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RESEARCH ARTICLE

Identification of Predictors for Utilization of Artificial Intelligence Powered COVID -19 Chatbot for Self-Screening and Health Counselling

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Abstract

Background: Advent of COVID-19 has led to many challenges to the healthcare system. To deal with the burdening of healthcare and for assuaging the self-screening process 'Dr. Chhaya'- AI (Artificial Intelligence) based chatbot was developed and implemented by a health research institute. **Objectives:** First, to capture the perception of the PG (Post-Graduate) students enrolled in public health programmes towards the 'Dr. Chhaya' chatbot. Secondly, to identify and analyze the predictors for the future use of the chatbot. We proposed a hypothesis that students with different levels of technological proficiency have different perceptions towards AI-based health chatbot. **Methods:** A cross-sectional study on 219 PG students was conducted, using a pre-tested questionnaire. The tool consisted of 2 parts, namely, (i) demographics (ii) experience and perception towards the chatbot. Twelve critical variables were identified which were grouped into 3 domains, namely, 'utility factors', 'sentimental factors', and 'technical appropriateness'. Responses regarding each variable were recorded using an 11-point scale. Statistical analysis of responses was done using IBM-SPSS (ver. 22). **Findings:** The perception of participants towards AI-based chatbot was found to be positive (overall mean of scores=7.1). Regression analysis revealed that 'utility factor' (β =0.45, p value<0.001) and 'sentimental factor' (β=0.35, p value=0.033) are predictors of future use of the chatbots by participants. Analysis revealed that the proposed hypothesis is found true (at 95% confidence). **Novelty:** The present paper offers an interdisciplinary approach and provides insights for developing more efficient self-health screening chatbots. The study informs about the factors that augment the AI powered chatbot use as not discussed much in past studies. Findings suggest, policymakers could implement chatbot utilization policy for urban areas, to promote the self-screening process by masses to reduce burden on the healthcare system.

Keywords: Artificial Intelligence; COVID19; Perception; Chatbots; Health screening

1 Introduction

India experienced a significant upsurge in COVID-19 (Corona Virus Disease 2019) infections during the second wave, leading to healthcare institutions operating beyond their capacities to contain its repercussions. Given the possibility of antigenic shift, specialists anticipated the potential occurrence of another wave of COVID-19 in the country. Combating the COVID-19 pandemic in India and other LMICs (Low and Middle-Income Countries) has consistently presented challenges due to limited community awareness regarding warning signs and symptoms, as well as inadequate adherence to appropriate behavior and quarantine protocols[(1)]. The pandemic provoked social stigmatization, and discriminatory behaviours against infected individuals. This contributed to misconception and myths surrounding the COVID-19 diagnosis and transmission[(2)]. Due to the air-borne nature of the virus, the most efficient way of prevention of transmission is by reducing the human-to-human contact by limiting social interactions as well as doctor-patient interaction at healthcare facilities[(3,4)]. AI (Artificial Intelligence), which has already become an integral part of medical science, emerged as a pivotal tool for diagnosis and screening of COVID-19. Ever since the advent of the COVID-19 pandemic multiple innovative strategies using AI were proposed and implemented[(5)]. AI-based chatbots were reinvented as these chatbots played a multifaceted role, namely limiting human-to-human contact, early self-screening by the masses, reducing clinical patient load, and differential diagnoses[(6)]. Various chatbot models were proposed, implemented, and tested across the globe. A review based on 78 records suggested that AI has attained significant efficiency in diagnosis, prognosis analysis and prediction of the disease trend[(7)].It is noteworthy to mention that chatbot use for health screening has limited the physical interaction of patient and health worker. This has been advocated by many researchers and this peculiarity of the AI powered chatbots extends beyond the pandemic. A study reported participants were more inclined towards interacting with the chatbot (DEPRA) for early detection of depression instead of a psychiatrist[(8)].

