CliniKiosk: An Innovative Technology to Expand Healthcare Access

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Background: Healthcare access is a pressing global problem affecting both developed and developing countries (Davis, 2023). According to the World Health Organization (WHO) Tracking Universal Health Coverage: 2023 Global Monitoring Report, more than 4.5 billion people do not have access to healthcare, including preventive care, screening services, maternal care, and behavioral health services (World Health Organization, 2023). Healthcare disparities are widespread globally, with marginalized and vulnerable populations often facing the greatest obstacles to get the care they need (Akinyemi, 2024). Even in developed countries, these inequalities exist, with economically disadvantaged communities struggling to access healthcare, resulting in millions of deaths annually (Wen and Sadeghi, 2023). Healthcare access is projected to worsen in rural communities, with more than 30% of hospitals at risk of closure (Becker's Hospital Review, 2024). Additionally, workforce shortage is expected to further exacerbate lack of access to healthcare (Mercer, 2021). WHO estimates a critical shortage of 10 million healthcare professionals by 2030, primarily in low to middle-income countries (World Health Organization, 2020). This will result in a significant mismatch between supply and demand, disproportionately affecting under-resourced communities, which may lead to potentially worse health outcomes. The inability to meet growing demands by healthcare systems, which are already overwhelmed, will result in longer wait times and overcrowded emergency departments (Derlet RW et al., 2000). The traditional appointment-based healthcare delivery is unlikely to keep pace with increasing needs and potentially lead to higher rates of mortality, disability, and shorter life expectancy. This investigation aims to develop digital healthcare solutions to enhance healthcare delivery to diverse patient populations, particularly in under-resourced communities.

Digital health technologies can help mitigate some of the challenges associated with healthcare delivery, especially the shortage of healthcare professionals (Popa et al., 2024). These technologies can potentially address the mismatch between supply and demand in under-resourced communities (Sun and Zhou, 2023). In recent years, health chatbots with text or voice-based interfaces have multiplied and are becoming increasingly popular (Rebelo et al., 2022). However, current health chatbots, while useful in select scenarios, typically depend on pre-scripted responses (Abd-Alrazaq et al., 2020). They lack personalization, and support only limited languages, which limits their capacity to effectively serve diverse populations (Laymouna et al., 2024). In addition, these health chatbots lack intelligent, up-to-date, evidence-based recommendation capabilities, real-time adaptability to the user and other capabilities, such as diagnostic testing or medication dispensing. Lower levels of health literacy, language barriers, and cultural differences can prevent effective interaction with health chatbots and reduce utilization (Jin et al., 2024). **Thus, there is a critical need for an innovative approach to address these limitations and improve healthcare accessibility for diverse**

populations. The solution lies in scalable, cost-effective digital healthcare innovations that ensure quality healthcare access for everyone without adding burden to existing healthcare systems. This investigation proposes CliniKiosk (Figure 1), an Artificial intelligence (AI)-powered digital health kiosk designed to deliver real-time, evidence-based, multilingual, empathetic, and personalized health assessments that are adaptable to culturally diverse communities. In contrast to traditional health chatbots, it dynamically adapts to users by analyzing demographics, symptoms, and medical history to provide both empathetic and personalized health recommendations. Its multilingual capabilities ensure broader access, and its evidence-based recommendations conform to current clinical best practices. Additionally, CliniKiosk can be scaled up to deliver FDA-approved point-of-care diagnostic tests and dispense some medications, including antibiotics, directly at the kiosk. Through the management of these cases, it can ease the burden on emergency departments and primary care facilities. This study hypothesizes that it is feasible to design digital healthcare solutions capable of delivering empathetic, evidence-based personalized health recommendations to culturally diverse patient populations.

Research Question: Can a multilingual healthcare kiosk software leveraging machine learning algorithms and GPT-based conversational AI be developed to accurately assess patient symptoms and provide real time, evidence-based, empathetic, and personalized health recommendations?

Figure 1. OpenAI Depiction of the CliniKiosk

Methodology: The CliniKiosk platform was developed through a multi-phase process combining full-stack implementation, advanced AI integration, and performance testing. A GitHub repository was created to contain each file of CliniKiosk. React, TypeScript, and Vite were used to create the package.json located in the GitHub repository, as well as basic tools and rules for the environment. Supabase enabled secure authentication, while SendGrid supported custom email verification OTP. The AI engine used GPT-4o with OpenAI Whisper for speech-to-text, and multilingual functionality was implemented via i18next. PubMed data was integrated through Supabase Edge Functions for evidence-based responses, and mem0 enabled personalized, memory-aware interactions. The platform was deployed via Netlify after domain setup on GoDaddy. For model evaluation, a clinician-validated dataset of 500 simulated patient case scenarios was constructed, reflecting a wide range of medical conditions, risk factors, acuity levels and demographic diversity. CliniKiosk was compared against GPT-4o Mini, Claude 3 Opus, and Mixtral 8x7B (via OpenRouter).

