ORIGINAL RESEARCH

A Study to Refine and Test the Usability of an Artificial Intelligence and Machine Learning-based Dental Technology and Smartphone App "DentalFriend" to Detect Dental Diseases

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ABSTRACT

Aim and objectives: This study presents a community-based participatory research (CBPR) strategy to refine and test the usability of an artificial intelligence (AI) and machine learning (ML)-powered dental technology and it's smartphone mobile app version called as DentalFriend for dental disease detection.

Methodology: The study involved two phases: refinement of the app using a CBPR approach and usability testing of the refined app among a sample of 1000 individuals from the community.

Results: Descriptive statistics and subgroup analyses were used to analyze the data collected in the study, which showed a 99% precision in detecting dental diseases.

Conclusions: The study highlights the potential of using a CBPR approach in developing AI and ML-powered health-care apps that meet the needs and preferences of the community.

Key words: Artificial intelligence, Community-based participatory research, Dental diseases, DentalFriend app, DentalFriend, Precision, Smartphone app, Usability testing.

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INTRODUCTION

Dental diseases are a major public health problem affecting people worldwide. Early detection and treatment of dental diseases are crucial to prevent further progression and complications. Unfortunately, many people do not receive timely diagnosis and treatment due to limited access to oral health-care services. The use of artificial intelligence (AI) and machine learning (ML) in dentistry has emerged as a promising solution to improve access to oral healthcare services. The development of an AI and ML-powered smartphone app for dental disease detection has the potential to revolutionize the field of dentistry.[1-4]

The proposed study aims to use a community-based participatory research (CBPR) strategy to refine and test the usability of an AI and ML-powered smartphone app "DentalFriend" for dental disease detection. The study involves two phases: Refinement of the app using a CBPR approach and usability testing of the refined app among a sample of 1000 individuals from the community.

Dental Diseases and AI/ML in Dentistry

Dental diseases refer to a range of conditions affecting the teeth and gums, including tooth decay, gum disease, and oral cancer. These conditions can cause pain, discomfort, and affect a person's ability to eat, speak, and smile. Early detection and treatment of dental diseases are crucial to preventing further progression and complications, such as tooth loss and infections.

AI and ML technology have shown promise in dentistry by improving the accuracy and efficiency of dental disease diagnosis and treatment. AI and ML algorithms can analyze large amounts of dental images and patient data to identify patterns and anomalies that may indicate the presence of dental diseases. This technology has the potential to improve access to oral health-care services by reducing the need for in-person dental appointments and enabling remote diagnosis and treatment.[5-8]

CBPR

CBPR is a collaborative approach to research that involves community members, stakeholders, and researchers in all aspects of the research process. The CBPR approach recognizes the importance of community engagement in research and seeks to address community needs and priorities. CBPR has been used

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in various fields, including public health, education, and social sciences, to address health disparities and improve health outcomes.

The use of CBPR in developing health-care technology can help ensure that the technology meets the needs and preferences of the community. CBPR involves engaging community members and stakeholders in the research process to identify their needs and concerns, and to develop solutions that are culturally and socially appropriate. By involving community members in the development of healthcare technology, CBPR can help ensure the technology's acceptability and effectiveness in the community.[9-11]

Refinement of the AI/ML-Powered Smartphone App

In the first phase of the study, we have used a CBPR approach to refine the AI/ML-powered smartphone app for dental disease detection. We have engaged with community members, dental professionals, and technology experts to identify the DentalFriend app's features, design, and functionality that meet the community's needs and preferences. We have also conducted a pilot test of the DentalFriend app to identify any technical issues or bugs.

The CBPR approach has involved engaging community members in focus group discussions and surveys to identify their needs and preferences regarding the DentalFriend app's features, design, and functionality. We have also engaged dental professionals and technology experts to provide feedback on the DentalFriend app's technical and clinical aspects. The feedback received from the community and stakeholders has informed the refinement of the app's features, design, and functionality.

Usability Testing of the Refined App

In the second phase of the study, we have conducted usability testing of the refined app among a sample of 1000 individuals from the community. The participants have been asked to use the app to detect dental diseases and provide feedback on its usability. We have collected data on the app's accuracy, sensitivity, and specificity in detecting dental diseases.

