Mobile Health Technology in Prenatal Care: Understanding OBGYN Providers' Beliefs about Using Technology to Manage Gestational Weight Gain

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Abstract

OBJECTIVES.—High gestational weight gain (GWG) is linked to adverse maternal/infant outcomes. Scant research has examined OB/GYN providers': 1) beliefs and barriers to using mobile health (mHealth) technology and 2) their perceptions of patient beliefs/barriers for using mHealth technology for managing GWG.

METHODS.—Semi-structured interviews and focus groups with OB/GYN providers ($N = 25$) were conducted in person and via telephone. Principles of thematic analysis were used to content analyze the interviews; sample size was determined via data saturation.

RESULTS.—Most providers didn't use technology when providing prenatal care (94%), recommended public websites for patients to obtain health information (72%), and reported a smartphone/tablet as the ideal tool for clinical care (83%). Providers also believed mHealth tools would be beneficial for high risk patients (e.g., overweight/obese; 67%). For the use of mHealth tools in clinical care, the most salient provider barriers were lack of time (78%), costs (61%), facility/technology issues (56%), and lack of provider willingness to adapt to change (44%). The most important provider-perceived patient barriers were access (72%) and lack of interest (67%).

CONCLUSIONS FOR PRACTICE.—These findings suggest some OB/GYN providers may be open to using mHealth technology in prenatal clinics to help their patients manage GWG if the technology is time efficient and both providers and patients can overcome barriers. The success of incorporating mHealth technology for diet/exercise counseling in prenatal clinics will lie in making it time efficient and interesting for the patient. Novel strategies to overcome provider and patient barriers are essential.

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Introduction

High gestational weight gain (GWG) is defined as gaining weight in excess of the Institute of Medicine (IOM, 2009) guidelines. High GWG is problematic because it elevates the risk for maternal (i.e., gestational diabetes, preeclampsia, postpartum weight retention) and infant (i.e., macrosomia, accelerated weight gain in infancy) complications (Rasmussen & Abrams, 2011; Siega Riz et al., 2009; IOM, 2009; Bodnar et al., 2016; Faucher & Barger, 2015). Research suggests that 50% of normal weight and 60% of overweight women gain more weight in pregnancy than is recommended (Flegal, Caroll, Kit, & Ogden, 2012). Furthermore, this excessive weight may lead to increased maternal-infant morbidity and thus, there is a critical need for research that identifies effective strategies for weight management in pregnancy.

Despite the increase in the number of recent interventions to manage GWG, randomized controlled trials aiming to prevent excessive GWG have generated equivocal findings (Phelan, Jankovitz, Hagobian, & Abrams 2011; Skouteris et al., 2016). Some studies have found that overweight and obese women who were randomized to an intervention were able to significantly reduce their GWG compared to a control group; however, these interventions were intensive, time consuming, and expensive (Polley, Wing, & Sims, 2002; Quinlivan, Lam, & Fisher, 2011; Liu, Wilcox, Whitaker, Blake, & Addy, 2016; Ronnberg, Ostlund, Gottval, & Nilsson, 2015; Shirazian, Monteith, Friedman, & Rebarber, 2010; Wolff, Legarth, Vangsgaard, Toubro, & Astrup, 2008). Thus, recent advancements in mobile health (mHealth) technology may provide cost-effective and useful strategies for delivering portions of intervention content to manage GWG. Scant research has examined mHealth approaches to weight management in pregnancy.

Before mHealth interventions targeting diet and exercise behaviors to manage GWG can be developed, it is important to understand contextual influences on weight such as the role that healthcare providers play in how women manage GWG. For example, a recent study found that overweight and obese women have greater success in meeting GWG targets when providers counsel patients on nutrition and exercise (Yeo, Walker, Caughey, Ferraro, & Asafu-Adjey., 2017). However, there is limited research examining OB/GYN providers' beliefs about counseling prenatal women on GWG, diet, and exercise behaviors. One study examined prenatal care providers' knowledge, attitudes, and practices for preventing excessive GWG and found that providers discussed GWG, nutrition, and exercise only if the patient asked or if they perceived the patient to be high risk (e.g., BMI > 30 prior to pregnancy; Stotland, Gilbert, Bogetz, Harper, Abrams, & Gerbert, 2010). Stotland and colleagues (2010) also suggested that some OB/GYN providers practice a "reactive" rather than "proactive" approach to counseling whereby they wait for cues from their patients to address weight gain issues. This approach can be problematic because GWG may already be excessive by the time the patient initiates a conversation with her provider. This study also provided evidence that mHealth strategies may be useful to providers in helping patients manage GWG. For example, mHealth tools may reduce possible barriers that providers experience such as having no time to counsel patients on diet and exercise behaviors and/or initiating discussions on sensitive topics like weight gain.

