Proposal Title: Improving Prenatal Health Literacy in Underserved Populations Using Personalized Messaging

Abstract: According to govt. reports (NHSRC, 2023), mobile health interventions are generic, inflexible to adapt, and ultimately less effective than expected. We employ a WhatsApp chatbot to deliver control messages based on local learning modules created for ASHA workers under the National Rural Health Mission, and treated messages that are personalized to the context of the end user to evaluate the differences in adoption of the system between treated and control groups. The learning modules train ASHAs to deliver timely and relevant information manually to each of the beneficiaries that they are responsible for supporting. We measure adoption and behavioral change for the treated and control groups indicating the efficacy of the personalization intervention. The system will employ LLMs trained using continual learning techniques that incorporate ASHA worker guidance and feedback to improve their relevance to the end user persona.

Research goals and problem statement: Our research focuses on advancing health literacy in India by personalizing the delivery of mobile messages to urban and rural families. Our work seeks to advance health literacy to reduce the risk of preventable maternal deaths, improving existing mobile health literacy programs (El Ayadi et. al, 2023; Choudhury et. al, 2021). among our target population with the potential to scale into a state-wide partnership within six months of program completion. Building on work that shows how digital literacy interventions contribute to significant improvements in health outcomes, our work answers the question, **Does personalization of messaging improve the impact of mobile-based interventions to improve health literacy among rural and urban villages in Jalgaon, India**? We investigate whether **input from end users and care workers can be applied to adapt mobile messaging to increase the relevance of responses provided to beneficiaries**. We conduct a randomized controlled trial utilizing our existing WhatsApp-based chatbot to deliver a novel digital literacy intervention to end users and investigate how it can improve existing nationwide mobile-based interventions (Murthy et. al, 2020). It allows us to:

Identifying key user personas and the contextual information beyond facts: Support various user types, for instance, based on stages of pregnancy, health risks, age, gender, socioeconomic status, education level, and profession, each of whom requires different contextual information. Studies have shown that health information tailored to specific demographics enhances effectiveness (Glanz et al., 2008). **Personalize the adaptation for each individual within the user segment:** Personalize health information to meet the specific needs and contexts of individuals. Current systems often fail to dynamically adjust to an individual's unique circumstances and preferences. This is especially vital in shared usage contexts where multiple family members share a device to cater to each user's specific requirements.

Improve Privacy and Trust: Privacy Concerns: Ensuring data privacy in a context where multiple family members use a single device is inherently challenging. Systems must secure personal health information while offering granular privacy controls (Dove et al., 2017).

Building Trust: This involves transparent communication about data usage, benefits and limitations of AI recommendations. While trust can be built through community engagement and co-design processes involving the end-users (Gillespie et al., 2018), this is challenging in our target setting. Given the intermediary role of male family members, establishing trust requires engaging all family members in understanding and valuing the AI system's benefits and truly being informed when providing consent.

Current Challenges: As one of the countries with the highest prevalence of maternal deaths India invests over USD 4 billion annually into healthcare services and national welfare programs to create an expansive system of last-mile care delivery at the village level. With a focus on health literacy improvement and care provision, trained accredited social health activists (ASHAs) offer frontline support maternal and child health programs at the rural and urban levels through personal visits to their beneficiaries. States actively engage in partnerships with nonprofits to launch mobile applications complementary to in-person programs, and a National Health Systems Resource Center (NHSRC) report discusses challenges with multi-state, mobile-based, awareness-focused interventions. It underscores the lack of long-term impact achieved at local and national levels, attributing them in part to generic content affecting compliance, lack of adaptability, and hyper focused design that limits their adaptability. Most families in rural Jalgaon use a shared mobile phone. Consequently, information delivered through calling, messaging, and WhatsApp tends to pass first through the male members of the family to the others. In other cases, interaction time for different family members is rationed during specific times of the day. We further verified the challenges with over 30 interviewees at the national, state, district, and block levels to confirm they all faced the **lack of personalized responses.** Programs are created specific to a single end user while mobile devices are often shared by family members for whom the messaging feels generic and irrelevant. This results in noncompliance, reduced trust, and dropoffs. **Interviews and Qualitative Analysis**: We will conduct in-depth interviews with diverse stakeholders, including adolescents, parents, teachers, and ASHA workers. The qualitative data will help understand the nuanced needs and barriers faced by different personas. **Evidence-Driven Interventions**: We will use insights from qualitative analysis to design targeted interventions such as the consenting use of end user data to target interventions to persona types. These will be pilot-tested, and iterative feedback will be incorporated to refine the interventions. Quantitative assessments will compare the group-wise differences in adoption, health literacy, and participant dropoff following the cessation of incentives provided to end users.

