and data not normally distributed were analyzed using Wilcoxon Rank Sum tests. All analyses were conducted using SAS 9.3.

Interview responses were documented on a data collection sheet and reviewed to identify similarities among responses. Responses reported by two or more participants were identified for further analysis and categorized into three overarching themes: perceived helpfulness, benefits, and challenges using the assigned intervention. The study was approved by the BMC Institutional Review Board.

3. Results

3.1. Study consort diagram

We recruited 61 participants in a 12-month period; all 61 recruited women were screened eligible and enrolled into the study for one month. We collected outcome data from baseline to follow-up on 57 participants (Fig. 2).

3.2. Quantitative results

3.2.1. Baseline demographic and clinical characteristics—The demographic and clinical characteristics of the 61 women enrolled in this study are presented in Table 2. On average, participants were 35 years old; 51% identified as white, 26% as black, 2% as Asian/Pacific Islander, and 21% as other races; and 20% identified as Hispanic. Eighty-four percent of participants primarily spoke English at home, while 11% primarily spoke Spanish. Seventy-nine percent of women had completed at least some college, and 89% of them worked full-time or part-time. In regards to yearly household income, 44% reported making less than $49,000, and another 46% reported making more than $50,000. Ten percent of participants refused to disclose their income status.

On average, women in the study had a BMI of 28 kg/m^3 and scored a 7 on the PHQ-9 assessment; 30% reported having chronic health problems, and 67% regularly took prescribed medication. An average BMI score of 28 kg/m^3 is classified as being overweight, while a PHQ-9 score greater than 5 denotes mild depression [40]. Three percent of participants reported smoking, and 70% reported drinking alcohol at least once a month or

more. There were no significant differences in demographics or clinical characteristics between groups.

3.2.2. Stress management techniques—In Table 3, the most popular stress management techniques at baseline among participants included: engaging in physical activity (69%), listening to music (70%),and spending time with friends (66%). At one month, there was no significant difference in the number of adaptive coping techniques between groups. The proportion of women who reported eating as a coping technique did decrease, although not significantly (55% to 29% for intervention, 50% to 38% for control).

At baseline, 67% of participants reported drinking alcohol at least once a month or more to manage their stress. At 30 days, there was a significant decrease in the number of women who used alcohol for stress management in the intervention compared to the control group (35% to 14% for intervention, 30% to 31% for control; p = 0.03). The number of stress management techniques increased in both groups, though there was no significant difference (μ = 1 to 4 for intervention, μ=2 to 3 for control). There was no significant difference in the perceived stress scale in the intervention compared to the control group.

At baseline, women in both groups were identified as being mildly depressed, with an average PHQ-9 score of 7. At follow-up, PHQ-9 and SF-12 scores did not differ significantly between the two groups (p = 0.36 and p = 0.28, respectively). However, it is worth noting that PHQ-9 scores decreased by two units in the ECA group compared to a one unit decrease in the control group.

3.2.3. Food and nutrition—Specific eating patterns are documented in Table 4. Analysis revealed that ECA users significantly increased the average amount of fruit servings they ate compared to women using patient information sheets (μ = 2 to 4 for intervention, μ = 2 to 2 for control; p = 0.04). The amount of vegetable servings increased for both groups, but not significantly. There were trends in the reduction of weekly caffeine and snack consumptions after 30 days for women in the ECA group compared to the control group, although statistically insignificant. Consumption of whole grains, red meat, and fish did not differ significantly between the two groups from baseline to follow-up. There was no significant difference in food knowledge, food insecurity, and breakfast consumption between groups (p = 0.15, p = 0.99, and p = 0.11, respectively).

