# Development and Scale-Up of a Community-Based mHealth Kiosk for Chronic Disease Screening in Rural America

Applicant Organization: xyz

Key Project Features

- Phased R21/R33 design with milestone-based transition criteria
- Community-based, CHW-operated screening platform
- Solar-powered, offline-capable mHealth kiosk
- Integrated screening for hypertension, diabetes, and obesity
- Emphasis on implementation, scalability, and health system integration in an LMIC setting

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# Introduction

Non-communicable diseases (NCDs) are a leading and growing cause of morbidity and mortality in low- and middle-income countries (LMICs), yet early detection remains limited in many rural settings due to structural barriers to facility-based care. This phased R21/R33 project seeks to develop, validate, and scale a community-based mobile health (mHealth) screening system tailored to rural USA. We will design and evaluate a portable, solar-powered community health kiosk operated by community health workers (CHWs) to deliver standardized screening for hypertension, diabetes, and obesity in community settings. Using a milestone-driven R21 phase followed by a multi-site R33 implementation phase, this project will generate rigorous, generalizable evidence on the feasibility, effectiveness, and scalability of shared mHealth infrastructure to improve early detection and referral linkage for chronic diseases in LMIC contexts.

## SIGNIFICANCE

America faces a rapidly increasing burden of chronic non-communicable diseases (NCDs), particularly hypertension, diabetes, and obesity. In rural State, screening rates remain disproportionately low due to limited access to health facilities, shortages of trained clinical staff, unreliable electricity, and high out-of-pocket costs. Many individuals seek care through informal or community-based settings such as village markets, outreach camps, and basic health units, resulting in delayed diagnosis and missed opportunities for early intervention.

Although mobile health (mHealth) technologies offer promise, most existing approaches rely on individual smartphone ownership, continuous connectivity, and high digital literacy assumptions that do not consistently hold in rural State. As a result, current mHealth solutions often fail to reach populations at highest risk.

We address these gaps by developing and evaluating a **portable, solar-powered community health kiosk** operated by community health workers (CHWs) in rural State. The kiosk integrates validated screening tools for blood pressure, blood glucose, and anthropometry with a low-literacy, tablet-based interface that supports offline data capture and delayed synchronization. By embedding screening capacity directly within community settings, our approach aligns with local care-seeking behaviors and reduces structural barriers to early detection.

The proposed research directly advances the goals of this NOFO by generating rigorous, generalizable evidence on LMIC-appropriate mHealth systems that improve screening access, support health system integration, and strengthen local implementation capacity.

## INNOVATION

We introduce innovation across **technology design, delivery model, and implementation science**.

First, we shift mHealth delivery from individual mobile phones to a **shared, community-based platform**, overcoming inequities related to phone access and digital literacy while retaining the advantages of mobile and wireless technologies.

Second, we design the kiosk specifically for rural LMIC environments by incorporating solar power, offline functionality, and icon-based navigation. Unlike adaptations of high-income country technologies, this system is purpose-built for unreliable electricity, intermittent connectivity, and low-literacy contexts.

Third, we integrate multiple disease screening functions into a single, interoperable platform, enabling disease-agnostic application and scalability across diverse health priorities.

Finally, through the phased R21/R33 design, we advance innovation in implementation research by generating evidence not only on technical feasibility, but also on workforce usability, community acceptability, referral uptake, cost, and scalability—critical domains where empirical data remain limited in LMIC settings.

# APPROACH

## Approach Overview

*LMIC Setting – Rural State*

Rural districts in State Province are characterized by limited health infrastructure, dispersed populations, and heavy reliance on CHWs for preventive and outreach services. Electricity supply is unreliable, and digital access varies widely. These conditions make rural State a high-impact and appropriate setting for evaluating community-based mHealth screening systems.

*Community-Based Design*

We embed the intervention within existing CHW programs, placing screening capacity in village markets, outreach camps, and basic health unit catchment areas. CHWs serve as kiosk operators, strengthening local workforce capacity and ensuring cultural acceptability.

