AdolescentBot: Understanding Opportunities for Chatbots in Combating Adolescent Sexual and Reproductive Health Problems in Bangladesh

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ABSTRACT

Traditional face-to-face health consultation-based systems largely failed to attract teenagers to get reproductive and sexual health supports from doctors and practitioners in Bangladesh as 'sex' or 'adolescent' related issues are considered social taboos and are rarely discussed openly with anyone. This has damaging implications for the physiological and mental well-being of a large group of people. In this paper, we study chatbot's effectiveness to assist adolescents in seeking reproductive and sexual health supports by analyzing the responses from 256 participants, including adolescents and medical personnel from six different regions of Bangladesh. We prototype an interactive chatbot, namely AdolescentBot, and analyzed users' communication patterns, feelings, and contexts of use as the first point of support for getting adolescence related health advice. Our analysis finds that a chatbot can satisfy most of the users' queries, and the majority of the queries are associated with wrong-beliefs. Finally, we discuss ethical and societal issues with chatbot usage and recommend a set of design propositions for the AdolescentBot.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI**; **Empirical studies in interaction design**.

KEYWORDS

Adolescent health; Chatbot; HCI4D; Bangladesh

1 INTRODUCTION

Chatbots are drawing significant attention as virtual assistants in different domains. Due to its wide range of applications, we have seen many commercial and non-commercial chatbots in recent times. Examples include assistance for online shopping [12], navigating website [1], and general-purpose chatbots like Siri[2] by Apple, Google Assistant[3] by Google, Cortana[4] by Microsoft, Alexa[5] by Amazon. Besides, almost 300,000 bots are currently active in Facebook messenger [20] as virtual assistants. These chatbots have the ability in making positive social impacts by emphasizing users' autonomy, efficiency, and counter-intuitively social relatedness [16]. Hence, Human-Computer Interaction (HCI) communities have started exploring the opportunities of chatbots in solving problems in different domains [9, 37]. Medical chatbots, conversational agents built with medical applications in mind, have the potential to reduce healthcare costs, and improve accessibility to medical knowledge and services for patients.

Adolescents (any person between ages 10 and 19) in a developing country like Bangladesh often suffer from various physical and mental problems because of inadequate knowledge about sexual and reproductive health [7]. Moreover, they do not discuss these problems openly with doctors or friends, or even with family members due to social taboos and shyness. This is in contrast to the developed countries, where a plethora of online forums are available and through these forums, young people can interact with

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[1]https://collect.chat/
[2]http://www.imore.com/siri
[3]https://assistant.google.com/
[4]https://www.microsoft.com/en/mobile/experiences/cortana/
[5]https://developer.amazon.com/alexa

each other and health professionals to find solutions to their adolescent problems. However, similar facilities are largely absent in a conservative country like Bangladesh [2]. Again Bangladesh has serious lackings in healthcare service due to insufficient medical centers, doctors, and necessary infrastructure. The number of the adolescent population in Bangladesh is approximately 36 million, more than one-fifth of the total population [41]. Researchers have found that these adolescents have very limited or no access to sexual and reproductive health-related information and services, and face serious hindrance to get information and guidance regarding those issues [7, 29]. Bangladesh government has recently launched adolescent-friendly health services (AFHS) operating in 13 districts out of 64 districts to facilitate health service to adolescent people [2, 3]. However, a recent study indicates that social taboo and shyness discourage adolescents and their families from seeking treatment from AFHS centres [2]. The findings of the study demonstrate that young adolescents are still reluctant to use specialized services and have limited awareness about their sexual and productive health issues. Moreover, there also exists some safety and privacy concerns in availing these services.

To overcome the above challenges, the goal of our study is to find out the potentiality of a chatbot for adolescent health education where the users of the bot are adolescent communities residing in both urban and rural areas of Bangladesh. Most of them are school & college-going students (level-5 to level-12), and few are university freshmen. For the ability to reach people in affordable ways [23], users are most familiar with smartphone applications and the internet. The government of Bangladesh has undertaken a new project to supply high-speed internet connections[6] to both urban and rural areas as part of modernization under the 'Digital Bangladesh' agenda. However, most of the school going students share their parents' devices [22], and hence they are novice users for applications like chatbots. These novice users are the assets of our literature for understanding the feasibility and design issues of the adolescent chatbot.

The primary objective of our study is to investigate the feasibility of using chatbots for adolescent health education. Medical chatbot for adolescent health seeks to provide reliable knowledge of sexual and reproductive health while leveraging self-efficacy and maintaining privacy. Note that we do not claim that a chatbot as an alternative for a real-life doctor. However, it can interact with adolescents to provide basic knowledge and suggestion to young adolescents. Therefore, we investigate the following research questions in the context of different regions of Bangladesh.

- What are the types and patterns of questions adolescents seek from a chatbot?
- What are the feelings of users towards a chatbot for adolescent health education?
- What are the adolescents' contexts of using a chatbot?

To investigate the above research questions, we study users' interaction or communication patterns and perceptions by developing a prototype of AdolescentBot, an interactive text-message based question/answering chatbot in Bangla language. We take responses from 256 anonymous participants, including adolescents and medical personnel. The adolescents were passionate about the

opportunity to seek reliable information from AdolescentBot as the first line of contact. Our study finds that most of the queries by adolescents are in a nature that can be answerable by a chatbot, which gives us the confidence of the potentiality and robustness of such technology in this specific public health domain. We also study the influential role of relatives and friends regarding adolescent health problems. Finally, we discuss ethical, societal issues with chatbot usage for adolescent health education and recommend the chatbot design propositions to provide effective information about specific public health issues that significantly contribute to the HCI community.

The rest of the paper is organized as follows. Section 2 reviews the related works and presents the current situation of adolescent health and related technology. In Section 3, we discuss the procedures of collecting data from both physicians and adolescent participants and explain our basic findings in Section 4. We present a number of design propositions and highlight ethical and societal issues associated with chatbot usage in Section 5. Finally, in Section 6, we conclude the paper with a number of future directions of our work.

2 RELATED WORKS

The related body of work mostly includes the basic overview of existing medical chatbots, usages of technology for adolescent health education in the perspective of Bangladesh and other countries, and different studies related to understanding opportunities for chatbots in other tasks.

2.1 Existing Medical Chatbots

The need for digital personal assistants and chatbots in healthcare is obvious and not new at all. ELIZA [47] was the first chatbot ever created in 1966 that was taught to simulate a Rogerian psychotherapist. ELIZA applied keyword extraction technique and pattern matching algorithm on users' queries to select pre-defined knowledge-base responses. The first chatbot to pass the Turing Test was PARRY[7], implemented in 1972 by psychiatrist Kenneth Colby. PARRY tried to simulate a person with paranoid schizophrenia. Currently, artificial intelligence has developed to a point where programs can learn and effectively mimic human conversations. HealthTap[8] in Facebook Messenger enables patients to learn more, get help, and take action immediately to meet new symptoms. Melody[9], a chatbot powered by artificial intelligence that lives inside the existing Baidu Doctor app to collect medical information from users through online text conversations and then provides them to doctors in a form that makes it easier to use for diagnostic purposes. Florence[10] performs like a nurse, which helps find a specialist in the nearby area, tracking body weight, periods, etc. and reminding of taking pills. Fitmeal[11] assists users in keeping a food diary and controlling their diet. YourMD[12] takes users' health information and gives a decision when to visit a doctor.

Recently there also have been many studies about the development of medical chatbots in specialized domains. Lokman et al. [27] propose an architectural design of a chatbot that will function as a virtual diabetes physician/doctor. Agrawal et al. [1] build a text-to-text diagnosis bot that engages patients in conversation about their medical issues and provides a personalized diagnosis based on their symptoms and profile. Eleonor et al. [10] introduce a Pharmabot: a pediatric generic Medicine Consultant Chatbot. It is a conversational chatbot designed to prescribe, suggest, and give information on generic medicines for children.