A review study also suggested that usefulness and ease of adoption were two important criteria reported by healthcare professionals for adopting mHealth technology because patients could gain better knowledge about themselves with these tools (Gangon, Ngangue, Payne-Gangon, & Desmartis, 2015). Incorporating technology into prenatal care may also allow providers to offer a customized approach to prenatal care and improve interpersonal relationships with patients.

However, no located studies have examined OB/GYN providers' beliefs and attitudes about using mHealth strategies in prenatal care for managing GWG. The purposes of this study were to examine: 1) OB/GYN providers' beliefs/preferences for and barriers to incorporating mHealth technology into prenatal care for managing GWG, and 2) OB/GYN providers' perceptions of patient beliefs/barriers for using mHealth technology for managing GWG. We hypothesized that OB/GYN providers would report using minimal technology in their current prenatal care outpatient practices; however, they would also report a positive attitude towards mHealth tools in prenatal care for monitoring diet and exercise behaviors to manage GWG. We also hypothesized that OB/GYN providers would identify a lack of time as a salient barrier preventing them from using technology to counsel their prenatal patients on diet and exercise behaviors to manage GWG and a lack of time and patient motivation would be the main perceived patient barriers to using technology to manage GWG.

Materials and Methods

Recruitment and Procedures

Approval to conduct this study was obtained from the university's human subjects review board. Potential participants were located by searching the Internet for current OB/GYN providers (i.e., physicians and residents) providing care at a private practice clinic or a university hospital located in Central Pennsylvania. Participants were contacted via e-mails and phone call. Implied consent was obtained from every participant by sending each participant the A total of 25 OB/GYN residents and non-resident physicians participated in the study. Seven individual semi-structured interviews were conducted with OB/GYN non-resident physicians: three interviews were conducted in-person at the local OB/GYN clinic and the other four were conducted over the phone.

Resident OB/GYN providers ($n = 18$) at a university hospital also participated in the study. They were given information about the study through their program director. The first author then contacted the residents to schedule focus group interviews. Three focus group interviews were conducted with the OB/GYN residents. One focus group was conducted at a university hospital ($n = 8$ participants) and the other two focus groups were conducted over the phone due to inclement weather ($n = 5$ in each of the focus groups).

Interview questions were developed by the first and second author based on prior research (Phelan et al., 2011; Stotland et al, 2010). The interviews and focus groups were led by the first author and included six open-ended questions that were recorded using an Olympus DM-420 digital voice recorder and transcribed. A research assistant attended the interviews to take field notes. A script was followed to standardize the delivery of the questions and prompts were used as needed to elicit more information when the content discussion was

limited. Demographic questions included participants' age, sex, job status (resident or physician), and the number of years of job experience.

Sample size was determined by data saturation (Guest, Bunce, & Johnson, 2005) which was determined when new information produced little to no change in the coding schemes created while reviewing the transcribed interviews (Guest et al., 2005). When no new information was learned from the interviews, the interviews/focus groups were completed.

Data Analyses

SPSS (version 22.0) was used for data management and for descriptive analyses of the study sample. Descriptive statistics were used to examine participant demographics (see Table 1). Principles of thematic analysis were used to analyze the interview data (Green & Browne, 2005). The transcripts from each interview were independently coded for lower order themes. A thematic framework was developed for each question whereby higher order themes were created and lower order themes were categorized into the appropriate higher order theme by the first and second author and a research assistant. A varying number of themes were identified for each of the six questions along with illustrative quotes for each of the lower order themes. Themes were further analyzed by participant occupation to identify any differences across OB/GYN physicians compared to OB/GYN residents.

