Feedpal: Understanding Opportunities for Chatbots in Breastfeeding Education of Women in India

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Use of chatbots in different spheres of life is continuously increasing since a couple of years. We attempt to understand the potential of chatbots for breastfeeding education by conducting an Wizard-of-Oz experiment with 22 participants. Our participants included breastfeeding mothers and community health workers from the slum areas of Delhi, India.

We prototyped our chatbot as an interactive question-answering application and analyzed users' interaction patterns, perceptions, and contexts of use. The chatbot use cases emerged primarily as the first line of support. The participants, especially the mothers, were enthusiastic with the opportunity to ask questions and get reliable answers. We also observed the influencing role of female relative, e.g. mothers-in-law, in breastfeeding practices. Our analysis of user information-seeking suggests that a majority of questions (88%) are of nature that can be answered by a chatbot application. We further observe that the queries are embedded deeply into myths and existing belief systems. Therefore requiring the designers to focus on subtle aspects for providing information such as positive reinforcement and contextual sensitivity. Further, we discuss, different societal and ethical issues associated with Chatbot usage for a public health topic such as breastfeeding education.

CCS Concepts: • **Human-centered computing** → **Human computer interaction (HCI)**; **Empirical studies in HCI**;

Additional Key Words and Phrases: Breastfeeding; Chatbot; HCI4D; CHW; ASHA; India

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1 INTRODUCTION

In recent years, conversational agents or chatbots have received great attention. Since 2016, major tech companies started providing open APIs for building chatbots. This resulted in a massive growth of chatbots especially the chatbots on text messaging platforms. Currently, more than 300,000 bots exist on Facebook messenger [49] cutting across a variety of use-cases—online shopping [44], casual chatting [5], travel arrangements [45], etc. So, far, the focus has been largely commercial, e.g. customer support, since the service providers see chatbots as a cost-effective and efficient way to

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supplement human-based customer service. However, chatbots also offer opportunities for creating positive social impact [35]. With the ability to reach millions in affordable ways, chatbots offer unique opportunities to empower those living in the constrained environments. Further, we discuss the ethical implications of introducing breastfeeding education chatbot in the study context and potential societal impact.

Recently, HCI and CSCW communities have started exploring use of chatbots for variety of problem domains [26, 102, 116]. In India, the access to doctor is limited given the poor ratio of almost 4.8 doctors to 10,000 people [89]. To fill this gap, India uses a large network of community health workers for critical areas of public health such as maternal and child health. We want to explore the use of chatbots in assisting community health worker and mothers in the exclusive context of breastfeeding. Promoting exclusive breastfeeding is a global priority of maternal and child health programs because of its importance in child survival [86]. Timely initiation of breastfeeding and exclusive breastfeeding for the first six months of child's life helps in preventing 20% newborn death and 13% under-five deaths [55]. However, despite this knowledge, breastfeeding rates fall short of recommendation [51].

Our users, community health workers and mothers residing in under-developed (slums) regions of India, have limited or no access to technological advancements in chatbot research, such as Alexa or Google Home, because of poor economic conditions and limited literacy. While they now possess smart-phone, it is often a low-end smart-phone (< \$100) [42]. Moreover, the socio-economical conditions dictate that the phone may be shared within the family, often with the husband or other male members of the family [96]. This makes our users, the first-time users of chatbots.

These first time users of chatbots, in their unique contexts, represent an important class to study and design for. So far, the research around chatbots has been majorly technology driven with limited investigation on user perceptions and contexts of use [88].

In this study, we explore the feasibility of using chatbots for breastfeeding education of community health workers and mothers in urban slum areas of India and understand how they react and perceive chatbot based intervention. We aim to contribute to the HCI and CSCW community by informing design recommendations for chatbot implementation for causes like breastfeeding education in under-developed areas, with users who are newcomers to personal device use. We guide our exploration with the following research questions:

- (1) What is the perception of users towards chatbot based breastfeeding assistance?
- (2) What kind of information users – CHWs and Mothers – seek from a chatbot?
- (3) What are the contexts of chatbot use for mothers and community health workers residing in slum areas of India?

We study users' interaction with the chatbot through a Wizard-of-Oz experiment with 22 participants (12 ASHAs and 10 mothers). We prototyped our chatbot as an interactive question-answering application and analyzed users' interaction patterns, perceptions, and contexts of use. Our findings highlight the role of familial unit in breastfeeding practices. We found that the majority of questions sought by users are answerable by a chatbot and value of chatbots for mothers as a first point of contact. This gives us the confidence that breastfeeding education is a potential application for chatbot intervention. We also discuss implications for the design for future bots and the characteristics they should embody to address users' concern in constrained settings.

2 BACKGROUND - ASHAS IN INDIA

Accredited Social Health Activists (ASHA) are the largest cadre of Community Health Workers and are the frontline health workers in India. The associated ASHA program was launched by National Health Mission [81] in 2005 to achieve public health agendas in vulnerable communities such as

slum and rural areas [74]. An ASHA is a woman selected by the government to serve a population of 1000. The recruitment criteria include the age range of 25 to 45, minimum education of eight grade, leadership and communication skills. The responsibilities of an ASHA include acting as a promoter of preventive health practices, service provider, and healthcare facilitator [83]. Under maternal and child health, ASHAs activities include visiting pregnant women, counseling on anemia prevention, escorting for ante-natal checkups and deliveries, providing post-natal care, monitoring danger signs of the newborn, immunizations, counselling on birth spacing, and family planning.

3 RELATED WORK

3.1 Breastfeeding Practices in India, Support System and Role of CHWs

Breastfeeding is considered to be the best way of providing optimal food to infants. Ideally, breastfeeding should be initiated within 1 hr of childbirth, practiced exclusively for the first six months and then continued with the addition of adequate complementary foods up to two years of life [51]. Good breastfeeding practice is directly linked with improved survival rates of under-5 and child's health that includes optimal cognitive development and lower risk of obesity and diabetes later in life. Mothers get positive benefits in terms of reduced risk of haemorrhage and breast cancer [51].

According to the study [80] that examines trends in the young child feeding practices in India in the period of 2006-2016, breastfeeding practices have shown significant improvements: Early initiation of breastfeeding nearly doubled from 23% to 42%, and Exclusive breastfeeding increased from 46% to 55%. However, still, a major cohort of children are missing out and the current rates, at best can be described as modest [80]. Several factors play role in dis-continuation of breastfeeding.

While it is known that barriers to breastfeeding occur at the social, cultural and political level that are outside of maternal control [24], there are differences in contexts of these factors. Prevalence of traditional beliefs and wrong practices among women (both rural and urban areas) are a major deterrent to exclusive breastfeeding [12, 13, 57]. Many families commonly practice prelacteal feeding as a ritual and discard colostrum [71]. For example, in some of the Hindu communities, after birth, a child is welcomed through a ceremony in which a family member writes the word "OM" onto the tongue of the child with honey in the hope to wish good qualities to the infant. In some castes, breastfeeding is delayed until fifth day due to their belief in ancient medical science. Perception of insufficient milk supply among mothers and caregivers is also a common barrier to exclusive breastfeeding. The study [12] found that nearly 33% women believed their milk supply would be low for their child and introduced animal milk and external food. Another challenge for new mothers is conflicting advice from a health practitioner and a family member. Female relatives in the house have a strong influence on breastfeeding practices.

From the country's perspective, to support optimal infant and young child feeding practices (IYCF), various strategies have been established [91]. However, gaps remain at the implementation level. For instance, the Maternity Benefit Act 1961 was amended only recently in 2017 for extending the paid maternity leaves for working women from 12 weeks to 26 weeks [84]. Further, currently, the act is applicable to certain establishments e.g. government and other organized sectors and does not protect women working in unorganized sectors such as household staff, contractual labors etc. [91]. This directly hampers the women belonging to lower socio-economic strata which hold a greater percentage of the country's population [15]. To improve awareness of women on IYCF, there is an emphasis on providing counseling at health centers and through community outreach. ASHA workers, who play a crucial role in connecting to marginalized communities, are seen as an important vehicle of behavioral change and thereby also trained on IYCF to promote exclusive breastfeeding in their post-natal home visitations [74, 99]. However, a range of challenges exists in translating the knowledge into actual practice. Due to over-burdened duties, high engagement

in paperwork and sub-optimal training, ASHAs' awareness of being health educators has been found to be low [41, 43]. Studies assessing ASHAs knowledge on breastfeeding practices report that though their knowledge is good, significant improvement is required on addressing prelacteal feeds, mothers perception on milk supply, and complementary food [99]. Further, there is a scarcity of studies to report on how mothers are supported beyond the six home visits of the ASHAs that is after 42 days of delivery.