Meanwhile, several research works emphasize utilizing chatbots not only in physical issues but also in mental and other necessary supports for e-health and the digitalizing healthcare system. A primary care chatbot system, Mandy, has been developed by Ni et al. [30] to assist healthcare staff by automating the patient intake process. This chatbot interacts with patients by carrying out a natural language conversation to realize their major problems and submit reports to the doctors for further in-depth analysis. Madhu et al. [28] propose a personalized chatbot based on AI to predict the diseases by evaluating the symptoms and suggest the list of available treatments as well as give the composition of the medicines and their prescribed uses. Kowatsch et al. [24] investigate how text-based healthcare chatbots (THCB) can be implemented to support patients and physicians effectively in therapeutic settings beyond direct consultations. They present an open-source THCB system designed for childhood obesity intervention, and preliminary results with 15 patients show promising outcomes. Amato et al. [5] propose a chatbot HOLMeS (Health On-Line Medical Suggestions) that has been able to help patients choose the most proper disease prevention pathway by asking for different information and support the related prevention check-up and the final diagnosis.

2.2 Technologies in Adolescent Health

The explosive growth of the internet has caused an increase in internet-delivered health promotion initiatives, especially for adolescents. Relevant studies indicate that adolescents have been using the internet and web-based sources for their health-related information for more than two decades [8, 18]. These sources offer them confidential and convenient access to an unprecedented level of information about diverse subjects. Therefore, the incorporation of credible online health information resources into the school health education curriculum could be a promising approach for promoting health literacy [17].

However, the adoption of technologies among communities may differ depending upon the population's demographic and cultural characteristics. In a work of Smaldone et al. [39], a sample of urban Latino parents and youth were surveyed regarding their current use of mobile & social media technologies and preferences for the use of these technologies for health communication to show the impact of technology in adolescent health. They found that most respondents had shown little interest in using social media for health communication. Olson et al. [31] proposed using a personal digital assistant (PDA) to enhance adolescent health screening and counseling and discovered that the method enhances physician counseling and improves adolescents' perceptions of the well-check visit.

In another study, a chatbot enabled adolescents to ask questions about sex, drugs, and alcohol, and the provided information was more useful than traditional information outlets or search engines [11]. Huang et al. [21] present an adolescent-oriented intelligent chatting system in the Chinese language called TeenChat, which acts as a virtual friend for sensing and releasing adolescents' stress. After performing a month's study, they claimed 'TeenChat' as an effective application in detecting and reducing teenagers' stresses. However, most of the existing technologies are available for developed countries. Not so much study and efforts have been provided to adolescent health in conservative countries like Bangladesh. Again the majority of works have emphasized just building chatbot systems, ignoring societal and ethical studies.

2.3 Studying the Feasibility of Chatbots

While most research works around chatbots have focused on implementing technology, few studies seek the feasibility of chatbots in any specific domain [32]. Yadav et al. [50] attempted to understand the robustness in breastfeeding education of women in India by performing the 'Wizard-of-Oz' (WoZ) technique. They examined users' perceptions, contexts of use for effective chatbot design, and discussed different social and ethical issues with chatbot usage. Thies et al. [44] explored using the 'Wizard-of-Oz' technique to understand better how young, urban Indians would prefer to interact with a chatbot. The challenges of 'WoZ' have been discussed in [6], where 'WoZ' is not preferable when multiple respondents participate in an experiment concurrently. The responses of multiple wizards may vary, and it can interrupt in finding out users' actual interaction patterns and perceptions. Again, the engagement of multiple wizards concurrently in the same server is cumbersome.

2.4 Adolescent Health and Related Technologies in Bangladesh

Although the health and well-being of adolescents are crucial for the future of the country, issues regarding sexual and reproductive health (SRH) remain a cultural taboo, especially for adolescents and young unmarried people because of the socio-religious aspects of a conservative country. Recently, the 'Population Council of Bangladesh' has launched a study about works of different NGOs and government facilities that focus on adolescent health in early 2017 [2]. Most of the programs only focus on married girls, and they are unevenly distributed throughout the country. Therefore, the study proposed to incorporate adolescent-friendly health service (AFHS) in existing medical facilities as well as traditional awareness rising approaches [3].

However, a later study [3] has indicated that although unmarried girls frequently use this service, only a few boys have ever used it. The awareness of this service is minimal, and there is also a lack of privacy and safety issues associated with the participants. Again this service is present in only 13 districts. Moreover, this study also suggested that non-traditional, age-appropriate interventions, such as sports-based interventions, the use of information and communications technology (ICT), and game-based or interactive interventions may be effective ways of reaching adolescents, particularly young adolescents ages 10-14. Therefore, an automated medical chatbot in the Bangla language has the prospect of reaching

the adolescent population so that they can access the necessary information and work as a virtual consultant for them.

According to our very best knowledge, there is not yet any fully developed chatbot in any domain in the Bangla language, let alone adolescent medical assistance in the context of Bangladesh. Recently, some chatbots integrated with Facebook messenger to conduct an introductory conversation with users for various services. For example, DU MamaBot[13] is an automated conversational agent (chatbot) who helps one find university bus schedules, routes, and much more info. Mastercard's banking bot, available through Facebook Messenger, can assist with reviewing account information, listing purchase history, monitoring spend levels, providing Mastercard cardholder benefits, and helping with financial literacy.

In the medical scenario, there exist some web forums. 'Maya'[14] provides an anonymous messaging platform that connects users with expert advice and answered over 100,000 questions. It is available on the web, android, iOS covering a wide range of legal topics like medical, health, fitness & well-being. However, its reply is also sometimes vague, irrelevant, and not satisfactory at all. 'It-sokayBD'[15] is an online platform that gives consultancy related to mental health for all ages. 'Beshto'[16] provides an open domain platform for question/answering. All these platforms are operated manually, and the response delay is high. Again these platforms do not provide services specifically for adolescent services. Some medical blogs like 'Surecell'[17], 'Bdhealthsolution'[18] publish articles about adolescence and reproductive knowledge irregularly, and any open discussion on them is not possible due to social constraints. Newspapers also publish a medical section weekly and answer some relevant questions. Certainly, the existing means of communication in this scenario are insufficient to reach all adolescents and provide the necessary knowledge.

3 METHODOLOGY

In this section, we present the design and implementation level details of our chatbot prototype and experiment details. Different studies [14, 49] have suggested that adolescents provide improved levels of response in several dimensions while participating in interview-based research studies than text-based methods such as electronic form and paper-pencil based methods. However, direct interview with adolescents about their sexual and reproductive health knowledge is not effective as they feel hesitant to discuss these issues in a face to face interview. So we performed an online survey via electronic form.

3.1 Participants

We conducted our study in three schools, two colleges, and one university that are situated in six different regions of both rural and urban areas in Bangladesh. We took permission from their respective authorities. By visiting these institutions, we offered enthusiastic students to participate in our study. For collecting responses from medical personnel, we visited a reputed medical

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college of Bangladesh. Table 1 is presenting the distribution of participants.

From Table 1, we observe that a total of 256 members participated in our research. The study was conducted anonymously, and identifications were not collected during the online survey and questionnaires. Therefore, the respondents did not feel hesitant to express their opinions. 75.78% of our participants were male, and the rest were female. More than 99% of them were accustomed to using technology and the internet.

Most of the participants (81.64%) were within the age range of 10-19 years. We included some university freshmen (1st year undergraduate students) since they have just passed the adolescent period and could be assets for our literature with their most recent experiences. Therefore, we categorized them as adolescents (Table 1) in our study. As our participants, we also included school going students who had limited digital experience and no prior exposure with chatbots [22].

