Pregnancy-Related Information Seeking in Online Health Communities: A Qualitative Study

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Abstract. Pregnancy often imposes risks on women's health. Consumers are increasingly turning to online resources (e.g., online health communities) to look for pregnancy-related information for better care management. To inform design opportunities for online support interventions, it is critical to thoroughly understand consumers' information needs throughout the entire course of pregnancy including three main stages: pre-pregnancy, during-pregnancy, and postpartum. In this study, we present a content analysis of pregnancy-related question posts on Yahoo! Answers to examine how they formulated their inquiries, and the types of replies that information seekers received. This analysis revealed 14 main types of information needs, most of which were "stage-based". We also found that peers from online health communities provided a variety of support, including affirmation of pregnancy, opinions or suggestions, health information, personal experience, and reference to health providers' service. Insights derived from the findings are drawn to discuss design opportunities for tailoring informatics interventions to support consumers' information needs at different pregnancy stages.

Keywords: Information seeking · Needs assessment · Consumer health information · Pregnant women · Online community

1 Introduction

Pregnancy is an important phase of women's life in which women often experience a variety of physiological, emotional, and medical issues [42]. For many women, pregnancy makes them more intensively interact with the healthcare system, which is fragmented and challenging to navigate in many countries [25]. According to the Healthcare Cost and Utilization Project of the Agency for Healthcare Research and Quality [17], 94.1% of the deliveries in the U.S. in 2008 had experienced complications, such as preterm labor, hemorrhage, and low birth

weight, imposing great risks to women's health as well as financial burden to the society and the families. Due to insufficient information obtained from health providers, women and their caregivers often proactively search and consume health information by themselves. Addressing their pregnancy-related information needs is of utmost importance as appropriate prenatal education improves maternal and fetal outcomes [32, 37]. The literature points out that the internet has been widely used as an effective tool by women to fulfill their information needs related to pregnancy [47, 49]. In particular, social media, including online health forums and social Q&A sites, has become hugely popular as an alternative source for searching and receiving pregnancy-related information, sharing concerns and experiences felt during pregnancy, and communicating with peers who share similar conditions [15, 31, 39, 48]. Compared with the traditional, face-to-face consultation with obstetricians, inquiring about pregnancy-related information on online health forums is *"convenient, detailed, practical, customized, and unbiased"* [55]. However, the information online often lacks credibility and is not well organized [4]. In both means of consultation, consumers may experience health information overload [34], which may have negative effects, such as stress, confusion, and cognitive strain [19].

Similar to other chronic conditions such as diabetes, pregnancy is a "stage-based" health condition, including pre-pregnancy, during-pregnancy, and post-partum [2]. In particular, during-pregnancy can be further categorized into three gestational trimesters based on the week of pregnancy. Women during the entire pregnancy trajectory may face different challenges and uncertainties, thereby having evolving information needs. For example, women who are considering pregnancy have different questions and needs from those who are pregnant. However, previous studies about pregnancy-related information-seeking mostly treat pregnancy as an uniform condition and have not adequately examined women's information needs in different stages [24]. To design health information technologies for supporting information needs in different pregnancy stages for consumers, it is crucial to obtain an in-depth understanding of their information needs throughout the pregnancy trajectory and how these information needs vary across different stages. However, existing studies were primarily focused on information needs of pregnant women during the trimesters of pregnancy, with little attention paid to before or after pregnancy stages [10, 20, 24, 28, 33, 48, 50, 55]. Thus, a study examining the comprehensive typology of consumers' information needs throughout their pregnancy trajectory is necessary.

To fill this research gap, we investigated consumers' pregnancy-related information seeking in different stages in online health communities. The reason for choosing online health communities is that they are common channels for people to seek and share health-related information. Also, online health communities are advantageous in facilitating peer support as they enable consumers to post and answer questions in natural language and include contextual information, such as specific complications they experience during or after pregnancy, period cycles, and medical histories. In this paper, we conducted an in-depth content analysis on 6,713 question posts collected from the Pregnancy and Parenting

category of Yahoo! Answers, one of the most well-known social Q&A websites. The analyzed posts covered the pre-pregnancy, during pregnancy, and postpartum stages. Our analysis uncovers the types of information or support consumers in different stages of pregnancy seek, how different they are, and what types of responses they receive from peers. We then draw our findings to discuss practical and theoretical implications for online support interventions. This study is a preliminary study of a large research effort to design and develop a computational approach for delivering tailored information support to healthcare consumers, who are either trying to get pregnant, experiencing pregnancy, or parenting. The contributions of the study are two-fold:

1. An in-depth, comprehensive understanding of consumers' information needs throughout the entire course of pre-pregnancy, during-pregnancy, and postpartum;
2. Practical and theoretical implications for technology support to aid pregnancy-related information seeking and retrieval.

