Evaluating the use of chatbot during pregnancy: A usability study

João Luis Zeni Montenegro, Cristiano André da Costa *, Luisa Plácido Janssen

Software Innovation Laboratory – SOFTWARELAB, Programa de Pós-Graduação em Computação Aplicada, Universidade do Vale do Rio dos Sinos, Av. Unisinos 950, 93022-750 São Leopoldo, RS, Brazil

ARTICLE INFO

ABSTRACT

Reduced anxiety is critical for the baby's health during the thousand days of pregnancy. In this age of false information, unreliable data can be harmful to pregnant women during prenatal and postnatal periods. This work presents the findings of a pilot study that investigated the use of chatbots to assist pregnant women during the prenatal and postnatal periods in Brazil. We conducted experiments with healthcare professionals and pregnant women, using the parallel convergent mixed method design to compare the perceptions of the two groups. We applied a quantitative/qualitative study using data collection tools available via the internet. Before responding to the survey instrument, both groups spent seven days interacting with the chatbot. Two doctors validated the questionnaires, and we used a previously validated questionnaire for pregnant women. Seven physicians' and thirteen pregnant women who met the search criteria participated in the study. Pregnant women believe that interacting with the chatbot educated them and, their physicians will approve of their use. The most significant and positive construct was related to the chatbot's performance expectation ([Mean 4.61][SD 0.74]). The construct that had the least positive influence on pregnant women was Facilitating Conditions ([Mean 3.30],[SD 1.24]). Pregnant women, according to physicians, benefit from clear language and comprehensive information in a variety of ways. Finally, it was established that the presented agent is viable and beneficial for pregnant women and healthcare providers. We intend to focus more on Natural Language Processing (NLP) techniques to improve the chatbot conversation aspects in future studies.

1. Introduction

Healthcare interventions require a high level of interaction of users to build engagement. Health behavioral change, such as walking or smoking cessation, may take months or years of continuing education to succeed, even when the behaviors involved are relatively simple Minian et al. [1]. Agents can contribute to improving the quality of life and psychological well-being [2].

However, some interventions need not only sustained effort over time but also the use of a range of counseling and training techniques, media, and new methods Wang et al. [3]. In this sense, chatbots can act in different healthcare situations. For medical students, agents can train decision-making skills regarding thromboembolism, using natural language processing techniques, and machine learning for interactions Dolianiti et al. [4].

Adults with attention deficit disorders are on the rise, necessitating prompt diagnosis and treatment. According to [5], a chatbot intervention may treat symptoms of attention deficit disorder. Growing patient demand has put primary care nurses under a lot of stress. The chatbot can help nurses and patients by offering vetted, evidence-based content to aid care management.

In [6], describes the development process of a BOTCURATIVO chatbot aimed at assisting non-specialists in treatment by providing a step-by-step guide to wound dressing recommendations for each type of injury. Vaccine information such as HPV (human papillomavirus) is delivered through a conversational agent guided by an OZ Wizard protocol [7]. To promote a healthy lifestyle CoachAI engages its users in health-related activities via a conversation medium. The method employs a clustering algorithm to assist physicians' in assigning activities to patients and grouping patients together [8].

Several types of research in the field of obstetric care were conducted using conversational agents for education support [9]. Many of these studies have explored the chatbot's use as a health tool through validations in clinical trials. A Q&A[1] knowledge database-based chatbot (Dr. Joy) was developed and tested for perinatal women, with a focus on obstetric and mental health care, using a text-mining technique and contextual usability testing (UT) [9].

Breastfeeding promotion is an example of a healthy habit that necessitates the application of multifaceted longitudinal technology. Newborn intervention should begin with providing pregnant women with information on the benefits of breastfeeding, encouraging them

---

* Corresponding author.
E-mail addresses: joaomontenegro18@edu.unisinos.br (J.L.Z. Montenegro), cac@unisinos.br (C.A. da Costa), janssen0204@edu.unisinos.br (L.P. Janssen).
[1] Question-Answering.

to start immediately, and ensuring that they have access to all of the information they will need. Although mothers are generally well-informed about breastfeeding shortly after birth, there are times when mothers must be aware of common problems, as well as the option to contact a breastfeeding consultant [10].

Pregnant women are among the most vulnerable patients since they are more susceptible to infections and have limited mobility owing to their medical condition. Furthermore, preventive measures such as social isolation and lockdown have hampered their access to healthcare. In [11] study covers these difficulties in a prototype chatbot application that offers antenatal care and support to pregnant women from the comfort of their own homes.

The chatbot is employed to combat nutritional disinformation in the study [12]. Nutripedia is a tool for providing knowledge and instruction on appropriate nutrition for women and babies during pregnancy and the early years of life. Nutripedia provides users with evidence-based scientific information in an easy-to-access format via a website, a social media page, and a personalized advisory app called "Nutripedia Chatbot". We conducted a cross-sectional study using a mixed methodology. The study entails the development of dialogue settings and the chatbot prototype. A structured questionnaire is used to assess the respondent's level of agreement using the Likert Scale and analyze the application's use path through its database [13].

In the study of [14], the pregnant teenager's nutritional status was surveyed to be 37.8 percent underweight, 46.9 percent normal weight, 12.1 percent overweight, and 3.3 percent obese in 2008. The study's most recent findings indicate an increasing trend in the increasing prevalence of overweight adolescent pregnant women in Brazil and its regions, consistent with the global pattern observed in children, adolescents, and adults. Another gap that we identified was in assessment constructs. Many studies use a variety of theoretical models to assess the acceptability and usability of the conversational agent in health [15,16]. The UTAUT2[2] Unified Theory of Acceptance and Use of Technology 2 (UTAUT2) model was cited as the most appropriate theoretical lens for modeling the adoption of health issues [17]. In this context, the main contributions of the article are:

- Describe the development of a chatbot for pregnant women's health literacy over a thousand days.
- Validate the use of chatbots for retrieval information purposes with physicians and pregnant women.
- Conducting a mixed analysis of the two groups' perceptions.

We proposed a pilot study to evaluate the use of a chatbot tool for prenatal and postnatal monitoring. We performed a qualitative survey of physicians and a quantitative survey of pregnant women, analyzing and comparing their responses to seek confirmation, distortions, and fresh insights. We proposed validations for usability, trust, hedonism, intention to use, ease of use, anxiety, and medical influence through the UTAUT2 model. We think that the research can give us new ideas about how chatbots might be used in this situation.

