Nursing and Health Studies Faculty Publications

Marion Peckham Egan School of Nursing and Health Studies

3-2021

"Alexa, Am I Pregnant?": A Content Analysis of a Virtual Assistant's Responses to Prenatal Health Questions During the COVID-19 Pandemic

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Peer Reviewed

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35   **"Alexa, Am I Pregnant?": A Content Analysis of a Virtual Assistant's Responses To**

36   **Prenatal Health Questions During the COVID-19 Pandemic**

37   Abstract

38   Objective: To elucidate whether Amazon's virtual assistant, Alexa, provides evidence-based

39   support as a supplement to provider-facilitated prenatal care, during the COVID-19 pandemic.

40   Methods: Using a conceptual content analysis approach, a query of 40 questions, relating to all

41   phases of pregnancy, was collected from Alexa by two independent investigators, using two

42   unique devices, over a one-week period between May 20, 2020 and May 27, 2020. Alexa's

43   responses were matched to the evidence-based content from the American College of

44   Obstetricians and Gynecologists (ACOG) and reviewed by a Certified Nurse Midwife for

45   completeness and currency.

46   Results: Of the 40 questions asked of Alexa, it was unable to answer 14 questions (35%). A total

47   of 21 out of the 40 responses (52%) were not evidence-based and three COVID-specific

48   questions (about 1%) were answered incorrectly or insufficiently. Four questions (10%) were

49   answered accurately.

50   Conclusion: Alexa was largely unable to provide evidence-based answers to commonly asked

51   pregnancy questions and, in many cases, supplied inaccurate, incomplete, or completely

52   unrelated answers that could further confuse health consumers.

53   Practice Implications: Ensuring that mobile health (mhealth) tools, such as Amazon Alexa, are

54   evidence-based and credible in answering common prenatal questions has important implications

55   for this pandemic and future consumer needs.

56   *Keywords:* Women's health, health promotion, maternal/infant health, reproductive health,

57   technology, prenatal care

1. Introduction

Frequent prenatal visits are a hallmark of pregnancy care. The Office on Women's Health suggests that pregnant individuals attend approximately 14 prenatal appointments during a 40-week pregnancy [1]. The Novel Coronavirus SARS CoV-2 (COVID-19) pandemic transformed prenatal care in the United States in an effort to decrease patient exposure. A modified format for prenatal visits was documented at a COVID-19 epicenter, New York City. These guidelines suggest one, in-person, prenatal visit at weeks' 11-13, 18-22, 27-28, 36, 39, and 40, with an additional seven to eight telehealth visits, spaced throughout the pregnancy [2]. An alternative paradigm, from the University of Michigan, suggests a total of four in-person visits, one ultrasound, and four virtual visits [3]. Often, pregnant patients are asked to purchase a blood pressure cuff for home monitoring [4]. In fact, similar models of a reduced prenatal care schedule, or a schedule with virtual, phone, and online support, have been shown to have comparable quality of care, versus traditional care, in a recent randomized controlled trial at the Mayo Clinic [5,6].

Women are increasingly utilizing mobile health (mhealth) for prenatal health information. The widespread use of smartphones [7] has led to a research-based call for the inclusion of such technologies [8]. These mhealth tools may be a suitable adjunct to formal care if they provide high quality, evidence-based information such as vitamin consumption, nutrition tips, and sleep information. A study of 193 women seeking prenatal care found that the majority of respondents utilized apps for their convenience and accessibility [9]. First-time mothers were the most frequent health app users, however, users expressed concern over the credibility of the apps [9]. A meta-analysis of 15 randomized controlled trials, related to prenatal information on mobile apps, found that these technologies had the potential to promote maternal well-being in a

81   variety of areas, including preparedness and knowledge, but the credibility of included content

82   could not be confirmed [10].

83   Virtual assistants, like Amazon Alexa and Google Home, exist in the homes of

84   approximately 50 million Americans [11]. A survey of over 1,000 virtual assistant users found

85   that the majority of respondents used their virtual assistant multiple times per day [11].