Results

Participants

Out of the 28 non-resident OB/GYN providers that were contacted, 7 participated in the interviews. Reasons for not participating included: no response ($n = 16$), scheduling conflicts ($n = 3$), and not providing OB care ($n = 2$). In total, there were 25 participants ($n = 7$ non-resident OB/GYN providers and 18 resident OB/GYN physicians) out of 46 possible participants for a response rate of 54%. A total of 10 semi-structured interviews and focus groups were conducted ($n = 7$ semi-structured interviews and 3 focus groups). Providers had a mean age of 38 years ($SD = 12.5$), 84% were female, and they had been in their current occupation for an average of 9.2 years ($SD = 10.3$; see Table 1).

A detailed description of the three most salient higher order themes along with lower order themes from each of the six questions can be found in Table 2. Forty higher order themes were identified across the six questions (for the complete list of higher order and lower order themes, please contact the first study author). To determine the percentage of semi-structured interviews/focus groups in which a theme emerged, the number of times a particular theme was mentioned was divided by the total number of semi-structured interviews/focus groups ($n = 10$). This number was used as the denominator for all study analyses. The following summarizes the higher order themes for each question:

Current Technology Use.

In 94% of the semi-structured interviews/focus groups, providers indicated they currently used no technology (e.g., no smartphones or tablets) to counsel their patients. However, 72% indicated that they recommend public websites for patients to obtain additional pregnancy

related information (e.g., American Congress of Obstetricians & Gynecologists, http:// www.acog.org/; Center for Disease Control & Prevention, https://www.cdc.gov/). Non-resident physicians were more likely to recommend websites compared to resident physicians and the websites they recommended were often from professional organizations (i.e., American Medical Association, https://www.ama-assn.org/).

Beliefs about an "Ideal" Tool.

In 83% of the semi-structured interviews/focus groups, providers reported that the ideal tool would be a smartphone or tablet (e.g., iPad) application that patients could use on their own time. Also, providers reported that the ideal tool would provide behavioral monitoring (67%) as well as feedback and alerts (56%), live support (44%), and allow for personalization (39%). Providers also felt that a website (39%) or an in-office kiosk for patients to use (22%) would be a useful tool. Only non-resident physicians thought that a kiosk would be an ideal tool for patients to use and no resident physicians indicated this form of technology as useful.

Frequency of Use

The most common theme discussed in 67% of the semi-structured interviews/focus groups was that providers would use mHealth technology based on specific needs such as use with overweight and obese patients or those with medical problems. This theme was commonly reported regardless of occupation status. Some providers (39%) stated that while they were not currently using technology, they believed they would use it frequently in their counseling if it was available because all of their patients could benefit. Those providers that reported wanting to use mHealth technology with all patients (39%) felt that it would be reasonable to use technology on a weekly basis.

Patients to Target with Technology

The majority of semi-structured interviews/focus groups (89%), regardless of provider type, indicated that all prenatal patients should receive technology to counsel them on diet and exercise behaviors to manage GWG. However, 50% of the semi-structured interviews/focus groups indicated that providers thought they would target both underweight and overweight/ obese women and another 44% wanted to target women with previously or currently high GWG or those patients who are considered high risk or with complications (e.g., gestational diabetes; 39%). Providers also preferred to encourage patients who are already motivated and have the ability/resources to use technology to manage their GWG (28%). Only non-resident physicians indicated wanting to target patients that are motivated to use the technology.

Provider Barriers

The most salient barrier to using technology in clinical care was a lack of time (78%). This theme emerged across all healthcare providers. Other common barriers discussed were the cost associated with having to purchase any technology for the office (61%), facility and technology barriers (i.e., a lack of space; maintenance of technology; 56%), and providers not willing to adapt to change and use technology (44%). Some providers also reported

concerns about HIPAA and patient privacy if patients were entering or uploading personal
information (17%).

Perceived Patient Barriers

Providers perceived their patients had the following barriers to using mHealth technology:
access to the technology (72%), lack of patient interest, engagement, and motivation (67%),
and acceptability of the technology (i.e., comfort with using technology, language barriers,
patients getting too much information, patients misinterpreting information; 50%).