3.2.4. Patient satisfaction of assigned intervention—At follow-up, participants were asked to evaluate their satisfaction of their assigned intervention based on topics of healthy eating, physical activity, and stress management (Table 5). Women favored using Gabby to improve stress management and increase physical activity more than women using patient information sheets. Sixty-nine percent utilized suggestions from Gabby to improve healthy eating, 52% to increase physical activity, and 70% to manage stress: all of which were greater–but not statistically significant–relative frequencies than participants using patient information sheets (66%, 49% and 66%, respectively). There was no significant difference in self-confidence to manage stress, to engage in physical activity, and to eat healthy between groups. Although statistically insignificant, duration of exercise increased in both groups for stretching/ strengthening (p = 0.18) and aerobic exercise (p = 0.27).

3.2.5. ECA system utilization—For one month, ECA users spent a median total of 52 min (interquartile range [IQR] = 101.4, N = 31) interacting with Gabby and logged in 5 times (IQR = 7, N = 31). The average time spent per individual session was 12.1 min (σ = 6.1, min = 3.9, max = 25.8).

3.3. Qualitative results

Findings suggest that most participants perceived the health information they received to be helpful, and intervention participants identified specific benefits and challenges to using an ECA. Users from both groups generally highlighted that their assigned intervention was very informative, easy to use, and served as a good reminder to keep their health status in check through mindfulness, physical activity and healthy eating. Interestingly, a majority of ECA users commented that Gabby was most relevant in regards to stress management. For example, intervention participants reported: "It definitely gave me more tools for stress management""She helped me relax", and "She reminded me to take care of myself even when I'm in the midst of a crazy work life". Additionally, the majority of those who interacted with Gabby described her as empowering and relatable. One participant stated, "She relates to my stress … you can tailor it to your specific interests and needs". In contrast, control group participants generally found it difficult to use the patient information sheets due to reported lack of accountability and follow-up. For example, some control group participants commented: "No accountability, no checking to see if you made improvements" and "Sheets were easy to ignore".

For the intervention group only, participants highlighted specific benefits and challenges to using the ECA system. The majority of users perceived Gabby to be a fast, reliable, and credible source of information. Participants' comments to support this finding included: "The right answer is always there no matter what … I don't have to wait for a doctor" and "I did not think she shared incorrect or unsupportive info". Challenges using the Gabby system included the sound and quality of her voice, time commitment to use the system, and program accessibility. Several participants described Gabby's voice as "robotic"; one participant in particular commented that they "could not stand how slowly she talked". Intervention participants also found it difficult "having the time and sitting in front of the computer to do it", and highlighted her laptop and desktop accessibility limitations, stating "she was only on a computer, not a phone".

4. Discussion and conclusion

4.1. Discussion

In this study, we demonstrated that it is feasible to use ECA technology to deliver multiple healthy lifestyle recommendations on physical activity, healthy eating, mindfulness, and stress management techniques among diverse urban women. Among our study sample, interaction with an ECA was shown to be effective in decreasing alcohol consumption for stress and increasing daily fruit consumption. There was also a trend increase in the number of stress management techniques used.

Adherence to a healthy lifestyle includes stress management; however, fewer than 10% of adults in the United States follow this pattern, including women [46]. Gabby users reported utilizing more stress management techniques from baseline, and 70% of them responded that they used Gabby's suggestions to improve their stress. In the qualitative data, both groups reported being more knowledgeable about managing their stress post-intervention. Similarly, one pilot study implemented a virtual coach to provide mindfulness training, and found that participants who had coach-based training performed the techniques more effectively and regularly than participants who had to teach themselves the same techniques using paper and audio materials [22]. There was no statistically significant difference in perceived stress among women in the Gabby group compared to the control group. However, our study was not adequately powered to detect such a difference; therefore, an adequately powered clinical trial is necessary to determine efficacy in stress reduction.