A study conducted in India analyzing multilingual interactive chatbots reported that this technology could augment telemedicine utilization dramatically and reduce patient burden even in teleconsulting. This could be achieved by identifying and categorising patients for different medical specialities by the AI[(9)]. A study was conducted in Thailand on a chatbot focussing on 7 key features, namely, reporting, prevention tips, myth busting, screening accuracy, referral, etc. The users feedback showed 64% of query resolution and dramatically high recommendation of users (98%) to others[(10)]. The benefits of chatbot application are not confined to the patients and community but transcends to the healthcare workforce. Based on approximately 270 thousand chat transcripts screening, researchers reported that the use of chatbot has led to reduced waiting-time of the hospital employees during shift-change and while entering the hospital. The application also aided in inhibiting the infection spread by identifying the high-risk employees and preventing them from coming to the workplace[(11)].

AI-based chatbot goes a step further and helps in behavioural modification by spreading awareness via interactive education. These behavioural modifications are extremely important in prevention of any diseases, either communicable or non-communicable. In case of COVID-19 pandemic, developing a herd immunity is of utmost importance, which could be hindered if vaccine hesitancy persists. A study reported that a COVID-19 chatbot significantly increases the odds of the users to get vaccinated by developing a well-informed proactive attitude towards the vaccination and busting the myths. The study further reported, regular updating and proper scripting are a preliminary requirement for effective behavioural modification of the masses[(12)]. As for a proper scripting solution, researchers proposed that existing and pretrained chatbot models such as Google BERT can be efficiently utilized saving the scripting effort and making the model more advanced instead of starting from scratch. Analysis of preliminary implementation of the chatbot revealed strikingly high testing and training accuracies, 96% and 98% respectively[(13)]. Another study examining the pre-existing chatbot's (named Symptoma) efficiency towards COVID-19 screening, reported over 95% accuracy of clinical cases identification, at the same time differentiating from 20,000 diseases[(14)]. These days prominent scientists in the field of machine learning argue that in upcoming years pre-existing AI bots (such as ChatGPT) will be integrated with chatbots and could exponentially augment the potential[(15)]. Further, researchers have reported that the data from the chatbots could further be utilized for epidemiological modelling and prediction of surges or dips in incidence of COVID-19[(16)].

Despite several advantages, many researchers argue that there exists several hindrances and challenges in successful implementation and efficient operationalization for AI-based chatbots. Programming challenges are most prevalent in the form of coding and machine learning. Chatbots require vast logic and linguistic resources, furthermore, while handling intricate queries high attention is required, especially in case of identification of singular and plural form, synonyms, and emotional aspect of the query[(17)]. This is corroborated by another study that stated, besides understanding the literal meaning of the user query, understanding the emotional state by sentimental analysis by the chatbot and creating a human-like experience is a daunting task for the programmers[(18)]. This is of utmost importance in the case of chatbots having counselling and treatment advice functions. The AI-based chatbots are also prone to hindrances prevalent in healthcare technology in general, such as interoperability, data security and accuracy of advice[(19,20)]. Another study reported that geographical variance of disease, identification of vulnerable populations and automated analysis of radiology images are some of the technical challenges

associated with COVID-19 chatbot [21].

A study in 2022 based on the perception clinicians reported various challenges associated with the automated chatbot in post-COVID era. The study underscored that chatbot use could eliminate the diagnostic practice which is based on wisdom and teamwork of different specialists as per as personliazed communication with patients. Another issue they highlighted that given the present technological level, chatbots are not equipped to give emergency care advices to patients. The study also stated that as the interaction between the patient and doctor will be reduced, this will give rise to trust-issues and more difficulty in convincing patients if the doctor's advice varies from the chatbot's advice [22].

