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Assessing the Feasibility of a Decentralised Community-Based Model for Clinical Trial Delivery in a Resource-Limited Setting: Lessons from a Structured Pre-Implementation Pilot in Sierra Leone

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Abstract

Background

Community-based delivery of clinical trials may improve access to research participants in low-income countries, but requires careful operational preparation, especially when complex technical procedures must be managed in a non-clinical environment. A structured pre-implementation pilot was conducted to assess the operational feasibility of delivering a Phase II malaria vaccine trial through community-based household visits in Bo District, Sierra Leone, and to identify operational, procedural, and system-level modifications required before initiation of the definitive trial.

Methods

A descriptive operational feasibility assessment was conducted using the same eligibility criteria and procedures planned for the Adult Malaria Reduction Intervention Trial (AMRI), a three-dose, individually randomised, double-blind, placebo-controlled Phase II trial of combination malaria vaccines. The pilot aimed to recruit 200 adults and evaluated recruitment, informed consent, eligibility assessment, electronic randomisation, dummy vaccination, biological specimen collection, electronic data capture, cold-chain management, vaccine accountability, and participant follow-up. Operational performance and system failures were documented and reviewed to inform corrective actions.

Results

Of 213 adults approached, 211 (99%) consented and 203 (95%) were eligible and received the first dummy vaccination. Electronic randomisation was completed for 200 participants; three could not be assigned because their vial barcodes were unrecognised in the electronic inventory and therefore did not proceed to subsequent visits. Among 200 randomised participants, 185 (92.5%) and 171 (85.5%) received the second and third dummy vaccinations, respectively. Dried blood spot (DBS) samples were collected from all 203 vaccinated participants, and the venous blood collection target of 100 was exceeded (103 participants). Attrition was primarily attributable to temporary migration of final-year students for examinations, with additional losses associated with household decision-making. Findings informed recruitment timing and participant selection, strengthened vial-inventory validation, revised field SOPs, and optimisation of REDCap database, pharmacy, laboratory and logistical workflows.

Conclusion

The pilot demonstrated the capacity of an established population-surveillance platform to support community-based delivery of a complex clinical trial, while revealing vulnerabilities at the interfaces

between physical, digital and clinical systems. Structured pre-implementation feasibility assessment may strengthen readiness for complex community-based clinical trials in resource-limited settings.

Trial registration

Pan African Clinical Trial Registry, PACTR202501701465667. Registered 16 January 2025, http://www.pactr.org

Background

Fixed research facilities have traditionally provided the infrastructure for conducting Good Clinical Practice (GCP) compliant clinical trials in low- and middle-income countries (LMICs), including large-scale vaccine trials [1]. In this arrangement, study participants are recruited and attend scheduled visits for trial-related procedures and assessments at fixed research facilities [2]. A decentralised clinical trial is one in which some or all protocol-specified activities occur outside the investigator's location, without requiring physical site visits (e.g., tele-visits, home visits, remote assessments) [3]. This approach can bring recruitment and other trial activities closer to participants, reduce participation burdens from frequent travel, and leverage established community relationships, potentially improving access, recruitment and retention [4–6]. It may also offer a low-cost option for conducting trials, by reducing the need for substantial investment in fixed trial infrastructure.

Facility-based trial workflows cannot, however, simply be transplanted into households because they require management of technical procedures in a non-clinical environment, such as vaccination, venepuncture, specimen handling, cold chain, randomisation, blinding, electronic data capture, safety observation and emergency referral [7, 4]. Repeated follow-up among adults in community settings may also be challenging in ways that differ from facility-based settings because of mobility, work commitments and other competing responsibilities, potentially affecting retention and adherence to scheduled trial visits [4].

Njala University (Bo, Sierra Leone) has had substantial experience in community-based epidemiological studies, but had not previously hosted a clinical trial. Healthy Sierra Leone (HEAL-SL) is a collaborative effort of Njala University, the Sierra Leone National Public Health Agency (NPHA), and the University of Oxford. It is a population-surveillance platform that produces annual data on mortality rates and causes of death at national and subnational levels using verbal autopsy [8]. The sample units are enumeration areas (EAs) predefined by Statistics Sierra Leone to be 80–120 households per unit. The HEAL-SL sampling frame nationally covers about 700 such units. Mortality data from the HEAL-SL platform is currently available for 2018–2024, comprising about 60,000 enumerated and well-characterised households from urban and rural census EAs distributed across the country's five regions and 16 districts.