Proposed Research: We will randomize the allocation of 1000 study participants into a single-arm treatment and control group, where WhatsApp message personalization is applied only to the treated group while others receive existing messaging around maternal care drawn from past learning modules including Mobile Academy. Personalization is based on data collected from interviews and qualitative analysis that will be used to adapt the LLM responses generated to the

beneficiary persona without retraining the LLM. We will provide 120 days of continuous access to the system along with usage-based financial incentives to improve compliance by promoting app usage for both groups. We plan to conduct baseline (pretreatment) and endline surveys for both groups that receive access to the system in order to account for any sampling biases, especially those based on location, socioeconomic status, The Aadhar Bahuddeshiya Sanstha, our partner in ongoing healthcare projects, has established significant health and monitoring infrastructure locally, operating a network of 116 care workers across 16 blocks and hundreds of villages in Jalgaon. We have supported care workers in the region to digitize their offline data collection in remote regions that eliminates the downstream data entry task of up to 17 handwritten pages per family visited.

Long-term Outlook: Towards Agents with Lifelong Socially-Adaptive Capabilities.
The insights gained from this project are meant to inform the subsequent development of AI agents with lifelong, socially-adaptive capabilities. To be effective in dynamic and diverse user environments, the deployed AI agents must continuously adapt to changing user contexts. As users and communities engage with the system, the user needs, preferences, social norms evolve continuously to adopt the technology. Continuously adapting to these in deployment ensures the AI remains relevant and effective in providing personalized healthcare guidance over time. Research highlights the necessity of such adaptability for the long-term success of AI in health interventions (Topol, 2019). Beyond the individual AI agent, our broader technological framework aims to incorporate all stakeholders so that the humans and AI agents can continually co-evolve. The qualitative analysis in this project through interviews to identify the relevant stakeholders and personas will serve to inform the logistics of deploying locally viable feedback loops and participatory design processes for AI systems to co-evolve with the community needs.

Explanation of your qualifications to conduct this research: PI Mazar is an award-winning researcher for her book 'Behavioral Science in the wild'. She has conducted megastudies across large populations to measure the effects of personalized treatments in the healthcare and vaccination context. She was the inaugural senior behavior scientist that helped set up the World Bank's internal behavioral insights unit, conducting randomized control trials in the field with various underserved communities globally. Co-PI Raman's research focuses on developing computational techniques and tools to anticipate, analyze, record, and synthesize multimodal social human behavior—especially in physically-situated or virtually-embodied interactions in the wild, particularly machine-mediated interactions. His skills and expertise span different disciplines, including generative multimodal machine learning, computer vision / graphics, distributed systems, and affective computing. He is Board Director at the US-based nonprofit, SimPPL, that has built and deployed pilots of digital literacy chatbots for menstrual health in Bangladesh, called Sakhi (https://sakhi.simppl.org), providing valuable experience with real-world deployments.

This research promotes socially beneficial applications of AI for underserved communities in their own language. We aim to increase the user's agency over their private data. It protects users against misleading information and harmful health outcomes and improves familial outcomes by targeting multiple personas with the same intervention. It is well-aligned with Google's AI principles.

This project has received interest for two state-wide pilots that will be launched if we can win the grant funds to support it. We have letters of support to indicate commitment from nonprofits that want to partner with us and we have raised funds to launch other pilots before. There is a lot of work to be done and we are the ones to do it, but we really need the funding and support. We are actively applying to other avenues to secure funding for this work.

For ongoing projects, explain how this funding (whether by unrestricted gift or another type, specified in the RFP) would enhance your existing project.

For RFPs that specify the use of a particular product, methodology, or other constraint, please clearly describe how your project will incorporate and utilize that specific requirement.

Budget

Nonprofit Resources and Staff per Pilot Study: Cost to deploy and monitor pilot experiment for 350 users per site
14,500 x 3 = 43,500

Travel to Site: Includes 2-way airfare and local transportation to reach site
5,000 x 2 = 10,000

Cloud Computing
Host servers and obtain LLM-generated responses
8,000

Hardware
Purchase local mobile phones for testing chatbot performance
1,000 x 2 = 2,000
Research Engineer: System development and observability infrastructure
19,500

Project Lead: Project implementation and reporting
17,000