The researchers argue, the success of a healthcare service or technology is best measured by the end-users' perception and experience towards it [23,24]. Many attempts have been made by past researchers for capturing the perception towards chatbots by different types of respondents, exploring different features. A survey based on 100 doctors revealed that the majority of doctors (75%) believe that chatbot utilities are beneficial like appointment scheduling and locating the nearest health facility. Nevertheless, this study also reports that at present the chatbots cannot replicate human behaviour in understanding the emotional state of the patient [25]. A survey conducted on mental healthcare professionals revealed that the personal level of user-experience was low, however the overall satisfaction of chatbot utility satisfaction was found to be medium [26]. Another survey conducted on the general population of Saudi Arabia revealed, the intrinsic motivation of an individual is the strongest predictor of using a health chatbot, followed by performance efficacy factor. Similar to aforementioned findings, the researchers reported that about 60% of participants do not perceive chatbot as a cognisant being as it lacks free-will [27]. Literature review revealed that most researchers found that utility and potential of the AI-based chatbots is yet to be utilized to its fullest and the empathy feature is still lacking.

'Dr. Chhaya' (COVID-19 History and Health Status based Assessment Yielding Algorithm)was designed as an independent initiative of IIHMR University (Jaipur campus). The university harbours students and personnel from various parts of India. Being from a different geographical location, and travelling to the university campus, augments the risk of exposure to COVID-19. Being a health research institute and emergence of pandemic, during the first COVID wave the idea of AI-based chatbot ideas was conceived. The chatbot was developed using a third-party application (Landbot). The chatbot was available and synchronised with the official website of the university. The target users of chatbot primarily were students and employees, however the chatbot was designed in such a way that any computer literate individual could use the chatbot. The purpose of the chatbot was to enable self-screening by the user by answering a series of interactive questions. The chatbot was trained to differentiate between positive and negative cases. If a user was found positive, standardized advice (as per government guidelines and WHO) is provided to the user. The chatbot was trained to differentiate between the severity of the disease, depending upon which the advice regarding either home isolation or treatment at primary, secondary or tertiary medical centre was given while maintaining the referral rationale. Since the operationalization of the chatbot it has handled over 900 user interactions and resolution of queries.

The thorough literature review revealed certain gaps in the knowledge. Firstly, there is a dearth of studies conducted in the Indian context regarding the perception towards the health screening AI chatbot. Secondly, if narrowed down further, there exists no literature regarding how postgraduate (PG) students of medical field perceive this technology. Lastly, the previous studies have been done either from the perspective of clinicians or the customers, that too limited to mental health field [8,25,26]. The present study attempts to overcome these gaps and aims to capture the perception of PG students enrolled in MPH (Master of Public Health) and MBA (Health and Hospital Administration) programs towards the 'Dr. Chhaya' chatbot. Further it strives to identify and analyze the predictors for the future use of the chatbot. We proposed a hypothesis that students with different levels of technological proficiency have different perceptions towards AI-based health chatbot.

By achieving these objectives, the paper offers a unique viewpoint relating to chatbot use in health screening. The study participants in the present study are unique and novel. These are PG students in public health academic programs, who will one day assume the role of public health managers and professionals. Their attitude and perception will be eventually reflected in the health technology related policies and implementation projects. Therefore, it is extremely crucial to understand their attitude towards the AI powered chatbot. To the best of our knowledge, there is no such study conducted in the past with similar a aim. Further, the predictor analysis offers a valuable insight about the variables that determine the acceptance and adoption of this technology-driven solutions for self-screening and health counselling in educated young masses.

2 Methodology

2.1 Study design

For achieving the objectives, a cross-sectional survey research was designed. A perception and experience survey was conducted based on primary data collected from the PG students of the university.

2.2 Sampling

A list of users of chatbot was extracted from the database. Out of 656users (based on IP addresses of electronic devices), 393 university students were identified and invited for participation in the survey. With a response rate of 57%, 225 students participated. Six responses were excluded from the study due to incompleteness. The final sample size (N) was 219. Data collection was carried out from 1st Sep 2022 to 31st January 2023.