The following sections comprise the article: Materials and Methods 3 show details of the proposed architecture and the experiment methodology, Results 4 shows the study's outcomes, Discussion 5 addresses the main insights generated from the obtained results, and the section Conclusion 6 addresses the main work considerations.

2. Related works

We analyze different studies involving conversational agents for Health literacy on pregnancy context. Health literacy it is a similar concept to pregnant education, and includes numeracy, oral literacy, print literacy, and cultural and conceptual awareness and is defined as the "grade to which people can receive, process and understand the

basic health information and resources they need to make effective health decisions" [18]. Studies involving this topic commonly explored evaluations with physicians and patients [19–21]. In this section, we seek studies that focus on health literacy/education and with applied experiments with health professionals or pregnant women.

Conversational agents have been used to encourage consultations on preconception care. Preconception care was identified as an intervention to minimize perinatal mortality and morbidity [22]. However, preconception care is low due to a low level of awareness of the availability and benefits of the service. The study focused on intervention analysis with a group of respondents aged 18 to 41 years in 14 Dutch municipalities with relatively high perinatal morbidity and mortality rates. The strategy contributed to 587 preconception consultation requests [23].

The use of conversational agents in preconception of health is also explored in [15]. Where authors evaluate approaches in primary care settings. The objective of the study was, among other things, to assess and evaluate the impact of the preconception health intervention on knowledge and behavior. Women of all ages can benefit from preconception care, but adolescents and young adults in particular may benefit from it to ensure the health of their unborn children and themselves. More research is needed to determine whether reducing preconception risks affects outcomes such as preterm birth [24].

It has also shown benefit for women's midwifery care and mental health studies. According to scoping review conducted in [25], chatbots are improving the access to mental health services over the last decade. When it comes to implementing chatbot technology for healthcare, patient perception is favorable.

A contextual chatbot was built in [9] using a text-mining technique to provide instant messages on these topics. The most perceived benefits in this study were related to the user's intention to seek information about their health and its correlation with improving their lives [9]. Another type of information that is frequently sought after during pregnancy is information about illnesses that occur during the period. Discover what information users seek in a health chatbot that provides information on gestational diabetes mellitus and the effects it can cause in actions are studied in [26]. The same concerns are shared in the study by [27], in which the pregnant woman's content absorption and the quality of information through the Alexa mechanism are evaluated.

In Brazilian territory experiments were conducted through the use of a chatbot for guidance related to breastfeeding. Topics related to cleaning the umbilical stump and bathing, breastfeeding details, such as expressing breast milk, and explanations about the different types of nipple are factors that the user wants to know [13].

Physical activities have also been investigated. The proof of concept study in [28] sought to assess the feasibility (recruitment and retention) and preliminary efficacy of physical activity and Mediterranean-style dietary intervention delivered by an artificially intelligent virtual health coach.

Recent literature on experiments with conversational agents in the context of pregnant women reveals a wide range of topics addressed, strategies employed, and research conducted. We believe there is still a lack of research in Brazil on the use of conversational agents for reliable info delivery. However, gaps in studies that specifically addressed content related to the baby's thousand days, one of the most critical times for the child's health, were identified. As a result, our study fills this gap by attempting to make new contributions regarding Brazilian doctors' and pregnant women's perceptions of the use of this type of tool in Brazil.

3. Materials and methods

3.1. Ethical issues

The National Health Council granted protocol approval for this study (No 3.599.678) due it involves a low-risk scenario for patients. Before administering the questionnaire, we explained the research protocol to patients to obtain their consent.

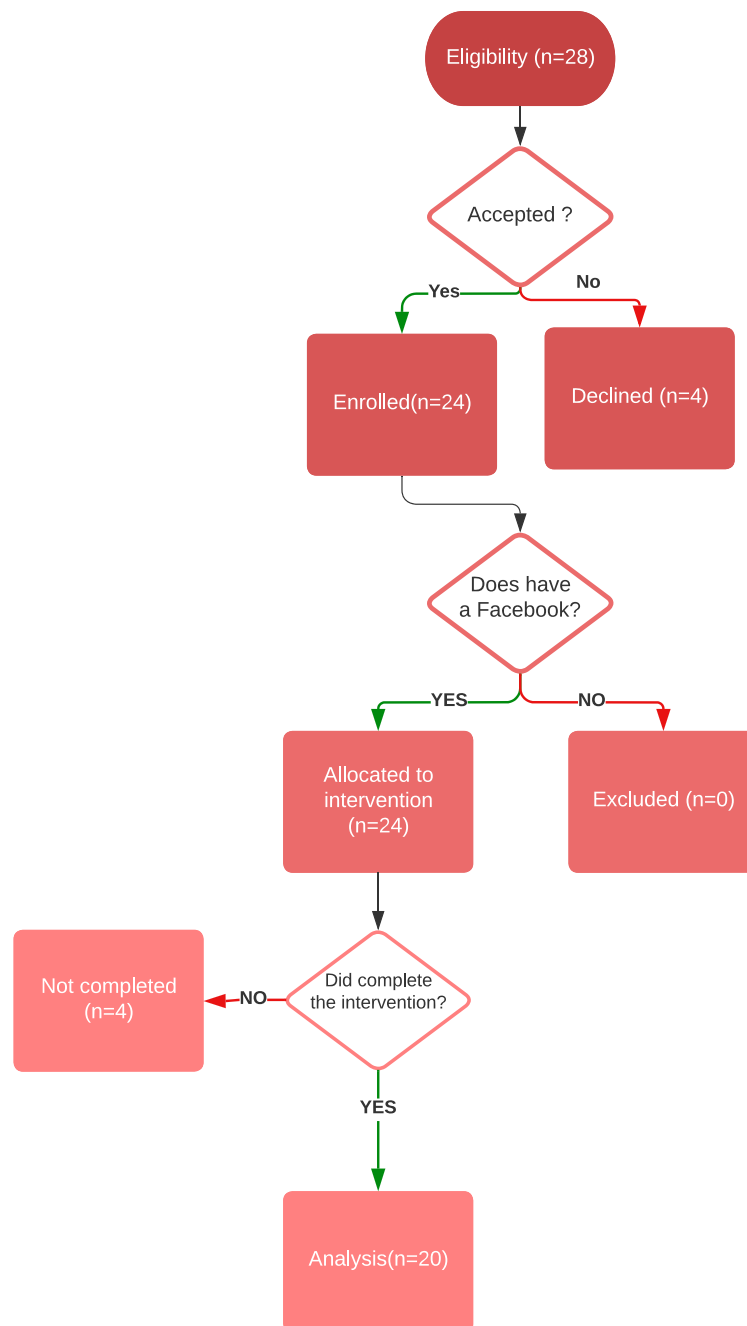[2] Unified Theory of Acceptance and Use of Technology 2.