Our results also show a significant decrease in alcohol use for stress management (63%) for women who interacted with Gabby compared to the control group. Research has found the use of technologies among non-dependent alcoholic drinkers to be promising [47, 48]. In several studies to reduce alcohol use among college students, participants who received tailored text messages were more likely to report a reduction in alcohol consumption and an increased awareness to manage drinking behaviors [49–51]. Furthermore, mindfulness training has been shown to help decrease stress levels and as a result, may partially decrease engagement in alcohol use [52–55]. In light of our findings and previous studies, we believe that aspects of Gabby, including personalization and face-to-face engagement [16], may promote healthy decision making on stress management among its users. More research is needed to prioritize which aspects of the system are important in supporting patients beyond the dissemination of information on stress management.

Generally, healthy eating habits improved in both the intervention and control groups. Specifically, increased fruit consumption was statistically significant for Gabby users. Only 13% of the adults in the United States consume the recommended daily amount of fruits (4 to 5 servings) [56, 57]. Very few technologies have been developed to support healthy eating habits among disparate populations: one study found that a web-based nutrition program led to increased–but not statistically significant–fruit consumption compared to a traditional in-person nutrition education among low-income adults [58]; another study revealed that female ethnic minority college students ate more servings of fruit when they received motivational text messages [59]. With Gabby, we find that women were actually consuming an increased amount of fruit servings relative to those who were given patient information sheets–results consistent with these two studies mentioned above.

Based on our qualitative feedback, we believe that users would have utilized the ECA system more had it been available on multiple technology platforms, such as mobile devices. With smartphone ownership increasing steadily [60], having the Gabby system installed on a frequently used device would provide more opportunities for patients to engage in learning and practicing meaningful health behaviors. Use of technology, such as having access to the Internet or owning cell phones with data, is common among underserved racially diverse populations [5]. The National Standards for Culturally and Linguistically Appropriate Services in Health and Health Care encourage healthcare organizations and providers to use

multimedia when communicating health information to culturally diverse patients [61]. However, more information is needed on how technology can be used to create healthy behavior changes for such racially and culturally diverse patient populations.

Limitations to this feasibility study include a small sample size, short duration of the intervention, specific inclusion criteria, and self-reported information. By including only women who had access to the internet, we may have biased the sample towards women who have favorable use of technology. The Gabby system was also developed in English, excluding participants who are not fluent in English. Lastly, participants could have inaccurately reported their health behaviors due to a lack of knowledge or feeling uncomfortable sharing information with a web-based system.

4.2. Conclusion

Feasibility data on the Gabby system are encouraging, and show that ECA technology can help improve education on lifestyle information on physical activity, healthy eating, mindfulness and stress management methods for diverse, urban women.

4.3. Practice implications

In medical settings, clinicians give patients after-visit summary plans that usually include patient information sheets. ECAs are an encouraging way to provide patient information in a customized interactive format. ECAs may help patients adhere to behavioral changes through improved decision making and experiential learning as opposed to passive reading.

Acknowledgments

Appendix A. Dialogue Script

Gabby: Hi there! My name is Gabrielle, but you can call me Gabby. (pause 2 s)

On the right hand side of the screen you will see some buttons, just let me know that you can see them by pressing on any one of the responses.

- Hi Gabby!

- Okay

- Could you repeat that?

Gabby: <USER's NAME>, have I got that right?

- Yes!

- No

Gabby: Great. So, <USER's NAME>, I'm here every day to go over topics for your health! I want our interactions to be like a conversation. I am here to support you as you learn new ways to care for your health.

- Okay

- Could you repeat that?

Each time we meet I will offer you a menu of topics to choose from. By asking you questions and listening to your responses, I will be able to coach you better. Answer my questions by clicking the buttons I show on the right side of your screen. The only way for our chats to move forward will be by you pressing a button.

- Sounds good

- I can do that

- Could you repeat that?

Gabby: It is fun for me to share pictures and tips with you about stress, nutrition, and exercise.

- Sounds fun!

- Okay

- Could you repeat that?

Gabby: I am excited to take this journey to better health with you. Together we are team. I hope that you can check in with me daily. But that's up to you! The more time we spend together the more I can support you in the changes you are making in reducing your stress and improving your health.

- Great

- Okay

- Could you repeat that?