3.2 Architectural Workflow and Design of the AdolescentBot

In this subsection, we briefly discuss the approach of developing the prototype of our AdolescentBot. It includes the major components of our design, their workflow, and the structure of the knowledge-base.

Problem Analysis and Response Generation

Figure 1 provides an overview of the AdolescentBot's building blocks. When a user asks for a query, the bot performs pre-processing (e.g., tokenization, stop words removal, stemming & lemmatization, synonym mapping, etc.) on user text, and analyzes them. For each query text, the bot tries to identify two questions. First, the problem or disease that the user is talking about, and second, the user's query regarding that particular problem. We handle four types of queries (e.g., definition, symptom, cause, and advice) for each disease.

Definition - What is the problem associated with this disease?
Symptoms - What are the major symptoms of the disease?
Cause - Why does this problem happen?
Advice - How to avoid this problem?

We have used Wit.ai[19] application, a popular NLP tool from messenger UI, to find out significant entities and intents i.e., overall underlying meaning of text input. It trains the underlying model with related training sets and tries to find two entities about each query.

- **Subject** What is the problem that the user is talking about? Wit.ai application is previously trained to identify ten diseases, and they are attached to the entity subject.
- **Intent** What does the user want to know about the subjects? We assigned four categories of intents for all diseases. They are definition, cause, symptoms, and advice about the problem or disease.

If both the disease (or problem) and the user query about the problem are identified, the bot selects an appropriate response from the database and sends it to the user. Otherwise, it normalizes the text, measure similarity, and select the nearly relevant response from
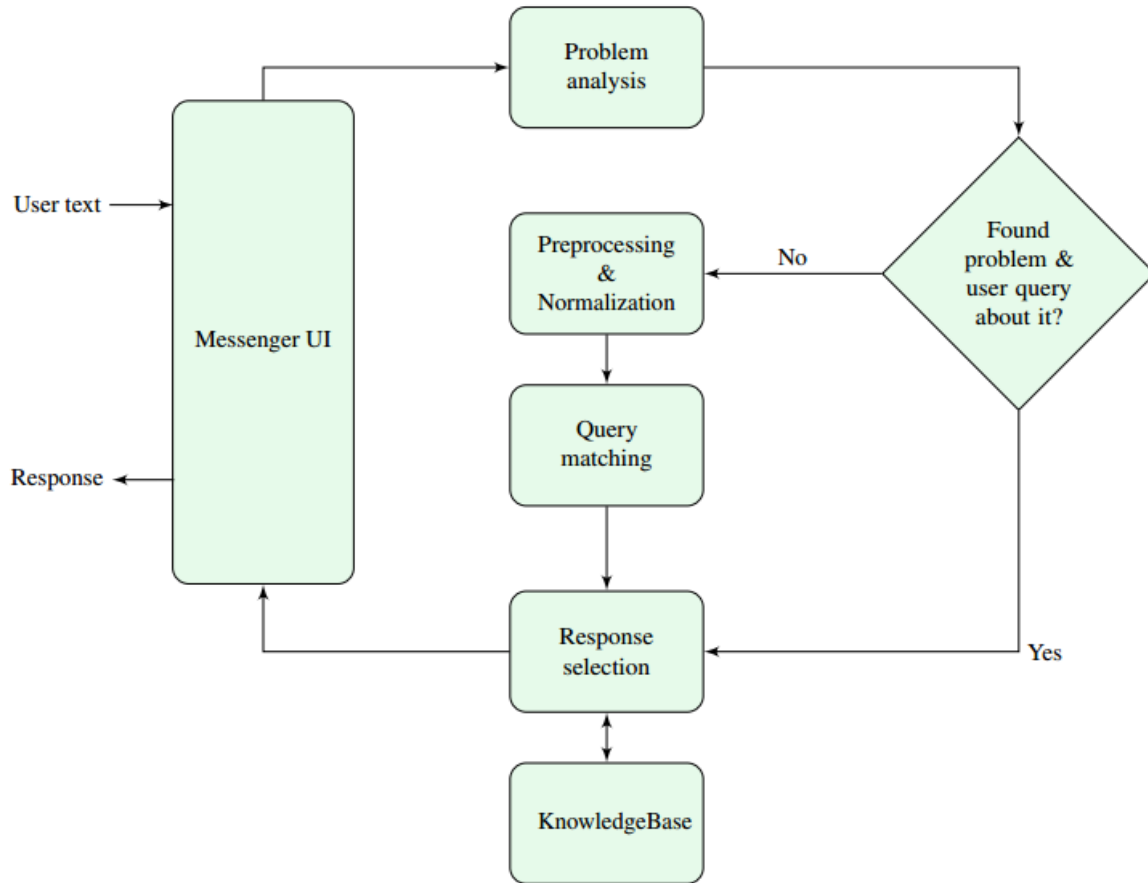

Table 1: Distribution of participants

Participant	Class/Level	Age range (years)	Number of participation	Category
School going students	5–10	10–16	94	Adolescent
College going students	11–12	17–19	115	Adolescent
University freshers	1st year undergraduate	20–21	41	Adolescent
Medical personnel	medical student or intern doctors	24–30	6	Medical personnel

Figure 1: Building blocks and control flow

the best-matched reference questions. We have used Chatterbot[20], a Python module that works on the similarity between the user query and reference questions stored in our knowledge base. Text similarity confidence measure δ is defined as follows.

$$\delta = \frac{2 \times \text{number of words common in both text}}{\text{total number of words in both texts}}$$

If text similarity confidence measure δ is above the given threshold, then the corresponding response of the best-matched reference question is chosen as the response. We choose the Flask[21] framework as the back-end. Flask is a micro web framework written in Python language which provides tools and libraries for building web applications.

Figure 2 provides sample chatbot conversations about how it handles the context of a conversation or similar type of questions. We also keep the functionalities of counter-questioning and resend prompts for clarifying users' queries. Again 'Option based query' feature is present in our prototype through which users can learn

[20]https://github.com/gunthercox/ChatterBot

[21]https://flask.palletsprojects.com/en/1.1.x/

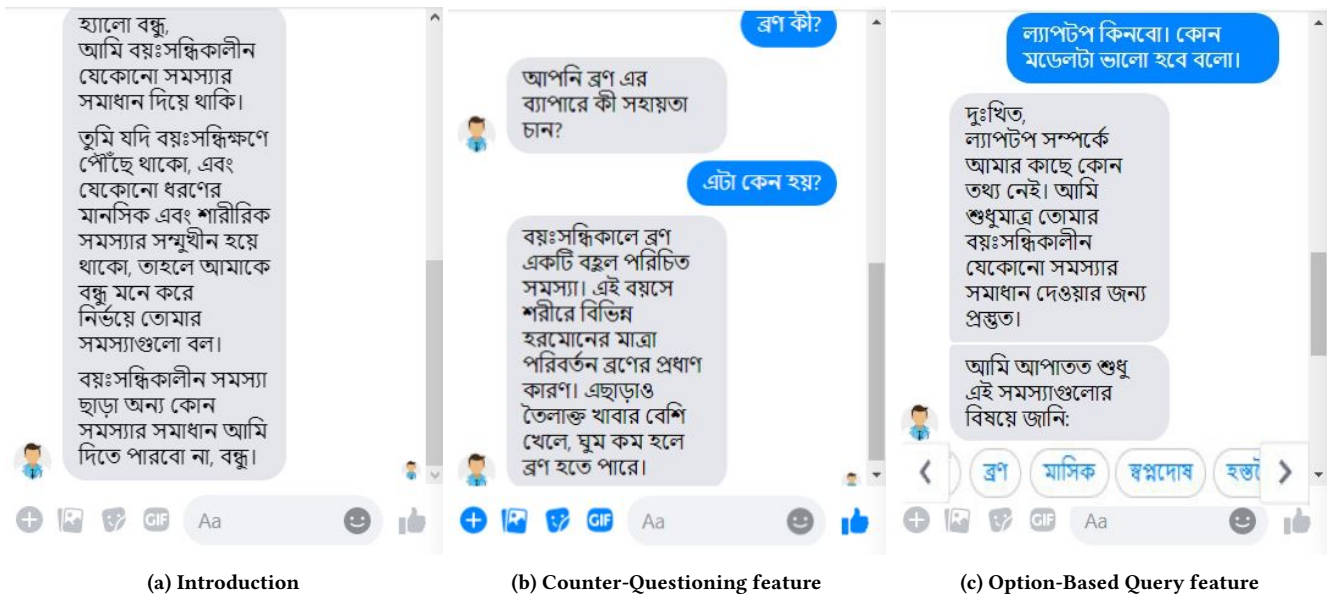| (a) Introduction | (b) Counter-Questioning feature | (c) Option-Based Query feature |