2   Background and Related Work

Online health communities are digital platforms where patients connect with others in similar scenarios to discuss health concerns [43]. Seminal studies have investigated the information seeking behavior in online health communities and how to support such online information-seeking activities (e.g., [7,14,22,29,30,46,53,54]. A well-recognized advantage of online health communities is that patients can obtain valuable experiential knowledge and easy-to-understand medical information from their peers, which the clinicians may not sufficiently provide [26]. Prior work revealed that many patients shared their personal health information and even illness trajectory to contextualize their information seeking in order to elicit personalized advice and suggestions [29]. In the case of pregnancy, existing literature shows that consumers have a variety of questions and confusion related to pregnancy [18,36,44]. As such, they often turn to online health forums to obtain experiential knowledge from their peers pertaining to, for example, how to conceive, how to address some experienced symptoms during pregnancy, and how to deal with complications after giving birth. More importantly, existing research indicates that online health communities provide an anonymous space for consumers to share intimate details and disclose sensitive information, without the concern of being judged by others [40].

A large body of research has examined how consumers seek information and peer support during pregnancy (e.g., [6,14,28,35,41]. For instance, Zhu et al. [55] analyzed pregnancy-related information-seeking on social media among expectant mothers in China; the results revealed that social media increasingly empowers expectant mothers to make more informed decisions during pregnancy. Robinson et al. [45] assessed pregnant women and caregivers' information needs to discover the types of needs that were not met. Gui et al. [24] investigated

support seeking for pregnancy in Babycenter along the three gestational stages during pregnancy. Some work also investigated peer support seeking during post-partum and reported that new parents benefited from the experience of their peers in a wide range of topics related to postpartum such as parenting new-borns, postpartum depression, and breastfeeding [14, 22, 29]. We also found a few research projects that examined information-seeking about maternal risk factors, such as infertility [10].

While these studies examined the support sought by consumers about preg-nancy or postpartum, they only focused on one stage of pregnancy or mixed multiple groups without studying distinct groups in depth [16, 28]. To the best of our knowledge, no prior work has attempted to thoroughly examine consumers' information needs throughout the trajectory of pregnancy, including before, dur-ing, and after gestation. Existing literature points out that pregnancy is a unique health condition that is "staged", with each stage presenting different physio-logical, emotional, and informational needs [24]. Therefore, it is imperative to examine the information needs of women over the course of pregnancy and how online communities respond to these needs. An in-depth understanding of these aspects can shed light on designing personalized online support interventions to provide stage-based, tailored, and more suitable pregnancy care support. Our study aims to fill this knowledge gap.

3   Methods

3.1   Data Collection

Approved by the Institutional Review Board at Pace University, we used a sec-ondary dataset collected from the "Pregnancy" and "Parenting" category of Yahoo! Answers between 2009 and 2014. The dataset consists of a total of 14,646 question posts. As many communities under this category are not health-related, we filtered out these irrelevant ones (e.g., "Adoption", "Baby Names", "Tod-dler & Preschooler", and "Parenting") and extracted four communities that are highly relevant to pregnancy experience, including "Pregnancy & Parenting", "Trying to Conceive", "Pregnancy", and "Newborn & Baby". After this step, 6,713 posts were retained for further analysis. The name of these four forum communities and the number of posts retrieved from each community are sum-marized in Table 1.

3.2   Data Analysis

Three researchers performed a content analysis on the entire 6,713 posts. The analysis consists of the following steps (shown in Fig. 1): First, we developed a codebook using 200 posts randomly sampled from the corpus. More specifically, the sampled posts were independently reviewed by two coders, C1 and C2, for relevance judgment. For posts that were considered relevant, we used an open coding technique to categorize posts and their chosen replies (also known as the

Table 1. Relevant online communities and the number of retrieved posts from each community

Community	Number of retrieved posts
"Pregnancy & Parenting"	1,822
"Trying to Conceive"	1,449
"Pregnancy"	1,552
"Newborn & Baby"	1,890

"Best Answer"). As the quality of the post answers varies, the poster often chose a reply which fulfilled his/her information needs as the "Best Answer". Therefore, examining the best answer responses could help us not only understand what types of support were provided but also confirm the poster's information needs.