Appendix B. Nutrition Knowledge Quiz

The following questions are about food knowledge:

Please answer true or false.

34 Beans contain only a few useful nutrients, therefore their health benefit is not great. T F

35 A healthy meal should consist of half meat, a quarter vegetables, and a quarter side dishes. T F

36 Fat is always bad for your health; you should therefore avoid **all** fat. T F

37 Oily fish (salmon, mackerel) contain healthier fats than red meat. T F

38 How much folic acid should women of childbearing age take every day to help prevent birth defects?

    ☐   None

    ☐   200 micrograms (mcg)

    ☐   400 micrograms (mcg)

    ☐   1000 micrograms (mcg)

39 Good advice for eating healthy includes all of the following **except**?

    ☐   Cut back on foods with added sugars, salt and fat.

    ☐   Eat fish 1–2 times a week

    ☐   Save half your plate for fruits and vegetables.

    ☐   Eat packaged foods

    ☐   Snack on nuts like almonds

40 How many servings of fruits and veggies should you get each day?

    ☐   1 servings

    ☐   2 servings

    ☐   5 servings

    ☐   10 servings

    ☐   Another amount: _____ servings

41 What 1 vitamin or mineral is important for having strong bones?

    ☐   Calcium

    ☐   Iron

    ☐   Omega-3 Fatty Acids

    ☐   Fiber

    ☐   Vitamin B

42 What 1 vitamin or mineral is most important for having healthy blood?

    ☐   Calcium

    ☐   Iron

    ☐   Omega-3 Fatty Acids

    ☐   Fiber

    ☐   Vitamin B

43 What are some good sources of omega-3 fatty acids?

    ☐   Fish

☐   Walnuts

☐   Olive oil

☐   Avocados

☐   All of the above

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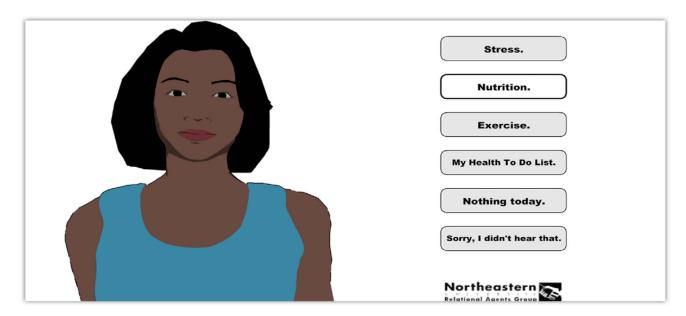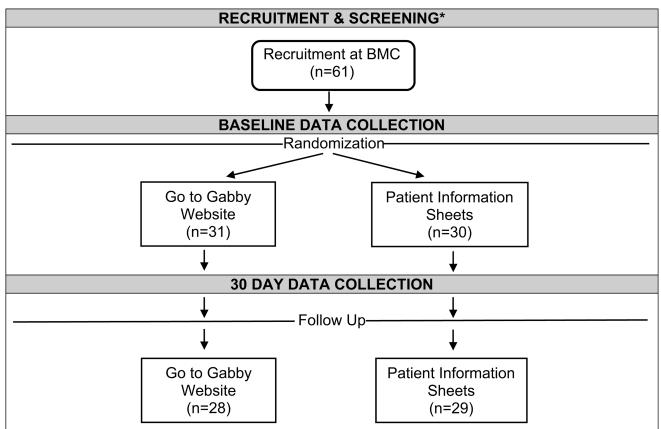
Fig. 1.
Gabby Embodied Conversational Agent (ECA) Interface.

RECRUITMENT & SCREENING*

Recruitment at BMC
(n=61)

BASELINE DATA COLLECTION

Randomization

Go to Gabby
Website
(n=31)

Patient Information
Sheets
(n=30)

30 DAY DATA COLLECTION

Follow Up

Go to Gabby
Website
(n=28)

Patient Information
Sheets
(n=29)

*All patients (n=61) recruited over the 12 month period were screened as eligible and enrolled.