Fig. 1. CONSORT: checklist template for the clinical trial.

3.2. Participants and evaluation

We conducted a randomized trial using the Consolidating Standards of Reporting Trials (CONSORT) guideline. The CONSORT is a statement that includes ten recommendations for conducting clinical studies. The CONSORT criteria are well-known as a gold standard for this type of research. The CONSORT recommendations applied are shown in Fig. 1.

The study began in October and ended in late November 2021. We chose this period in order to capture group perceptions within the timeline permitted by the ethics committee. Due to the inability to meet the study's eligibility requirements, 24 of the 28 participants chosen for the study were excluded. We discarded four more questionnaires due to inadequacy.

This study used qualitative and quantitative instruments to collect information about physicians and patients. One of our objectives was

to validate perceptions based on age, and thus both questionnaires included an age variable. The study divided pregnant women and physician is into two groups. Pregnant women in the prenatal or postnatal stages, as well as physicians' from maternal care units, are recruited. The pregnant woman needed to have a Facebook account to participate in the studies. This tool made it easier to use the conversational agent to interact with pregnant women.

The study did not exclude any health professionals. We recruited seven physicians and thirteen pregnant women in total. Before completing the questionnaire, participants interacted with the chatbot for seven days. The participants were reminded following the period to utilize the tool and complete the questionnaire.

We opted for a reduced sample because our objective with this first study was to capture perceptions related to the two groups without failing to observe contributions and reported failures about the

Table 1
Questionnaire developed for qualitative assessment by physicians.

N	Question
1	What is your opinion about chatbot topics?
2	What is your opinion about the language type used?
3	In your opinion, is the information correct and reliable?
4	Do you consider it easy to interact with this tool?
5	Do you have any suggestions for future improvements?

Table 2
Questionnaire for pregnant women Intervention.

N	Performance Expectancy
Q1	I find the knowledge is helpful and the chatbot enables me to understand health better.
Q2	Using chatbots improves the knowledge of my health.
	Effort Expectancy
Q3	It is easy for me to improve my health knowledge when using the chatbot.
Q4	I considered it easy to improve health knowledge from a chatbot.
	Attitude Toward Improving Health
Q5	Improving health via chatbot is fun
Q6	Using a chatbot makes the conversation more interesting.
	Medical Influence
Q7	I believe that the use of a chatbot can support my doctor.
Q8	I believe that my doctor would approve the chatbot's use.
	Facilitating Conditions
Q9	I have the resources necessary to use the chatbot.
Q10	I know what is necessary to communicate with the chatbot
	Self-Efficacy
Q11	I could use a chatbot if I have much time
Q12	I could use a chatbot if I find helpful information
	Anxiety
Q13	I feel anxious about getting information via chatbot.
Q14	Using chatbot is intimidating for me
	Trust
Q15	I think that I trust in this technology
Q16	I think that this technology is designed for my needs

chatbot. Numerous participants could contribute to neglecting some improvements and biasing our quantitative analysis in case of many outliers.

The study looked at a pilot version of a text-based chatbot designed to help pregnant women. We conduct structured and individual interviews with physicians to obtain information about the chatbot's content, language type, facility, and trust. Understanding the user experience of chatbots for customer service is essential to realizing the potential of this technology. Such chatbots are typically designed for efficient and effective interactions, accentuating pragmatic quality, and there is a need to understand how to make these more pleasant and engaging, strengthening hedonic quality. One promising approach is to design for more humanlike chatbot interactions, that is, interactions resembling those of skilled customer service personnel [29]. Also, we ask for recommendations for improving the chatbot's performance for the group of physicians'. The questionnaire presented is in Table 1.

Pregnant women were applied to the quantitative methodology. Both methodologies aimed to collect opinions and perceptions about the chatbot. To assess health literacy in pregnant women, we used the UTAUT2 scale of [30], which has also been used in other studies [17,31,32]. We summarized this scale to reduce the questionnaire's response time, redesigning several items and adding others. To do so, we removed several items, leaving only those that were most relevant to this study. Table 2 depicts the final questionnaire.

The data was collected through an online form, a link that participants could access and evaluate via email, and the chatbot structure

via a button. We used a structured questionnaire sent via WhatsApp[3] for qualitative data collection, receiving responses from physicians' asynchronously via text and audio.

3.3. Measures and hypothesis

We describe the original and modified constructs that support UTAUT2, as well as the hypotheses that can be derived from them, in this section. The studies listed below serve as the foundation for our model [17,30–34] introducing a new change in the construct from social and medical influence.

Performance Expectancy (PE) is defined as "the degree to which an individual believes that employing the system will assist him or her in achieving advances in job/task performance." Hypothesis 1: We believe that PE positively affects pregnant women's behavioral intention to use chatbots.

Effort Expectancy (EE): is described as "the degree of ease connected with the use of the system." Hypothesis 2: Effort Expectancy has a beneficial effect on pregnant women's behavioral intention to use chatbots.

Facilitating Condition (FC): is defined as "the degree to which the individual believes that an organizational and technical infrastructure exists to support the system's use. Hypothesis 3: Pregnant women's behavioral intention to use chatbots is positively influenced by the Facilitating Conditions.

Medical Influence (SI): is defined as "the degree to which an individual perceives that their physician believes they should use the new system". Hypothesis 4: Medical influence positively affects pregnant women's behavioral intention to use chatbots.

Attitude Toward Improving Health (AH): refers to "the fun or pleasure derived from using technology". Hypothesis 5: Attitude Toward Improving Health positively affects pregnant women's behavioral intention to use chatbots.