86   Although not specifically related to health, almost two-thirds of users used the device to seek

87   information and females made up a higher percentage of users [11]. It is critical to understand

88   the role and reliability of mhealth in prenatal care, especially with the recent changes to health

89   care delivery. The goal of this research is to elucidate whether Amazon's virtual assistant,

90   Alexa, provides evidence-based information in response to common pregnancy questions.

91   **2. Methods**

92   A list of frequently asked prenatal questions were curated from the American College of

93   Obstetricians and Gynecologists' (ACOG) Frequently Asked Questions webpage [12] and

94   reviewed for relevance by a Certified Nurse Midwife (CNM). Three COVID-specific questions

95   were added to address the current health crisis. Forty questions were queried of Alexa including:

96   confirming a pregnancy, identifying warning signs, and recognizing the signs of labor (see

97   Appendix). The investigators, using two unique devices, independently asked Alexa the same

98   set of questions and recorded the responses. In addition to the responses, unsolicited data

99   sources provided by Alexa were recorded. The query took place during the COVID-19

100   pandemic, over a one-week period between May 20, 2020 and May 27, 2020. Alexa's responses

101   were transcribed verbatim and their accuracy confirmed using the associated Alexa app, which

102   transcribes the responses and sources. Alexa was not provided prompts or contextual

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103 information. Alexa's responses were compared to ACOG's prenatal guidelines to verify accuracy

104 and completeness by two independent coders, including a CNM, a content expert [12].

105 **3. Results**

106   Conceptual content analysis was conducted employing explicit coding [13] and

107 dichotomous categorization of all 40 responses for accuracy (accurate or inaccurate) and

108 completeness (complete or incomplete). As both coders compared Alexa's responses with

109 ACOG's evidence-based information, there was complete agreement between the coders. Alexa

110 supplied identical responses to 36 out of the 40 questions (90%) (see Appendix). Overall, four

111 responses (10%) were accurate relating to: changing cat litter, caffeine consumption,

112 preeclampsia, and foods to avoid. Alexa was unable to answer 14 questions (35%) responding,

113 "Sorry, I don't know that one" or "Hmm.. I don't know that." The unanswered questions

114 included, "How do I know if I'm in labor?" and "Is it safe to smoke while pregnant?"

115   A total of 21 out of 40 responses (52%) were not accurate based on current evidence. An

116 additional response was deemed incomplete, only listing some of the relevant nutrients needed in

117 prenatal vitamins. Inaccurate answers were tangentially related to the question, such as when

118 asked whether it is safe to drink alcohol during pregnancy, Alexa replied, "Non-alcoholic beer

119 has not been proven safe for consumption during pregnancy." For six questions (15%) in the

120 inaccurate category, the responses were not relevant to the question. For example, when asked

121 about the safety hot tub use, Alexa replied, "You can get pregnant when having sex in a hot tub,

122 bath tub, or hot springs with high water temperature." When asked which vaccines were safe

123 during pregnancy, Alexa replied, "You can't get the vaccine while you're pregnant, and

124 contracting the measles during your pregnancy can be very dangerous for your baby."

125   The three COVID-specific questions were answered incorrectly or insufficiently. When

126   Alexa was asked about the main symptoms of COVID-19 in pregnancy, it reported information

127   on cholestasis, "intense itching without a rash is the main symptom of intrahepatic cholestasis…"

128   When asked, "Should I go to my OB appointment during the COVID-19 pandemic?" and

129   "Should I give birth outside of a hospital during the COVID-19 pandemic?," Alexa replied with

130   information about when and where COVID-19 was identified, how it spreads and information on

131   donating to those affected. Alexa's answers to one COVID-19 question varied between the

132   researchers. For one researcher, Alexa replied to the question about seeking in-person OB care

133   during the pandemic, "Sorry, I don't know that one," but for the other researcher, it provided an

134   identical answer to each of the aforementioned COVID-19 questions (see Appendix).

135   Alexa often noted its source in the response (i.e., "According to the Mayo Clinic" or

136   "Here is something I found on Reference.com"), if a reference was not provided in the response,

137   the Alexa app supplied the sources. The most frequently reported source was Reference.com

138   (n=9), which is not a reliable source of maternal health information. Alexa also referred to

139   Wikipedia or Wikihow (n=4), VeryWellFamily (n=3), Answers.com (n=1), BabyCenter (n=1), or

140   BabyMed (n=1). On four occasions, the app offered, "This information is not medical advice.

141   Consult a healthcare professional if you have a medical problem." This response was supplied to

142   questions related to vaginal bleeding, heartburn, symptoms of preeclampsia, and regularity of

143   fetal movement (see Appendix).