Data Analysis: A Chi-square test was used to compare the treatment recommendation accuracy, medical recommendation consistency, hallucination rate, empathy, and explainability. A t-test was used to compare average response length and lexical diversity. Qualitative assessments were made through internal reviews of conversational quality, emotional adaptability, user engagement, trust, and overall usability. Sentiment analysis was performed to measure empathy in responses.

Results: CliniKiosk demonstrated high response consistency (90.0%), significantly outperforming Claude 3 Opus (65.4%, $p < 0.05$), though slightly trailing GPT-4o Mini (98.4%, $p < 0.05$) and Mixtral 8x7B (93.4%, $p < 0.05$). In treatment recommendation accuracy, CliniKiosk achieved 56.8%, significantly higher than GPT-4o Mini (40.4%, $p < 0.05$) and Claude 3 Opus (35.8%, $p < 0.05$), but slightly below Mixtral 8x7B (61.6%, $p < 0.05$). CliniKiosk and GPT-4o Mini both achieved a 0% hallucination rate, significantly outperforming Claude 3 Opus (34%, $p < 0.05$) and Mixtral (74%, $p < 0.05$). Response length for CliniKiosk averaged 222.5 words—longer than Claude 3 Opus (156.9, $p < 0.05$), comparable to Mixtral (224.4, $p < 0.05$), and shorter than GPT-4o Mini (264.3, $p < 0.05$). CliniKiosk showed strong empathy (92.4%), significantly exceeding Claude 3 Opus (40.4%, $p < 0.05$) and Mixtral 8x7B (59.6%, $p < 0.05$), while slightly behind GPT-4o Mini (97.6%, $p < 0.05$). Its explainability score was near-perfect (97.8%), just below GPT-4o Mini (99.6%, $p < 0.05$), yet significantly higher than Claude 3 Opus (64.0%, $p < 0.05$) and Mixtral (91.2%, $p < 0.05$). CliniKiosk also achieved the highest lexical diversity (0.545), significantly outperforming GPT-4o Mini (0.539, $p < 0.05$), Claude 3 Opus (0.536, $p < 0.05$), and Mixtral 8x7B (0.462, $p < 0.05$).

Figure 2. Comparison of CliniKiosk, GPT-4o Mini, Claude 3 Opus, and Mixtral 8x7B (via OpenRouter) Treatment Suggestion Accuracy and Medical Recommendation Consistency

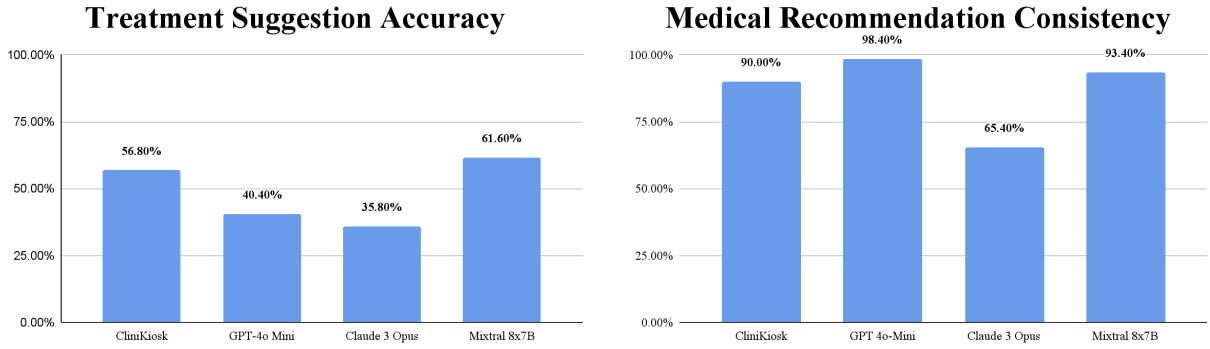


Figure 3. Comparison of CliniKiosk, GPT-4o Mini, Claude 3 Opus, and Mixtral 8x7B (via OpenRouter) Average Response Length, Hallucination Rate, Empathy, and Explainability