Self Efficacy (SE): refers to people's ability to self-serve with the tool". Hypothesis 6: Self Efficacy positively affects pregnant women's behavioral intention to use chatbots.

Anxiety (AX): is defined as "uncertainty or anxiety about the behavior and the seriousness of the potential consequences of the behavior." Hypothesis 7: Anxiety increases pregnant women's behavioral intention to use chatbots.

Trust (TR): individuals must trust technology in educational settings, even more so if responses are to be collected accurately and anonymously". Hypothesis 8: Trust positively affects pregnant women's behavioral intention to use chatbot's.

3.4. Intervention

The chatbot development used the DialogFlow tool, and is represented in Fig. 2. A researcher oversaw and assisted in the conversation's flow development and content selection. The topics were chosen based on their importance. We decided not to use information that could become dangerous for expectant mothers, making them anxious. Some topics such as complications information was not be used,due to the high potential for emotional damage they could cause. The selection of topics was made with the help of the participating medical researchers.

The design was based on both scenarios, whether the user was pregnant or not. At the end of each flow, there was an option to return to other flows and continue the interaction or end the conversation by providing feedback. The dialogues used rule-based and NLP strategies. We train the DialogFlow machine learning engine on a set of ten training phrases plus three entities to support the intention classification for navigation/interaction via questions. If a phrase was misunderstood, a fallback was activated to redirect the user to another flow or repeat the query.
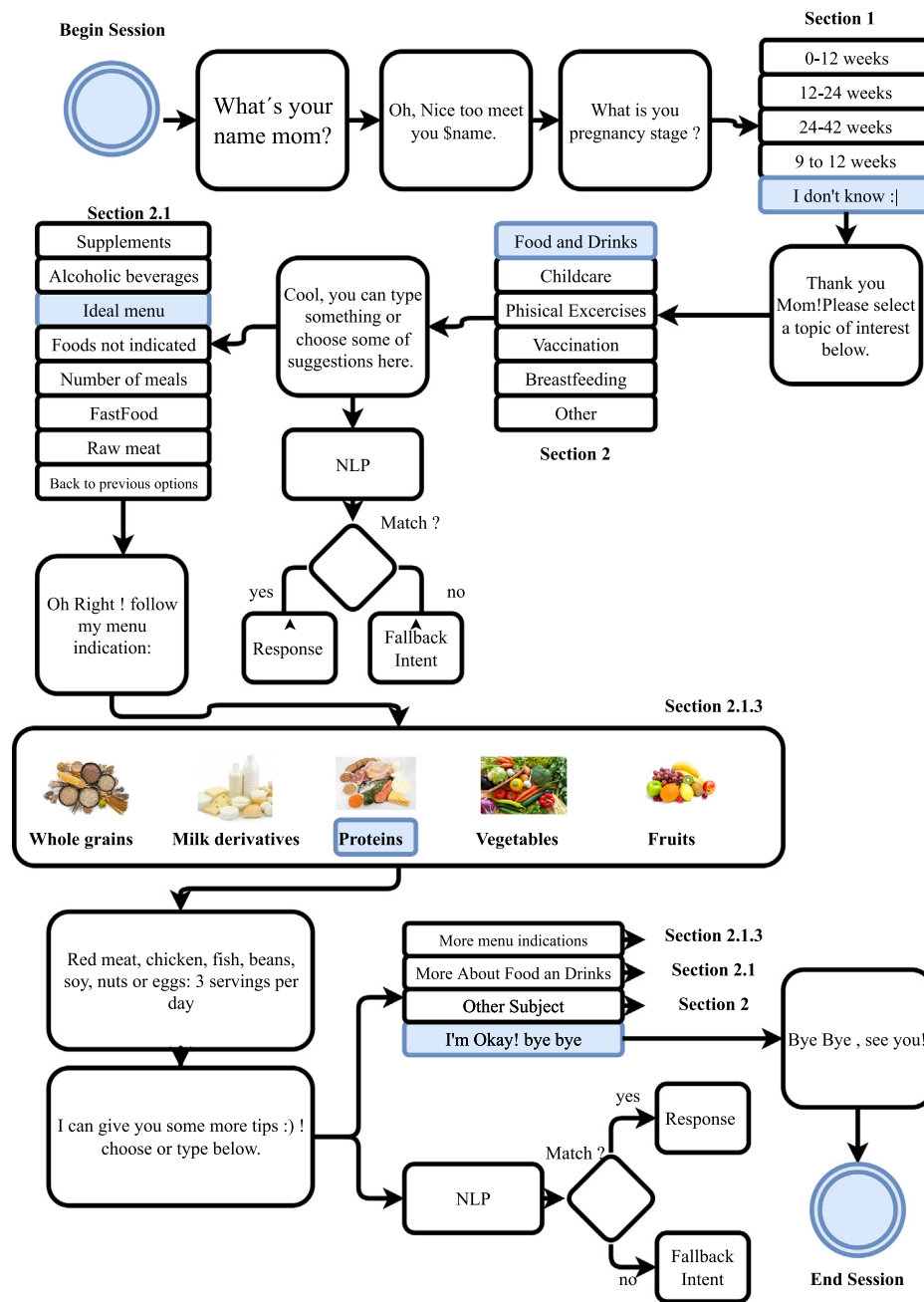

Fig. 2. Chatbot Maria design.

3.5. Data analysis

We propose a convergent parallel analysis based on quantitative and qualitative data. This design aims to provide equal weight to analysis when looking for patterns or contradictions in the data by comparing and contrasting the outcomes of both groups. We used mean and standard deviation to identify which components were most and least essential to respondents for quantitative evaluation of pregnant women. We transcribed the doctors' interviews to increase understanding of the outcomes, reviewing and summarizing significant points generated to record essential concepts from the conversations. The viewpoints of physicians' were expressed using literal citations.

4. Results

The average age of participants in this second study was less than 30 years. Pregnant women with an average age of 23 years and a low income answered the quantitative questionnaire. While the physicians' group was made up of newly trained physicians, residents, and specialists, all of whom were 28 years old.