Figure 2: Snapshots of the prototype

about the definition, symptoms, prevention, and cures of any ado-lescent health issues by selecting options. If any query is out of the scope of our domain, this feature persuades participants to be confined to a specific domain with a default response.

Knowledge Base

As the topic of this study is relatively an un-explored area of re-search, dataset or built-in question-answer pairs were not readily available for our design. We have manually created our knowledge-base by fetching data from local sites (e.g., "Maya", "ItsokayBD"), and Bengali Facebook groups & pages for medical help. We have also collected data from foreign sites, such as WHO[22], TeenMental-Health[23], etc and translated them into Bangla. We have chosen all these sources by evaluating users' rating and review. They were also referred and verified by health experts. We took the exact questions queried by users from Question-Answer(QA)-based web forums. Then we have analyzed their given solutions with authentic books, Wikipedia, etc., and generated complete, concise, and coherent re-sponses. These answers have been verified by medical experts and inserted into the "Question to Answer" table.

We have collected almost 500 question-answer pairs and general symptoms, causes, solutions of different adolescent health prob-lems. In this study, we primarily focused on ten major adolescent issues by analyzing 100 most commonly asked queries in different web forums. These issues include both adolescent diseases (e.g., acne, frequent nocturnal emission, menstrual disorder, weakness etc.) and mental & behavioral problems (e.g., depression, emotional dysregulation, etc).

We implemented a simplified version of a retrieval-based chatbot as the prototype. Figure 3 shows the detailed entity-relationship

diagram (ERD) of our knowledge base. Each problem or disease has a definition i.e., some general information and three other en-tities, "Cause", "Symptom" and "Solutions" related to the problem. Some general conversations such as greetings and some common questions with their pre-fixed answers are stored in the "Question to Answer" table. A problem can be related to some other prob-lems, so there is a "role relationship". The labels "Problem_key" and "Related_Problem_Key" are called roles (Figure 3). The relation between problem and associated symptoms have some weights that indicate how strongly a symptom is related to the problem.

At first, AdolescentBot will analyze user input and predict the probable sets of problems from the queried text. The bot will then ask a question with the most weighted symptoms of all relevant problems to the user to determine the specific problem. After defin-ing the exact problem, the bot can provide definitions, causes, so-lutions, and other general information by reprieving the answer from associated tables in the knowledge base.

The prototype is developed in Bangla language. Other languages and romanized Bangla language are considered out of scope of this paper. Since we collect data from local sites and pages, it can manage non-bookish and regional terms.

Messenger UI

We have also integrated AdolescentBot with Facebook Messenger UI, one of the most popular social media. Approximately 55% of the Facebook users of Bangladesh are young aged[24]. The Messenger platform offers a core set of APIs, web plug-ins, and a full web-view that provide a powerful way to connect with people through Facebook. Again, this platform provides the opportunity of 24 × 7 availability feature. Furthermore, We have been looking for an interactive design of AdolescentBot that will be consistent with
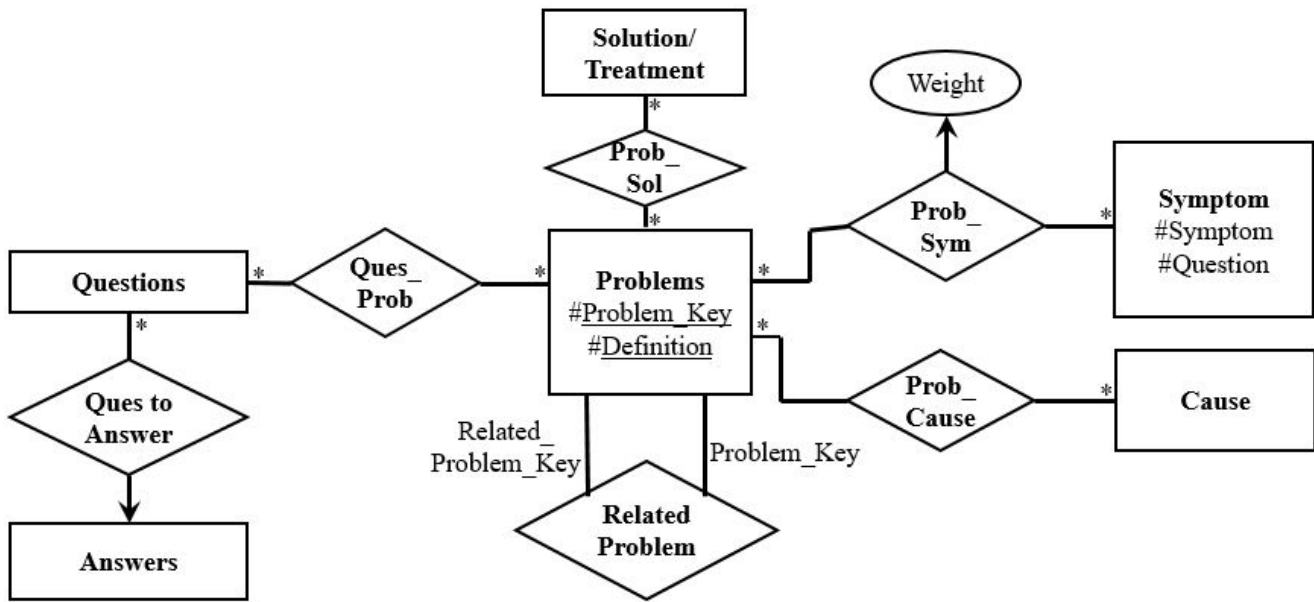
Figure 3: Entity relationship diagram of knowledge base

smartphones and desktop computers. It is the fundamental reason behind choosing Facebook Messenger UI as a prototype platform that supports both smartphones and desktop computers. Figure 2 shows some snapshots of our designed prototype of AdolescentBot.

Pre-pilot Study

Before deploying the prototype to the participants, we have conducted a pre-pilot study with five freshmen of our institution. This pre-pilot study helped us get the ideas of participants' question patterns and estimate the duration of our experiment. From this study, we found acceptable accuracy of AdolescentBot in understanding users' queries and choosing suitable, informative, and personalized responses. Moreover, we got positive feedback regarding the user-friendliness of the bot. We added the 'option-based query' feature in our prototype based on this pilot study.

3.3 Experiment Details & Feedback Collection

For providing convenience and comfort, we made institution visits to operate our experiment. These visits gave us a direct opportunity to investigate users' interactions. The interviews with medical personnel were operated in their respective hospitals. Two of our research staff were present in the experiment venue. We attained approval from both our own and visited institutions for our experiment.