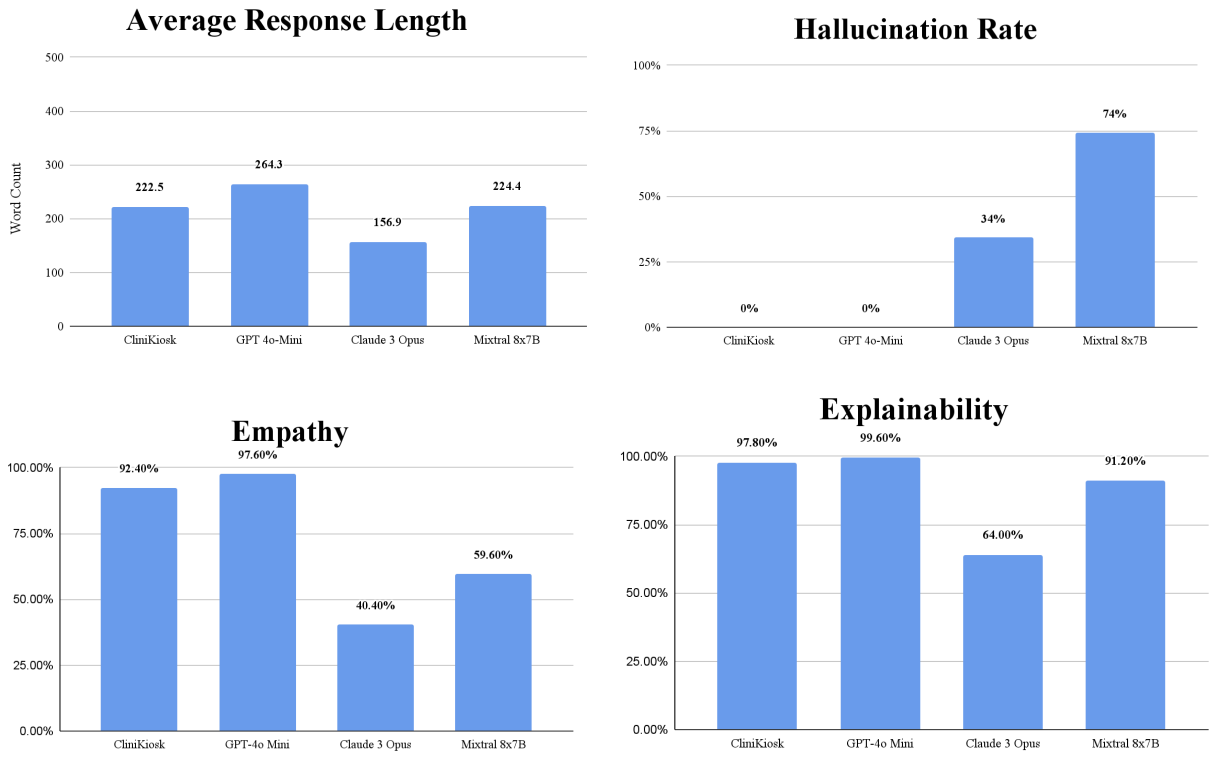
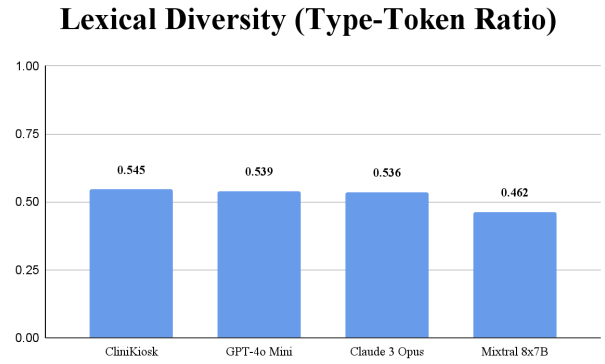


Figure 4. Comparison of CliniKiosk, GPT-4o Mini, Claude 3 Opus, and Mixtral 8x7B (via OpenRouter) Lexical Diversity



Discussion: CliniKiosk provides users with a personalized, AI-driven health assessment tool, showcasing strong capability when compared to highly reputable ChatBots. While it shows room for improvement in treatment suggestion accuracy, its high medical recommendation consistency, impressive empathy level, and strong explainability make CliniKiosk a reliable and practical solution for the world of healthcare. Despite promising improvements, several limitations should be acknowledged in this study. To begin, the evaluation was based on 500 simulated patient cases, which, while diverse, may not encapsulate the complexity and variability of real-world patients. Second, the use of simulated cases rather than actual patient interactions may limit the generalizability of the findings, as real-world factors such as clinician-patient communication, patient history, and nuanced symptom presentation were not accounted for. Third, the models were evaluated in a controlled setting, which may not reflect their performance in dynamic, high-pressure clinical environments. Additionally, the study did not assess potential biases beyond basic demographic categories, meaning that disparities related to socioeconomic status, comorbidities, or regional healthcare variations were not considered. Finally, the evaluation focused on accuracy and response length, but did not measure factors such as user trust or clinical decision-making impact, which are crucial for real-world adoption. Next steps include: 1) Refining the model with Retrieval-Augmented Generation (RAG) and Agentic AI, enabling more context-aware, dynamic, and accurate medical reasoning by leveraging real-time retrieval of medical knowledge; 2) Enhancing physical assessment capabilities by integrating AI-driven camera modules for visual examinations; 3) Implementing advanced NLP models trained for empathy, cultural sensitivity, and supportive interactions; 4) Integrating real-time physiological data from wearable devices (e.g., smartwatches, fitness trackers) to monitor vital signs and health trends; 5) Implementation & Pilot Testing to gather user feedback and evaluate key performance metrics.

Conclusions: CliniKiosk offers a well-balanced, multilingual, personalized, and efficient AI-driven health assessment solution, performing competitively alongside leading AI models. The results of this study will serve as a foundation for developing a highly innovative healthcare kiosk that can deliver personalized healthcare recommendations, point-of-care diagnostic testing and dispense medications directly at the kiosk.

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