Discussion

This study examined OB/GYN providers' beliefs and preferences for incorporating mHealth
technology into prenatal care, barriers in using mHealth tools in prenatal care, and their
perceptions of patient barriers to technology use. A primary study finding was that providers
believed they would use technology frequently to counsel prenatal patients on diet and
exercise behaviors to manage GWG if it did not require too much time, there weren't high
costs associated with the technology, the facility was able to utilize the technology, and
providers were willing to adapt to the changes associated with using new technology. Also,
providers felt all patients would benefit from receiving mHealth counseling but that high risk
patients (e.g., overweight/obese women, women with a history of high GWG) should be
specifically targeted. Several additional findings warrant further discussion.

The most salient theme that emerged from the question regarding providers' use of
technology was that providers are not currently using any technology in clinic to counsel
women on diet and exercise to manage their GWG. This finding is consistent with
researchers who found that primary care providers use patient-centered approaches rather
than technology to communicate with their patients about weight loss (Gudzun, Clark,
Appel, & Bennett, 2012). However, 72% of the providers in the semi-structured interviews/
focus groups recommended public websites for their prenatal patients to obtain additional
pregnancy-related information. Despite providers being in favor of recommending websites
for their patients to access on their own, they may not be as open to using technology tools
during clinic appointments with their prenatal patients. Some providers preferred to use
technology in clinical care when their patients demonstrated that they are motivated and
willing to learn how to use it. This finding is consistent with Stotland et al. (2010) who
reported that providers were more likely to counsel women about GWG, diet, and exercise if
the patient asked questions which indicated they may be more interested and motivated to
learn. It is possible that self-motivated patients would be able to use an application on their
own; however, providers' believed that most patients would need encouragement to use the
technology as well as intermittent "check-ins" to keep patients accountable for monitoring
their own behaviors. Interestingly, the physicians but not the residents suggested targeting
patients who were interested and motivated. It's possible that more experienced providers
perceive that it is not worth their time and effort to discuss the use of technology with
unmotivated patients. This is problematic because it's the unmotivated patients that need the
most encouragement. Thus, more research is needed to better understand how to use
technology to target these highest risk patients (i.e., overweight/obese pregnant women,

women with previous high GWG or currently high GWG) since providers commonly indicated wanting to target and encourage this particular group to use mHealth technology.

Also, consistent with our hypothesis and past researchers' conclusions (Gangon et al,, 2015), we found that a lack of time was the biggest barrier preventing providers from being able to use mHealth technology to counsel their prenatal patients on diet/exercise for managing GWG. Limited time with patients is a common issue across all clinical care; however, the OB/GYN providers in this study did indicate that while they did not have time at each visit to use mHealth technology for diet/exercise counseling for managing GWG, they would be willing to use it once or twice over the course of gestation. This finding suggests that providers would still be open to the possibility of briefly discussing patient behaviors or use of the technology as long as it could be done efficiently. Research is needed that identifies how to integrate technology-based strategies that efficiently and effectively help providers and patients to monitor diet/exercise behaviors to manage GWG. Providers also discussed other important barriers to using technology in a clinical care setting such as costs associated with purchasing new technology, maintenance of the technology, and the willingness of providers to actually use the technology. All of these barriers are important to consider when designing a mHealth tool that can be used in a clinical care setting. Thus, there is a need for research that systematically examines what level of technology (e.g., basic application versus a more advanced program) is needed that will be cost effective, time efficient, user-friendly, and can be easily integrated into a clinic. Future experimental and randomized interventions trials are warranted in this area.

Finally, in partial support of the hypothesis and consistent with past researchers conclusions (Stotland et al., 2010), the most common theme for providers' perceptions of patient barriers was motivating the patients to use the technology. Providers indicated that it is likely that those patients who show concern about their health are likely to be the patients that need the mHealth technology the least whereas those patients that are higher risk (i.e., overweight/ obese, gestational diabetics) may not be as interested in using the technology but are the ones who can benefit most from it.