The Adult Malaria Reduction Intervention Trial (AMRI) is a Phase II, individually randomised, double-blind, placebo-controlled clinical trial intended to be delivered through the HEAL-SL platform. It aims primarily to evaluate the immunogenicity and safety of the R21/Pfs230D1-CRM197 combination malaria vaccine among adults residing in Bo District, Sierra Leone. Its procedures include intramuscular injection (three scheduled doses of active vaccine and placebo), venous blood collection, dried blood spot (DBS) collection, immediate post-vaccination observation, electronic randomisation, vaccine accountability, laboratory/pharmacy/logistics coordination, and repeated household visits. The HEAL-SL sampling frame has previously been used to successfully recruit 6,000 adults and 1,200 children for a serosurveillance study [9]. Although reassuring, these experiences do not establish that the HEAL-SL platform can support delivery of a complex clinical trial such as AMRI. The multiple clinical procedures conducted at household level, together with the need to manage community concerns, make operational feasibility particularly important.

Successful implementation of clinical trials requires rigorous operational preparation [10, 1, 11]. Preparatory activities and readiness assessment can identify gaps before trial initiation [12, 13], and help to ensure feasibility. However, the operational literature provides limited reporting on structured pre-implementation validation of community-based trial processes and the lessons learned before participant recruitment. A structured pre-implementation pilot was conducted to assess the operational feasibility of delivering the AMRI trial through community-based household visits in Bo District, Sierra Leone, and to identify operational, procedural, and system-level modifications required before initiation of the definitive trial.

Methods

Study setting and design

The study was conducted in a semi-urban part of Bo District, in the southern region of Sierra Leone. The pilot aimed to recruit 200 eligible adults and assess their ability to complete the three-dose vaccination schedule. DBS samples (from all recruited and vaccinated participants) and venous samples (from 100 participants) were to be collected during the dose 1 visit. The pilot was designed as a descriptive operational feasibility assessment.

Site selection

Four EAs were selected from the established HEAL-SL EAs in Bo District. Selection took into consideration the characteristics of the EAs and the team's existing knowledge of its households, geographical layout, accessibility and fieldwork requirements. Because HEAL-SL had conducted repeated household-based activities within the area, the study team had prior knowledge of the distribution of households, local terrain, community structures and practical considerations for field

deployment. This information was used to plan household visits, allocate field teams and anticipate logistical requirements before commencement of the pilot.

Community engagement

Two pre-recruitment meetings were held. The district-level meeting was held at the Njala University Conference Hall, with representatives from the Ministry of Health, traditional and community leaders, and influential community members. The meeting was chaired by the Principal Investigator (PI) and Clinical Trial Manager and supported by the field supervisor. The PI made a formal presentation of the study, after which participants had the opportunity to ask questions about areas that were not clear, and express any concerns. The community-level meeting was held at the community meeting centre and was open to all community members. Actively invited stakeholders included the District Health Education Officer, health centre in-charge, community chiefs, youth and women leaders, religious leaders, traditional societal leaders, and bike riders' chairman.

Field team structure

Four field teams were deployed for the pilot. Each team comprised two field workers – one male and one female – responsible for conducting study procedures at households. All were health workers (nurses, public health practitioners, and community health officers) who had received training in GCP and all relevant AMRI standard operating procedures (SOPs), including the risk assessment and mitigation plan. Most were from the study communities, understood local cultures and values, spoke the local languages fluently, and were familiar with the terrain. The field teams were headed by a field supervisor who also served as the logistician. The field supervisor coordinated the teams, troubleshot challenges, and was responsible for transferring logistical items between the laboratory/pharmacy and field teams.