144   **4. Discussion and Conclusion**

145   4.1 Discussion

146   Women are increasingly using mhealth and virtual tools for information [14]. Recent

147   studies indicate a sense of empowerment and control over one's health through the use of

148 mhealth technology [8]. Text messaging programs, such as text4baby, were designed to provide

149 women with accurate prenatal health information in a readily available mhealth platform [15].

150 One randomized controlled trial of text4baby found it helpful in reducing alcohol consumption

151 during pregnancy [15].

152 Overall, Alexa was unable to provide answers to commonly asked prenatal questions and

153 often supplied inaccurate, incomplete, or completely unrelated answers that could further

154 confuse health consumers. Many of these answers can readily be found on evidence-based

155 websites (i.e. ACOG and womenshealth.gov), but very few evidence-based sources were

156 consulted by Alexa. In contrast, other mhealth tools, like the "What to Expect" mobile app

157 includes answers to questions curated by health professionals.

158 In this digital era, when many people rely on virtual assistants to supply basic, yet

159 specific, information, it is surprising that Alexa does not have the ability to search reputable sites

160 for information related to pregnancy. It is important for health care providers to point out

161 mhealth limitations and offer reliable sources for information. Further, healthcare providers must

162 advocate for virtual platforms to improve the accuracy and reliability of the information

163 provided.

164 4.2 Conclusion

165 The pandemic related disruption in prenatal care demonstrates the opportunity to utilize

166 mhealth to support patients. Public reliance on technology and mhealth tools is well established.

167 Ensuring these tools are credible for answering frequently asked prenatal questions has important

168 implications for this pandemic and future patient care needs.

169 4.3 Practice Implications

170   Consumer use of inaccurate virtual assistants to obtain health care information can create

171 false knowledge and subsequent anxiety about what they have learned and how to proceed. On

172 the contrary, an astute patient consumer, using reliable sources, can productively advocate for

173 themselves and their family. It is imperative that media sources provide evidence-based

174 information and that health care providers inform their patients of accurate, reliable sources [16].

175 Virtual assistants that render evidence-based information can improve the health outcomes.

176 Future research on the reliability of information offered by virtual assistants is warranted.

177 Likewise, the exploration of consumer confidence of and reliance on health information from

178 virtual assistants, like Alexa, is needed.

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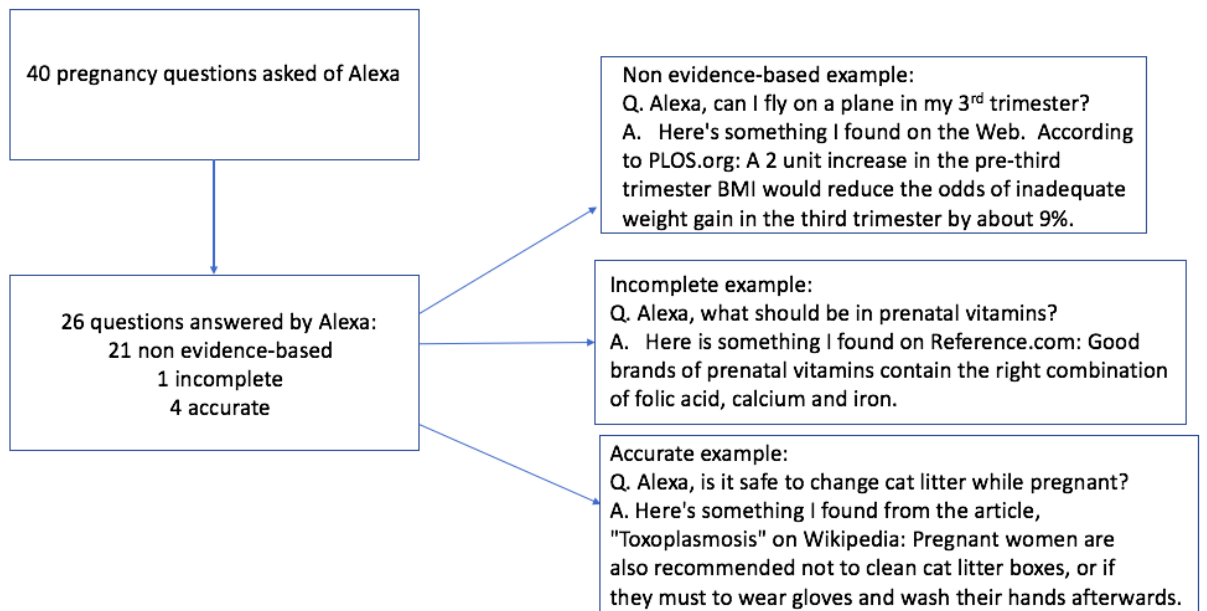
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246   *Figure 1*. Example Alexa responses to common prenatal queries