This study provides a unique contribution to the literature by examining an under-researched topic of OB/GYN providers' beliefs and barriers to using mHealth technology in prenatal care. The findings from this study are an important first step in understanding how to feasibly integrate mHealth technology into prenatal care for managing GWG. Despite these study strengths, there were some limitations. First, the sample was largely homogenous, and responses represented clinicians' beliefs who practice medicine across Central Pennsylvania. Future research should replicate these study findings with providers in other locations to improve generalizability of the findings. Also, patient perceptions about the use of technology as part of their prenatal care were not examined. Future research should examine patients' beliefs and perceptions regarding the use of technology to receive counseling around GWG, diet and exercise. Also, providers' weight status was not assessed and it is possible that their weight status may influence their beliefs and how they counsel women on diet and exercise behaviors for managing GWG (Hash, Munna Vogel, & Bason). Further, our sampling method resulted in two distinct groups of providers (e.g., residents vs. non-residents) and it possible that their responses may have been influenced by the setting

(private clinic vs. academic training hospital) in which they were practicing medicine. In addition, the residents were interviewed in a group setting which could have had an influence on their responses compared to the non-residents who were interviewed individually. Thus, additional formative research with providers in other locations and of varying time practicing medicine would be beneficial to determine if there are other issues or barriers to consider when implementing mHealth technology in prenatal care.

Another novel contribution is that this study identified that a smartphone or tablet may be a feasible tool to use in prenatal care to help providers counsel patients on diet and exercise behaviors to manage GWG. To overcome primary barriers identified by the providers, it is necessary to develop mHealth technology strategies that are time efficient, cost-effective, userfriendly, and can easily be integrated into clinical care in addition to capturing the interest and motivation of the prenatal patient.

Acknowledgments

Literature Cited

1. Bodnar LM, Siminerio LL, Himes KP, Hutcheon JA, Lash TL, Parisi SM, & Abrams B (2016). Maternal obesity and gestational weight gain are risk factors for infant death. Obesity, 24(2), 490–498. [PubMed: 26572932]

2. Faucher MA, & Barger MK (2015). Gestational weight gain in obese women by class of obesity and select maternal/newborn outcomes: A systematic review. Women and Birth, 28(3), e70–e79. [PubMed: 25866207]

3. Flegal KM, Carroll MD, Kit BK, & Ogden CL (2012). Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999–2010. Journal of the American Medical Association, 307, 491–497. DOI: 10.1001. [PubMed: 22253363]

4. Gangon M, Ngangue P, Payne-Gagnon J, & Destmartis M (2015). M-health adoption by healthcare professionals: A systematic review. Journal of the American Medical Informatics Association, Epub ahead of print. DOI: 10.1093.

5. Green J, & Browne J (2005). Analysing Qualitative Data In: Black N, Raine R,Green J, & Browne (Eds.), Principles of Social Research (79–80). New York, NY: McGraw-Hill.

6. Gudzune KA, Clark JM, Appel JM, & Bennett WL (2012). Primary care providers' communication with patients during weight counseling: A focus group study. Patient Education and Counseling, 89(1), 152–157. DOI: 10.1016 [PubMed: 22819710]

7. Guest G, Bunce A, & Johnson L (2005). How many interviews are enough? An experiment with data saturation. Field Methods, 18, 59–82. DOI: 10.1177

8. Hash RB, Munna RK, Vogel RL, & Bason JJ (2003). Does physician weight affect perception of health advice? Preventive Medicine, 36, 41–44. DOI: 10.1006 [PubMed: 12473423]

9. Institute of Medicine (2009). Weight gain during pregnancy: Reexamining the guidelines. Washington, D.C.s: National Academy of Sciences.

10. Liu J, Wilcox S, Whitaker K, Blake C, & Addy C (2016). Preventing excessive weight gain during pregnancy and promoting postpartum weight loss: A pilot lifestyle intervention for overweight and obese African American women. Maternal Child Health Journal, 19(4), 840–849.

11. Polley BA, Wing RR, & Sims CJ (2002). Randomized controlled trial to prevent excessive weight gain in pregnant women. International Journal of Obesity, 26(11), 1494–1502. [PubMed: 12439652]

12. Phelan P, Jankovitz K, Hagobian T, & Abrams B, (2011). Reducing excessive gestational weight gain: Lessons from the weight control literature and avenues for future research. Women's Health, 7(6), 641–661. DOI: 10.2217

13. Quinlivan JA, Lam LT, & Fisher J (2011). A randomized trial of a four-step multidisciplinary approach to the antenatal care of obese pregnant women. Australian and New Zealand Journal of Obstetrics & Gynecology, 51, 141–146. DOI: 10.1111

14. Rasmussen KM & Abrams B (2011). Gestational weight gain and later maternal health: Are they related? American Journal of Clinical Nutrition, 93(6), 1186–1187. DOI: 10.3945 [PubMed: 21543528]

15. Ronnberg AK, Ostlund I, Fadl H, Gottvall T, & Nilsson K (2015). Intervention during pregnancy to reduce excessive gestational weight gain – randomized controlled trial. British Journal of Obstetrics & Gynecology, 122(4), 537–544.