Once an initial version of the codebook was established, the researchers met to discuss whether to keep, remove, merge, or replace any codes. After the researchers reached an agreement about every code in the codebook, the codebook was then utilized to standardize the coding procedure. The finalized codebook contained 14 themes, which were organized by three general stages of pregnancy: pre-pregnancy, during-pregnancy, and postpartum (shown in Table 2).

Next, the third coder (C3) coded another 100 randomly sampled posts to examine the exhaustiveness of the codebook. Through this process, no new codes merged, confirming that the codebook was comprehensive enough. Following that, C1 and C2 coded another random sample of 200 posts and applied Cohen's Kappa Coefficient to test their inter-rater reliability (Fig. 1, Step 3). Two coders achieved a substantial agreement (kappa's value is 0.80). Once we resolved the disagreements, C1 and C2 coded the remaining posts to conclude the analysis (Fig. 1, Step 4).

4   Results

4.1   General Observations

Overall, we found that posters sought various informational supports on the forum, which can be roughly categorized into three categories, including *advice, pregnancy-related medical knowledge* and *experiential knowledge*. For example, posters explicitly asked for peers' advice and actionable suggestions about what they should do next or how they should handle a situation. A typical example of this type of question is *"I am now 4 days late on my period, however, the pregnancy test still shows negative. I have been trying (to conceive) for a while now, does anyone have any suggestions?"* Furthermore, many posters inquired about pregnancy-related medical knowledge, such as commonly seen pregnancy symptoms, effects of a specific medication, and diagnostic abilities of lab tests. Lastly, they also sought experiential knowledge from others who had similar
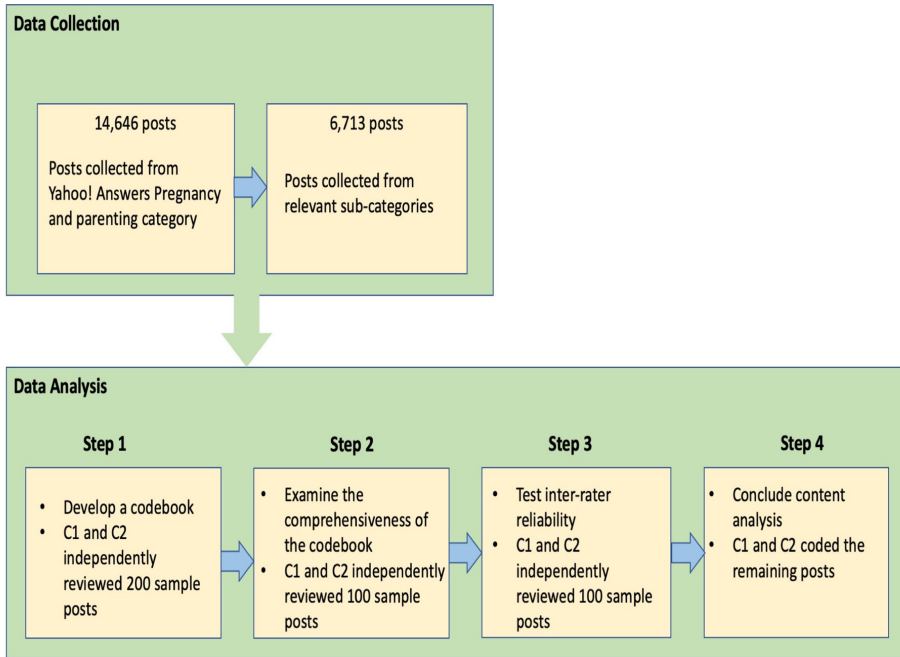
Fig. 1. Data collection and analysis steps

Table 2. Summary of themes for information needs. Some posts fell into multiple themes, so percentages add up to more than 100%. Percentage equal to the number of occurrence divided by the totoal posts analyzed.

Stage	Theme	N (%)
Pre-Pregnancy	Chances of pregnancy	571 (20.4%)
	Conceive or implantation	231 (8.3%)
	Medication or treatment	132 (4.8%)
	Period or ovulation	154 (5.6%)
	Symptoms of pregnancy	141 (5.1%)
	Miscarriage	40 (1.4%)
During-Pregnancy	Health concerns & Disease of pregnancy	434 (15.7%)
	Knowledge and Prognosis of Pregnancy	135 (4.9%)
	Labor	74 (2.7%)
Postpartum	Breastfeeding	68 (2.5%)
	Health Concerns of Newborn	196 (7.1%)
	Nurturing Newborn	124 (4.5%)
	Medication or Treatment	132 (5.8%)
Across Pregnancy Trajectory	Lab Test	335 (12.1%)

conditions or went through the pregnancy stages. Posters asked this kind of questions to understand what is going to happen next. An example question is *"Anyone had a C-section and a natural birth? Can you tell me the difference?"*