Fig. 2.
Study consort diagram.

Table 1

Curriculum content of the ECA (Gabby) system.

Stress management	Nutrition	Physical activity
Stress 101 content	**Healthy Eating content**	**Activity content**
• Many ways to reduce stress	• Fruits and vegetables	• Benefits of activity
• What is mindfulness	• Healthy Eating Plate (protein, grains, fruits, vegetables, oil, water)	• Finding Time to be Active
• Introduction to being in the moment	• Being a fat detective	• The FITT Equation (frequency, intensity, time, type)
• How does stress affect my body	• Portion sizes	
• Coping with stress	• Eating and stress	• Baseline Daily Monitoring
• Difficult communications/social support	• Caffeine	• Setting Goals about Physical Activity
• Setting goals about stress management	• Healthy weight	
	• Setting goals About nutrition	
Mind Body Techniques	**Supplements Content**	
• Breathing meditation (short and long versions)	• Calcium	
• Body scan	• Iron	
• Introduction to mindful yoga	• Multivitamins	
• Progressive Muscle relaxation	• Folic acid	
• Guided Imagery	• Vitamin D	
• Self-massage	• Herbals supplements	
	• Omega fatty acids	

Table 2

Baseline Demographic and Clinical Characteristics of Participants.

Variable	Total Baseline (N = 61) n (%)	Gabby Baseline (N = 31) n (%)	Control Baseline (N = 30) n (%)	p-value[a]
Age (23–50)	μ = 35 (σ = 8.4)	μ = 33 (σ = 8.1)	μ = 37 (σ = 8.4)	0.08
Race				0.78
White	31 (51)	15 (48)	16 (53)	
Black	16 (26)	8 (26)	8 (27)	
Asian/Pacific Islander	1 (2)	1 (3)	0 (0)	
Other	13 (21)	7 (23)	6 (20)	
Ethnicity				0.22
Hispanic	12 (20)	8 (26)	13 (4)	
Non-Hispanic	49 (80)	23 (74)	87 (26)	
Language				0.79
English	51 (84)	26 (84)	83 (25)	
Spanish	7 (11)	3 (10)	14 (4)	
Other	3 (5)	2 (7)	3 (1)	
Education				0.38
High School/GED	13 (21)	8 (26)	17 (5)	
College	48 (79)	23 (74)	83 (25)	
Work				0.32
Full/Part Time	54 (89)	28 (90)	86 (26)	
Unemployed	5 (8)	3 (10)	7 (2)	
Disabled	2 (3)	0 (0)	7 (2)	
Income				0.88
Less than $10K	6 (10)	3 (10)	10 (3)	
$10K–$49K	21 (34)	12 (38)	30 (9)	
$50K–$99K	15 (25)	8 (26)	23 (7)	
$100K or more	13 (21)	5 (16)	27 (8)	
Refuse/Don't Know	6 (10)	3 (10)	10 (3)	
BMI	μ = 28 (σ = 6.6)	μ = 27 (σ = 5.6)	μ = 29 (σ = 7.5)	0.37
Pain Score	μ = 3 (σ = 3)	μ = 3 (σ = 3.4)	μ= 3 (σ = 2.6)	0.97
PHQ-9 Score	μ = 7 (σ = 4.6)	μ = 7 (σ = 4.7)	μ = 7 (σ = 4.6)	0.82
SF-12				
PCS Score	μ = 56 (σ = 10.2)	μ = 56 (σ = 10.8)	μ = 56 (σ = 9.6)	0.95
MCS Score	μ = 59 (σ = 10.7)	μ = 61 (σ = 11.6)	μ = 59 (σ = 9.8)	0.46
Health Conditions that Cause Pain				0.71
Yes	27 (44)	13 (42)	14 (47)	
Chronic Health Problems				0.52
Yes	18 (30)	8 (26)	10 (33)	
Take Prescribed Medications				0.93
Yes	41 (67)	21 (68)	20 (67)	

Variable	Total Baseline (N = 61) n (%)	Gabby Baseline (N = 31) n (%)	Control Baseline (N = 30) n (%)	p-value[a]
Smoking				0.98
Yes	2 (3)	1 (3)	1 (3)	
Alcohol Use				0.30
Yes	43 (70)	20 (65)	23 (77)	

[a]Continuous variables were analyzed using two-sample *t*-tests and categorical/dichotomous variables were analyzed using Chi-square tests of independence.