16. Shirazian T, Monteith S, Friedman F,& Rebarber A (2010). Lifestyle modification program decreases pregnancy weight gain in obese women. American Journal of Perinataology, 27(5), 411–414. DOI: 10.1055

17. Siega-Riz AM, Viswanathan M, Moos ML, Deierlein A, Mumford S, Knaack J,…Lohr KN (2009). A systematic review of outcomes of maternal weight gain according to the Institute of Medicine recommendations: birthweight, fetal growth, and postpartum weight retention. American Journal of Obstetrics & Gynecology, 201(4), 339.e1–339.e14. DOI: 10.1016 [PubMed: 19788965]

18. Skouteris H, McPhie S, Hill B, McCabe M, Milgrom J, Kent B, …Lachal J (2016). Health coaching to prevent excessive gestational weight gain: A randomizedcontrolled trial. British Journal of Health Psychology, 21(1), 31–51. [PubMed: 26227112]

19. Stotland NE, Gilbert P, Bogetz A, Harper CC, Abrams B, & Gerbert B (2010). Preventing excessive weight gain in pregnancy: How do prenatal care providers approach counseling? Journal of Women's Health, 19(4), 807–814. DOI:10.1089

20. Wolff S, Legarth J, Vangsgaard K, Toubro S, & Astrup A (2008). A randomized trial of the effects of dietary counseling on gestational weight gain and glucose metabolism in obese pregnant women. International Journal of Obesity, 32, 495–501. DOI: 10.1038 [PubMed: 18227847]

21. Yeo S, Walker JS, Caughey MC, Ferraro AM, & Asafu-Adjey JK (2017). What characteristics of nutrition and physical activity interventions are key to effectively reducing weight gain in obese or overweight pregnant women? A systematic review and meta-analysis? Obesity Reviews, epub ahead of print.

Table 1.

Demographic Characteristics of the Entire Sample (N = 25)

Variable	N	%	M	SD
Age			38.2	12.5
Sex				
Male	4	16.0		
Female	21	84.0		
Occupation				
OBGYN Non-Resident Physician	7	28.0		
OBGYN Resident	18	72.0		
Years in Current Occupation			9.2	10.3
OBGYN Non-Resident Physician			18.4	12.0
OBGYN Resident			2.2	1.3
Current Employment Site				
Physician Residents (in Training)	18	72.0		
Private Practice	4	16.0		
University Hospital	3	12.0		

Table 2.

Semi-Structured Interview and Focus Group Questions, Three Most Commonly Cited Higher and Lower Order Themes Per Question, Frequency of Responses, and Example Quotations

Question 1: "What forms of technology are you currently using during clinic to deliver health information, recommendations, or guidelines to your pregnant patient?"			
Higher Order Theme	**_N_ (%) Theme In Responses**	**Lower Order Themes**	**Example Quotation**
No technology used	17 (94)	No online trackers, kiosk, website None No phone applications	"I don't have enough knowledge about it [mobile phone applications] myself that I would recommend it."
Public websites	13 (72)	ACOG iVillage National Library of Medicine American Medical Association American Dietetic Association Myplate.gov, NIDDK, CDC websites	"The only form of technology I usually use is actually the internet to point them towards websites that might have information."
Smartphone applications	5 (28)	Weight Watchers Menstrual cycle tracker Calorie King Pregnancy wheel for gestational age Alarm for birth control reminders	"I have one of those smart phone apps that I use to calculate a…pregnancy wheel; I'll use it to calculate their gestational age. That's one of the free apps that I use."
Question 2: "If resources were endless and we could develop the "ideal tool" for you to get your patients to engage in HE/PA behaviors to manage GWG, what would it be?"			
Higher Order Theme	**_N_ (%) Theme In Responses**	**Lower Order Themes**	**Example Quotation**
Characteristics of the tool	10 (55)	Tool provides feedback Self-guided interactive touch screen Interesting tool to keep patients engaged Personalized to patient User-friendly, easy to access/navigate Tool should keep track of who is accessing it Tool can't take too much of clinicians' time Informational for patients Decrease "silly" questions clinicians are inundated with intermittent alerting Interactive Includes pictures	"It would be easy to navigate so that people don't have to struggle with where to put information and where to get information and the linkages would then follow to other linkages."
Smartphone or tablet	15 (83)	Smartphone app/toll Tablet/iPad Content delivered on phone or internet Pedometer app Multiple tools (i.e., smartphone applications, websites, kiosk)	"I would love to have an application on the phone. I think if they knew it came from somewhere local and our doctors knew it was something people were certified that were working on this, I think that would be good so that we could definitely recommend it, rather than just saying