METHODOLOGY

Study Design

The proposed study is a CBPR strategy to refine and test the usability of an AI and ML-powered smartphone app for dental disease detection. The name of our app is DentalFriend. The study involves two phases: Refinement of the DentalFriend app using a CBPR approach and usability testing of the refined DentalFriend app among a sample of 1000 individuals from the community.

Phase 1: Refinement of the App

The first phase of the study involves the refinement of the AI/ML-powered smartphone DentalFriend app for dental disease detection using a CBPR approach. The study has been conducted in collaboration with community members, dental professionals, and technology experts.

Sampling

We have recruited community members who are willing to participate in focus group discussions and surveys to provide feedback on the app's features, design, and functionality. We have also recruited dental professionals and technology experts who are willing to participate in providing feedback on the DentalFriend app's technical and clinical aspects.

Data collection

We have collected data on the DentalFriend app's features, design, and functionality using focus group discussions and surveys. We have conducted focus group discussions with community members to identify their needs and preferences regarding the app's features, design, and functionality. We have also conducted surveys to collect quantitative data on the DentalFriend app's features, design, and functionality.

We have also collected data on the DentalFriend app's technical and clinical aspects using feedback from dental professionals and technology experts. We have engaged dental professionals and technology experts to provide feedback on the DentalFriend app's technical and clinical aspects, such as its accuracy, sensitivity, and specificity in detecting dental diseases.

Data analysis

We have analyzed the data collected from focus group discussions and surveys using qualitative and quantitative methods. Qualitative data analysis has involved identifying themes and patterns in the data, while quantitative data analysis has involved descriptive and inferential statistics.

Phase 2: Usability Testing of the Refined App

The second phase of the study involves the usability testing of the refined DentalFriend app among a sample of 1000 individuals from the community. The participants

have been asked to use the DentalFriend app to detect dental diseases and provide feedback on its usability.

Sampling

We have recruited a sample of 1000 individuals from the community who have access to a smartphone and are willing to participate in the study. The participants have been recruited through community outreach programs.

Data collection

We have collected data on the DentalFriend app's usability using a combination of self-reported data and observational data. The participants have been asked to use the app to detect dental diseases and provide feedback on its usability using a survey. We have also collected observational data on the participants' use of the app and the app's accuracy, sensitivity, and specificity in detecting dental diseases.

We have also collected data on the participants' demographics, oral health status, and experience using smartphone apps.

Data analysis

We have analyzed the data collected from the usability testing using descriptive and inferential statistics. We have calculated the DentalFriend app's accuracy, sensitivity, and specificity in detecting dental diseases. We have also conducted regression analysis to identify factors that are associated with the app's usability and effectiveness.

Ethical Considerations

We have obtained informed consent from all participants before their participation in the study. We have also ensured the confidentiality and anonymity of the participants' data by assigning unique identification numbers to each participant's data. We have followed ethical guidelines for research involving human subjects.

RESULTS

Phase 1: Refinement of the DentalFriend App

The refinement phase involved 50 participants, including 20 community members, 10 dental professionals, and 20 technology experts. The focus group discussions and surveys revealed that the participants preferred an app that was easy to use, had a simple interface, and provided clear, and concise instructions on how to use it. The participants also emphasized the importance of the app's accuracy, sensitivity, and specificity in detecting dental diseases.

The feedback from dental professionals and technology experts revealed that the app's technical and clinical aspects were satisfactory. They noted that the AI and ML algorithms used in the app were accurate, sensitive, and specific in detecting dental diseases.

Based on the feedback received from the participants, the app was refined by incorporating the following changes:

- Simplification of the interface
- Improving the clarity of the instructions on how to use the app
- Improving the accuracy, sensitivity, and specificity of the AI and ML algorithms
- Adding a feature to enable users to schedule an appointment with a dental professional if they detect any dental diseases.

Phase 2: Usability Testing of the Refined DentalFriend App

The usability testing phase involved 1000 participants from the community. The participants had a mean age of 36 years, with a standard deviation of 10 years. About 58% of the participants were female, and 42% were male. The majority of the participants (75%) reported having used smartphone apps before.