While asking questions, it is common to see that posters provided different background and contextual information related to their personal characteristics (e.g. age and period cycle), health and well-being (e.g., symptoms, medication taken, and medical history), medical data (e.g., lab results, ultrasound images, and doctor's diagnosis), lifestyle (e.g., diets, exercises), and personal life (e.g., personal relationships), in order to solicit personalized information situated in their context (Fig. 2). For instance, in one post, the poster asked several questions while providing her personal information:

> *"In April, I had 2 periods one from 5th–6th and the other from 28th–30th. Is this normal? I have never had 2 periods so close together, my cycle is normally 29 days. Is it normal to have a lot of discharge one week after ovulation day? [. . .] Me and my husband are TTC (trying to conceive) and I ovulated on the 11th (took a test), and I still have a lot coming out (sorry too much information). We had sex on May 10, 11, 13 and 20. [. . .] Took a test this Thursday, it was negative. [. . .] Was it too early to test? When do you think I should test? Any ideas?"*

As shown in Fig. 2, we also analyzed the correlation between the types of information posters provided and the types of support posters were seeking to better understand how consumers formulated their questions to fulfill their information needs. For example, in the pre-pregnancy stage, posts inquired about the chances of getting pregnant frequently provided information about demographics, menstrual cycle, symptoms, conception details, or lab results. People during pregnancy often asked questions by providing information about demographics, due dates, or symptoms, while postpartum posts often disclosed newborn's symptoms and demographics, as well as lab results.

4.2   Information Needs at Each Stage of Pregnancy

Although the types of information support (e.g., advice, medical knowledge, and experiential knowledge) consumers sought on the forum were relatively consistent across the entire pregnancy trajectory, the specific information needs expressed by posters varied across different stages of pregnancy. In this section, we present posters" information needs for different stages of pregnancy. The number and percentage of each type of information needs, categorized by the stage of pregnancy, are shown in Table 2. The themes were categorized into pregnancy stage if the type of information need was pertinent to that particular stage.

Pre-pregnancy Stage. In this stage, consumers often raised questions related to the chances and symptoms of pregnancy, conception and implantation, issues related to period or ovulation, and medication or treatment for certain health concerns. In particular, requests for help determining the chances of pregnancy
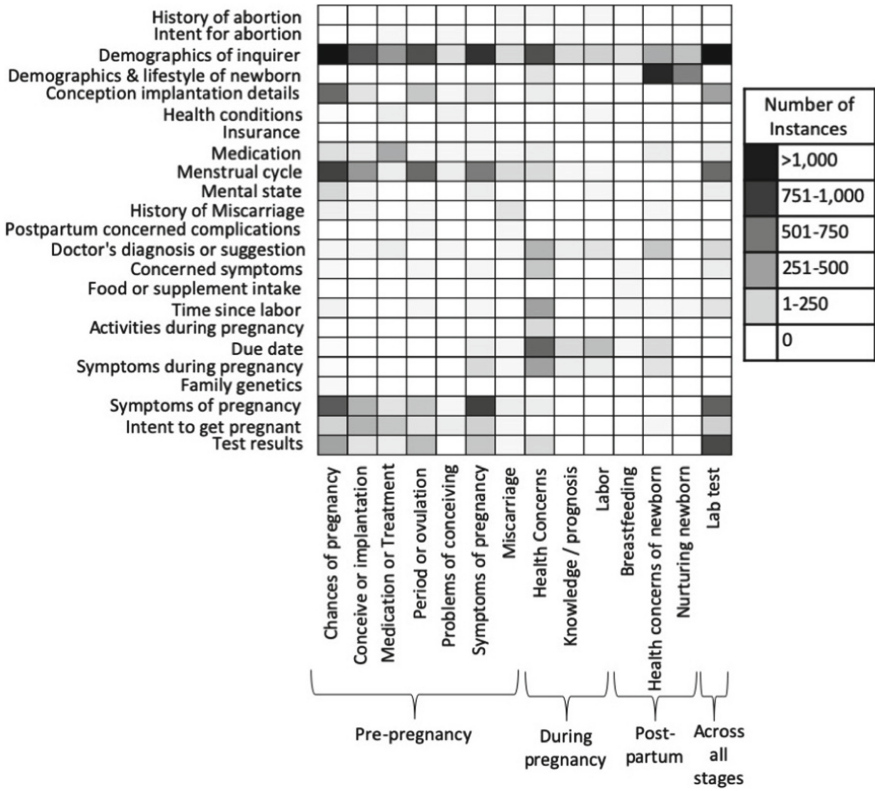
Fig. 2. Co-occurrence of information needs at different stages. x-axis represents the types of information needs in different pregnancy stages and y-axis lists the types of information provided by the posters in a question post. The legend dictates the number of co-occurred instances among the total coded posts.