Logistics in the field

Field activities were supported by four main categories of equipment and supplies: a vaccine cold box; a separate cold box for venous blood samples; a larger equipment bag containing physical measurement devices, consent documentation and the DBS transport box; and a smaller bag containing phlebotomy and vaccination supplies and biohazard bags (Fig. 1). These materials were transported daily by vehicle from the central study site to the field teams. To support systematic and traceable distribution, transfers of field materials and equipment were recorded in the logistics database using barcode scanning. The field worker receiving the materials and the field supervisor responsible for the transfer were identified through their staff ID barcodes, while the barcodes of equipment bags and vaccine and specimen boxes were scanned to document transfer and receipt. This provided an electronic record of the movement and accountability of field materials throughout each field activity.

Clinical safety arrangements in the community

AMRI had SOPs for safety oversight (adverse-event assessment, documentation, and reporting) and for detection and management of anaphylaxis, on which all field workers were trained. Each team was also equipped with two epinephrine pens. The field supervisor was responsible for rapid transfer of participants to the referral hospital, where the study safety physician was based, if required.

Data and trial systems

The database for direct data capture was REDCap Cloud, developed by the contract research organisation (CRO) and co-maintained by the AMRI Data Manager. Case Report Forms (CRFs) in the AMRI REDCap database followed the same structure as HEAL-SL, with individual participant folders nested within households. A second database – the logistics database – was developed and maintained by the AMRI Data Manager, and comprised pharmacy, laboratory, logistics, and trial-management modules. The logistics database, maintained accountability and an audit trail for study consumables and equipment, including study vaccines and biological samples.

Vaccine and vaccine handling

Dummy vaccines were prepared using empty vials labelled with barcodes based on the actual vaccine-vial structure. The dummy vials were packed daily in preconditioned cold boxes for dispatch to the field at 2–8°C, with continuous temperature monitoring. All vials for dispatch were scanned into the logistics database, which automatically synchronised this information with the REDCap database. REDCap then recorded the status of each dispatched vial on the basis of field data entry – used, unused or damaged.

Community-based trial model and household-level procedures

The field teams moved within the study areas, approaching households for participation. A field team sought permission for household entry from a household representative. If more than one adult in a household wished to learn about the study, information was first provided at group level using a flipbook illustrating the study procedures. Informed consent, including documentation of consent, was then obtained individually while maintaining confidentiality. Consented adults were assessed for eligibility and subsequently underwent the study procedures illustrated in Fig. 2. Pregnancy screening, including verbal assessment and urine testing, was performed by the female field worker.

Participants and procedures tested

Participants were recruited using the same eligibility criteria as the definitive AMRI study. These were non-pregnant adults residing in Bo District, with no plans to relocate in the next year and no prior history of allergies to foods or medications. The pilot evaluated the intended AMRI processes, including

recruitment, informed consent, eligibility assessment, randomisation, vaccination simulation, specimen collection, electronic data capture, cold-chain management, and participant follow-up.

Documentation of operational challenges and adaptations

Observations were recorded by field, clinical, data-management, pharmacy, laboratory, logistics, and trial-management personnel during pilot activities and reviewed during debriefing meetings. Identified barriers were documented together with the corresponding corrective action or proposed modification for the definitive trial. These observations were intended to identify operational problems rather than to provide a formal qualitative assessment of participant or community experience.

Feasibility outcomes

- Proportion of approached adults providing informed consent.
- Proportion of consented participants who meet the study eligibility criteria.
- Proportion of eligible participants successfully randomised.
- Proportion of randomised participants receiving each scheduled vaccine dose.
- Proportion of expected biological specimens successfully collected.

Statistical analysis

The datasets were exported from REDCap Cloud as CSV files. Data cleaning and analysis were conducted in R version 4.4 [14]. Feasibility outcomes were summarised descriptively, with no formal hypothesis testing.

Results

Community engagement

During the pilot, no study-related rumours or community concerns requiring specific intervention were reported to the study team.

Participant recruitment and vaccination

The participant flow is presented in Fig. 3. Of 213 adults approached, 210 (98.6%) provided informed consent. Of those who consented, 203 (96.7%) were eligible and received the first dummy vaccination. Electronic randomisation was successfully completed for 200 of these 203 participants (98.5%); three could not be randomised because their vial barcodes were not recognised by the electronic inventory system. Among the 200 randomised participants, 185 (92.5%) received dose 2 and 171 (85.5%) received dose 3.

Participants were recruited from 104 different households. As illustrated in Table 1, they ranged from 18 to 80 years of age and 127 (63.5%) were female.