We conducted this experiment in the computer lab of affiliated institutions. Before starting the sessions, we briefly described the purpose and scope of our study. We also gave instructions about the terms of using our prototype version of AdolescentBot since many participants were first time users of a chatbot. After describing terms and policies, we provided the credentials of pre-generated dummy accounts of Facebook to participants randomly so that they

could not claim any privacy violation. We conducted our exploration among 30 (6 for medical personnel) participants at a time. Hence, there was no scope to claim about the privacy violation of a particular participant. Participants were free to use their own devices or lab computers. We also took ten smartphones of 'Maximus D7' series, which is the lowest cost ($42.26) smartphone in Bangladesh[25]. This series smartphone is affordable to all communities of Bangladesh because according to the statistics of 2019, GDP per capita of Bangladesh is $1287.8[26].

There are some technical and ethical issues related to this experiment. Wolfendale [48] showed that some users tend to grow strong emotional attachments towards bot and develop high expectations despite knowing the bot's scope. So, we presented the functionalities, domain, and scope of our technology very clearly. On another note, the bot's response may be unclear, which can build a negative impact on the bot. Therefore, we requested the users to inform any problems if they faced any issues during the experiment. We also noted these issues for future design. Again we took their permissions to utilize their data in our future research purpose and assured them not to use their data in other tasks.

We divided our experiment into three phases. First, we deployed AdolescnetBot to the participants to use freely. In this phase, we presented our prototype as an under-developed chatbot and wished to analyze their experiences, interaction patterns, and contexts of use. We then conducted online surveys to learn the influences of other sources like family members, friends, web forums, physicians, etc., and gather relevant useful information. This phase was not conducted for medical personnel. Finally, we took the feedback to understand users' expectations and perceptions of using the

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[25]https://www.mobiledor.com/price-bdt-0-to-5000-tk/
[26]https://tradingeconomics.com/bangladesh/gdp-per-capita

AdolescentBot. For second and third phases, we designed the questionnaires in 'google form'[27]. To design suitable questionnaires for adolescents, we emphasized both question structure and simplicity, as mentioned by some studies in very best practice on questionnaire design [15, 19, 25, 45].

We conducted the questionnaires of the second phase only for adolescent participants. For this phase, we included multiple-choice questions, multiple answers questions with other options/explanations, polar questions, and open-ended questions for the participants' opinions or comments. Besides collecting basic information (age, gender) of the participants, the questions focused on the role of family members, friends, physicians & other existing sources of knowledge for reproductive health like web forums & books, and hesitations faced by adolescents regarding knowledge seeking and privacy ensuring.

After that, the participants had been provided several questions about the effectiveness of AdolescentBot in the third phase. They were asked if AdolescentBot could accurately understand their questions or language. We also verified whether the responses given by the bot were consistent with their questions. We collected their feedback about how helpful and friendly the bot seemed to them. There was a question about the ability of the chatbot to provide personalized questions/answers. Finally, they were asked to provide their satisfaction level. All these feedbacks had been taken by a scoring system out of 5 in Likert scale [4]. We also asked participants to describe their perceptions with short explanations. Finally, we sought their involvement in any improvement regarding the bot's responses and other features.

Thus, we conducted three phases of our experiment, which took approximately 15–20 minutes overall. The time range for these three phases was equally distributed. The participants had full rights to leave the experiment spot at any time when they wanted. We also presented the 24×7 availability feature of AdolescentBot so that they could use it further. Again, the presence of two research staff had not affected the responses because 30 (6 for medical personnel) respondents were present at a time in the experiment spot, and they were giving their responses electronically. So there was no way of focusing on their specific responses. In addition to these experimental recordings & interview data, we also used chat logs in our data analysis. Together with these, we worked on finding an interactive and user-friendly design to provide information.

3.4 Alternative Approach (Wizard-of-Oz) and its Limitations

An alternative to our experiment and feedback collection step would be performing the Wizard-of-Oz (WoZ) approach like Yadav et al. [50]. In this procedure, a human wizard imitates the mechanisms of a chatbot by making users believe that they were interfacing with a real chatbot. We could not apply the WoZ technique because we performed our experiment among multiple respondents (nearly 30) simultaneously. Appointing multiple wizards concurrently may cause different patterns of responses, which can impose a negative effect on participants' actual perceptions and expectations [6]. Again, we found that adolescents felt uneasy sharing their issues individually to a wizard in front of two research staffs. Another

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[27]https://docs.google.com/forms/u/0/

reason was the slow response of the wizard, which may generate negative intuition on chatbot application to the respondents. Thus, the concerns for privacy violation and lack of consistency of the responses mainly motivated us not to apply the WoZ experiment. Furthermore, we had an opportunity and means for creating a bot, which can alleviate the above mentioned limitations of WoZ based approach.

4 FINDINGS

In this section, we present our findings by analyzing users' interactions with the chatbot, online survey & feedback questionnaires, and field observations.

4.1 Sources of Information and their Impact

In this section, we describe the role of close family members, friends, and physicians in adolescent health education. We also focus on available sources including web forums, books, etc. from where adolescents attempt to find information. Figure 4 depicts the empirical statistics of the usage of different sources which varies from gender to gender. The socio-cultural obstacles and hesitations, faced by teenagers in gaining reproductive knowledge have also been highlighted.
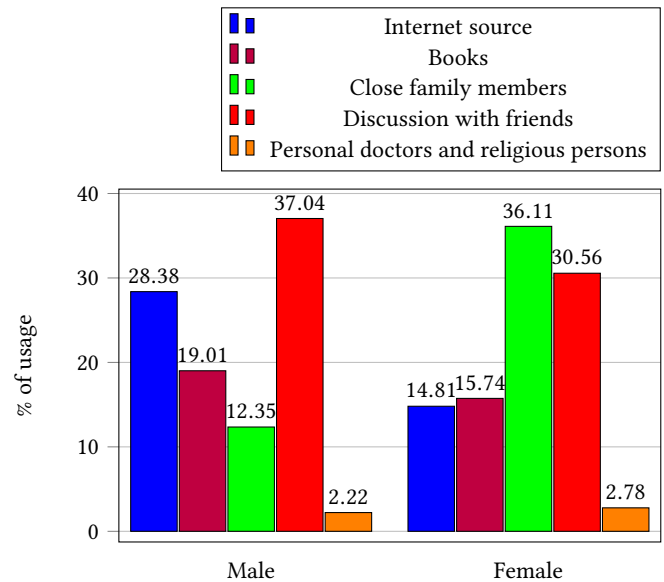
Figure 4: Percentage usage of different sources for adolescent health issues by respondents

4.1.1 Role of Close Family Members. We find from Figure 4 that, female participants prefer close family members like elder siblings, and parents to gain sexual knowledge. A female participant described her elder sister's role as follows, "***I have gotten the awareness about menstruation and the rules of using pad from my elder sister***". Another female respondent added, "***My mother is always concerned about my physical & mental health***". Again boys try to hide their adolescent health issues from their families and consider these as bad topics to talk about. An arbitrary male

participant said, "*My parents always ask me about any health-related issues, but I don't prefer sharing these bad talks with them. I also feel shy*". However, the role of family members regarding adolescent health is significant, especially for girls.

4.1.2 Role of Friends. From Figure 4, we observe that males feel free to discuss sexual issues with their friends. Some take this topic as fun and spread misinformation. One male participant shared his experience, "*One of my friends told me that nocturnal emission is the symptom of HIV AIDS. I got so much depressed and couldn't sleep at night*". Another respondent added, "*My friends think nocturnal emission as the consequence of bad deeds.*". One female participant also shared her experience about getting false information, "*My friend told me that menstruation occurs only in bad girls, so start practicing religion and beg pardon to God for your sins*".