Pregnant women were assessed using a questionnaire with a five-point Likert scale. The constructs are rated from 1 to 5 on a scale of 1 to 5. (1 = strongly disagree, 5 = strongly agree). Incompatibility with a pregnant woman's mobile phone was reported during the experiments, but it was solved using the desktop application. Fig. 3 describes the distribution of responses using the Likert scale. The pregnant majority of respondents have positive attitudes toward the chatbot, with more answers closed to 5 than 1.

Based on the data from the Likert scale, we grouped the items by construct to see which one stood out the most. Fig. 4 presents the results from the experiments carried out with patients. The bars in blue color indicate the mean, while the error bars (black) indicate the standard deviation for each questionnaire item. We found that, in general terms,
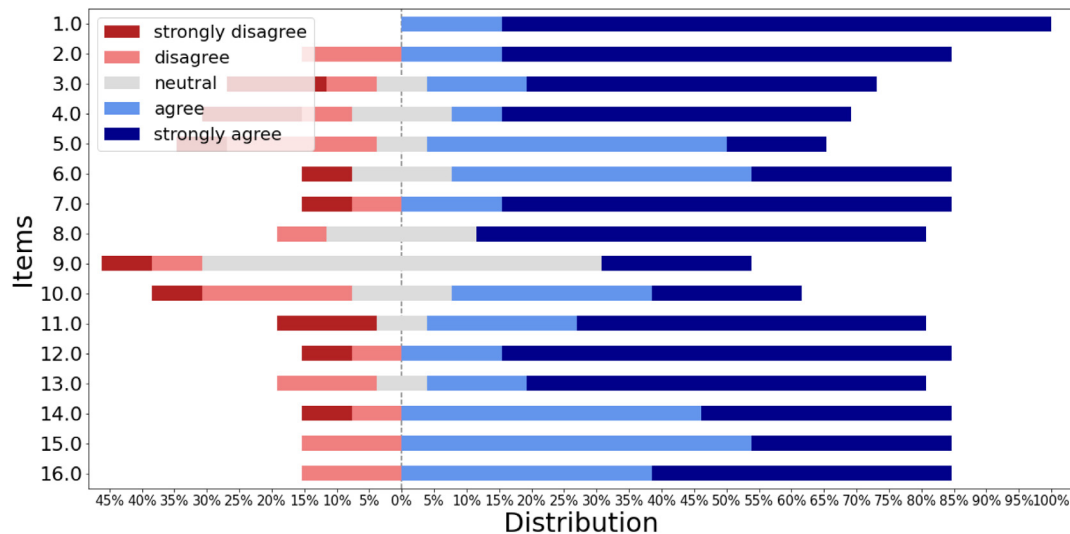
Fig. 3. Pregnant women's response distribution on a five-point Likert scale.

Table 3
Physician's perception of chatbot evaluation.

General consideration about the chatbot
1. "A great tool to help pregnant women and resolve doubts"
2. "Quick and simple mechanism of resolving issues"
3. "I thought it was complete and important for this period"
Language Perception's language
4. "Adequate and effective "
5. "Pretty easy to understand "
6. "Very good! Sympathy and simplicity promote proximity to the reader "
Content Perception's
7. "Not in the information, but in the functioning of the chat. I got stuck, without the chat moving forward... after a while it worked normally"
8. "Clear and lay language, easy to interpret and understand. I believe that topics can be divided by themes, not just diseases 1, diseases 2..."
Future directions for chatbot
9. "I suggest a better approach in the questions, so the person can better choose what they want to know, what is their doubt"
10. "Perhaps some notification/message recommending finding a doctor based on more serious situations/that may pose a risk to the pregnant woman depending on the topic of choice or doubt"
11. "Topics related to covid"
12. "Sexual relationship during pregnancy
13. "Approach a user profile in the father role. He also has doubts that he should participate in prenatal care, and the program could also involve him"

the results obtained support the use of the chatbot by pregnant users. The construct that had the highest average in this experiment was the Expectation of performance ([Mean 4.61][SD 0.74]), while the construct that obtained the lowest average was the Facilitating Conditions construct ([Mean 3.30],[SD 1.24]).

A qualitative questionnaire was used to discover the physicians' perceptions. The goal was to determine physicians' attitudes toward suggestions and address any issues that arose. Among those present were general practitioners, gynecologists, and medical students. All professionals and students agreed on the tools used. Table 3 depicts the primary physician's point of view. The following section discusses the study's main findings, which attempted to connect the perceptions of physicians' and pregnant women about the chatbot.

5. Discussion

We sought to understand how healthcare professionals and pregnant women felt about using the chatbot in this study. We applied a convergent parallel design methodology to comprehend both points of view differently. Despite numerous studies evaluating chatbot technology from the perspective of pregnant women, little is known about practicing medical physicians' perceptions on the use of these technologies in health care [35] and this was one of the goals that motivated

us to conduct this study. The evaluations provided qualitative and quantitative insights into various aspects of the seven-day's chatbot user experiences.

The sample consisted of two groups with a low mean age. Physicians described the experiment topics as "assertive and comprehensive". Prenatal, postnatal, food, prohibitions, mild complications, physical activity, cosmetics, and medications, as well as period curiosities, have all been discussed. Doctors argued that it was necessary, timely, and relevant. The investigation with pregnant women confirmed the findings.

The first hypothesis tested in this experiment with pregnant women was that the expectation of use would positively influence the intention to use the chatbot, which was validated. The Performance Expectancy construct, related to the understanding and usefulness of the service for pregnant women in providing health information, had the highest agreement score. The [9] study, which included obstetric and mental health care contents for perinatal women and their families, found that high-quality contents provide users with relevant value, increasing their interest in the tool.