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Appendix. Complete list of Alexa queries (N=40)

Pregnancy Question
1. How do I know if I'm pregnant?
2. When should I start taking prenatal vitamins?[a]
3. What should be in prenatal vitamins?
4. What should I do if my home pregnancy test is positive?
5. When should I seek prenatal care?
6. Where should I seek prenatal care?
7. Is it safe to drink alcohol in pregnancy?
8. How much alcohol is safe to drink in pregnancy?
9. How much caffeine can I have while pregnant?[b]
10. What medicines can I take for pain while pregnant?
11. Is it safe to have sex while pregnant?
12. Is it safe to exercise while pregnant?
13. Is bleeding during pregnancy normal?
14. How do I relieve constipation during pregnancy?
15. How do I relieve heartburn during pregnancy?[c]
16. When will morning sickness go away?
17. I'm pregnant and vomiting, what should I do?
18. I'm pregnant and dizzy, what should I do?
19. When should I feel the baby start kicking in pregnancy?
20. How often should I feel the baby move in pregnancy?
21. What foods should I avoid while pregnant?
22. What is the best position to sleep in while pregnant?
23. Is it safe to go in a hot tub while pregnant?
24. What activities should I avoid while pregnant?
25. Is it safe to smoke while pregnant?
26. Is it safe to dye my hair while pregnant?

27. Is it safe to paint while pregnant?
28. Is it safe to change cat litter while pregnant?
29. What vaccines should I get while pregnant?
30. Can I fly on a plane in my third trimester?
31. When should I get an ultrasound in pregnancy?
32. How do I know if I'm in labor?
33. How do I know if my water broke?
34. How far apart should my contractions be when I go to the hospital?
35. What are signs of anemia in pregnancy?
36. What are signs of preeclampsia?
37. Is it normal to have swollen feet during your third trimester?
38. What are symptoms of COVID-19 in pregnancy?
39. Should I go to my OB appointment during the COVID-19 pandemic?
40. Should I give birth outside of a hospital during the COVID-19 pandemic?[d]

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253 [a]Alexa responded to this query with a musical album for one researcher. For the second
254 researcher, a more relevant response was provided, "Here's something I found on Reference.cm:
255 the best time to take vitamins is in the morning, according to Mother Nature Network. Upon
256 waking from sleep, the body needs nutrients for energy to start the activities of the day. Vitamin
257 supplements are synthetic substances that break down and are absorbed into the body best with
258 food." The latter, more relevant answer, was coded.
259 [b]Alexa responded to one researcher with, "According to First Databank: Using caffeine while
260 pregnant may have risks. For medical advice, always consult your healthcare professional."
261 Alexa responded to the second researcher with, "Here is something I found from the article
262 "Caffeine" on Wikipedia: The UK Food Standards Agency has recommended that pregnant
263 women should limit their caffeine intake, out of prudence, to less than 200 mg of caffeine a day
264 the equivalent of two cups of instant coffee, or one and a half to two cups of fresh coffee." The
265 latter, more detailed reply, was coded.
266 [c]For one researcher Alexa replied, "Here's something I found on howtostuff.com: In a similar
267 manner; reflexology can speed up labor, but it's also helpful for relieving pregnancy symptoms
268 like heartburn. This information is not medical advice. Consult a healthcare professional if you
269 have a medical problem." For the other researcher, Alexa replied, "Here's something I found on
270 Wikihow: Step 1-Avoid foods that commonly trigger heartburn, Step 2-Eat smaller meals, Step
271 3-Don't eat too close to bedtime, Step 4-Avoid beverages that cause gastrointestinal distress."
272 The latter, more relevant reply, was coded.
273 [d]For one researcher, Alexa replied, "Sorry, I don't know that one" and for the other researcher,
274 an identical response to the previous COVID question (question #39) was supplied. The latter,
275 complete answer, was coded.

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