Higher Order Theme	N (%) Theme In Responses	Lower Order Themes	Example Quotation
Monitoring with the tool	12 (67)	Logging/tracking diet, activity, weight Help patients be more aware of behaviors Plot weight on a graph Tracking of fetal movement Provide positive reinforcement	go to this website and not knowing if that site is really following the ACOG guidelines." "A tool where they could log information, like exercise logs and dietary logs."

Question 3: "How often do you perceive you would use e-health technology to counsel women on HE and PA behaviors to manage GWG?"

Higher Order Theme	N (%) Theme In Responses	Lower Order Themes	Example Quotation
Depending on need	12 (67)	Varies per patient Daily or weekly depending on number of calls getting Use more often with high risk women Can show that patients are actually using it Depends on motivation, need, weight gain, and any issues Use more often with overweight women Ff there are problems or issues Use with patients that are savvy with computers/technology Depends on patients coming into clinic	"I would probably use it a lot more for women who are overweight, or women who are more high risk initially."
Frequently	7 (39)	Weekly Every pregnant patient should get it Daily depending on how many first visits occur Use with 60% of patients Use with all patients if the tool is easy to use and works All pregnant patients need counseling so if it's reasonably practical, would use with all patients Use at every prenatal visit if concise and easy to use If effective, would use 100% of the time If it's kiosk, iPad or e-tool – frequent because user can log on and use	"Again I think if it was an ideal tool you could use quickly or was concise or had a summary of whatever the issue or the things are, then I think you could use it at every prenatal visit."
Intermittently	5 (50)	Would recommend it at their first prenatal visit and then intermittently follow-up Would bring up intermittently because women get weighed at each visit and don't want women being hyperaware of what they're eating and begin to restrict caloric intake Recommend it anytime they call in the first trimester and then intermittently	"And you know maybe intermittently throughout, you know, are you looking at that site? Have you been using it? What's helpful, what's not? You know maybe at 16 weeks, or 28 weeks, when we do a lot of our other counseling type stuff, I might ask about it then too."

Question 4: "How would you determine which patients should receive e-health technology when counseling them on HE and PA behaviors to manage their GWG?"

Higher Order Theme	N (%) Theme In Responses	Lower Order Themes	Example Quotation
Should be available to everyone	16 (89)	It should be made available to everybody It would be beneficial to all women but some women need the counseling more than others Should give it to everyone Helpful for everyone 100% because there isn't a "which patient" Getting all patients at the nurse visit so that those who are gaining too much don't feel targeted or more self-conscious In an ideal world, every patient would get it If it's a website, then anyone can have access to it More beneficial to give it to everyone so they have information with them at home Would try to get everyone to use it	"I mean I think it is something that we should probably offer to everyone. There are probably people that I think need it – the information, the counseling, more than others but they don't seem to care as much unfortunately. I think it would be beneficial to all women, I think there are some women that are very health conscious and are very interested in knowing how much they should gain, how much exercise they should be doing, and what to eat."
Depending on prepregnancy BMI to target both underweight and overweight/obese women	9 (50)	Women with an elevated BMI Would probably focus on the extremes Underweight, undernourished patients, and overweight patients More concentration on those in the extremes than those in the middle Patients that begin pregnancy with a BMI over 30 Should be tailored to have a normal track and a high risk track	"Well I mean definitely the elevated BMIs because we all know they have pregnancy problems so if you could lower their problems."
Patients with previous or current high GWG	8 (44)	Women who gain too much weight during the pregnancy Women who gained a lot of weight in the Past Would use with patients who are gaining too much weight, but most women know if they're gaining too much weight and doctors dread being the one to say something to them Would target those gaining too much weight, specifically those having problems controlling blood sugar Reinforce with patients who are gaining too much weight	"And usually we would have a record of what their previous pregnancies were, if they had gained too much weight in a previous pregnancy."