were by far the most common theme in the corpus. Posters often disclosed their recent history of sexual behavior and symptoms that were signs of pregnancy to obtain more accurate estimation. For example, a post provided relevant information and asked about the chance of getting pregnant:

> "Ok so I had sex 5 days after my period stopped with my bf and according to my cycle I wasn't supposed to ovulate for another week but 3 days after having sex I felt ovulation coming on. It's now been 12 days since I had sex and my breasts are really tender, cramping and have a lotion-like white discharge when I use the bathroom, I felt sick to my stomach almost to the point of throwing up and my period isn't due for another week and a half [...]. Is it too early to be feeling symptoms? I stress over it every day [...]. Can anyone tell me what you think my chances of being pregnant is? If I'm not pregnant what could it be?"

As conception and implantation are the necessary processes of getting pregnant, a considerable amount of questions raised in the forum also fell into this theme. In particular, posters often consulted about the process and length of conception and implantation, how to increase the chance of conception, and how to handle the obstacles of conception or abnormal symptoms they experienced while trying to conceive. For example, a post asked: *"Lately for the past 3 or 4 days, I've been having minor headaches, trouble sleeping, loss of appetite, weird heart thumps, queasy stomach, gassy & nausea (not to the point of throwing up but almost). I'm sexually active but been having a hard time conceiving so doubting this is pregnancy. So, what could be wrong?"*

During-Pregnancy Stage. In this stage, consumers mainly asked for three types of information: knowledge and prognosis of pregnancy, health concerns on pregnancy, and labor.

Knowledge and Prognosis of Pregnancy. Posters commonly sought knowledge and prognosis related to pregnancy, especially during the first trimester of their pregnancy. In most cases, posters inquired about how far along was their pregnancy: *"My last period started April 27th. I just found out I was pregnant. How far along am I now? I'm unsure about my days in between around 28 to 33."* Similarly, some questions asked for estimation of the due date: *"If I conceived on August 19th, when will I be due?"*

In addition, some posters also sought for knowledge about abortion. For example, one post wrote: *"I'm 20 years old. Last night I took a pregnancy test and it came back as positive. When and how do I go about having an abortion?"* Another post inquired about the side effects of abortion: *"What are the side effects after having an abortion at age 32?"*

In other cases, posters would like to know the proper diet during pregnancy. For example, a post asked: *"Is it safe to eat black berries during pregnancy? 35 weeks pregnant."* Lastly, questions related to gender prediction were raised by many posters. As one question wrote: *"I had a girl born first and then a boy. Thinking about another baby, what are my chances that it will be another girl???"*

Health Concerns on Pregnancy. Once a woman gets pregnant, her body undergoes hormonal changes which could trigger symptoms ranging from morning sickness, headache, ligament pain, to shortness of breath, contractions, and general discomfort [13, 27]. Some symptoms are more common in the first trimester, whereas others are often seen in the second and third trimesters. Nevertheless, we observed that posters raised a variety of health concerns during pregnancy, across the three trimesters. For example, many posts asked about how to handle concerned symptoms they had during pregnancy (31.8%), whether the effects of symptoms during pregnancy can still sustain after giving birth (48.6%), and what consequence of prenatal exposure to certain substances (e.g., alcohol and smoking) could be (2.8%). For example, a post wrote: *"I have had a headache for over 24 h now [...] I'm pregnant, so I can't take Aleve or Ibuprofen. Any suggestions on how to get rid of it?"*

Labor. We found that posters often raised questions about giving birth, especially during their third trimester (which usually lasts from week 29 of pregnancy through birth). The most frequently asked questions under this theme included identifying signs of labor and deciding when to go to the hospital to give birth, knowing the process of delivery and what to prepare, and understanding the pros and cons of giving birth naturally compared to assisted delivery. It is also worth noting that a number of posts are related to emotional state. For example, one post asked for other people's experience of giving birth in order to prepare themselves for the upcoming delivery, both physically and mentally: *"How many weeks were you when you gave birth and how badly did the contractions hurt?"*