Table 1
Baseline characteristics of randomised participants (n = 200)

Characteristic	N = 200 (%)
Age (years)	
Mean (SD)	32.8 (16.0%)
Minimum, Maximum	18–80
Sex, n (%)	
Male	73 (36.5%)
Female	127 (63.5)
Education, n (%)	
Illiterate	30 (15.0)
Literate without Formal Education	1 (0.5)
Below primary	1 (0.5)
Primary	18 (9.0)
Junior Secondary School	29 (14.5)
Senior Secondary School	90 (45.0)
Vocational / Technical / Nursing / Teaching	4 (2.0)
Other	27 (13.5)
Occupation, n (%)	
Agricultural and Fishery workers	9 (4.5)
Clerks	3 (1.5)
Craft and related trade workers	10 (5.0)
Elementary workers	1 (0.5)
Legislator, Senior Officials and Managers	3 (1.5)
Professionals	13 (6.5)
Service workers, shop and market sales workers	42 (21.0)
Technicians and associate professionals	3 (1.5)
Other	116 (58.0)

Performance of the trial systems

Quantitative feasibility outcomes

The pilot met or exceeded the planned dose 1 vaccination and specimen-collection targets, although electronic randomisation could not be completed for three participants who had received the first dummy vaccination because of a vial-barcode recognition failure. DBS collection was achieved in all 203 participants who received the first dummy vaccination (Table 2).

Table 2
Operational feasibility targets and achievement

Domain	Target	Achieved	Achievement (%)
Consent	200	210	105.0
Dose 1	200	203	101.5
Randomisation	200	200	100.0
Dose 2	200	185	92.5
Dose 3	200	171	85.5
DBS	200	203	101.5
Venous sampling	100	103	103.5

Data and cold-chain performance

Direct electronic data capture using the intended database was successfully implemented during the pilot, allowing study information to be entered at the point of participant contact. The pilot also tested integration of participant-level data with the logistics database, particularly vaccine-accountability functions. Data review during implementation identified gaps in validation logic; additional logic, range, and completeness checks were introduced before initiation of the definitive trial.

The pilot also tested transport and temperature monitoring of dummy vaccine vials under the intended cold-chain conditions of 2–8°C. One field team experienced temperature excursions in its vaccine boxes during the initial rounds of field work. Troubleshooting by the field supervisor attributed these excursions to prolonged opening of the vaccine boxes. Field vaccine-box handling procedures were subsequently reinforced and opening time was minimised during household visits.

Operational barriers and adaptations

The pilot identified operational barriers requiring modification before implementation of the definitive trial (Table 3). These related principally to participant mobility and retention, household-level decision-making, timing of study activities, field specimen-collection conditions, electronic randomisation and data validation, and coordination of field workflows.

Participant recruitment and retention

Field observations identified temporary migration as a potential threat to completion of the three-dose vaccination schedule, including school examination-related travel among some final-year students. Recruitment procedures for the definitive trial were therefore revised to place greater emphasis on anticipated availability throughout the vaccination and follow-up period and to account for predictable mobility patterns. Household visits were also scheduled earlier in the day where possible, because working adults were less available later. Reasons for missed doses were not systematically categorised for all participants, so the contribution of these factors could not be quantified.

Social and religious considerations

Household decision-making influenced continued participation in some cases, including hesitation or withdrawal associated with spousal or family concerns, highlighting the need to strengthen community and household engagement procedures. Ramadan also affected willingness to undergo blood collection among a small number of fasting participants, indicating the importance of considering religious calendars when scheduling visits involving blood collection.

Field procedures and specimen collection

The household setting did not consistently provide clean surfaces suitable for aseptic study procedures. Single-use disposable work surfaces were therefore introduced to standardise field conditions and reduce dependence on household infrastructure.

Digital and product-accountability systems

Failure of the electronic system to recognise three vial barcodes demonstrated the importance of testing the complete pathway linking physical vaccine inventory, electronic accountability, and participant randomisation. Pre-deployment barcode reconciliation and database validation were strengthened, and additional REDCap logic, range, and completeness checks were introduced.