4.1.3 Role of Physicians. Both male and female participants have shown small interests in physicians and religious persons (Figure 4). By claiming lackings of specialists as the reason, one respondent mentioned that, "*There is a shortage of specialist in this area*". Another one added, "*It is not something that needs discussion with doctors. Everybody will learn these things naturally with the increasing of age*". Again the socio-cultural condition of Bangladesh interrupts young people to discuss sexual and reproductive issues openly. An arbitrary medical personnel said, "*Teenagers come to take their consultancy only in serious phase. They feel shy in an open discussion because of socio-cultural & religious issues*".

4.1.4 Role of Books and Online Sources. We observe that adolescents consider books and online forums as supportive mediums. However, they also encounter several difficulties in these mediums. By facing difficulties with topic searching one respondent stated, "*For a piece of information related to the sexual issue, I wasted several days by seeking the topic in books. I didn't know the bookish terminology*". Huge explanations have been written in books and sometimes the language used in books is too hard to understand. Again different web forums contain conflicting information. One respondent claimed, "*Many online heath forums!! many conflicting information and tips!! What should I follow?*". By pointing to the response delay of a popular question/answering based web forum, another participant mentioned, "*I had gotten the response of an immediate serious question from an online forum after one week delay from my query date*".

4.2 Information Seeking

In this subsection, we analyze participants' interaction, communication, and question patterns with the bot. We received a total of 926 queries in 256 interactions from our experiment stated in Section 3. The objective is to understand users' question type, topic, and structure that will help in designing a knowledge base and interactive chatbot application in the future. We also present queries connected to existing wrong-beliefs.

4.2.1 Question Type. Respondents' query belong to both fact-based (queries that have standard text-book answers) and condition-based (queries that have personalized and condition based answers). Again we divide these questions into simple and complex classes. Table 2 presents distribution and examples of respondents' question type.

From Table 2, we observe that 85% of participants' queries are of simple category and these answers can be easily given from the knowledge base. By applying advanced form of fact finding, complex fact-based questions can be answered. Complex condition-based questions need specialist intervention because proper body-checkup is required for answering these questions.

4.2.2 Query Topics. We categorize all the query topics into two classes, the first one is adolescent diseases which include 11 diseases, and the second one is mental & behavioral problems that include 9 problems. Figure 5 presents all of these diseases and problems. Table 3 shows the topmost queried 3 topics for each category and Figure 5 depicts the query counts of all problems of both categories. Out of 256 respondents, 125 persons (48% of male participants and 51.6% of female participants) queried about acne, and 95 queries were related to weakness feeling where 67 participants were male (34.54% of male participants) and 28 were female (45.16% of female participants). Again 68 participants asked for the solutions to frequent nocturnal emission. Most of the mental & behavioral problem-related queries were regarding the solutions for depression. In Figure 5, we observe that 100 participants sought instructions to get rid of pornography addiction. Queries related to drug addiction were also asked and 4% queries pertained to sexually transmitted diseases like HIV, syphilis, etc.

By analyzing all the queries, we find that 14% queries are out of scope and the rest 86% queries can be included in our pre-described two categories.

4.2.3 Query Structure. The majority of the queries were short in length and asked for general inquiry. However, depending on the participants' question framing style, language, and content, we identify some issues in query structure as follows.

- Query missing key informative components
- Query missing implicit information (e.g., "*My menstruation has been stopped for few months. What is the reason?*". Here the value of 'few' is missing)
- Long query for seeking multiple information
- Question using multiple languages, romanized Bangla language, and regional language
- Query using traditional non-bookish terms

4.2.4 Query Related to Existing Beliefs. From query analysis, we find that around 47% queries are connected to existing beliefs which are mostly wrong. One participant asked for information related to reproductive health like, "*Does kissing cause pregnancy?*". Another male respondent queried about nocturnal emission, "*Is nocturnal emission the symptom of syphilis?*". The main reasons behind these wrong beliefs are lackings of reliable sources for open discussion, and the huge expansion of misinformation.

4.3 User Perceptions

In this subsection, we discuss users' feelings from the interaction with AdolescentBot.

Table 2: Participants' Question Type

Query Pattern	Class	%	Example Quotes
Fact-based	Simple	68%	*Can you provide some tips for the prevention of acne?*
	Complex	2%	*Do you know the biological structure of sperm?*
Condition-based	Simple	17%	*I have acne, so how many glasses of water should I drink per day?*
	Complex	13%	*If I have menstruation one night, can I go to college for attending exam next day?*

Table 3: Participants' Query Category with Topmost Queried 3 Topics

Category	Topics	Total queries	Example Quotes
Disease	Acne	125	*So much pimples on face. Recommend some solutions.*
	Weakness	95	*Feel sleepy all day long and can not eat anything.*
	Frequent Nocturnal Emission	68	*I have been seeing bad dreams and wetting my trouser for consecutive 3 days. Give some immediate solutions.*
Mental & behavioral problems	Depression	136	*Can you recommend any tips that will minimize my depression?*
	Emotional Dysregulation	131	*I feel crying without any reason.*
	Mental Pressure & Anxiety	130	*I can not have a sound sleep at night.*

Trusting Partner. After receiving correct and verified answers, participants developed trust in 'AdolescentBot'. An arbitrary medical personnel attempted to test the bot by asking the prevention mechanisms of menorrhagia, got satisfactory answers, and said, "***Excellent! I will give the same answer if I am asked this question***". Again, two of our research staff showed the evidence of the encrypted database with anonymity to the participants by making sample conversations. One participant said, "***It is promising that the bot is ensuring anonymity by managing encrypted databases.***" Thus, the privacy-preserving characteristics of the bot increased the trust among them. Similarly, 210 participants out of 256 thought of the chatbot as the trusting partner (Figure 6a).

24×7 *Availability Service.* For the 24×7 availability feature, participants started perceiving 'AdolescentBot' as their friend. One respondent described, "***Sometime critical situation arises when it is not possible to contact anyone for an immediate response, then we can get this bot beside us***". Another one added, "***Chatbot's response is seeming like a friend to me. If I face any adolescent health problems at any time, I can ask it to the bot***". 240 participants together with 178 male (91.82% of male respondent), and 59 female (95.68% of female respondents) put their opinions about the availability of the service (Figure 6a).

Ensure Privacy Issue. A shy participant who felt hesitant in sharing adolescent health issues shared his feeling as, "***I feel hesitation in sharing my secret problems in front of doctors. 'Adolescent-Bot' can ensure my privacy issues in this regard***". Like this comment, 198 respondents including 157 male (80.92% of male participants), and 41 female (66.13% of female participants) expressed their perception in ensuring privacy (Figure 6a).

Raise Awareness of Reproductive Health. A respondent who was a medical student shared his feeling as, "***As Bangladesh is socially and culturally conservative country, a chatbot has the ability to raise awareness related to sexual and reproductive issues among all adolescent communities***". 120 participants agreed with this perception (Figure 6a).

Lessen Mental Stress. A mentally stressed participant stated his perception as, "***For last few days, I was so much mentally depressed about my secret problems. I searched different books and web forums, but could not get satisfactory answers. This chatbot for the specific domain can lessen my stress by giving satisfactory answers***". 166 respondents delivered positive expression with this perception (Figure 6a).

The pie-chart in Figure 6b presents the overall feedback of AdolescentBot from our feedback questionnaires. 82.3% of participants gave their positive feedback regarding the potentiality of the bot.