Postpartum Stage. For posters at the postpartum stage, they commonly asked questions concerning the health issues of their newborns (7.1%). In particular, new mothers inquired a lot about how to handle the symptoms of their newborns, what might cause the health issues, and what they should do and/or what medications and treatment options are available to deal with certain health issues. As new mothers often experience anxiety or frustration when their children present health issues, it is common to see their posts containing emotional stress, signaling the importance of providing emotional support:

> *"My daughter was 7 weeks old yesterday and she has been crying ALL day for the pat 3 days. She doesn't have a fever and she is exclusively breast fed so it's not constipation. I have no idea if something is wrong or if it is just colic. The only time she is okay is if I wrap her up real tight and turn the vent on in the bathroom with the light off and bouncing her. I'm exhausted! Any suggestions? Encouragement?"*

In addition, some posts are concerned about how to nurture and more broadly, take care of their newborn, including food, sleeping, and breastfeeding. For example, a post inquired about the appropriate amount of formula intake: *"How much formula does your 3-month old baby eat per day?"* In another post, the mother inquired the effect of her medication taken on breastfeeding: *"Can you take some kind of birth control pill while breastfeeding?"*

Across Pregnancy Trajectory. We found that questions pertaining to lab tests were frequently raised by posters across the entire pregnancy trajectory. For example, regardless of the pregnancy stage, women usually take a set of laboratory tests, such as blood tests and Pap smear, to make sure that there is no medical condition that could affect pregnancy. However, as highlighted in previous work [10, 52, 53], people often have difficulties comprehending and acting upon their lab results. This is more evident for people who have lower health and numeracy literacy [56]. Therefore, they often turn to online forums to seek information or second opinion. The most commonly asked questions related to lab tests include when to take a test, the meaning of lab results, and the accuracy and reliability of lab results. For example, one post sought help clarifying whether a specific lab result over a particular pregnancy period was

considered normal: *"I'm about 4–5 weeks (pregnant), I took a HCG test and its level is 1000 something, 2 days later I took a second and it showed a little over 2000. Is that normal?"* Or *"My wife delivered a baby 21 days before when we tested to thyroid past 5 days before her tsh level is 5.2 is this normal level or she want to take some treatment?"*. In another case, a poster suspected that she might have gotten a false negative result since the lab results she received did not align with her symptoms, motivating her to come to the forum to seek help: *"Could I have gotten a false negative result? I'm 10 days late in my period. That NEVER happens to me. I've taken a blood pregnancy test, but it was negative. Could it be wrong?"*

Since there are many known and unknown factors that could affect the implication of lab tests for a person [51], posters often provided contextual information to solicit personalized suggestions pertaining to the indications of lab results. For example, they usually provided demographics, the results of current and previous tests, medical history, and doctors' diagnosis or suggestions to contextualize their inquiries: *"Me ([age] 24) and my husband ([age] 26) are TTC 3 and we had sex on May 10,11,13 20. I ovulated May 12 (took test) for the last couple of days. I have been having really watery/sticky discharge [. . .] When would be the best time to take a test? [. . .] My previous pregnancies were surprises so I'm not quite sure what I should be looking for."*

4.3   Types of Replies Posters Received

Among the replies directly addressed posters' information needs, we categorized them into five types: *affirmation of pregnancy*, *opinions or suggestions*, *health information*, *personal experience*, and *reference to healthcare providers' advice or service*. The number of each response type is shown in Table 3. Below we describe the replies chosen by consumers in details.

Affirmation of Pregnancy. Very often, responders replied to affirm whether or not a poster was pregnant based on the information that the poster had provided, such as period cycle, recent sexual activity, and symptoms: *"That does indeed sound like pregnancy symptoms. Since you've already had some period signs, you're mostly like far enough to take a test. [. . . .] But yeah, sore boobs, exhaustion, frequent urination, and the sudden stop of an otherwise normal menstrual cycle...those definitely sound like pregnant symptoms."*

Opinions or Suggestions. Peers on the forum also replied posters with their opinions or suggestions to help posters make better decisions. For example, a post expressed concerns about whether to have a baby if parents have a 25% chance of passing on a severe genetic condition; the chosen answer replied: *"Personally, no. 1 in 4 odds of not living a normal life is not something I would chance. I would rather be childless than to have to bury my children."*

Some responders also suggested what the posters can do given their situations at a specific pregnancy stage. For example, for a poster who was confused about how soon to test for pregnancy, a person replied: *: "Symptoms will show up only after implantation, that takes 12 days from the day you have had sex, if you*

have conceived. Sometimes it takes longer for symptoms to surface. Wait until you miss your periods and then take a pregnancy test."