Operational capacity and workflow

The pilot showed that achievable recruitment throughput depended on coordinated capacity across field, pharmacy, and laboratory teams rather than recruitment capacity alone. Daily recruitment targets and workflows were therefore revised to reflect the capacity of the entire participant pathway, with corresponding refinements to pharmacy, laboratory and logistics procedures.

Table 3
Operational challenges and corrective actions

Operational domain	Challenge identified	Evidence from pilot	Modification before definitive AMRI trial
Recruitment	Final-year students travelled for examinations	Field observations of missed follow-up during examination-related travel	Assess anticipated availability and examination-related travel before enrolment
Visit timing	Working adults absent later in the morning	Reduced household availability	Begin household visits earlier
Household dynamics	Spousal influence on continued participation	Withdrawals or hesitation	Strengthen household engagement and consent counselling
Specimen collection	Lower willingness during Ramadan	Fasting-related concerns	Schedule blood-intensive activities outside Ramadan where possible
Field asepsis	Lack of consistently clean household surfaces	Observed field constraint	Introduce single-use disposable work surfaces
Randomisation	Vial barcode lookup failure	Three dose 1 recipients not randomised	Strengthen database validation and pre-use barcode reconciliation
Data capture	Validation gaps identified	REDCap queries and inconsistencies	Add logic, range and completeness checks
Staffing/capacity	Variable throughput across pharmacy, field and laboratory	Recruitment-flow observations	Model daily recruitment against functional capacity

Recruitment and vaccination throughput

Operational throughput differed between the initial and second vaccination visits. A total of 203 participants received dose 1 over 11 field days, with a median throughput of 20 participants per day and a maximum of 23. For dose 2, 185 participants were vaccinated over 16 field days, with a median throughput of 7 participants per day and a maximum of 37 (Table 4).

Table 4
Recruitment and vaccination throughput at dose 1 and dose 2

Visit	Vaccinated	Field days	Median/day	IQR	Maximum/day	Days to n = 100	Days to n = 150
Dose 1	203	11	20	16.5–22	23	7 field days	9 field days
Dose 2	185	16	7	3–15.75	37	7 field days	9 field days

Recruitment timing

We used consent time as a proxy for time of recruitment. Consent activity was concentrated in the morning between 09:00 and 11:00, with the highest hourly volume recorded at 10:00 and declining thereafter (Fig. 4). These observations provide an empirical basis for planning the timing and deployment of household visits.

Discussion

This pre-implementation pilot showed that the core processes required to deliver a three-dose malaria vaccine trial through household visits could be implemented in a clinical-trial-naïve setting using existing HEAL-SL infrastructure. Participants could be recruited, consented, assessed for eligibility, vaccinated with dummy product, observed for immediate safety, and provide biological specimens within a community-based workflow. Importantly, the pilot evaluated not only recruitment but also the interaction of clinical, digital, pharmacy, laboratory, and field systems under conditions resembling the intended trial. Similar to prior pre-implementation preparatory work [12, 13], the pilot identified trial-specific weaknesses requiring correction before implementation of the definitive trial.

Although the host institution had no previous experience of running a clinical trial, the study team was able to draw on HEAL-SL's established household sampling frame, prior experience with repeated community-based field activities, and existing knowledge of household distribution, accessibility, local terrain, and community structures. Experience from the STRIVE trial – an Ebola vaccine trial in Sierra Leone – showed that deploying staff from Freetown to study sites in the rural districts was challenging, as they were unfamiliar with the local area and languages and lacked established relationships with District Health Management teams [12]. The findings from this study suggest that established population-based platforms may provide a solid foundation for complex community-based clinical research [16]. Leveraging existing infrastructure may reduce duplication, strengthen institutional research capacity and generate locally grounded evidence for building sustainable clinical-research systems, consistent with experience from cluster-randomised implementation of the RTS,S/AS01E malaria vaccine through national immunisation programmes [17].

The pilot also illustrated the value of testing the complete trial pathway rather than individual components in isolation. In the pilot simulation, three participants received the first dummy vaccination but electronic randomisation could not subsequently be completed because their vial barcodes were not recognised by the electronic system. This exposed a failure at the interface between vaccine inventory, electronic accountability, and randomisation that, if encountered during the definitive trial, could have compromised protocol-compliant allocation and product accountability. Barcode reconciliation and database validation were therefore strengthened before the definitive trial. More broadly, the findings support systems thinking in pre-implementation testing, in which failures at the interfaces between physical and digital systems are actively sought rather than assuming that individually functional components will operate reliably when combined [15, 18].