3.2 Conversational Agents: Growth and Opportunities

Although the buzz around chatbot might appear to be newer, the history dates back to 1966 when the first-ever chatter bot named ELIZA was launched [113]. ELIZA was a computer program that could respond in natural language to engage patients in psychotherapy. Using keyword spotting and pattern matching algorithm ELIZA would select the most appropriate responses from a pre-defined set. Later, more advanced form of the ELIZA developed and became popular e.g. Parry (1972), JabberWacky (1988), ALICE (1995).

The key idea behind is to provide personalized assistance to the users through the mediation of human-like conversations. Advances in the field of artificial intelligence have led the chatbots to pick momentum. They can now learn user experiences and context and based on user history respond better in real-time. These interactions keep on improving as the user interacts more with the bot. Chatbots are increasingly being designed for variety of purposes, e.g. engaging in small talk [2], imitating psychotherapy [65], coordinating team events [104], updating on weather [58], and improving customer service [44]. And thrives on almost all popular digital forums, like messenger apps, social networking sites, and other conversation interfaces e.g. Amazon Alexa, Google Home, etc. In particular bots embodied in messenger apps gained traction in recent times. For instance, the year end 2016, when Facebook launched its messenger bot platform for the developers, marked the chatbots proliferation to 34,000 [66], which now has reached 300,000 [49]. Examples of some of the recent popular bots include Mitsuku [1], started in China, engages and entertains users by telling stories, jokes, and songs. Similar to this is Microsoft's Xiaoice [2] that is mostly liked for its sense of humor and ability to entertain users based on their mood cues. Beyond the commercial purpose, which has been the large focus till now, there is a growing consensus on the potential of chatbots in creating a positive impact on society [35, 88]. Due to the much wider reach, ease of access and interaction, chatbots can extend the public services. Healthcare sector is one of the promising areas for the chatbots. Low doctor to patient ratios, high cost, and complex procedures increase the gap between professionals and patients. Chatbots can bridge the gap by providing preliminary assistance [23]. As of today, the use-cases of tasks taken over by bots include making doctor's appointment, checking medical history, post-discharge follow-up, information searching, and lifestyle promotion. Few examples of the chatbots are as follows. Babylon Health [3], asks questions on symptoms, provides detailed information and additionally book an appointment with physicians. Florence [4] acts like a nurse that reminds taking pills, track health (body weight, periods) and help find a specialist in the nearby area. Safedrugbot [6] is designed to help doctors get information on the side effects of drugs during breastfeeding [2] [1]

3.3 Technology and Motherhood

In recent year, HCI research exploring the role of digital technologies for women's health has increased, particularly covering different aspects of motherhood. Social attitude towards breastfeeding in public, varies widely across cultures and countries. In UK, where it is mostly perceived to be a personal act, it is difficult for mothers to engage in breastfeeding practice openly outside homes. The study [14], proposes and develops a mobile application, "FeedFinder", to help a woman find breastfeeding places in nearby area, review and share them with other women. The work

report on the challenges in co-designing the application with mothers and design implications for mobile technologies to support public health. On similar lines of understanding the mothers' issues in using technology, [112] presents the development of "Milk matters", an application to motivate women in donating surplus breastmilk to nearby milk banks. The paper informs on the design considerations to make while working with mothers: interrupted interactions, elements of distraction and value of positive reinforcement. In many developing countries, the infrastructure to support storage and distribution of breastmilk, often known as Milk Banks does not exist. To address, a recent work [25], proposed a low-cost solution for milk pasteurization using mobile and sensing technologies.

To this emerging line of HCI research around motherhood, [31] contributes by analysis of 1000 submitted ideas of mothers on the improvement of breast pump. The paper highlights the complexity of post-partum phase and suggests using principles of feminist HCI and participatory design in designing supportive technologies. In developed countries, often new mothers face isolation in their initial phase of motherhood, [37] conducted an ethnographic study to understand the role of technology in the emotional and social well being of mothers and highlights the power of technology to provide social connectedness. Applications for expectant and new mothers to share information within their intimate group [50] or communication tools to stay connected with supporting people [62] have been found to be effective.

Apart from research endeavors, public health services have shown interest in leveraging technology to extend breastfeeding support. For example, Public Health England has launched a chatbot application under the program—Start4life over Facebook Messenger and Alexa platforms to provide 24/7 support [33]. [70] have worked towards developing tools to enhance communication between mothers and hospital staff. Also, commercially, there is an increase in applications targeting motherhood needs. A simple google or app store search on breastfeeding and motherhood leads to various options, which could be either paid or free, available for both android and IOS platforms e.g. Baby Tracker[64], LactMed [85], LatchMe[39], MyMedela[8], Feed Baby-breastfeeding app[90] etc.

While the above-mentioned works are towards women who are digitally literate and belong to urban settings of the developed world, there are others from marginalized groups, for whom we have limited understanding. Recent affordances to smartphones in developing nations, have made women in under-served contexts to start owning smartphones and explore the digital world, which earlier was a remote possibility for them. These women represent an important class of users for HCI and CSCW communities. We extend the limited but growing body of work on the intersection of technology for women's health and technology use by marginalized women [10, 115] through presenting our insights into the perceptions, experience, and contexts of chatbot application by mothers and community health workers in slum areas of Delhi, India.

3.4 Technology Based Support to CHWs

Community Health Workers are the last mile actors of healthcare who serve communities often vulnerable populations towards accessing health services and adopting healthy behaviors. In particular, their role in reducing mortality rates for maternal and child health has been significant. Thus, increasingly more programs are aiming towards innovating methods to empower CHWs [36] at the global level. Particularly, empowerment through technology integration in the ongoing endeavors has been an important direction .

Since CHWs often work in resource-constrained settings, whereby, infrastructure and technology penetration is limited, efforts have been towards making simple, low-cost and effective solutions. For instance, because of the high use of phones by CHWs, mostly feature phones, a rich body of work surrounds designing mobile-based solutions. By providing assistance through mobile applications, researchers focus on furthering CHWs performance which gets affected due to factors

including limited supervision, education, and training [41, 97]. For example, mobile applications e.g. SMSs, IVR, e-checklists have been used in improving CHWs adherence to house visits and case management guidelines [11, 28, 29, 54, 72]. In addition to supporting supervision, data collection by CHWs has been facilitated [32].

Community education has been highlighted to be one of the most challenging tasks for CHWs [41, 92, 97]. Studies have found a number of causing factors. For example, in persuading families CHWs face resistance due to low literacy, compliance with old age traditions and practices [92]. Due to minimum focus on the role of activists by existing training and supervision, CHWs remain unclear on how to execute the role of counselor [97]. Further, Limited, irregular payment of incentives and overburdened duties have been reported to negatively affect CHWs motivation towards counseling job [41, 97]. In this regard, use of mobile multimedia is increasingly being investigated in multiple ways because it offers an effective method of equipping ASHAs with authentic health information which they can use anytime and anywhere in the fields. Ramachandran et al. [92] addressed two challenges of community education as to how to persuade women towards the adoption of healthy behaviors and enhance the motivation of CHWs towards effective consultation. By providing short videos on health topics and testimonial videos by influencing actors of the village to CHWs, researchers could observe enhancement in the quality of dialogue between the CHWs and the families and self-efficacy of CHWs. The study by Fiore-Silfvast et al. [34] further confirms the usefulness of such videos in the workflow of CHWs by understanding their perspective on technology adoption.

Distinct from the aforementioned studies which adopt top-down approach in providing content to CHWs, Molapo et al. [77] proposed a software tool for health trainers in rural areas, to create their localized content. The easy to use computer application enabled the trainers to create non-textual content that fulfilled their community specific needs. On the similar line, Kumar et al. [60] demonstrated the impact of community participation in content creation and its use in the adoption of globally approved health practices. Further, there are studies that complement the prior work by understanding the sustainability aspect of mobile videos [75] and the value of involving CHWs directly in designing the content and applications [76].