Personal Experience. A large proportion of the responders answered questions by reflecting on their own experience to help the posters better understand their situation and determine what to do. For example, a poster was concerned about the safety of epidural and asked for opinions about it. The responder of the chosen answer offered personal experience about epidural: *"I had four kids. With three of them I had an epidural and with one I had natural child birth. The natural childbirth wasn't exactly by choice. Lol. I got to the hospital too late to get the epidural and had the baby in less than hour after I got there".*

Reference to Providers' Advice or Service. In some cases, responders realized that answering certain questions may require professional expertise, subsequently they would suggest that the posters should refer to doctors' advice. For example, a poster experienced some unusual symptoms and suspected if those symptoms indicate pregnancy, a responder replied: *"To me it sounds like a two-week miscarriage but I'd check with the doctor just to make sure".*

Table 3. Summary of themes for chosen reply

Theme	N
Affirmation of Pregnancy	138
Opinions or Suggestions	941
Health Information	802
Personal Experience	664
Reference to Providers' Advice or Service	138

5   Discussion

In the study, we investigated the information needs throughout the pregnancy trajectory and the support they received from the peers online. We found clear distinctions of information needs in different stages. Below we draw on our findings to discuss the design implications for helping consumers better manage personal health, search information, and make decisions in different stages of their pregnancy trajectory.

As consumers filling their knowledge gap about pregnancy, they engage in self-observation, self-judgement, and self-reaction of their health conditions, which are three sub-processes in the social-cognitive view of self-regulation [8]. Such self-regulation is initiated with the exertion of a common goal to achieve better health outcomes for both the mother and the newborn. As a result, consumers feel more empowered. According to existing literature [5], psychological empowerment has two dimensions: intrapersonal empowerment and interactional empowerment. On one hand, consumers are intrapersonally empowered as they

obtain more control and competence by learning knowledge about and experience of pregnancy in online communities. On the other hand, consumers are interpersonally empowered as they actively involve in communicating and exchanging experience of and advice for pregnancy with peers who are in similar situations in the *small world* of social groups [11].

Hence, they come to online forums to seek advice. Online forums offer a wide range of topics to consumers. However, these forums may not use a well-designed typology, classification, or taxonomy to organize information. As a result, it is difficult for consumers to sort out which topic group to post questions. For example, Baby Center has 2543 groups for the topic "pregnancy", consumers may not know where to post questions, in a trimester-specific group or a problem-specific group. In the pre-pregnancy stage, infertile consumers may encounter different problems than those initiating normal preparation for pregnancy. They may not find enough support from communities for regular birth preparation and may need to visit infertility-specific communities. As it is still challenging to address the problem of how to organize pregnancy-related topics in online forums, a comprehensive typology is needed for finding consumers' target information.

We found that consumers made different inquiries as they transit from one stage in pregnancy to another. Therefore, online technology interventions should provide stage-based and customized support instead of providing uniform support for different foci during different stages. In other words, healthcare systems designed to support consumers' information needs should take into consideration the evolving circumstances of consumers' physiological, informational, and emotional needs throughout their pregnancy journey. This study assessed the stages of and types of questions related to pregnancy, which can be used to better categorize pregnancy related information so that consumers can find relevant questions and solutions more easily.

Also, we found posters sought experiential knowledge from their peers with similar conditions. Therefore, technology interventions could incorporate experiential knowledge of peer patients. For instance, similar or relevant experience of peers could become an effective alternative for consumers to fulfill their information needs. This population often expressed stress (e.g., worry, anxiety, and disappointment) while making inquiries, thus, receiving information from peers who have gone through similar experiences and emotions could be a great help.

Supplying health information that is reliable, operationalizable, and suitable for the personal circumstances of the specific health consumer is crucial. In our analysis, posters' inquiries indicated that they often encountered individualized health issues concerning pregnancy. However, as health providers may offer one-size-fits-all information, sometimes these individualized problems may not receive information that can be operationalized within their personal contexts. Therefore, it is important that providers develop systematic approaches to better operationalize and personalize pregnancy-related information that suits the individualized needs and provide such information at the right time. Technology designers could consider the impact of patients' contextual information (e.g., demographic information and medical / medication history) on the appropriate

medical suggestions these patients receive. The contextual information could be modeled as groups of useful features to retrieve medical information and health suggestions relevant to consumers' health situations. For example, the information a 25-years old black woman with family inherited complications, no health insurance, no history of miscarriage, previously delivered one child, search for during her pregnancy is very likely different from a 32-years old white woman at the postpartum stage, with insurance coverage and history of miscarriage, no child previously delivered.