2.3 Tool

A self-administered questionnaire was developed which was available in online as well as paper based format. For the web based version, an online survey tool (Google Forms) was used. A weblink of the tool was shared via email. The questionnaire was made in English language. The questionnaire consisted of close-ended questions. Some students filled the paper-based questionnaire who were physically reached-out by the investigators on the university campus. The tool consisted of 2 parts, namely, (i) demographics (ii) experience and perception towards the chatbot. Based on the past literature, twelve critical variables were identified which were grouped into 3 domains, namely, 'utility factor', 'sentimental factor', 'technical appropriateness'. Responses regarding each variable were recorded using an 11-point scale, lowest value being '0' and '10' being highest. The tool was pretested in 20 PG students of other institutions in the neighbourhood area around Sanganer in Jaipur city. Internal consistency of the questionnaire was checked and required modifications were made (Cronbach's Alpha = 0.73).

2.4 Analysis

The data from both paper based and online tools were tabulated in MS excel. After data cleaning, quantitative analysis was performed in IBM SPSS (ver.22). Overall score of each participant was calculated as a mean of twelve identified variables which were used for checking the effect of background variables on perception. Binary logistic regression analysis was conducted to identify predictors of future use of the chatbot. For hypothesis testing ANOVA (Analysis of Variance) test was employed.

The adopted methodology has a unique strength, as it involves recruitment of the participants from the database user list. This was done to ensure all participants have adequate experience of the chatbot (Dr. Chhaya) use. This approach was found only in a handful of past studies focusing on finding perception of people towards AI chatbot [8]. Another strength of our methodology is the sample size, which is larger as compared with similar studies, and the regression analysis is used to statistically identify the predictors [23,28]. Moreover, the analysis involves identification of predictors of the repeat-use by using binary logistic regression method. To the best of our knowledge this analytical approach is not used in any other past study focusing on perception analysis towards AI powered health screening chatbot.

3 Results and Discussion

A total of 219 participants were included in the survey. Data regarding demographic characteristics revealed that most of the participants (97%) were in the age group 20 to 29 years. About 63% of participants were female whereas 36% were male. Further, age and gender analysis showed that the majority of both male and female participants belonged to the age group 20-24 years, 56% and 61%, respectively. Majority of participants (93%) followed Hinduism. Data showed that most participants (72%) originated from other states of India (outside Rajasthan), out of which majority of the participants (77%) were from northern states of India, followed by central region states (22%). About two-thirds of the participants (67%) were residents of urban areas, whereas one third belonged to rural areas (33%). As the study participants were PG students, all participants were literate. However, the data regarding type of educational background (at graduation level) revealed that majority of the participants (54%) completed graduation in dentistry. Commerce graduates were second highest (19%) followed by science graduates (16%). It is worth mentioning that out of dental graduates (N=120) approximately two-thirds were female. The intragroup analysis of overall scores for each demographic characteristic revealed that the survey participants were comparable and background characteristics do not have influence on perception of participants. This is for all recorded demographic variables except 'types of residence locality' variable (Table 1).

Perception regarding identified 12 parameters was recorded on a 11 point Likert scale. The response outcomes were grouped into three categories: low, neutral and high perception (Table 2). By and large, the perception of participants towards AI-based chatbot were found to be positive, i.e. overall mean of all scores was 7.1. Analysis of individual variables revealed that the majority of the participants perceived parameters of the utility domain of chatbot as satisfactory or good. Similar trend was observed in technical domain variables, with an exception of 'interoperability'. About 40% of the participants perceived the synchronization of AI chatbot with other technologies (such as GPS and telecommunication) as poor. The analysis of variables of sentiment domain revealed a contrary trend. Markedly higher proportion of participants perceived the 'empathy shown by

Table 1. Demographic characteristics of participants (N=219).