Physicians' assessment that the tool brought complete and crucial content. Still, the chatbot was considered easy interaction by professionals. In this sense, we ask about the language used, since one of the main focuses of this chatbot is its use in health units with low-income
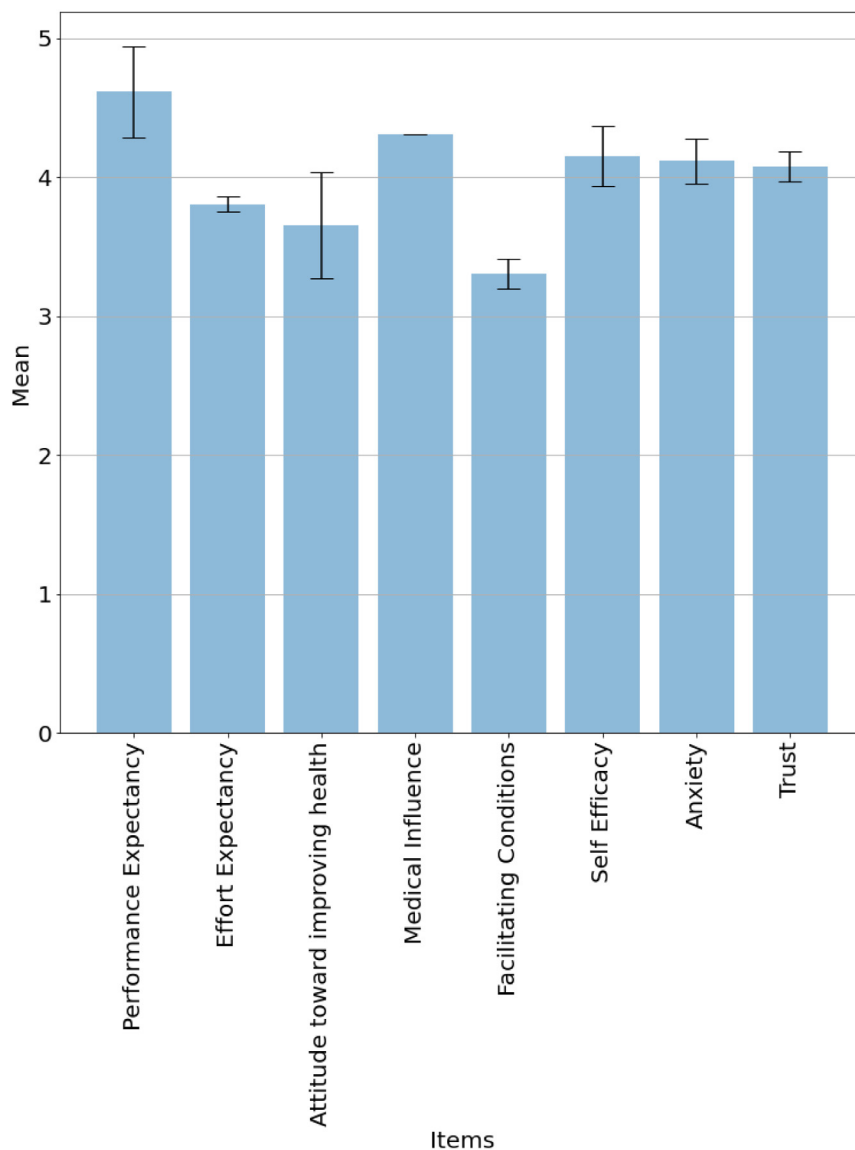
Fig. 4. Mean and Standard Deviation of pregnant women's perception.

people [36]. According to all physicians', the language used was clear and didactic.

We assessed this behavior in pregnant women using the Effort Expectancy and Facilitating Conditions constructs. These constructs stood out as the worst among the items evaluated, despite having a more positive than negative perception on average. Effort Expectancy aspects related to understanding the content and obtained an average [3.8].

Facilitating conditions envisaged as a hypothesis that pregnant easily use the chatbot since they would have the necessary resources. We received two informal feedbacks from pregnant women who complained that the chatbot interactions were too slow and had incorrect button functionality.

In addition, the chatbot's performance was not tested on different mobile phones, which may have interfered with the user's experience with their device. The approach had reservations in the question presented and the separation of topics. Healthcare professionals have reported that button captions have become small, and navigation could be improved by reducing the number of buttons.

Although text dialogues are available, the chatbot was built on the rule-based concept, encouraging users to interact by clicking rather than text dialogues.

Less than a quarter of all respondents used NLP mechanisms. With this finding and based on results collected in another study [37], it can be suggested that a greater incentive for interaction via text, ensuring a satisfactory level of accuracy for responses, may lead to an increase in engagement and availability of information that the increase in the use of the tool.

Additionally, we examined physicians' attitudes toward chatbots to assist pregnant women. The study was carried out with pregnant women belonging to the Unified Health System in Brazil (SUS). The SUS pregnant's [38] are quite diverse, making simplified strategies and popular language the best alternatives for this type of tool. According to professionals, this technology is prepared to assist pregnant women due to its simple and quick nature. The majority of women participating in the study strongly believe that their doctors would approve of using the chatbot. However there is not signed agreement on aspects aimed at a feeling of leisure or fun when interacting with the chatbot.

We evaluated the Self-Efficacy construct, which refers to the infrastructure and knowledge requirements for interacting with the chatbot. The results show that pregnant women are not completely comfortable with this tool in terms of Self-Efficacy. Despite the low average age, which may indicate a higher level of familiarity with this technology, the item ('Using the chatbot is intimidating for me') reach (avg =

4.00), indicating possible discomfort or a lack of habit with this type of technology. The average for agreement on facilitating conditions (avg = 3.07) was the lowest, indicating that not all pregnant women believe they have the necessary conditions (internet, cell phone, technical knowledge) to use the chatbot.

On the other hand, pregnant women agree that they trust the chatbot (avg = 4.17) and want to learn more from it (avg = 4.11). One of the most difficult challenges this technology can overcome is providing information without instilling anxiety [39]. These tools are useful for professionals, but they may also include new features.

A variety of benefits for the chatbot have been proposed, including improved patient education and treatment adherence compliance. One of the future suggestions was a search-based system for finding a doctor in an emergency. There are already studies of generalist chatbots acting as physicians' recommenders [40]. Covid disease was omitted from our materials and was suggested to improve the content. Some studies have addressed this topic involving pregnant women and the prompt support of information for this disease [11,41]. Finally, the father role during the Thousand Days was mentioned briefly but insufficiently in a few topics, necessitating further expansion of this content. According to doctors, pregnant women have numerous doubts about this subject, and sexual activities are not included.

6. Conclusion and future works

This study sought to understand the perceptions of physicians and pregnant women about chatbots to obtain important information about pregnancy. Furthermore, we try to identify content correlation and contradictions between the responses of the two groups.

The research also had limitations. As an exploratory study with a sample size of seven medical practitioners, findings are not generalizable to the entire population of medical practitioners. The average age of pregnant women was twenty-three years, which does not reflect the reality of the distribution of pregnant women in Brazil.