It is also worth noting that mobile health (mHealth) applications have been gaining momentum in supporting pregnancy-related information seeking [3,12,38]. For example, Ainscough et al. [3] investigated the impact of mHealth applications on behavioral change in overweight and obese pregnant women. Their results revealed that mHealth interventions could help overweight and obese women shift from contemplation/preparation to maintenance of healthy lifestyle in pregnancy, and could potentially have positive impact on pregnancy outcome, maternal and newborn's health [3]. Choi et al. [12] assessed the feasibility and efficacy of mHealth intervention in promoting physical activity to inactive pregnant women. The results demonstrated that mHealth is feasible in promoting physical activity of pregnant women [12]. Ledford et al. [38] compared the effectiveness of mHealth applications in prenatal education and engagement versus a spiral-note guide. The results showed that patients using mHealth to record information about their health developed greater patient activation than patients who used notebooks, indicating that mHealth can result in more activated self-management of prenatal health [38]. Despite these efforts, as Robinson et al. [45] pointed out, information needs of consumers are still largely unfilled by mHealth applications, highlighting the importance of examining how to better address the unmet needs.

Supportive applications (e.g. Pregnancy Tracker by *BabyCenter* [1]) now can provide immense information to consumers. Despite so, certain challenges still persist. For instance, throughout childbearing consumers' information encountering online [21], a large quantity of diverse information has been provided. Consequently, it could result in information overload and information anxiety [9], making it hard for consumers to identify the information they need. Furthermore, a lot of static information was provided with no or little customization based on the personal situation. Although such information is credible and well-organized, it is hard for consumers to quickly identify the information they need [23]. Hence, it is important that supportive tools are providing better ways of organizing and categorizing information to ensure that consumers find the information they need.

Taken together, we propose several recommendations for patient portals, which are summarized in Table 4. For pre-pregnancy consumers, portals should list symptoms of pregnancy, and provide tips for preparing for pregnancy and coping with miscarriage. During pregnancy, portals should offer antenatal knowledge, information about nutrition, healthy lifestyle, and labor. For postpartum care, portals could list common issues with the newborns and breastfeeding.

Table 4. Design recommendations

Stage	Design recommendation
Pre-Pregnancy	List symptoms of pregnancy
	Provide tips for preconception preparation
	Offer information related to period and ovulation
	Supply tips for preventing miscarriage
During-Pregnancy	Provide antenatal knowledge to patients
	Introduce information about health lifestyle for pregnancy
	Supply strategies for labor preparation and due date calculation
Postpartum	Provide guidance for newborn care to first-time parents
	List common symptoms of newborns along with treatment options
	Supply treatment options for concerned symptoms during breastfeeding along with treatment options
Across Pregnancy Trajectory	Provide adequate information by the stage of pregnancy and at the right time
	Incorporate information regarding patient's unmet needs (e.g. dietary information)
	Incorporate peer experience and coping strategies if needed
	Provide personalized information and suggestions based patient's demographic information

Across the pregnancy trajectory, portals should provide adequate information at the right time, incorporate peer experience and coping strategies where appropriate, and personalize information and suggestions to new parents.

6   Limitations and Future Work

This study has certain limitations. First, we only focused on question posts from Yahoo! Answers, so the results may not be generalizable to other online health communities or the broader population. Also, due to the limited amount of data available, tracing how the type of inquiries a specific user made evolves across different stages became difficult, which prevents our investigation of the evolution of consumers' information needs in a case-by-case setting. In our future work, we will investigate the evolution of consumers' information needs about pregnancy. We will also compare consumers' pregnancy-related information seeking on our study site with other professional health forums, such as MedHelp. Second, this dataset was collected between 2009 and 2014. With the emergence of new tools

and applications, some of the information needs or concerns might have been addressed. However, new challenges can be introduced by these tools. For example, when using mobile health applications that are not designed to support "stage-based" information seeking, there is a potential risk that consumers may be confused by the inconsistent information or misinformed with inaccurate or unreliable information. Hence, our future work includes conducting user studies to investigate their needs and faced challenges in the current context.

7   Conclusions

In this study, we investigated the comprehensive typology of posters' information needs throughout the pregnancy trajectory by analyzing forum posts collected from a social Q&A site. Findings of this study implied that doctors need to know what responses consumers may receive regarding their questions online. The findings can also shed light on the design of personalized pregnancy-related technologies to accommodate different physical and informational needs that accompany different stages of pregnancy to provide personalized, stage-based, and situated care support. For future work, we will investigate the credibility of or perform fact-checking on the responses that health consumers receive regarding their questions online.

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