Table 3

Stress Management Techniques.

Variable	Total Baseline (N = 61) n (%)	Gabby Baseline (N = 31) n (%)	Gabby Follow-up (N = 28) n (%)	Control Baseline (N = 30) n (%)	Control Follow-up (N = 29) n (%)	p-value[a]
Adaptive coping						
Deep breathing/meditation	37 (61)	20 (65)	21 (75)	17 (57)	23 (79)	0.35
Exercise	42 (69)	19 (61)	20 (71)	23 (77)	24 (83)	0.51
Eat	32 (52)	17 (55)	8 (29)	15 (50)	11 (38)	0.12
Listen to music	43 (70)	21 (68)	19 (68)	22 (73)	20 (69)	0.81
Pray	30 (49)	13 (42)	10 (36)	17 (57)	14 (48)	1
Spend time with friends	40 (66)	22 (71)	17 (61)	18 (60)	15 (52)	0.49
Go shopping	27 (44)	14 (45)	7 (25)	13 (43)	10 (34)	0.89
Play video games	4 (7)	1 (3)	0 (0)	3 (10)	3 (10)	c
Go for a walk	34 (56)	18 (58)	19 (68)	16 (53)	18 (62)	0.72
Watch TV	38 (62)	19 (61)	14 (50)	19 (63)	21 (72)	0.19
Other[b]	16 (26)	9 (29)	5 (18)	7 (23)	6 (21)	0.6
Maladaptive coping						
Drink alcohol	41 (67)	11 (35)	4 (14)	9 (30)	9 (31)	0.03
Smoke cigarettes	3 (5)	2 (6)	1 (4)	1 (3)	1 (3)	c
Smoke marijuana	2 (7)	2 (6)	5 (18)	0 (0)	0 (0)	c
How many times did you do stress management techniques in the past week?	$\mu = 2$ ($\sigma = 2.3$)	$\mu = 1$ ($\sigma = 2$)	$\mu = 4$ ($\sigma = 3$)	$\mu = 2$ ($\sigma = 2.6$)	$\mu = 3$ ($\sigma = 3.3$)	0.17
(0–10 scale)						
Perceived Stress Score *(0–4 scale)*	$\mu = 18$ ($\sigma = 3.6$)	$\mu = 17$ ($\sigma = 3.7$)	$\mu = 20$ ($\sigma = 3.1$)	$\mu = 18$ ($\sigma = 3.5$)	$\mu = 19$ ($\sigma = 3.1$)	0.07

[a] Dichotomous variables were analyzed using two group McNemar tests of differential change for intervention and control groups. Continuous variables were analyzed using two-sample *t*-tests.

[b] Includes traveling, drawing, sleeping, reading, family time, thinking and counseling.

[c] No statistics were computed because there were zero participants in at least one group changed from baseline to follow-up.

Table 4

Daily Food Consumption and Nutrition.