*Rationale for Kiosk-Based Screening*

Kiosk-based screening enables standardized, high-quality measurements without requiring individual device ownership. Solar power and offline functionality ensure reliability, while shared deployment maximizes reach and cost-effectiveness.

*R21 vs. R33 Logic*

During the R21 phase, we establish feasibility, usability, validity, and acceptability at selected rural State sites. Progression to the R33 phase depends on achieving predefined milestones. In the R33 phase, we evaluate multi-site implementation, reach, referral uptake, and scalability within the State health system.

## R21 PHASE (Months 1–24): Development, Feasibility, and Validation

### Aim 1: System Development and Field Deployment

*Design:* Engineering development and field feasibility study.

*Population/Setting:* CHWs operating in rural State community sites.

*Procedures:*
We will integrate validated screening devices into a portable, solar-powered kiosk. A tablet-based interface will support Urdu and regional languages, icon-based navigation, and offline data capture with encrypted storage and delayed synchronization. Pilot deployment will occur at 1–2 rural sites.

*Measures:*
System uptime, data completeness, error logs.

*Analysis:*
Descriptive performance assessment.

*Milestones / Go–No Go:*

- ≥95% system uptime
- ≥98% data integrity

Go if thresholds are met; No-Go if recurrent failures or >5% data loss occur.

### Aim 2: Usability and Workflow Feasibility

*Design:* Mixed-methods usability study.

*Population:* CHWs from partner programs in rural State.

*Procedures:*
We will conduct standardized training, observe screening sessions, and iteratively refine workflows.

*Measures:*
Independent task completion, screening duration, error rate.

*Analysis:*
Descriptive statistics.

*Milestones / Go–No Go:*

- ≥80% independent operation
- ≤15-minute screening time

- ≤10% error rate

Aim 3: Measurement Validation

*Design:* Comparative validation study.

*Population:* Adults screened in community settings.

*Procedures:*
We will conduct parallel kiosk-based and clinic-based measurements.

*Measures:*
Blood pressure, glucose, weight/BMI.

*Analysis:*
Percent agreement and Bland–Altman analysis.

*Milestones / Go–No Go:*

- ≥90% agreement
- No clinically significant bias

Aim 4: Community Acceptability

*Design:* Mixed-methods acceptability assessment.

*Procedures:*
We will administer structured surveys, conduct qualitative interviews, and observe consent processes.

*Measures:*
Acceptability ratings, consent completion, adverse events.

*Analysis:*
Descriptive and thematic analysis.

*Milestones / Go–No Go:*

- ≥75% acceptability
- ≥85% consent completion
- 0 serious adverse events

## Human Subjects and Ethical Considerations

This project involves minimal-risk screening procedures commonly used in routine clinical and community health settings. All participants will provide informed consent prior to screening. Consent procedures will be adapted for low-literacy populations using verbal explanations, pictorial aids, and confirmation of understanding.

Participant privacy will be protected through de-identification of data, encrypted storage on the kiosk, and controlled access to synchronized data. Individuals identified with elevated screening results will receive standardized referrals to nearby health facilities, and CHWs will provide guidance on follow-up care. No experimental treatments will be administered as part of this study.

## Data Management and Sharing

All data collected through the kiosk will be stored securely using encrypted, password-protected systems with role-based access controls. The kiosk platform will support offline data capture with delayed synchronization to secure servers when connectivity is available. Personally identifiable information will be stored separately from screening data to minimize privacy risk.

Data will be managed in accordance with NIH data management and sharing policies. De-identified datasets and associated documentation will be made available to qualified researchers following publication or project completion, consistent with ethical approvals and local regulations.

## Risk Mitigation and Contingency Planning

Potential operational risks and mitigation strategies have been incorporated into the project design. Unreliable electricity will be addressed through solar power and battery backup. Intermittent connectivity will be mitigated through offline data capture and delayed synchronization. CHW turnover will be addressed through standardized training materials and refresher sessions.

If referral uptake is lower than anticipated, additional CHW follow-up and coordination with local facilities will be implemented. Technical issues identified during the R21 phase will be addressed prior to scale-up, ensuring readiness for multi-site implementation in the R33 phase.