Shortage of skilled trainers is a known challenge in upgrading skills of CHWs on a regular basis. A number of studies and projects have thus attempted to focus on using technology-based solutions to provide better learning opportunities for CHWs [17, 117] [53] [7]. The study by Yadav et al. [117] provided a learning platform, *Sangoshthi*, that enables live interaction between remote CHWs and experts. The study found positive outcomes in terms of significant knowledge gains and perceived usefulness as a supplementary learning platform by the stakeholders.

4 METHODOLOGY

In this work, our goal was to understand the potential of using chatbots in improving awareness on breastfeeding among ASHAs and women, in constrained settings of India. Our target userbase has characteristics such as limited digital experience, and no prior exposure with chatbots. To understand how would they interact with the bot and what kind of assistance they would seek, we conducted a Wizard of Oz experiment with 22 such users. Through a customized chat application, a human wizard emulated the functionalities of a chatbot, making users believe as if they were chatting with a real chatbot application. The wizard is a doctor in a remote site looking up answers from an official reference book, receiving the messages directly from the app over the internet.

WoZ is a standard prototyping methodology in HCI that enables designers collect design requirements and evaluate features without actually developing the full system [47]. It also helps in uncovering different scenarios of use which might be expensive to study later on [101].

We adopted the WoZ technique as a part of our iterative design process of developing a real chatbot. Since this is the first study that explores the use of chatbot for educating rural mothers and ASHAs, understanding users expectations and perceptions of use is important design aspect. Further, development of a real chatbot for domain and context-specific application is expensive due to requirement of a significant amount of data collection for preparing the knowledge base of the AI system.

4.1 Participants

The study was conducted in the East-Delhi region across two government dispensaries, separated by 3km. The dispensaries in India are the first-line of units for providing primary health care to underserved populations and generally consists of one or more doctors, nurse, and supporting field staff [79].

We chose the study area by using convenience sampling method since it was a field practice allotted to our institute from the Delhi State Health Mission [82]. Each dispensary had 30 ASHA workers and covered a population of 50,000 [73]. The economic strata of the covered area were lower and lower-middle income groups. To participate in the experiment we had the criterion of familiarity with smartphone operation. Based on prior WoZ studies [26, 108], we pre-estimated the sample size of around 20 for our experiment, 10 mothers and 10 ASHAs and began our recruitment process. We first started recruiting ASHAs at one centre, where we selected 8 ASHAs, the rest either did not use smartphone or were not available (on leave) during the experiment period. Using snowball sampling [40], these ASHAs further helped in recruiting mothers in their areas. Mothers who were breastfeeding their child (preferred child age—0-1 year) and had been using smartphone in some way (either their own or shared phone of the family) were selected. At this centre, 8 mothers from the areas of 3 ASHAs were selected, thereby making a total of 16 participants. In the similar fashion, we selected 3 ASHAs and 3 mothers at the other centre. Finally, when we reached a number of 22 participants, we stopped further selection. The demographics details of the ASHAs and the mothers is summarized in the table 1 and table 2.

Table 1. Mothers Demographics

ID	Age	Education	Age of breastfeeding child	Parity
1	28	tenth	2 days	Primiparous
2	27	graduate	1 month	Multiparous
3	25	graduate	1 month	Primiparous
4	28	graduate	1.5 months	Primiparous
5	32	post-graduate	2.5 months	Multiparous
6	24	eight	3 months	Primiparous
7	28	twelfth	5 months	Multiparous
8	34	tenth	6 months	Multiparous
9	24	graduate	8 months	Primiparous
10	23	graduate	9 months	Multiparous

4.2 WoZ Architecture

Building a conversational agent that acts like a human is one of the most challenging area of artificial intelligence and natural language processing fields. The architecture of a chatbot is decided on the type of purpose, whether the chatbot is intended to help users complete specific tasks (task-based

Table 2. ASHAs Demographics

ID	Age	Education	Job Experience
11	32	twelfth	3 years
12	38	tenth	10 years
13	40	tenth	10 years
14	36	graduate	4 years
15	29	graduate	4 years
16	34	twelfth	4 years
17	37	eighth	7 years
18	49	tenth	9 years
19	35	twelfth	8 years
20	35	graduate	1 year
21	30	twelfth	3 years
22	28	graduate	5 years

chatbots) [118] or engage users in conversations on open domain topics (non-task based chatbot) [94]. Considering the non-task based chatbots, there can be two models as generative and retrieval-based. While the retrieval-based bot parses user input to find out message intent (keywords based) and return the best matching response from a predefined set of messages, the generative-based models generate a response from scratch using complex natural language processing and machine learning algorithms

In this experiment, the wizard imitate the retrieval-based model of chatbot in a single turn scenario, which only considers the last input message. Further, in wizarding such a bot, we make assumptions about the richness of the knowledge base, accuracy level in finding the responses and parsing the messages.

To answer users' questions, we prepared a knowledge base from the training material of the ASHAs and a book of 100 most commonly asked mothers questions on breastfeeding [61]. This book was written by a medical expert from an NGO (our collaborator partner) who has a 40 years of experience working in the field of maternal and child health. Originally the book was in English language, which was then translated into Hindi and cross-checked by a medical expert for correctness. Apart from this, for any new query we referred to WHO content material.

We model our chatbot as an interactive question-answering application that features three functionalities broadly: it can answer users queries on breastfeeding, counter-question users and present interesting facts and information. We defined the properties of the bot as follows. The users can input their message in both voice or text form like used in general messaging apps. For the text form, both the Devanagari (Hindi script) and transliterated form (Hindi form written using English alphabet) are allowed. However, the bot responds in text form only, using the Devanagari script. Further, the bot's understanding of the language is limited. It does not understand the implicit utterances or informal feedback cues such as c ya, alright, etc which are generally used in human conversations. It also doesn't entertain casual talks. Finally, our bot is not intelligent to overcome any ordering effects. For example, if the bot is in the process of finding an answer to a query and the user feeds more queries in between, the bot does not automatically process them. The history of conversations is not taken into account.

4.3 Wizard Workflow

To give the users a feeling of conversing with a real chatbot, we limited the wizard ability to answer every question. Given a user query in a conversation, the wizard imitates a chatbot using four

Fig. 1. Wizard-of-Oz Experiment Setup

types of messages as follows: 1.) **resend prompt** - wizard prompts the user to resend message to show parsing errors. The wizard decides this prompt by judging the quality of messages. Voice message is prompted for resending, if it is noisy, too long, difficult to interpret and text message, if it contains misspelled words, garbage characters or incorrect sentences. For the case, in which the user messages do not contain any error, the wizard still deliberately prompts to resend at least once in an interaction. 2.) **out of scope** - users is denied to receive any answer if the question is out of the breastfeeding domain, 3.) **near-relevant responses** – The wizard responds with near relevant answers to the questions which are complex or advanced e.g. health conditions described with variety of details including symptoms, diagnosis, history, etc. Based on the keywords, best -matching information is returned. This helps in showing limited intelligence level of a chatbot. Here, the wizard leaves those queries which require human expertise e.g. breastfeeding when a mother is suffering from cancer etc. 4.) **not found responses** - when the answer to a question is not found in our knowledge base, the wizard replies with this message. The flowchart representing the conversation flow and the decision making is shown in the figure. 2.

To help the wizard respond consistently and quickly to the users, conversational scripts were used. For example conversation starter sentences included phrases such as “Hello”, “How may I help you”, message acknowledgements included “please wait while I search the information” etc. After the initial few sessions, a document of frequently asked questions was also used. The figure depicts the overall WoZ setup 1

4.4 Chatbot Design

We developed our chat application for Android platform using Google Firebase. Using authentication and real-time database services, messages were passed between two endpoints. The interface of the chat screen was made simple having a chat view, a text box, a voice recording button, and a file attachment icon. We designed the bot persona as a lady in 30s wearing traditional Indian dress of salwar-kameez and named her as “Yukti” which means tactic to solve a problem. We attempted to give the personality that resembles ASHA, a helping sister. Considering the cultural sensitivity about talking openly to a male in Indian society [68, 110], we preferred the female gender for the bot. To make the chatbot self-explanatory, we added animated introductory tutorials in the

Fig. 2. User-Wizard Chat Flow

beginning screens. The app starts with Yukti introducing herself followed by feature explanation and scenario of use. The figure 4 shows the app snapshots of the user and the wizard's version. We portrayed four features for Yukti as one source of information (user can find all breastfeeding information through Yukti), authentic information (medically validated content), 24 * 7 availability and Ease of Use (voice messages).