From the doctor's perspective, a few things stood out: everyone agrees on the use of chatbots for this purpose; everyone believes that the tool can contribute to pregnant women's education as long as simple dialogues and a lay approach are maintained. Suggestions for new topics such as family relationships and covid in pregnant women surfaced, as did the chatbot to physician overflow feature.

We developed some hypotheses before the experiment with pregnant women and confirmed, to varying degrees, that they were all accepted. The highest level of agreement was Expectation of Performance, in which pregnant women agreed that the chatbot had taught them something new. The assumption that came the closest to being rejected was one concerning enabling conditions to interactions. Not all pregnant women who responded said that they had the necessary infrastructure to interaction.

In future studies, we intend to investigate Natural language techniques to improve conversation aspects. Also, we aim to promote a multimodal chatbot to verify possible disparities in pregnant women's engagement between voice and text interactions. After this initial pilot study, we will conduct additional research to generalize the results through new studies involving a higher number of doctors and pregnant women, as well as used a longer time to understand the behavior of this audience.

Summary table

See Tables 4 and 5.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Table 4
What we already know about this topic.

- The gestation period is critical for parents, as it involves new situations, generating doubts and causing anxiety and stress.
- There is a large contingent of women who use the internet as a source of information for decision-making during pregnancy.
- Previous research has attempted to comprehend the use of chatbots to deliver trusted information all over the world.

Table 5
What we add to this field.

- According to our findings, it is the first educational chatbot that uses pregnancy guidelines to address specific concerns during the Thousand-days period.
- A mixed-methods evaluation was conducted to ascertain physicians' and pregnant women's perceptions of the chatbot's utility, which has not been done consistently in Brazil.
- A quantitative evaluation was conducted using the UTAUT2 scale, which was adapted for the context of low-income pregnant women in Brazil.

References

[1] N. Minian, T. Corrin, M. Lingam, W.K. deRuiter, T. Rodak, V.H. Taylor, H. Manson, R. Dragonetti, L. Zawertailo, O.C. Melamed, et al., Identifying contexts and mechanisms in multiple behavior change interventions affecting smoking cessation success: a rapid realist review, BMC Public Health 20 (1) (2020) 1–26.

[2] L. Aymerich-Franch, I. Ferrer, Investigating the use of speech-based conversational agents for life coaching, Int. J. Hum.-Comput. Stud. 159 (2022) 102745.

[3] H. Wang, Q. Zhang, M. Ip, J.T.F. Lau, Social media–based conversational agents for health management and interventions, Computer 51 (8) (2018) 26–33.

[4] F. Dolianiti, I. Tsoupouroglou, P. Antoniou, S. Konstantinidis, S. Anastasiades, P. Bamidis, Chatbots in healthcare curricula: The case of a conversational virtual patient, in: International Conference on Brain Function Assessment in Learning, Springer, 2020, pp. 137–147.

[5] S. Jang, J.-J. Kim, S.-J. Kim, J. Hong, S. Kim, E. Kim, Mobile app-based chatbot to deliver cognitive behavioral therapy and psychoeducation for adults with attention deficit: A development and feasibility/usability study, Int. J. Med. Inform. 150 (2021) 104440.

[6] G.d.S.L. Roque, R.R. de Souza, J.W.A. do Nascimento, A.S. de Campos Filho, S.R. de Melo Queiroz, I.C.R.V. Santos, Content validation and usability of a chatbot of guidelines for wound dressing, Int. J. Med. Inform. 151 (2021) 104473.

[7] M. Amith, K. Roberts, C. Tao, Conceiving an application ontology to model patient human papillomavirus vaccine counseling for dialogue management, BMC Bioinformatics 20 (21) (2019) 1–16.

[8] A. Fadhil, Y. Wang, H. Reiterer, Assistive conversational agent for health coaching: a validation study, Methods Inf. Med. 58 (01) (2019) 009–023.

[9] K. Chung, H.Y. Cho, J.Y. Park, et al., A chatbot for perinatal women's and partners' obstetric and mental health care: Development and usability evaluation study, JMIR Med. Inform. 9 (3) (2021) e18607.

[10] R.A. Edwards, T. Bickmore, L. Jenkins, M. Foley, J. Manjourides, Use of an interactive computer agent to support breastfeeding, Maternal Child Health J. 17 (10) (2013) 1961–1968.

[11] M. Bahja, N. Abuhwaila, J. Bahja, An antenatal care awareness prototype chatbot application using a user-centric design approach, in: International Conference on Human-Computer Interaction, Springer, 2020, pp. 20–31.

[12] E. Verduci, S. Vizzuso, A. Frassinetti, L. Mariotti, A. Del Torto, G. Fiore, A. Marconi, G.V. Zuccotti, Nutripedia: The fight against the fake news in nutrition during pregnancy and early life, Nutrients 13 (9) (2021) 2998.

[13] I.C.d.H.C. Barreto, N.B.S. Barros, R.L. Theophilo, V.F. Viana, F.R.d.V. Silveira, O.d. Souza, F.J.G.d. Sousa, A.M.B.d. Oliveira, L.O.M.d. Andrade, Development and evaluation of the GISSA Mother-Baby ChatBot application in promoting child health, Ciência & Saúde Coletiva 26 (2021) 1679–1690.

[14] A.E.d. Silva Júnior, M.d.L. Macena, L.G.L. Vasconcelos, N.B. Almeida, D.R.S. Praxedes, I. Pureza, N.B. Bueno, A.P.G. Clemente, Tendência do estado nutricional de gestantes adolescentes beneficiárias do programa de transferência condicionada de renda brasileiro Bolsa Família no período 2008–2018, Ciência & Saúde Coletiva 26 (2021) 2613–2624.

[15] T. Bickmore, Z. Zhang, M. Reichert, C. Julce, B. Jack, Promotion of preconception care among adolescents and young adults by conversational agent, J. Adolescent Health 67 (2) (2020) S45–S51.

[16] R. Devlieger, Recruiting in the interpregnancy period, in: Preconceptional Origins of Child Health Outcomes Workshop, 2021, p. 14.