## R21 → R33 Transition

Transition to the R33 phase requires achievement of **all** of the following milestones:

- ≥95% system uptime
- ≥80% CHW independent operation
- ≥90% measurement agreement
- ≥75% community acceptability
- Secure data synchronization demonstrated

## R33 PHASE (Months 25–60): Implementation, Reach, and Scalability

### Aim 5: Multi-Site Implementation

*Design:* Multi-site implementation study.

*Procedures:*
We will deploy kiosks at ≥6 rural State sites and train additional CHWs.

*Metrics:*
Number of sites deployed; system uptime across sites.

## Aim 6: Reach and Screening Coverage

*Design:* Observational reach assessment.

*Procedures:*
We will track screening volume and participant demographics.

*Outcomes:*

- ≥2,500 adults screened
- ≥30% increase compared to baseline
- ≥40% first-time screeners

## Aim 7: Referral Uptake and Linkage to Care

*Design:* Referral tracking study.

*Procedures:*
We will implement standardized referral pathways and verify clinic follow-up.

*Outcome:*

- ≥60% referral completion within 30 days

## Aim 8: Cost, Sustainability, and Scalability

*Design:* Cost and implementation analysis.

*Procedures:*
We will estimate cost per screening and conduct stakeholder interviews.

*Deliverables:*
Cost analysis and a rural State scale-up roadmap.

## Health System Integration and Policy Relevance

The project is designed to align with existing primary health care and community outreach structures in State Province. Screening and referral workflows will be coordinated with basic health units and local health facilities to support continuity of care. Findings from the R33 phase will provide evidence relevant to provincial and national decision-makers regarding the feasibility, cost, and impact of community-based digital screening infrastructure.

The scale-up roadmap generated through this project will inform policy discussions on integrating shared mHealth platforms into routine preventive care delivery in rural and underserved settings.

## Expected Outcomes and Impact

Following outcomes will be obtained with successful completion of this project:

### R21 Phase Outcomes (Months 1–24):

1. A fully functional, solar-powered community health kiosk capable of offline operation and delayed data synchronization, validated for use in rural State.
2. Demonstrated feasibility and usability of kiosk-based screening by community health workers, with ≥80% independent operation and ≤15-minute screening time.
3. Validated agreement (≥90%) between kiosk-based and clinic-based measurements for blood pressure, blood glucose, and anthropometry.
4. High community acceptability (≥75%) and safe implementation with no serious adverse events.
5. A milestone-driven evidence base supporting transition to multi-site implementation.

### R33 Phase Outcomes (Months 25–60):

6. Successful deployment of kiosks across ≥6 rural State sites integrated within existing CHW programs.
7. Screening of ≥2,500 adults, with ≥40% first-time screeners and ≥30% increase in screening coverage compared to baseline.
8. Improved linkage to care, with ≥60% of referred individuals completing clinic follow-up within 30 days.
9. A comprehensive cost-per-screening and implementation analysis informing sustainability and scale-up.
10. A practical, evidence-based roadmap for scaling community-based digital screening infrastructure within the State health system and other LMIC contexts.

### Long-Term Impact:

The project will establish a generalizable, disease-agnostic model for shared mHealth infrastructure that expands equitable access to early chronic disease detection in low-resource settings. Findings will directly inform health system decision-making, guide investment in community-level digital health platforms, and support sustainable integration of mHealth tools into LMIC primary care systems.

## FINAL SUMMARY

This phased R21/R33 project will generate rigorous, policy-relevant evidence on a **community-based mHealth kiosk model tailored to rural America**, addressing critical gaps in early detection of chronic diseases where facility-based screening remains limited. By integrating validated screening technologies into a solar-powered, low-literacy, community-deployable

platform operated by community health workers, we will produce generalizable evidence on the feasibility, effectiveness, and scalability of shared mHealth systems in low-resource settings. Our findings will directly inform health system decision-making by demonstrating how community-level digital screening infrastructure can expand population reach, improve referral linkage, and support sustainable integration within existing LMIC health systems, while aligning fully with NIH priorities for scalable, equitable, and context-appropriate digital health innovation.