The pilot also provided insight into the practical challenges of repeated vaccination and follow-up at household level. Of 200 randomised participants, 29 (14.5%) did not receive the third dummy vaccination. Field observations suggested that at least some missed visits were associated with predictable patterns of mobility and availability, including examination-related travel. The findings therefore support incorporating academic calendars, working patterns and other predictable periods of population mobility into recruitment and follow-up planning.

Household-level social dynamics also influenced continued participation. Spousal or family concerns contributed to hesitation or withdrawal among some participants, highlighting that individual consent within a household may be influenced by household social structures, consistent with findings from the ivermectin study in The Gambia, in which some heads of households used their authority to prevent their family members from taking part [19]. Strengthening community and household engagement may therefore be important not only for recruitment but also for retention. The absence of study-related rumours or community concerns requiring specific intervention during the pilot, together with the high proportion of approached adults who consented, suggested no major community-engagement barrier in this pilot.

The operational throughput findings provide an additional basis for planning community-based trial implementation. The maximum number of participants per day for dose 2 was higher than for dose 1 (37 versus 23), which is consistent with the additional procedures required during the dose 1 visit, including consent, eligibility assessment, sample collection, and anthropometry. The lower median daily throughput for dose 2 (7 versus 20) indicates that procedural simplicity alone does not determine follow-up capacity and is consistent with field observations that participant accessibility affected follow-up. The concentration of recruitment in the morning similarly provides empirical information that can be used to optimise household deployment. Together, these findings support use of field-day and time-of-day operational data when estimating staffing requirements and setting realistic recruitment targets for community-based trials.

A strength of this pilot was that it used the intended AMRI databases and SOPs and tested the interaction of field, clinical, pharmacy, laboratory, and logistics activities rather than evaluating these systems separately. The study nevertheless had limitations. It was a descriptive operational pilot. Corrective actions identified during the pilot were implemented before initiation of the definitive trial but were not evaluated in a separate repeat-pilot phase. Telephone safety follow-up and laboratory testing of collected specimens were not evaluated. The use of dummy vaccines may also have underestimated or altered concerns that could arise with an actual investigational product. Reasons for missed doses and loss to follow-up were not systematically categorised for all participants, and operational observations were not collected using a formal qualitative research framework; consequently, they cannot provide a comprehensive assessment of participant or community perspectives or quantify the causes of attrition. Finally, the high consenting rate should not be interpreted as a formal measure of community acceptability because the pilot did not include a structured qualitative or acceptability assessment.

Conclusion

Overall, the findings indicate that a structured pre-implementation pilot can provide more than an opportunity to rehearse study procedures. When conducted using the intended trial systems, careful pilots can identify operational weaknesses, characterise implementation capacity, and provide an empirical base for modifying procedures before recruitment into the definitive trial. Leveraging established community research platforms while systematically stress-testing clinical-trial-specific processes may provide a practical approach to strengthening readiness for community-based clinical trials in African and other low-income settings.

Abbreviations

AMRI Adult Malaria Reduction Intervention Trial

DBS Dried Blood Spot

EA Enumeration Area

GCP Good Clinical Practice

HEAL-SL Healthy Sierra Leone

SOP Standard Operating Procedures

Declarations

Ethics approval and consent to participate

Ethical clearance had been obtained from the Sierra Leone Ethics and Scientific Research Committee (SLESRC No: 016/12/2025) and Pharmacy Board of Sierra Leone (PBSL/001/006/063/2025). Signed informed consent was also obtained from each participant before undergoing any study procedure.

Competing interests

The authors declare that they have no competing interests.

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Author Contribution

R.A. and P.J. conceived the study, developed the study design, and served as principal investigators with overall responsibility for study conduct. J.E., R.H., F.S. and A.M. also contributed to the study design. A.D.B., A.A.T., D.K., J.R., V.K. and M.V. were responsible for field implementation. A.D.B. and A.A.T. conducted the data analysis. A.D.B. prepared the initial manuscript draft, and all authors contributed to subsequent revisions. All authors read and approved the final manuscript.