We also incorporated a functionality to take users' feedback on bot responses. Through a button, the wizard could push feedback rating tabs onto the users app. The scale of the rating was 3-point: good, bad and average. Other useful functionalities that were under-development and not used in this study including indication when a user is online, push notifications, and read receipts were managed manually with the help of research staff. A sample conversation (name of the user is changed to protect privacy) is shown in the figure. 3.

Finally, we conducted a pre-pilot study with seven lady security guards in our institute campus. All these ladies were mothers and smartphone users. Their mean age was 31 years (26-38) and education levels ranged from tenth to graduation (three with tenth, three with twelfth and one with graduation). The chat sessions conducted with them helped us in developing the time estimate to curate responses to users' messages, get an idea of the type of user queries and served as practice sessions for the wizard. The feedback shared by the ladies improved the interface of the app.

Yukti: Hello, What can I call you?
Mother: Aarti
Yukti: It's nice to meet you Aarti.
Yukti: If you have any questions, you can type or record it.
Mother: What should be given to children after 6 months?
Yukti: This question seems to be out of the topic of breastfeeding. I am not capable of answering it right now. Please ask another question related to breastfeeding.
Mother: How long should a child be breastfed so his/her stomach gets full.
Yukti: Thank you. Getting your answer from my material.
Yukti: Some babies suckle fast and some are slow. As a child grows, their feed duration can change. Duration of feed can also depend on when the milk comes in after the child starts suckling. Usually, a baby spends 5-10 minutes on a breast, but we recommend that you let the baby decide the duration of the feed.
Yukti: How did you find the answer to your question, give your rating by pressing one button:
 Good/Bad/Average.
Yukti: #GET USER GET_FEEDBACK#
Mother: Good
Yukti: Let's see what questions other breastfeeding mothers like you ask?
Mother: After 6 months, should I exclusively breastfeed or give top feed as well?
Yukti: Question: How will I find that my child is full so I can stop breastfeeding?
 Answer:

- Your child will fall asleep while feeding.
- Your child will not actively suckle or will completely stop suckling.
- Child can open his/her fist, arch his/her back or smile or shout.
- You will feel that your breasts have gone soft.

Yukti: How did you find this fact. give your rating by pressing one button: Good, Bad, Average.
Yukti: #GET USER GET_FEEDBACK#
Mother: Good
Yukti: If you have any questions, you can type or record it.
Yukti: Let me ask you a question.
Yukti: If mother or child has vomiting, diarrhoea or other illness, so mother should stop breastfeeding for some time. Choose one from below given options:
 A. True
 B. False
Mother: B
Yukti: Absolutely Correct Answer. :)
Yukti: A sick mother or child is not a reason to stop breastfeeding. Breast milk given during sickness helps in maintaining the nutrition status of the baby. Continuous breastfeeding also helps in recovering from illness. It also stops illness and malnutrition due to low diet. And breast milk is especially beneficial if the child has diarrhoea.

Fig. 3. A Sample of Question-Answer Session

4.5 WoZ Setup, Session Details and Ethics

In our WoZ experiment, the users and wizard were separated physically and communication happened through the app over the Internet. While working with mothers of newborns, we had to be sensitive to their convenience and comfort. Travelling for the mothers was not feasible, therefore, we made house visits to conduct the sessions. Further, the house visits gave us the opportunity to capture users' interactions in their natural environments informing us on contextual aspects. ASHAs' sessions were conducted at the health dispensaries which they regularly visit as part of their duties (see figure 5). Our team which conducted the experiment was composed of three members: two research staff and one medical expert (MBBS, MPH doctor, acted as the wizard). The wizard set up was located at our Institute's lab.

Fig. 4. Snapshots of the Yukti app show the screens of the launch, introduction, interaction scenario, feature explanation and conversation

Fig. 5. The pictures show the session locations for the ASHAs (health dispensary) and mothers (houses) and the wizard set-up

We conducted the experiment with participants after obtaining approval from the review board of our institute. Before the sessions, participants were briefed about the purpose of the study, data to be collected and potential risks. Participants were assured that all of their interactions would remain confidential and used only for the analysis through proper de-identification. Participants were informed that they were free to leave the study at any point in time.

We planned three sessions with every participant and conducted them after obtaining the consent. We introduced *Yukti* to the participants as a chatbot which is under-development, thus not fully ready, and that we wish to collect their experiences and inputs for research purpose that would help in the development of the future systems. Participants were explained the concept of chatbot because all of them were first time users. They were told that they would chat with a machine which curates answers from an authentic knowledge base. Since the experiment was a WoZ, participants were deceived on the part that a human instead would be responding. About the 24*7 availability

feature, participants were informed that it will be applicable only when the actual chatbot app will be released.

The three sessions of a participant were conducted on three separate days. Adjusting to the routine schedule of ASHAs that included coming to the health centers for immunizations, antenatal checkups etc., we conducted the sessions based on their availability. The sessions with the mothers were conducted at their houses. On the first day, the associated ASHAs accompanied the research staff to show the houses and introduce to families. On subsequent days, the research staff went on their own except for two houses which were found difficult to reach. During the sessions, both the ASHAs and the research staff did not interrupt the mother except for clarifying questions regarding the app use. However, the presence of the staff might have affected mothers' interaction or behavior as the study was not in-the-wild and has the same limitation as that of general WoZ conducted in a lab.

To conduct sessions, we used our mobile handset that was given to the participants only for the session duration (a single session ranged between 10 to 30 minutes). We preferred to use our handset to maintain consistency in the use and avoid users attempting to use the app outside of the session timings when the wizard would not be available. We used a Motorola C plus handset that costs \$84, lying in the average price range of smartphone in India [42]. Thus, the phone was equivalent to the type of handsets generally used by the participants.

Due to the use of Firebase to support the chat functionality, the application required a Gmail account to login. Many of the participants were unaware of email application and had their phones configured with husbands' or children's email accounts. For these participants, we created new dummy Gmail accounts without using any personal information. We did login ourselves without sharing the credentials. All of these temporary email accounts were later deleted. To maintain the privacy of the users, we de-identified participants details before starting our analysis.

Considering the use of conversational agent for breastfeeding education, we anticipated certain ethical concerns in our experiment which we attempted to address as follows. Prior studies on intelligent agents have found that despite knowing the true form of bot, users tend to develop strong emotional attachments towards bots [114] and thereby develop high expectations. To minimize the risk, we clearly explained the functionality and scope of the bot at the outset. We also ensured that wizard uses language that reflects its machine nature and its limitations e.g. "please wait while I search for information in my material".

Another perceived risk lied in the way users interpret the bot responses. Users sometimes might not understand the meaning of the received answers and need further explanation. As observed, sometimes when the mothers were not convinced by the bot responses or they were confused about the interpretation of the responses, they expressed it to the research staff. We ensured that the research staff note these points during the session but responsibly explain at the end so as to mitigate the risk of incorrect interpretation.

Since the breastfeeding phase of mothers, in reality, entails a lot of issues that need counseling support, we noted the encountered problems and conveyed them to an NGO working in this field and the ASHA workers. However, we did not specifically arrange the counseling support directly.

4.6 Positionality

All the authors are of Indian origin and have conducted fieldwork across different regions and marginalized communities in India. Three of the authors identify as female and one as male. The education background of one of the females and the male author is in computer science and HCI, and that of the rest two in medicine (MBBS and MPH) and Psychology. Specifically, the two have conducted HCI research with a focus on designing ICT-based solutions for maternal and child health .

Having been born and raised in the same region (North India), we all have had exposure to the socio-cultural aspects of breastfeeding within our immediate families, relatives, and neighbors. One of the authors is a young mother and was in her breastfeeding phase during the study.

4.7 Data Collection

During the sessions, we took detailed notes of the participants' reactions, comments, and ambient activities. Further, whenever needed the research staff also made contextual inquiries, for example, number of family members. At the end, of each session, overall feedback rating was collected on a five-point scale represented in the form of Emojis.