4.4 User Expectations

Several participants developed high expectations with our chatbot by ignoring the scope of our domain. We got 14% queries that were out of the domain. Few queries were like, "***I have caught a cold. Recommend some tips***", "***I have a serious back pain***. They got responses that were not satisfactory to themselves and pointed these as the limitations of the bot. Again one respondent asked a query about specific product information for menstrual pad, "***Of which product's pad will be the best?***". Furthermore, some adolescents were not convinced with short answers to their queries and claimed for more explanations. A participant who was a medical student demanded to keep all type of health-related consultancy, "***Adolescent health is a little area of medical science. You should do something that will cover all the fields of public health***". Nevertheless, the adolescent users took this application as an all-time available helper and first point of support for addressing adolescent health issues.
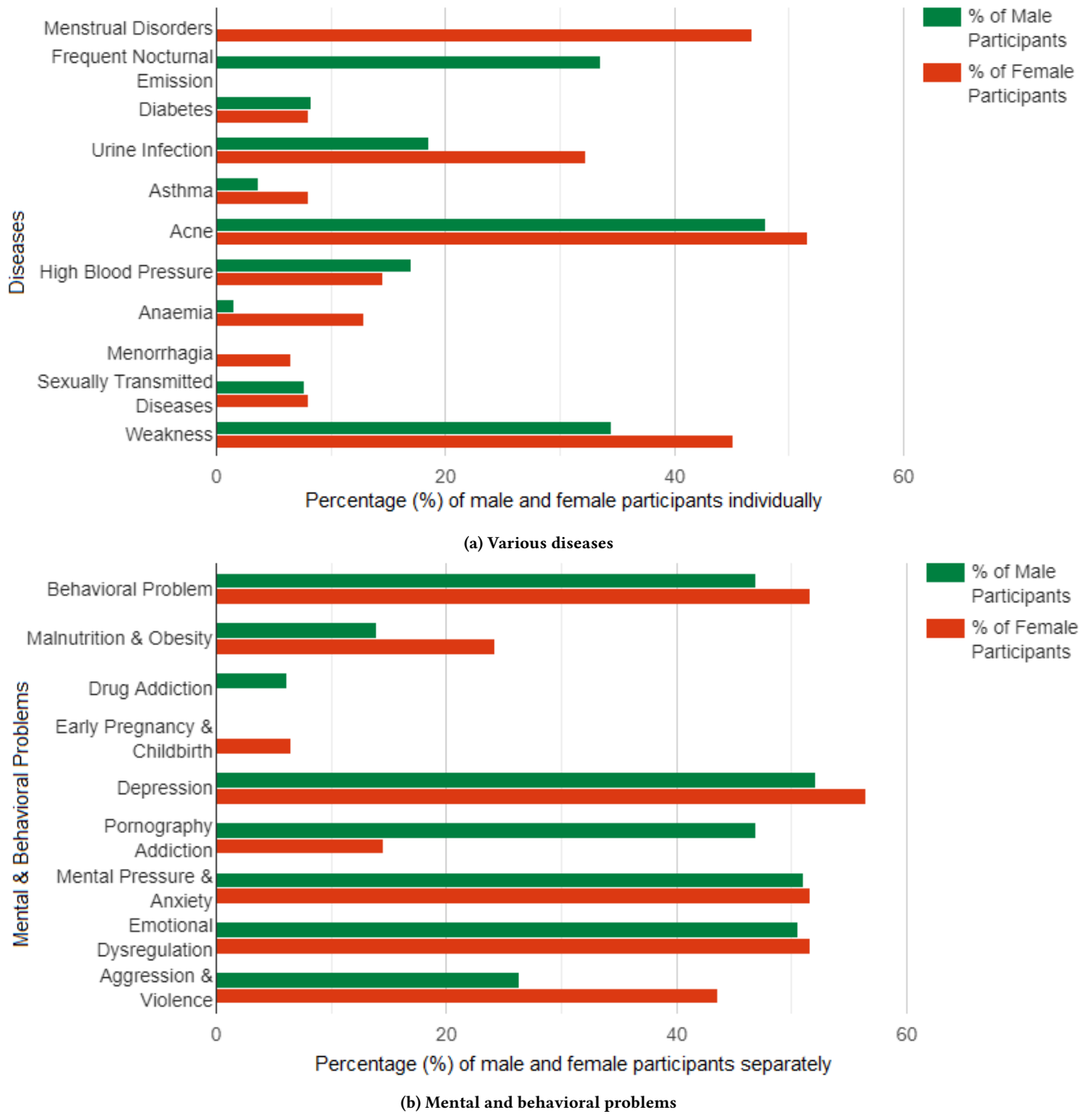
(a) Various diseases

(b) Mental and behavioral problems

Figure 5: Different adolescent health issues queried by participants

4.5 User Engagement

Chatbot application seemed like a person to adolescents. Some participants started their conversation by greetings, "*Assalamulaikum, what's up?*". The users also showed their excitement towards the

chatbot and wanted to recommend this app to their little brothers and sisters for future use.

Interactive Features & Information Presentation. Our prototype had a feature of counter-questioning so that participants could not be out of the domain. This feature was appreciated by the participants
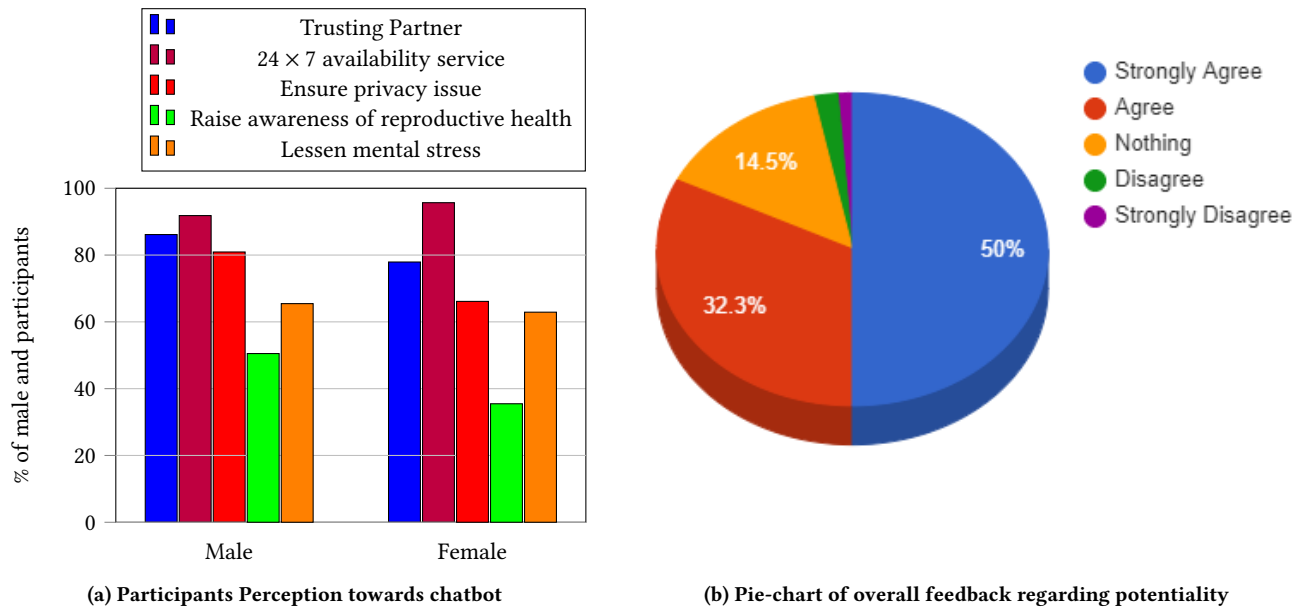
(a) Participants Perception towards chatbot

(b) Pie-chart of overall feedback regarding potentiality

Figure 6: The acceptability of participants towards chatbot

and they recommended us to keep more counter-questions. The respondents also appreciated our 'option based query' feature and the way of presenting the information.