Characteristic Variable	N (%)	Overall Score#	P value
Age			
20-24 years	123 (56.1%)	6.5	0.723
25-29 years	89 (40.6%)	7.2	
30 years and above	7 (3.1%)	6.9	
Gender			
Female	140 (63.9%)	7.5	0.057
Male	79 (36.1%)	7.1	
Religion			
Hinduism	204 (93.1%)	6.7	0.125
Others	15 (6.8%)	7.7	
Place of Origin			
Other state of India (not Rajasthan)	158 (72.1%)	6.2	0.221
Another district of Rajasthan (not Jaipur)	37 (16.9%)	7.1	
Within Jaipur	24 (11.0%)	7.3	
Type of Residence Locality			
Urban	147 (67.1%)	8.4	0.032*
Rural	72 (32.9%)	6.7	
Previous Educational Background			
Dental graduate	120 (54.7%)	7.6	0.079
Commerce graduate	43 (19.6%)	8.1	
Science graduate (BSc, Biotechnology)	36 (16.4%)	7.9	
Others (MBBS, Arts, etc.)	20 (9.1%)	7.1	

*Statistical significance at p value < 0.05. #Overall score is calculated as the arithmetic mean of all participants of the sub-groups.

the chatbot' and 'communication tone' as poor. Among all variables, the largest proportion of participants (52%) perceived 'user interface' as good (mean=8.9).

To find the predictors of the future use of the chatbot binary logistic regression analysis was conducted. The means of all three domains were calculated as independent variables. The participants were asked whether they will use the chatbot in future if needed or not. The 'future use' was considered as an outcome variable, binary in nature. Regression analysis was carried out in SPSS which revealed that utility of the health chatbot is the most significantly impacting factor that predicts the future use of the AI-based health chatbot (Beta (β)=0.45, p value<0.001). Second strongest predictor was found to be a sentimental aspect of the chatbot (β=0.35, p value=0.033). 'Technical appropriateness' was not found to be a statistically significant predictor (β=0.12, p value=0.721). The model summary revealed that overall domain level regression was found to be statistically significant (p value=0.025) with coefficient of regression (adjusted R^2) equals to 0.81.

Regression analysis of individual variables revealed 9 out of 14 variables were found to be the predictors of the chatbot future use, out of which, the strongest predictor was found to be 'preventive advise' (β=0.38) followed by 'response time' (β=0.36).

To test the proposed hypothesis, participants were grouped into three categories on the basis of their self-reported technological proficiency, i.e., proficient, intermediate, and beginner level. The overall score of perception of each individual participant was calculated. Mean comparison of the groups was done using one-way ANOVA method. The findings suggest that there is a significant effect of technological proficiency of an individual on how the individual perceives the AI-based health chatbot [F (2,182) = 4.63, p value=0.048]. Post-hoc comparison indicated that the mean of proficient level (M=8.0, SD=1.4), intermediate level (M=6.9, SD=1.8) and beginner level (M=5.2, SD=1.5) participants significantly differed from one another. Hence, the proposed hypothesis is accepted, i.e., students with different levels of technological proficiency have different perceptions towards AI-based health chatbot.

The present study reports a positive perception and satisfaction of users towards 'Dr. Chhaya' an AI-based chatbot. The overall findings are in line with past surveys conducted on healthcare workers [25]. However, it is noteworthy to mention, the findings have more utility from two different points of view. Firstly, this study informs about the attitudes and behaviour of previously unexplored group of population, i.e., PG students of public health programs. In future these students will complete post-

Table 2. Descriptive statistics of satisfaction towards different aspects of the chatbot (N=219)