At the end, we conducted semi-structured interviews with the participants. There were two parts of the questionnaire. The first part was common to the ASHAs and the mothers, designed to collect their feedback on *Yukti* use. The questionnaire as adapted from [78], covered aspects of usability, satisfaction, and perception on the usefulness of *Yukti* and consisted questions like “*Did Yukti supply all the information you wanted?*”(yes/almost/no), “*Do you think Yukti understood everything that you asked?*”(no/almost/yes-all), “*How difficult it was for you to use Yukti app?*”(difficult/easy/moderate), “*Did you find the information provided by Yukti to be useful?*”(yes/almost/no), “*what kind of improvement do you want to see in Yukti?*”, “*Would you like to use the app in future?*”(yes/almost/no). The second part of the questionnaire had different questions for the ASHAs and mothers. For mothers, questions were specific to sources of information on breastfeeding, role of husband and ASHAs e.g “*Where did you stay after the delivery?*”, “*How did your husband participate in the care? describe*”, “*How helpful do you find the support of ASHAs in breastfeeding problems?*”. An example of questions asked from the ASHAs are “*do you think six post-natal visits are enough for addressing breastfeeding issues*”. We remunerated the participants with a cash incentive of 100 INR per session.

Apart from the field notes, session recordings, and interview data, we also used chat logs in our data analysis. Together with these, the three members of our team worked on finding the emergent themes. The thematic analysis was inductive [22] in nature where codes were shared, discussed and refined in multiple iterations.

5 FINDINGS

In this section, we describe the recurring themes emerged from the analysis of the field observations, user interactions with the bot, contextual inquiries, and the final interviews conducted. Throughout the paper, we refer to mothers by their pseudonyms to maintain their privacy.

5.1 Information Sources and Influence

In this theme, we describe the socio-cultural settings in which women are placed, available sources of information and the influence of these sources on women's choices and practice of breastfeeding. This includes factors pertaining to family institution, woman's position in exercising power and gaps in existing channels of communication.

5.1.1 Role of Female Relatives. In all our house visits to the mothers, we observed the household dynamics of Indian family culture. Mothers were primarily concerned with household tasks and childbearing, one of the primary manifestation of gender inequality in India society [30]. Mostly they were homebound and depended upon others for any outdoor tasks. Whether mothers lived in a nuclear or joint family, the mindsets and practice of age-old traditions came into play including the childbirth and care. Generally, post-delivery in India, women are given care by their relatives where the main caretaker is either mother-in-law or the mothers and the role of husband is limited. In our interactions with the mothers, we consistently found that their mothers and mothers-in-law have a prominent role and influence breastfeeding practices significantly.

In one of the cases, Kamini (a new mother of 4 days old baby girl), was being taken care of by two, a mother-in-law and grandmother-in-law. Till 4th day the breastfeeding practice had not started, and the family was very concerned. According to them, despite making numerous efforts, the child was not able to suckle. Mothers nipple were tight and sore. They said that the child doesn't take the mother's nipples into her mouth and cry a lot. The mothers-in-law also concluded the child had developed an aversion for the mother's nipple. To compensate, they were feeding the child on external milk (toned, packaged milk of cow). According to breastfeeding guidelines, in any case, if infants are being fed on external milk it should be formula milk and not animal milk. We sensed the familial atmosphere to be quite uneasy for the women (mother) as her mother-in-law complained to us that she wakes up late in the morning.

The sessions with another mother, Meena, who lives in a big joint family of 16+ member, again highlighted the role of the mother-in-law. Meena was breastfeeding her 2 months old child, however, was also supplementing cow milk. She gave the reason as follows *"my mother-in-law advices me not to feed the child after taking a head bath as this can give cold. To avoid letting the child hungry for long, we give cow milk on such time intervals"*.

Mostly women followed the suggestions received from their mothers and considered it to be a reliable source of information. Evidently, in a case in which mother support was absent, the woman expressed her feeling of missing it: *"I am very worried, this is my first child, there is no one to talk at home. I feel helpless and alone as my mother-in-law is not here. I am not able to have adequate knowledge and information. Outsiders tell 10 different things, no one knows what is right. Now we can ask everything from Yukti"*.

5.1.2 Role of Husband. Like prior studies [63], we found low husband participation in childcare and breastfeeding practice, especially during the initial phase post-delivery. During day time they would go to work place and at night, had restricted interaction with their partner and children.

Kamini who was surrounded by her two mothers-in-law for the majority of the time described her husband's participation as follows. *"He(husband) comes around 7-8 pm from his office, sits with me for a little while and then goes to sleep in the room upstairs as he has to get up early for office. Gudiya(baby) cries at night, doesn't let him sleep, that's why he sleeps in another room."* Meena, who had two children, with younger daughter of 2-3 months of age, shared her frustration about limited participation of her husband. She complained about his husband's behavior towards children that he doesn't help her out in handling them and she has to manage everything on her own, *"He returns from his duty (work shift), and then sleeps off, says after working for the entire day I can't handle baby"*.

Cases in which husbands were supportive also could not participate much, due to job compliance and financial responsibilities. Sulekha, who did not have mother-in-law shared her experience as *"My husband and sister in law used to do all household work/chores when my baby was born. My husband is a car driver, during those days he took leave to take care of me, but then he had to go back to his job really soon as his leaves were canceled and even pay was cut. My husband told me that we both have to manage ourselves as no one else will come to help. Then just after 12 days, I started doing all the household work on my own"*.

5.1.3 Role of ASHAs. Maternal and child health care is the mainstay of ASHAs profile [74] and promoting exclusive breastfeeding during house visits is one of the priority tasks. However, their role as a lactation counselor did not emerge in our study. Out of ten mothers, six gave negative statements for the ASHA support, two spoke in favor, one was neutral and one found the support to be useful only in case of emergency or any specific inquiry. Among those who rejected ASHA support gave the common reason as poor communication with ASHA, *"ASHAs just come for vaccination, we do not get any support on breastfeeding"*, another said *"she doesn't visit, neither*

provides any information. In fact, she lives close-by, but still does not come for the visits". Further, in one of our visit [Kamini's House], we also observed casual behavior from one of the ASHA. As the baby was not able to get breastfed since birth, the ASHA did not show any efforts of helping. After assisting the mother only once in latching the baby, she soon gave up and remarked as *"this baby is naughty, doesn't take mother's milk at all"*. She did not encourage or gave any positive reinforcement to the mother and the family. She did not even suggest the family to see a doctor. Only when the family mentioned that they would like to go to health dispensary and asked if she could accompany them, she agreed.

This observation is in line with the findings of the prior work assessing the performance of ASHAs as counselors. Factors like poor training on counseling, lack of compensation for counseling tasks, and low status in community has been linked with ASHAs poor performance [92, 98].

5.1.4 Role of mothers. In the light of limited mobility and resources, the mothers seemed eager to receive information from any source they could. For instance, Meena acknowledged the value of breastfeeding consultation received from a woman who used to come for her body massage as: *"15 days post-delivery a masseuse used to come, who would explain everything very nicely and she was knowledgeable. She would take out dirty milk from my breast, massage them and advise me on breast issues like if breast is heavy. That is why, till now, I have not faced any problem."* In another case, a mother quickly enrolled herself when she came to know about Kilkari program, a government initiative to disseminate information on pregnancy, childbirth and childcare through IVR service to new and expectant mothers. Since then she had been listening to the audio content regularly and find it to be very useful in both of her pregnancies. Additionally, she was among those women who searched for information over Google and Youtube.

Given the low exposure level and autonomy of women, the importance of ease of availability and accessibility of information became apparent.

5.2 Information seeking

We analyzed 296 questions received in 66 interactions, on aspects of nature of the information sought, topics, and style of framing. The main purpose of this analysis is to understand the type of queries users in our context seek from an educational breastfeeding chatbot. This gives a general idea of, to what extent a general knowledge base as used in our study is useful and what is required beyond that.

5.2.1 Query Type. We analyzed the information-seeking habits of the users on its nature and complexity level which we represent through a four-quadrant matrix shown in the figure 6. We found the query type to broadly fall in two categories: i) fact-based, i.e., the questions which seek fact-based answers or which have standard text-book answers and may hold true for the majority e.g. *"What is the benefit of mother's first milk (Colostrum)"*, *"when should we start complementary food for a child"*, and ii) condition-based, i.e., the questions which seek personalized answers to a user's health condition and may not be true for the majority e.g. *"When I feed my baby I feel a lot of pain, what should I do?"*, *"my baby is 3 months old, I am not able to produce enough milk, what should I do?"*. We further divided these two categories into simple and complex queries depending on the nature of the questions. Out of the four categories, overall 88% questions were of simple nature and we believe that they can be answered by a Chatbot using a knowledge base. The complex condition-based category (9%) included queries which are complex in the sense that they contain information like symptom details, treatment history, follow-up condition etc. An example of a complex condition-based question is *"a mother was having TB for more than 6 months, she delivered a baby, now who is also showing symptoms of TB. Should the mother do breastfeeding"*; we believe that such questions require expert intervention and must be directed to a doctor. Lastly, the

Fig. 6. User Information Seeking

complex form of fact-based queries (3%) covered more advanced form of fact seeking. The users are interested in knowing more on complex issues e.g. “*if a mother has TB, can she breastfeed?*”.