[17] N.A.M. Mokmin, N.A. Ibrahim, The evaluation of chatbot as a tool for health literacy education among undergraduate students, Educ. Inf. Technol. (2021) 1–17.

[18] P.R. Lawrence, I. Feinberg, R. Spratling, The relationship of parental health literacy to health outcomes of children with medical complexity, J. Pediatr. Nurs. 60 (2021) 65–70.

[19] R. Vila-Candel, F.J. Soriano-Vidal, D. Mena-Tudela, J.A. Quesada, E. Castro-Sánchez, Health literacy of pregnant women and duration of breastfeeding maintenance: a feasibility study, J. Adv. Nurs. 77 (2) (2021) 703–714.

[20] T. Scull, C. Malik, A. Morrison, E. Keefe, Promoting sexual health in high school: A feasibility study of a web-based media literacy education program, J. Health Commun. 26 (3) (2021) 147–160.

[21] V. Poreddi, V. Sundaram, S.N. Reddy, K. Bidadi, R. Thimmaiah, Postpartum depression: Mental health literacy of Indian mothers, Arch. Psychiatr. Nurs. 35 (6) (2021) 631–637.

[22] P.P. Doke, J.S. Gothankar, P.D. Pore, S.H. Palkar, A.P. Chutke, A.V. Patil, A.V. Deshpande, K.K. Bhuyan, M.V. Karnataki, A.N. Shrotri, Meager perception of preconception care among women desiring pregnancy in rural areas: A qualitative study using focus group discussions, Front. Public Health (2021) 1489.

[23] H. Atrash, B. Jack, Preconception care to improve pregnancy outcomes: The science, J. Hum. Growth Dev. 30 (3) (2020) 355–362.

[24] B.W. Jack, T. Bickmore, L. Yinusa-Nyahkoon, M. Reichert, C. Julce, N. Sidduri, J. Martin-Howard, Z. Zhang, E. Woodhams, J. Fernandez, et al., Improving the health of young African American women in the preconception period using health information technology: a randomised controlled trial, Lancet Digit. Health 2 (9) (2020) e475–e485.

[25] A.A. Abd-Alrazaq, M. Alajlani, N. Ali, K. Denecke, B.M. Bewick, M. Househ, Perceptions and opinions of patients about mental health chatbots: Scoping review, J. Med. Internet Res. 23 (1) (2021) e17828.

[26] M.H. Sagstad, N.-H. Morken, A. Lund, L.J. Dingsør, A.B.V. Nilsen, L.M. Sorbye, Quantitative user data from a chatbot developed for women with gestational diabetes mellitus: Observational study, JMIR Form. Res. 6 (4) (2022) e28091.

[27] T.W. Bickmore, S. Ólafsson, T.K. O'Leary, Mitigating patient and consumer safety risks when using conversational assistants for medical information: Exploratory mixed methods experiment, J. Med. Internet Res. 23 (11) (2021) e30704.

[28] C.A. Maher, C.R. Davis, R.G. Curtis, C.E. Short, K.J. Murphy, A physical activity and diet program delivered by artificially intelligent virtual health coach: proof-of-concept study, JMIR MHealth UHealth 8 (7) (2020) e17558.

[29] I.K.F. Haugeland, A. Følstad, C. Taylor, C.A. Bjørkli, Understanding the user experience of customer service chatbots: An experimental study of chatbot interaction design, Int. J. Hum.-Comput. Stud. 161 (2022) 102788.

[30] V. Venkatesh, J.Y. Thong, X. Xu, Consumer acceptance and use of information technology: extending the unified theory of acceptance and use of technology, MIS Q. (2012) 157–178.

[31] Y.-T. Chang, C.-M. Chao, C.-W. Yu, F.-C. Lin, Extending the utility of UTAUT2 for hospital patients' adoption of medical apps: Moderating effects of e-health literacy, Mob. Inf. Syst. 2021 (2021).

[32] P. Duarte, J.C. Pinho, A mixed methods UTAUT2-based approach to assess mobile health adoption, J. Bus. Res. 102 (2019) 140–150.

[33] F.A.J. Almahri, D. Bell, M. Merhi, Understanding student acceptance and use of chatbots in the united kingdom universities: a structural equation modelling approach, in: 2020 6th International Conference on Information Management, ICIM, IEEE, 2020, pp. 284–288.

[34] M. Decman, Factors that increase active participation by higher education students, and predict the acceptance and use of classroom response systems, Int. J. Higher Educ. 9 (4) (2020) 84–98.

[35] A. Palanica, P. Flaschner, A. Thommandram, M. Li, Y. Fossat, Physicians' perceptions of chatbots in health care: cross-sectional web-based survey, J. Med. Internet Res. 21 (4) (2019) e12887.

[36] L. Vaira, M.A. Bochicchio, M. Conte, F.M. Casaluci, A. Melpignano, Mamabot: a system based on ML and NLP for supporting women and families during pregnancy, in: Proceedings of the 22nd International Database Engineering & Applications Symposium, 2018, pp. 273–277.

[37] K. Mugoye, H. Okoyo, S. Mcoyowo, Smart-bot technology: Conversational agents role in maternal healthcare support, in: 2019 IST-Africa Week Conference, IST-Africa, IEEE, 2019, pp. 1–7.

[38] C.R.B. da Fonseca, M.W.L. Strufaldi, L.R. De Carvalho, R.F. Puccini, Risk factors for low birth weight in Botucatu city, SP state, Brazil: a study conducted in the public health system from 2004 to 2008, BMC Res. Notes 5 (1) (2012) 1–9.

[39] E. Maeda, A. Miyata, J. Boivin, K. Nomura, Y. Kumazawa, H. Shirasawa, H. Saito, Y. Terada, Promoting fertility awareness and preconception health using a chatbot: a randomized controlled trial, Reproductive Biomed. Online 41 (6) (2020) 1133–1143.

[40] U. Jameel, A. Anwar, H. Khan, Doctor recommendation chatbot: A research study: Doctor recommendation chatbot, J. Appl. Artif. Intell. 2 (1) (2021).

[41] R. Wang, J. Wang, Y. Liao, J. Wang, Supervised machine learning chatbots for perinatal mental healthcare, in: 2020 International Conference on Intelligent Computing and Human-Computer Interaction, ICHCI, IEEE, 2020, pp. 378–383.