Through the 'option-based query' feature, participants could gain knowledge about the issues that they were facing but had no idea about the standard terminologies. One participant added, "*I was seeking for this problem, but I had no idea about how to term it. Thanks bot*".

As our retrieval-based chatbot prototype in Bangla is formal by nature, few participants were confused in realizing the meaning of some responses. Nevertheless, our research staff clarified those meanings to themselves on the spot. Apart from this, our responses were straightforward and not too long which might seem interactive to the adolescents. We got some suggestions to present images & demo videos to interpret responses easily. All these suggestions and appreciations guide us to keep a more interactive and colloquial design of the chatbot in the future.

5 DISCUSSION

Our study highlights the potential and opportunities of a chatbot for mitigating adolescent health-related problems of whole adolescent communities in Bangladesh. We attempt to understand users' perceptions and identify the robust design opportunities and challenges of a chatbot for adolescent health issues. We believe that this study will be beneficial for similar sensitive health-related works.

5.1 Promising Opportunities of Chatbot

Through our study, we identify the necessity of providing effective and authentic adolescent health-related consultancies to the adolescent community timely. These consultancies are essential to them. Due to the conservative society, shyness, and privacy issues, adolescents perceived AdolescentBot as the first level of assistance.

We want to mention that the chatbot can not be a replacement for doctors. However, it can provide complementary support to the adolescent community [33, 51].

Participants also welcomed the authentic and scientific responses by the bot which would help them eradicate traditional wrong beliefs and deeds. So there is no scope of being misled by friends or others. Again they need not spend much time by seeking authentic information from books or online forums. From our findings, we observe that the majority of users' queries (85%) could be answered by our designed prototype. The prototype only utilized our implemented knowledge base for fetching information and did not take help from other external sources which is a promising outcome.

Because of the privacy-preserving properties and correctness of AdolescentBot, teenagers seemed the bot a trusting partner. Again they appreciated the bot as their assistant for its all-time availability service. Finally, AdolescentBot is capable of raising awareness of reproductive health, and lessen mental stress that can lead adolescents to a better and healthy future.

5.2 Design Concerns

From our experiments, we identify some design concerns in building a chatbot for adolescent health-related issues.

- For naive users, the design should ensure pictorial instructions and video demonstrations [26, 33] so that there arises no doubt in terms of usage of the system.
- Social taboo hinders adolescents from sharing their problems with families and adolescent-friendly health corners. Thus, the design should keep a feature to encourage open discussions with families and doctors, raise awareness, and reduce the taboos.

- Design should include a counter-questioning feature to clarify users' queries, and an option-based query feature to handle out of domain queries.
- 47% queries were related to the justification of traditional practices and wrong-beliefs. This indicates the influence of cultural norms in handling adolescent health-related issues [33, 35]. So the design should be culturally responsive and persuade adolescents towards scientific and authentic practices [26, 40].
- Users' intent behind any query must be extracted by analyzing text [13]. This is literally a classification problem in natural language processing.
- We found that some respondents were not convinced by the responses. So the responses need to be context-based, complete, concise, and coherent so that there will be no way of misunderstanding. Again the design should also provide explanatory answers behind a query.
- We found several queries including romanized Bangla, regional language, and traditional non-bookish terms. These linguistic concerns should be considered in the design to make the interface more interactive.
- Techniques for developing users' empathy levels should be utilized [34] and any types of negative words should be avoided. Again, the sentiment & emotion detection technique may be utilized to identify the corresponding sentiment & emotion associated with the users' queries.
- The chatbot should have the ability to grow positive reinforcement for habit formation [42, 43]. Therefore, the design should include some periodic prompts like 'daily tips and reminders' and other persuasive methods.
- Furthermore, at the time of implementing the final design, privacy issues should be kept in mind. From our study, we observed that adolescents do not prefer open discussions regarding adolescent health issues because they feel hesitant and consider open discussions as their privacy violation. The design must ensure this privacy concern. Again anonymous password protective credentials can be added to the primary implementation to manage security issues.

Finally, user feedback is essential to improve the design periodically. Moreover, the effectiveness of an information source can be measured by user feedback.

5.3 Design Specific Ethical Considerations

The chatbot design also confronts several concerns that need serious ethical considerations.

- From our findings, we observed that some adolescents were considering our prototyped chatbot as a healthcare consultancy application. Such false expectations may mislead users from the actual context of use. So the chatbot design must clear the scope at the time of first interaction [38].
- Adolescent sexual and reproductive health is a sensitive issue. We found that some of the naive participants faced problems in understanding responses and developed wrong notions. Again adolescents find it cumbersome to seek information in books and web forums. So, the responses must be relevant and easily understandable to the users.

- Another concern is trustworthiness of the chatbot. We found one of the reasons for developing users' trust was the authenticity of the responses. For improving trust, the chatbot should provide references to the actual source of information for every response. Again medical personnel's feedback and verification should be needed occasionally to improve the chatbot.
- Some challenging ethical concerns are affordance and deployability. We have mentioned that the chatbot acts as a personal assistant for adolescent communities of all financial and educational classes. The design must be cost-efficient so that high deployability and affordance can be ensured.
- Another risk is the users' privacy and confidentiality. Before conducting our interview, we took consent from the participants not to use their data outside our design purpose. We also collected their information anonymously. Sharing participants' data outside the proposed study without their permission is strongly prohibited. Since most adolescents are not aware of web security, they must be safeguarded for their data utilization. Policy-level recommendations would be essential to implement this confidentiality [36].

5.4 Societal Impact

We have also identified some societal impacts of a chatbot in public healthcare sector. Our study has pointed out the lack of reliable & specific domain-based sources and the hesitations faced by teenagers due to socio-cultural aspects in sharing their problems. They have sought technology (e.g., chatbot) to obtain reliable and authentic answers to their queries. AdolescentBot can provide reliable and authentic responses and fix misinformation to eradicate existing religious and traditional wrong beliefs and myths. Finally, the chatbot can add new pure knowledge base to the community.

If the information from the chatbot is misused, it may cause negative influences and hinders the progress of society. Therefore, the designers need to understand to what extent the chatbot is working [16], and the scope should be clearly defined at the time of introducing the bot so that the chatbot can be utilized for the advancement of society.

In recent years, HCI & CSCW communities are focusing more on the role of technologies on sensitive issues by considering local cultures and customs [46]. The design should not go against culture and society. Sorcar et et. [40] respected local cultural aspects and developed a culturally sensitive design in providing HIV-related information, which is considered taboo in India. Similarly, chatbot design for adolescent health-related issues should follow all the cultural and societal aspects.

Furthermore, by providing scientific responses, the chatbot can develop confidence and positive social impact on the adolescents [50]. These scientific responses can also enhance the awareness of sexual and reproductive health among them and mitigate their mental pressure. This awareness can play a vital role in reducing social taboos. Therefore, AdolescentBot can assist in building a healthy and prosperous society.

6 CONCLUSION

In this paper, we have studied the feasibility of a chatbot in mitigating adolescent sexual and reproductive problems in the context of socially and culturally conservative countries like Bangladesh. Our target user-base includes all adolescent communities residing in both rural and urban areas. We have analyzed the chatbot's effectiveness for adolescent health education, where there is a lack of existing reliable resources to get the necessary help. We have discovered that by providing accurate and efficient information, the chatbot can meet adolescents' needs as the first line support for adolescent healthcare. We have also recommended various design propositions to provide information effectively by exploring users' interaction patterns, perceptions, and contexts of use. Furthermore, we have addressed the wrong-beliefs, socio-cultural importance, and other related ethical and societal issues in our design concerns. In the future, we plan to incorporate the shortcomings of the chatbot by analyzing our findings and design issues and deploy the chatbot in a large-scale.

ACKNOWLEDGMENTS

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