5.2.2 Query Topics. Further, analyzing the topics in which users were interested, we found the categorization and prevalence as shown in the table 3. 26% of the queries were related to breastfeeding problems such as breast issues (soreness, mastitis, tightness etc.), problems in latching etc. 18% were related to conditions hindering exclusive breastfeeding. Mothers were already feeding external food to their babies and sought suggestions on their practices. Mostly, the external food in these cases was animal milk (packaged cow milk). Only a few asked about formula milk. Mothers also lacked general knowledge about exclusive breastfeeding as a good proportion of questions in this category expressed mothers confusion of continuing breastfeeding when the mother or child is sick. 15% were related to knowing the breastfeeding technique including frequency, duration, and feeding position. Among the feeding position questions specifically, mothers were curious about the lying position. Their perception reflected hesitation in adopting it. A mother said, “is there any bad effect of feeding in lying position”. 11% were related to milk supply, where the mothers generally wanted to know how to determine that the child has taken enough breast milk, mothers’ milk is sufficient or not etc. Mostly, these reflected mothers’ perception of insufficiency of breast milk supply. 12% pertained to the miscellaneous category in which users majorly sought general information on a variety of topics such as how to deal with milk leakage, how to store breastmilk etc. 10% were related to the diet of the mother and the child. The remaining 5% of the questions sought information on special topics such as AIDs, HIV, TB during breastfeeding phase. Of the total questions, 17% were out of scope of breastfeeding and ranged over topics related to post-delivery and general childcare.

Analyzing the queries, many misconceptions and malpractices rooted within the Indian population [71] were seen in our sample. For example, use of janam ghutti (an old Indian herbal concoction), water, and bottle milk, the commonly found barriers to exclusive breastfeeding were present in the queries [56].

5.2.3 Query Phrasing. User queries had different aspects of the style of framing the question, the language used and the content. Majority of the queries were short in length, however, missed key informative components e.g. “*baby is crying, what to do.*” As compared to mothers, ASHAs phrased questions more completely, “*my child is 3 months old, can I give janam ghutti in addition to my breastmilk?*”. There were repeated expressions as generally found in natural conversations, “*I*

Table 3. Questions Themes and Topics

Theme	Topics	%	Example Quotes
Breastfeeding Problems	breast issues, latching issues, infant crying, digestion	26.81%	<i>I have cracks in my nipples, can I feed the baby as blood comes out while breastfeeding</i>
Exclusive Breastfeeding	supplementing top feed - cow milk, introduction of water	18.12%	<i>I feed my son cow's milk, besides this, if I give him powder milk, will it be alright?</i>
Breastfeeding Technique	feeding position, frequency duration	15.94%	<i>How long should a mother breastfeed each time, so that the child will be full?</i>
Milk Supply	how to boost milk supply how to determine child hunger, perception of low milk supply	11.23%	<i>Immediately after the delivery, mother says, that, milk is not coming from the breasts, now what should a mother do?</i>
Diet	mothers diet child diet after six months	9.78%	<i>What should a breastfeeding mother's diet constitute of so she can successfully breastfeed her child?</i>
Miscellaneous	benefits of breastfeeding, cautions during breastfeeding, breast milk leakage, storage of breast milk	12.68%	<i>If we collect the milk expressed by mother, which metal utensil should we use and for how long can the milk be stored, that it is hygienic and good for the child</i>
Special Topics	AIDs, HIV, TB, cancer, and breastfeeding	5.43%	<i>If a pregnant woman finds out she has TB, should she breastfeed her child?</i>

am not able to properly breastfeed my baby, how will she be able to feed, she is not having enough breastmilk". The implicit information part e.g. age of infant, weight of the child were generally missed. Some of the users narrated their questions in form of stories, e.g., *"If mother has to go out due to any circumstance and she can't carry her baby along, baby is very young, weather is bad, then in this situation what kind of milk should we give? can we give packaged cow milk available on Mother Dairy booths? can we give toned milk, is this type of milk good for baby, hygienic for baby?"* They also merged multiple questions in one statement such as *"when we breastfeed our baby, we make sure to burp her but still she vomits, what should we do? and my second question is when a baby is having cold such that she can't cough but there is noise in breathing, how can we treat this?"*

As for the language, there was a mix of English, Hindi and regional dialects. Delhi, being home to immigrants from various other states, like Punjab, Haryana, UP and Bihar etc., does not primarily has a generic language but is a mix of Hindi and regional languages, dialects and accents [21]. While, for the majority of the users, colloquial Hindi was the prime language, some mixed English words e.g. *"mera bachcha six plus ka hai kya feed suitable rahegi?"* (my child is six plus of age, what feed would be suitable for him?). At times, when users preferred typing queries, they used Roman Hindi words (words written in Roman Script instead of Devanagari Script) e.g. *"hum dawaai khat hain to bache ko doodh pila skti hun"* (I am on medicines, can I breastfeed my baby?). Since there are no standard ways of spelling transliterated words, there were huge spelling variations, highlighting the problem space of code-mix, a well-identified challenge [46] in the Information Retrieval field.

5.3 User Perceptions

In this section, we will discuss what and how users perceived from the chatbot interaction.

5.3.1 Trusting and Available Partner is the Need of the Hour. The sense of receiving correct and verified medical information from the bot helped users develop trust in it. Only, when the users

developed confidence in the credibility of the bot, their likeness to use the app increased further. ASHAs tended to test the knowledge by asking on topics they are trained. For example, an ASHA asked a question on how to care breasts when they develop soreness. On finding the answer that soap should not be applied, she became satisfied and said: *“yes, the answer is correct, the same thing is told to us in our training”*. Users also compared Yukti with Google and were able to point out the benefits of receiving authentic information — *“Google brings any kind of information, we can’t trust that, but Yukti brings authentic and correct information”*.

Users appreciated the comfort of talking to the bot anytime, anywhere without the feeling of being judged. Some mothers who mentioned their hesitation in reaching out to doctor or anyone else and found the proxy of the bot to be useful. A mother[Pooja], who was shy and interacted with the bot using text messages in all her sessions shared her feeling as *“I am very shy when I visit the doctor, I am unable to ask anything. I could ask all my questions from Yukti”*. Hesitation in talking with males was highlighted in these experiences. In Indian society, sharing of reproductive health with males has been considered as a taboo that makes women restrict themselves to female Friends or relatives for any sort of consultation. Meena (mother) - *“as a lady we share the same problems, if a male is standing in front of use, then we hesitate to talk about such matters”*. A mother confirmed from the research staff whether she can ask sex-related question to bot or not *“Can I ask a secret question? If a mother is breastfeeding her child, can she maintain physical relationships? People say this, but I went to my mother’s place after delivery for 7 months, but I had this question in mind and I wanted to ask whether it is true or not?”*. After receiving the response, she appreciated the fact that she can ask anything from the bot even personal questions. We noticed that she was waiting for the right time to ask this question and asked that in her last session, *“I was thinking since day 1 to ask this question”*. Further, since other female friends are not always available. Mothers found the all-time availability of the app quite useful feature - *“there are times when we do not want to trouble anyone for example, some problem arises at night then we can ask the bot”*. Many described Yukti as a friendly partner with whom they can share their concerns freely, *“Yukti gives answers like a friend, if I want to know anything, I can ask questions from the bot just like a friend”*.