Variable	Total Baseline (N = 61) n (%)	Gabby Baseline (N = 31) n (%)	Gabby Follow-up (N = 28) n (%)	Control Baseline (N = 30) n (%)	Control Follow-up (N = 29) n (%)	p-value[a]
Fruits	$\mu = 2$ ($\sigma = 1.1$)	$\mu = 2$ ($\sigma = 1$)	$\mu = 3$ ($\sigma = 1.1$)	$\mu = 2$ ($\sigma = 1.1$)	$\mu = 2$ ($\sigma = 0.9$)	0.04
Vegetables	$\mu = 2$ ($\sigma = 1$)	$\mu = 2$ ($\sigma = 1$)	$\mu = 3$ ($\sigma = 0.9$)	$\mu = 2$ ($\sigma = 1$)	$\mu = 3$ ($\sigma = 1$)	0.74
Soda						0.34
No	42 (69)	21 (68)	15 (54)	21 (70)	21 (72)	
Yes	19 (32)	10 (32)	13 (46)	9 (30)	8 (28)	
Caffeine						0.08
No	4 (7)	1 (3)	3 (11)	3 (10)	2 (7)	
Yes	56 (93)	29 (97)	25 (89)	21 (70)	27 (93)	
Snacks						0.09
No	2 (3)	1 (3)	6 (21)	1 (3)	1 (3)	
Yes	59 (97)	30 (97)	22 (79)	29 (97)	28 (97)	
Whole Grains						0.71
No	3 (5)	2 (7)	1 (3)	1 (3)	1 (3)	
Yes	58 (95)	29 (93)	27 (97)	29 (97)	28 (97)	
Red Meat						0.72
No	19 (31)	12 (39)	11 (39)	7 (23)	5 (17)	
Yes	42 (69)	19 (61)	17 (61)	23 (77)	24 (83)	
Fish						0.17
No	18 (30)	8 (26)	11 (39)	10 (33)	9 (31)	
Yes	43 (70)	23 (74)	17 (61)	20 (67)	20 (69)	

[a] Continuous variables were analyzed using two-sample *t*-tests. Dichotomous variables were analyzed using two group McNemar tests of differential change for intervention and control groups.

Table 5

Satisfaction and Confidence in using Gabby versus Patient Information Sheets on Healthy Eating, Physical Activity and Stress Management.

Variable	Gabby (N = 27) n (%)	Patient Information Sheets (N = 29) n (%)	p-value[a]
How satisfied were you in using the resource for improving ….?			
(1: Not Satisfied – 7: Very Satisfied)			
Healthy Eating	$\mu = 5$ ($\sigma = 1.7$)	$\mu = 5$ ($\sigma = 1.4$)	0.92
Physical Activity	$\mu = 6$ ($\sigma = 1.8$)	$\mu = 5$ ($\sigma = 1.5$)	0.62
Stress Management	$\mu = 6$ ($\sigma = 1.8$)	$\mu = 5$ ($\sigma = 1.6$)	0.07
Did you use any of the suggestions from the resource to improve ….?			
Healthy Eating	18 (69)	19 (66)	0.93
Physical Activity	14 (52)	14 (49)	0.88
Stress Management	19 (70)	19 (66)	0.89
Do you think that you will use some of the resource's suggestions in the future to improve ….?			
(1: Definitely No – 7: Definitely Yes)			
Healthy Eating	$\mu = 6$ ($\sigma = 2$)	$\mu = 6$ ($\sigma = 1.2$)	0.53
Physical Activity	$\mu = 5$ ($\sigma = 2.1$)	$\mu = 5$ ($\sigma = 1.7$)	0.94
Stress Management	$\mu = 6$ ($\sigma = 1.9$)	$\mu = 5$ ($\sigma = 2$)	0.29
How confident do you feel that you can continue the changes you made based on the resource's recommendations for ….?			
(1: Not Confident – 7: Very Confident)			
Healthy Eating	$\mu = 6$ ($\sigma = 1.3$)	$\mu = 6$ ($\sigma = 1.4$)	0.10
Physical Activity	$\mu = 6$ ($\sigma = 1.7$)	$\mu = 6$ ($\sigma = 1.4$)	0.22
Stress Management	$\mu = 6$ ($\sigma = 1.7$)	$\mu = 6$ ($\sigma = 1.5$)	0.25

[a] Continuous variables analyzed using two-sample *t*-tests. Categorical variables analyzed using Chi-square tests.