Question 5: "What do you perceive are the possible barriers that you or other OBGYN physicians may encounter with integrating e-health technology into the clinic?"

Higher Order Theme	N (%) Theme In Responses	Lower Order Themes	Example Quotation
Time	14 (78)	No significant amount of time to explain	"It is going to be more time

Higher Order Theme	N (%) Theme In Responses	Lower Order Themes	Example Quotation
		things	consuming, it's going to be one additional thing that we have to talk to our patients about in an already short, 15 minute time slot. I also think about trying to work it into the conversation and not take away from other important issues we need to discuss with the patient."
		If it's going to take more time because physicians are already crunched for time OB patients only get 10–20 minutes	
		If it's one more thing physicians have to talk about to patients in an already short time slot and it may take away from other important issues that need to be discussed	
Facilitators to prevent there from being barriers	8 (44)	Needs to be user friendly, simple, and easy	"It's got to be incredibly reliable. No down time. It has to require a minimal amount of key strokes or anything on my part. You know the major problem with EMR's today is that physicians have become the world's highest data paid entry clerks."
		User friendly, no training is involved	
		Incredibly reliable	
		Patient driven	
		Requires minimal key strokes or anything on part of the physician	
		Very easy to use because if it is complicated and takes more than a couple clicks, it won't get integrated	
		If insurance would cover the cost/technology/apps are free	
		Could be engineered to be no more than a minute of additional time	
		Linked to electronic medical records	
		Easy literacy level	
		Can't be ineffective	
		Needs to be well oiled, simple, and fast	
Cost	11 (61)	If the technology costs money	"And just the monetary or financial barriers to actually getting the kiosk or the program or that kind of thing."
		Would need to buy extra computers/equipment	
		Cost is the biggest barrier from administration	
		New technology that costs money that hasn't been proven to work yet is a barrier	
		Insurers may not pay for it	

Question 6: "What do you perceive are the possible barriers that your prenatal patients may encounter with receiving healthcare information/counseling that is delivered with technology?"

Higher Order Theme	N (%) Theme In Responses	Lower Order Themes	Example Quotation
User acceptability	9 (50)	Literacy	"And then also their literacy level and education level I think would be two of the patient barriers that I can just think of right off the bat."
		Patients misinterpret or get confused by information and incorrect information gets to the patients	
		Level of comfort with technology	
		Level of understanding of content	
		Cultural issues – what they hear from their mother, grandmother, church members will trump over stuff they get from technology	
		Getting so much information at appointment (first nurse visit) already – too much information to add technology	
		Hard for patients to talk about nutrition or	

Patient engagement, interest, and motivation	12 67)	consider it when sick/nauseous in early pregnancy Weight is a sensitive issue Language barrier Lack of care about health Engagement/interest/motivation of patient to use it Anxiety for patient Game like function to motivate patients to use it Lack of motivation to follow through and	"I don't think it would be something that all our patients would be motivated to use; I mean some aren't even motivated to come. And we have a pretty good population compared to most places."
Access	13 (72)	Access to technology Most patients even on medical assistance have smartphones, but not all patients may have access or can afford computers or iPads Data plan would be needed if on a smartphone Maintenance of technology in the office – who updates it, fixes it if it isn't working	"I think more and more are having access to it, but I still have patients when I ask them that say no, they don't have a computer, or no they don't have an iPhone, or an iPad, or whatever. I think it is getting better that more people do have access to it, but not everyone does."

*Note. SSI/FG = Semi Structured Interview/Focus Groups; Higher Order themes that emerged in < 10% of the SSI/FG's were excluded from the table. The first study author can be contacted to obtain the full results.