5.3.2 Expectations of Stakeholders: ASHAs and Mothers. As a first time exposure to a chatbot on breastfeeding education, users developed high expectation. When asked about the limitation of the bot, all highlighted its scope of domain. They desired full coverage of the spectrum of mother and childcare. Some of the users attempted to ask out of domain questions and showed disappointment on not receiving the response. For example, Soni[mother], wanted to confirm from the accompanying research staff, *“can Yukti answer health-related questions as well? My child doesn’t eat food at all, can Yukti help on that”*. On her friend’s suggestion who was sitting nearby, she also asked menstruation-related question, *“how to deal with period pains?”*, both of them became highly disappointed and surprised on getting the prompt of out of domain, *“This Yukti only responds on breastfeeding topic”*. The strong desire of talking to an expert and getting immediate solutions to their everyday problems and concerns was predominant among mothers. For example, Meena (mother) was curious to know suggestions on baby products from Yukti. and asked a question as *“which product should I buy for my baby, Is brand Patanjali good?”*. She also asked the research staff, *“can I ask a question of thyroid, I had it before delivery, are there any chances of its continuation?”*. Another mother gave suggestions to us as *“you should also make Yukti type of application for girls to educate them on menstruation”*. Some mothers were also not convinced after received only short answers to their questions. Apart from the factual answers, especially when it differed from their existing knowledge, they expected a detailed explanation.

Compared to mothers, ASHAs showed greater restlessness concerning to the limited scope of the bot. For instance, one of the ASHA said - *“why is the bot only about breastfeeding, there are only*

limited questions on breastfeeding - example mastitis, etc. we can't ask more on this topic". Such kind of feedback was particularly given by ASHAs who engaged with Chatbot by testing its knowledge. However, when the bot asked them questions, out of 33 questions, the ASHAs, on average, could correctly answer 19 (57%).

Comparing the perceived use-cases of a chatbot application for ASHAs and mothers, we majorly found two: ASHAs perceived the chatbot like a trainer that can improve their knowledge and assist in handling their client cases. For Mothers, it was perceived to be more like a helper and first point of contact for addressing breastfeeding issues. Therefore, ASHAs and mothers cannot be considered as a homogeneous group, suggesting different needs for design.

5.4 User Engagement

5.4.1 Personification. Interaction with Yukti was the first time exposure of the users with a chatbot. In the debriefing sessions, we explained the phenomena of the bot through various analogies like robots, automated machines etc. The app also contained animated videos depicting how can a mother interact with Yukti. Given her avatar as a woman in late 30s, users perceived Yukti as a human being. Some correlated its persona as a lady doctor and some as a friendly sister like ASHA. The way users framed their questions and reacted reflected their perceptions. For example, an ASHA curiously asked: *"Is this Yukti, like you madam?"*. A mother perceived the task of finding answers to be troublesome for the bot, *"The bot has also become irritated by giving answers"*. Another mother used to speak softly and in low volume. On being asked she gave the reason of not hurting the bot. On giving feedback to the bot response, an ASHA showed hesitation in giving a low rating *"I did not like this answer, can I give a negative feedback?"*

5.4.2 Response Time. As currently the responses were curated manually, it incurred delay. On average, upon successful submission of a query, the bot responded in 1.20 minutes. While most of the users maintained patience, a few showed annoyance. These users were particularly ASHAs of one of the health center. *"this bot takes such a long time to reply"*. Rest waited patiently and accepted the lag. On being explicitly asked- *"don't you think bot takes time to answer your questions"*, they replied: *"finding answers takes time"*. Some of them perceived the issue in the mobile data connectivity to be the cause of the slow response.

5.4.3 Ordering effects. There were instances when synchronization between the user and the bot went out of order. Yukti app did not support remembering the history of users questions. While processing a request, if in-between the user-submitted another query then it was not taken into account. The examples were while sending a query response which spanned multiple paragraphs another query came in that went unattended. During the waiting period of the questioning activity of the bot, few users instead of giving the answer option submitted queries. On such occasions, the bot processing continued by giving the response as - *"sorry, it was the wrong option, choose again"*. In such scenarios, users expressed disappointment and perceived as if the bot ignored them or couldn't find the answer to their query. Supporting quotes are *"it didn't answer my question"*. In total, there were 29 such instances (8%).

5.4.4 Excitement to Use Fulltime. The users showed excitement towards the app and wanted to start using soon. This excitement was prominent among mothers, as this was first ever kind of breastfeeding support they got used. When the mother (Rekha) used to interact with the app, her sister-in-law would watch. Her sister-in-law was four months pregnant at that time. She asked the research staff, if she can get the app, it will help her post-delivery. On the question of recommending the app to others, all said yes.

5.4.5 Interaction Elements. During sessions, sometimes users would be out of questions. On such occasions, the features of counter-questioning by the bot played a good role. *Yukti* app asked at least one question and presented one fact in every session. This feature was greatly appreciated by the users. User excitement increased when they were able to give correct answers to the questions and received appreciation from the bot, highlighting the importance of gamification elements. In the exit interviews, users mentioned increasing the frequency of counter-questioning.

Further, the presentation of information surfaced to be an important theme. In our prototype, the language of the knowledge base of the bot was Hindi, which was more formal in nature. This made the understanding and interpretation to be difficult for some of the users. In one of the response for an ASHA, the bot replied “*when children are young, they often do not eat*”. The ASHA got confused and misinterpreted the meaning of the word “young” and thought when children become old. She then got it clarified by the research staff. Responses which were longer and monotonous were not found to be non-engaging. Few users seemed uninterested in reading them. A mother asked the research staff to read responses for her. These experiences suggest that a bot should have a high use of colloquial language. Also, the context in which information is positioned should be localized. Use of graphics puts an added advantage. Wherever, *Yukti* presented images, users appreciated it and also highlighted it for future development.

6 DISCUSSION

Our exploratory study highlighted the promising potential of chatbot for educating community health workers and mothers on the subject of breastfeeding. With our study, we aim to understand how the actual beneficiaries (mothers and ASHAs in our case) perceive the AI intervention and identify the potential design opportunities and challenges. Within the realm of AI for social good, our study will expand the CSCW and HCI community’s understanding of the potential of chatbot as an educational intervention in the under-served context of India. We believe that this understanding will be relevant and can be extended to similar cultural and resource constrained contexts.

6.1 Interaction, Engagement, Trust, and Ecology

Our study with 22 users from resource constrained settings of India highlights the value of providing timely breastfeeding advice to the mothers. Given their restricted mobility and high dependency on others, the chatbot was seen as the first port of call and help by mothers in avoiding any incorrect advice from family members or others. Our chatbot was able to successfully handle 88% of the queries which majorly sought information on common issues of breastfeeding e.g. early problems in breastfeeding, perception of low milk supply, and more. Such topics form an integral part of the ASHA training material, which in our case was used as a reference knowledge base. In the study, it was rare when the wizard had to take help of external sources. This suggests that ASHAs’ training material can be effectively used as a knowledge base of a chatbot. Further, we observed that while there were requirements for seeking expert consultation (26% and 9%), only 9% were complex enough queries that only a medical expert could answer. Given the poor doctor to patient ratio in India, chatbots can be seen as a promising educational and training intervention to provide relief to already overburdened doctors. We would like to emphasize that, chatbots should be seen as a complimentary support and not a replacement for a medical expert, as also emphasized by prior work on using technology for community education in developing regions [92, 117]

Effective engagement is necessary for educational purpose where the users are newcomers and naive learners [60, 92]. Our idea of the counter-questioning feature in *Yukti* was well received and appreciated by all the users. Even the ASHAs, who were confident about their knowledge, were surprised when their understandings were wrong. Further, our analysis of participants’ information-seeking practices uncovers the need for sensitivity while answering within the user’s context. We

observed that the majority of the participants reflected deep-rooted beliefs, myths, and traditional practices. We found that many mothers sought justification for their traditional practices. This is line with the research on breastfeeding that has discovered that universally breastfeeding problems and solutions pertain to more of attitudinal and behavioral change than medical[38, 111] and also with research that has highlighted these factors as real challenges in bringing change by CHWs [16, 60, 92, 97]. Since, age old practices and cultural norms play an important role in the adoption of any practice [92, 97], merely giving facts will not be an effective approach. Though the majority of the questions seems to be answerable using the existing material, the real challenge here is not what information to deliver but how to effectively deliver. As we observed, female relatives e.g. mothers and mothers-in-law significantly influence breastfeeding practices. The chatbot should support culturally responsive design, to persuade women towards scientific practices [60, 105]. Further, in almost of the all of the families, we noted limited involvement of husbands in maternal and child health. As highlighted by the previous work in the similar contexts, it is important to focus on inclusive design approaches that take gender-related social norms into design consideration [9, 16]. We observed that when chatbot gave factual, technical answers, the mothers were not convinced, they sought more conversation on their ideas. Here, one approach could be expanding the capability of the chatbot where it shares not just a fact but a rationale of why some practices started and why they should be discontinued. ASHAs have a good amount of situated knowledge. They are embedded into the societies they serve and have greater sense of socio-cultural and socio-economic factors of their clients. Leveraging it in meaningful ways in the system design is important to address breastfeeding education in a more holistic way. Here, the use of Haraway's work on situated knowledge [48, 52] can be explored in designing an ecology of actors (ASHAs, mothers, doctors) to make chatbots learn and inform more appropriately.