The participants were asked to use the app to detect dental diseases, and 99% of the participants reported that the app was easy to use. The mean time taken to detect dental diseases using the app was 1 s. The accuracy, sensitivity, and specificity of the app in detecting dental diseases were 99%, 98%, and 98%, respectively.

Regression analysis revealed that age, gender, and experience using smartphone apps were not significant predictors of the app's usability and effectiveness. However, participants who reported having poor oral health status had significantly lower app effectiveness scores compared to those with good oral health status ($P < 0.05$) [Tables 1-4].

DISCUSSION

The results of the two-phase study on the refinement and usability testing of a dental disease detection app "DentalFriend" are promising. The first phase involved focus group discussions and surveys with a sample of 50 participants, including community members, dental professionals, and technology experts. The feedback received from these participants helped refine the app by simplifying the interface, improving the clarity of instructions, and enhancing the accuracy, sensitivity, and specificity of the AI and ML algorithms.

In the second phase, a larger sample of 1000 participants from the community were involved in the usability

Table 1: Feedback from participants on the refinement of the DentalFriend App

Participant Group	Feedback
Community Members	Preferred an app with a simple interface
	Emphasized the importance of accuracy in detection
Dental Professionals	Noted that the technical and clinical aspects were satisfactory
Technology Experts	Noted that the AI and ML algorithms used in the app were accurate, sensitive, and specific in detecting dental diseases

Table 2: Characteristics of participants in usability testing

Participant characteristic	Mean	Standard deviation
Age	36	10
Gender (Female/Male)	58%/42%	-
Previous App Use (%)	75%	-

Table 3: Usability testing results

Result	Mean	Standard deviation
App Ease of Use (%)	99%	-
Time to detect (seconds)	1	-
Accuracy (%)	99%	-
Sensitivity (%)	98%	-
Specificity (%)	98%	-

Table 4: Regression analysis of app effectiveness scores

Predictor variable	Coefficient	Standard error	*P*-value
Age	−0.02	0.01	0.10
Gender (Female)	0.04	0.02	0.08
Previous App Use	0.01	0.01	0.32
Oral Health Status (Poor)	−0.10	0.04	0.03*

*Significant at $P<0.05$

testing of the refined DentalFriend app. The majority of the participants (99%) reported that the app was easy to use, and the app was able to detect dental diseases with high levels of accuracy, sensitivity, and specificity (99%, 98%, and 98%, respectively). These results are consistent with the feedback received from dental professionals and technology experts in the first phase of the study.

Moreover, regression analysis showed that age, gender, and experience using smartphone apps were not significant predictors of the app's usability and effectiveness, indicating that the DentalFriend app was equally effective for different demographic groups. However, the finding that participants with poor oral health status had lower DentalFriend app effectiveness scores than those with good oral health status suggests that the app may be more beneficial to individuals with good oral health who are using it for preventive purposes rather than for diagnosing or treating dental diseases.

Overall, the results of this study suggest that the refined app has the potential to be a valuable tool for individuals to detect dental diseases and take preventive measures. Further research is needed to validate the app's effectiveness in clinical settings and to assess its impact on oral health outcomes.[12-14]

CONCLUSIONS

The results of this study suggest that the refinement phase of the dental disease detection app "DentalFriend" was successful in improving the app's usability and clinical effectiveness. Based on the feedback received from participants, the DentalFriend app was refined by simplifying the interface, improving the clarity of the instructions, and enhancing the accuracy, sensitivity, and specificity of the AI and ML algorithms.

The usability testing phase revealed that the DentalFriend app was easy to use, with a high accuracy, sensitivity, and specificity in detecting dental diseases. The regression analysis showed that age, gender, and experience using smartphone apps were not significant predictors of the app's usability and effectiveness. However, participants with poor oral health status had significantly lower app effectiveness scores compared to those with good oral health status.

Overall, the results suggest that the DentalFriend app has the potential to improve access to dental care by enabling individuals to detect dental diseases at an early stage with accuracy of 99% and seek professional help when needed. Further research is needed to validate the effectiveness of the app in real-world settings and to explore its potential impact on oral health outcomes.

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