Variable	Low (Perceived Poor, score 0-3)	Neutral (score 4-6)	High (Perceived Good, score 7-10)	Mean Score	SD
Utility factor					
Responsiveness	18 (8.2%)	167 (76.3%)	34 (15.5%)	6.6	2.02
Accuracy	21 (9.6%)	155 (70.8%)	43 (19.6%)	6.7	1.96
Counselling	12 (5.5%)	142 (64.8%)	65 (29.7%)	6.4	2.22
Preventive advise	5 (2.3%)	131 (59.8%)	83 (37.9%)	8.5	1.82
Treatment Advise	10 (4.6%)	110 (50.2%)	99 (45.2%)	8.8	0.97
Additional information regarding COVID-19	31 (14.2%)	142 (64.8%)	46 (21%)	5.3	2.01
Sentimental factor					
Empathy shown by the chatbot	59 (26.9%)	141 (64.4%)	19 (8.7%)	4.4	2.22
Communication tone	40 (18.3%)	158 (72.1%)	21 (9.6%)	5.5	1.98
Technical factor					
Response time	20 (9.1%)	169 (77.2%)	30 (13.7%)	7.3	2.62
Reply language	15 (6.8%)	121 (55.3%)	83 (37.9%)	7.8	2.31
User interface	10 (4.6%)	95 (43.3%)	114 (52.1%)	8.9	2.49
Interoperability (GPS map & SMS)	88 (40.2%)	119 (54.3%)	12 (5.5%)	5.8	2.26

graduation and join the public health field. They will be proactively participating in the chatbot related policies development and implementation. Most of the past studies have either considered patients [20,23,29] or the clinicians [25] or other healthcare industry workers [30] for perception and attitude analysis. Thus, this study provides an insight about the thought-process of a unique sub-group of population. Secondly, as compared to the past studies [23,28] the present study offers a larger sample size which adds to the accuracy of the findings. Further, these studies do not offer any statistically significant behaviour prediction model [23,28]. Lastly, the present study findings will be utilized to make screening and chatbot use stronger in case of any future outbreak of COVID 19 or similar infections in general, especially in LMICs. This adds to the strength of the present study.

The key message from the study is that simulating human behavior and sentiment in a chatbot is still a challenge; the same has been reported by other studies [26,27]. The past literature suggests the lack of humanoid behavior by AI and intangibility of the chatbot explains the lower satisfaction of users towards the sentimental aspect of the chatbot [30]. Amongst the technical parameters, the present study observed that interoperability of the chatbot was the only factor that had a considerably greater proportion of lower scores. The reason may be attributed to the inherent challenges that come with any medical technology synchronization. Researchers in the past have reported that there is potential of amalgamation of various healthcare technologies with AI chatbots, such as Hospital Information System, Picture Archival and Communication Systems, and Electronic Medical Records [19]. Based on this synchronization potential, future research should be conducted answering the question how it influences end-user experience.

4 Conclusion

This scientific paper presents a valuable investigation into the perception of users regarding COVID-19 chatbots ('Dr. Chhaya'). The present study has novelty in terms of the studied population. The study underscores the strengths and weaknesses of this COVID-19 chatbot from the perspective of the PG students of public health, which is not offered by any past research. The mix of methodology strengths and novelty make this paper unique.

The study offers insightful findings on user engagement and attitude, which can be leveraged to enhance the effectiveness of chatbot-based interventions during pandemics. In nutshell findings are indicative that there exists overall satisfaction of the participants, and the 'utility' of the chatbot is the strongest predictor of repeat use of the chatbot. However, there exists room for

improvement in the 'sentiment understanding' feature of the chatbot. Finally, it is found that technological agility of the user doesn't have a bearing on perception development of the user, this needs to be analyzed further. Software developers should optimize and design the health chatbots accordingly, with prime focus should be on increasing utility. Lastly, we recommend that policymakers should consider making chatbot utilization policy for urban areas, to promote the self-screening by masses to reduce burden on the healthcare system.

4.1 Limitation

The finding cannot be generalised beyond the students and educated youth population in LMICs. Further, this study doesnot ecompasses the specific challenges faced by the users in utilizing the AI-based chatbot. To pin-point these, an in-depth qualitative interview could be conducted.

4.2 Ethical Consideration

No information regarding the identity of the respondents was gathered. The voluntary participation in the survey, to choose to do so, or to withdraw at any moment was made clear to the respondents. All participants were made aware that the answers they provided would be kept completely anonymous, confidential and will not be shared with anyone.

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