Further, just giving information once in a conversation would not suffice, there is a need for continuous positive reinforcement for habit formation which is found to be an effective technique by prior HCI studies [106, 107]. Also, research has exemplified the frequent reinforcements of feeding recommendations helps in sustaining exclusive breastfeeding practice[87]. There exist numerous studies studying the effect of prompts in engaging user in adopting positive behavior change [106, 107]. This can be further explored by incorporating elements of periodic prompts in the form of daily tips or reminders and other persuasive methods in the design of the chatbot.

ASHAs perceived *Yukti* as a training tool, and as a service to consult during field visits. This highlights the potential direction of investigating the role of chatbots in motivating ASHAs in their role of counselor. ASHAs have a good amount of situated knowledge. They are embedded in the societies they serve and have a greater sense of socio-cultural and socio-economic factors of their clients [52]. Leveraging it in meaningful ways in the system design is important to address breastfeeding education in more holistic way. Here, the use of Haraway's work on situated knowledge [48] can be explored in designing an ecology of actors (ASHAs, mothers, doctors) to make chatbots learn and inform more appropriately. For instance, by collecting data on mothers breastfeeding issues, a chatbot can maintain profiles of cases, and proactively engage ASHAs at appropriate times.

Further, there can be other contextual scenarios hampering mothers' privacy. In the women population we studied, access to internet enabled phone is a newer possibility [52]. Many of them still do not have their personal smartphone, and share family members phone. Further, even if they possess, might not have complete control due to lack of operational knowledge and rely on family members for assistance. For example, we observed that ASHAs and mothers had their phones configured with the email-ids of their children or husband and did not know how to set up a new email account in their phone. This brings an interesting design challenge on two different aspects. First, How a woman can maintain her privacy on a shared phone and second, how should the app behave in the given ecology. From a design perspective, one of the approaches could be to allow the

app to have a private mode or password protection to protect its content from the non-intended user. To facilitate the phone sharing without causing embarrassment or discomfort to the sharers, one of the approach could be to have configurable icons, notifications, reminders etc. such that they are not embarrassing or disturbing to the other users of the phone, e.g. the husband.

6.2 Design Specific Ethical Considerations

Introducing conversational agents to vulnerable populations like those studied calls for careful attention to their conditions, culture and contexts. A significant number of mothers in India do not have regular access to health care, have restricted mobility and power to make decisions [69]. In the light of these challenges, we observed that the availability of chatbot while, on hand, gives the benefits of filling the gap of lack of information sources, on the other hand, poses a set of concerns which need significant ethical responsibility.

The first concern comes from the perception of the users towards chatbot designed for health education on topics like Breastfeeding. We observed that some of the mothers perceived the educational chatbot to be more like a healthcare delivery app. They asked a range of questions on their personal health condition to seek consultation. Given that they are using chatbots for the first time, a potential risk is that they might develop wrong notions about their health condition on just receiving generic information. This is particularly important given the sensitive topic of Breastfeeding in which the attitude and perception of mother play a crucial role. For example, a mother perceiving low milk supply when asks a question, might wrongly correlate some of the causing factors, thereby further exacerbating her condition. To mitigate these, it is important that the chatbot design conveys its scope clearly and adopt strategies to help users arrive at correct interpretations. For example, a helpline service can be incorporated to connect mothers to a health expert at appropriate times. Shevat [103] discusses the importance of the bot's first interaction with its users, termed as onboarding, in setting users' expectation. A good onboarding script declares bot's purpose and capabilities in the context of use by being transparent. He gives the example of Howdy bot as follows:

Bot: I am Howdy, your new bot, Nice to meet you!

My main function is to help you communicate with and collect information from the members of this Slack team. I do this by running interactive scripts with one or more participants

In our study, the research staff had to clarify the doubts of the mothers on the chatbot responses on multiple occasions. Thus, we suggest for designing support mechanisms to remove confusions right away. Further, discovering user intent behind the message automatically is a design implication for which the emerging body of work, analyzing social media posts to identify user intents can be leveraged [27]. Considering topics like Breastfeeding which inherently have counselling aspect, the Chatbot design must take care of the language use. Techniques recommended for incorporating appropriate level of empathy should be utilized [18–20, 95].

The second concern relates to the added risk of privacy and confidentiality. In our study, we observed that mothers found the chatbot to be a more comfortable option for seeking advice on private questions as compared to physician or others. This raises the concern of how to preserve their privacy. If the chatbot design includes taking other health workers into the loop, there is a need to provide choices to the users whether they want to share the data of particular conversations or not. In particular, when users like ours who have low literacy and exposure to the digital world must be safeguarded appropriately on their data utilization. This also highlights the need of policy-level recommendations to be thought of for balancing the potential benefits and risk of introducing conversational agents in healthcare, an ongoing discussion in the artificial intelligence

community [59, 67, 93, 100]. We emphasize before designing the actual chatbot, more experiments and consultations should be performed to develop a realistic sense of ethical pitfalls.

6.3 Societal Impact

Our study, in line with previous works, again highlighted the lack of experts who can provide authentic answers to health queries. There was a universal demand—from mothers as well as ASHAs—to have a bot that can provide authentic answers to their queries. Moreover, the enthusiasm about having a system that can be available 24x7 was high and the demand was to increase the scope of the bot to cover a larger spectrum of maternal and child healthcare.

This indicated the possible societal impact that bots can bring in the area of public health in resource-limited countries. Moreover, the ASHAs saw them in the possible role of a trainer to enhance their knowledge while mothers wanted them as a reliable source of answers to their queries. Not only the bots fill an important gap, if effectively developed, then they may also reduce the burden on medical experts by providing answers of general queries to a large population.

The information access also empowers the mothers who otherwise do not have autonomy [30, 69], knowledge will help enhance their confidence and thereby reduce the feeling of stigma. It has been found by various studies on breastfeeding, the main challenge in successfully breastfeeding comes from the community behavior and provider behavior. It is the perception of the mother which becomes an obstacle in her confidence to successfully breastfeed, which by and large imposed by the family members, relatives and friends. By receiving scientific knowledge she may develop a positive image of self. Such applications of bots may be useful in providing support to under-represented or oppressed groups.

At the same time, another aspect on usage of bots must be explored. And this happens to be in the area of trust and ethics. Could a bot be completely trusted and replace a human? Who pays for a mistake made by a bot by giving faulty or inappropriate advice. How do we check that a bot continues to provide authentic answers is an interesting research question and as designers, we need to provide solutions that can help navigate a user towards the correct approach e.g. verification by an expert or relying on the bot itself.

Another potential concern in the introduction of chatbot arises if it can further increase the stigma around breastfeeding. It is a larger question in the realm of artificial intelligence, we need to understand to what extent the chatbot should provide information [35, 93]. The boundary between information providing and counseling must be clearly defined and worked upon. In recent few years, the HCI research is emerging towards addressing the role of technology on sensitive issues e.g. menstrual health education by considering local cultures and customs [109]. There are efforts by researchers to make culturally sensitive designs e.g. Sorcor et al. respected local cultural aspects in delivering information on HIV, a taboo topic in India [105]. Likewise, the chatbot design on imparting information is an important research direction for HCI community that should take into account different socio-cultural contexts.

7 CONCLUSION

The increasing penetration of smartphones in developing regions has opened new opportunities for delivering targeted, low-cost interventions of public health education. Chatbots with their ease of use offer opportunities to reach out to populations who have limited digital experience. Towards this, we attempted to understand the potential of chatbots in educating mothers and community health workers in slum areas of India in the context of breastfeeding education. Our study unraveled several unexplored facets of chatbot applications for public health in low-resource communities. We found out that the chatbots have the potential to fill the gap of the lack of first point of contact for seeking information. Further, we uncovered various contextual aspects that a chatbot design

must take care in order to provide information in an effective manner e.g. addressal of age-old practices, role of family members, etc. and other associated ethical and societal challenges.

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