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Data Availability

Pseudo-anonymised data for this study are available upon request.

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Figures



Figure 1

Field logistics for community-based trial activities



Figure 2

Household level procedures for the AMRI clinical trial

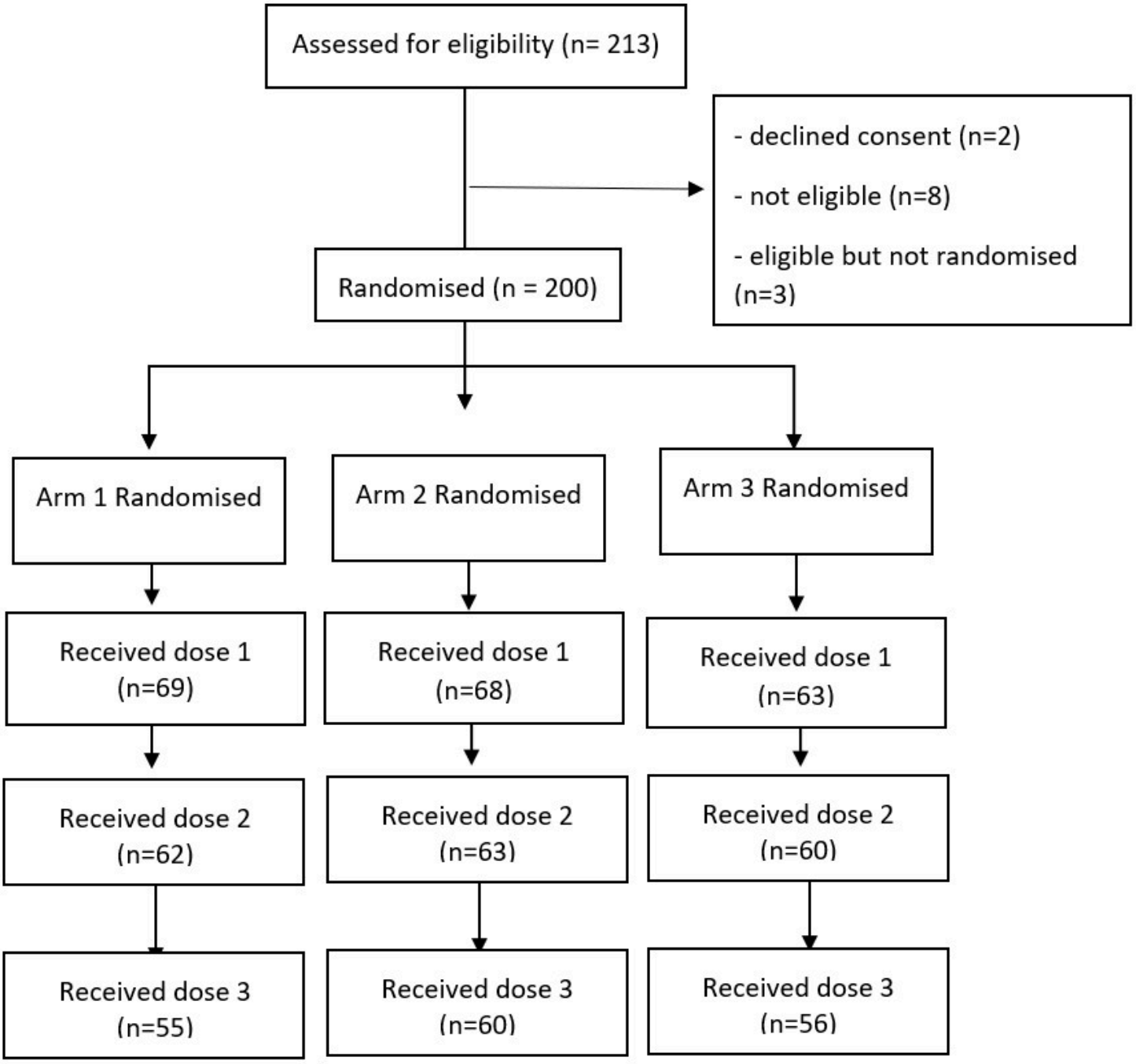


Figure 3

Participant flow

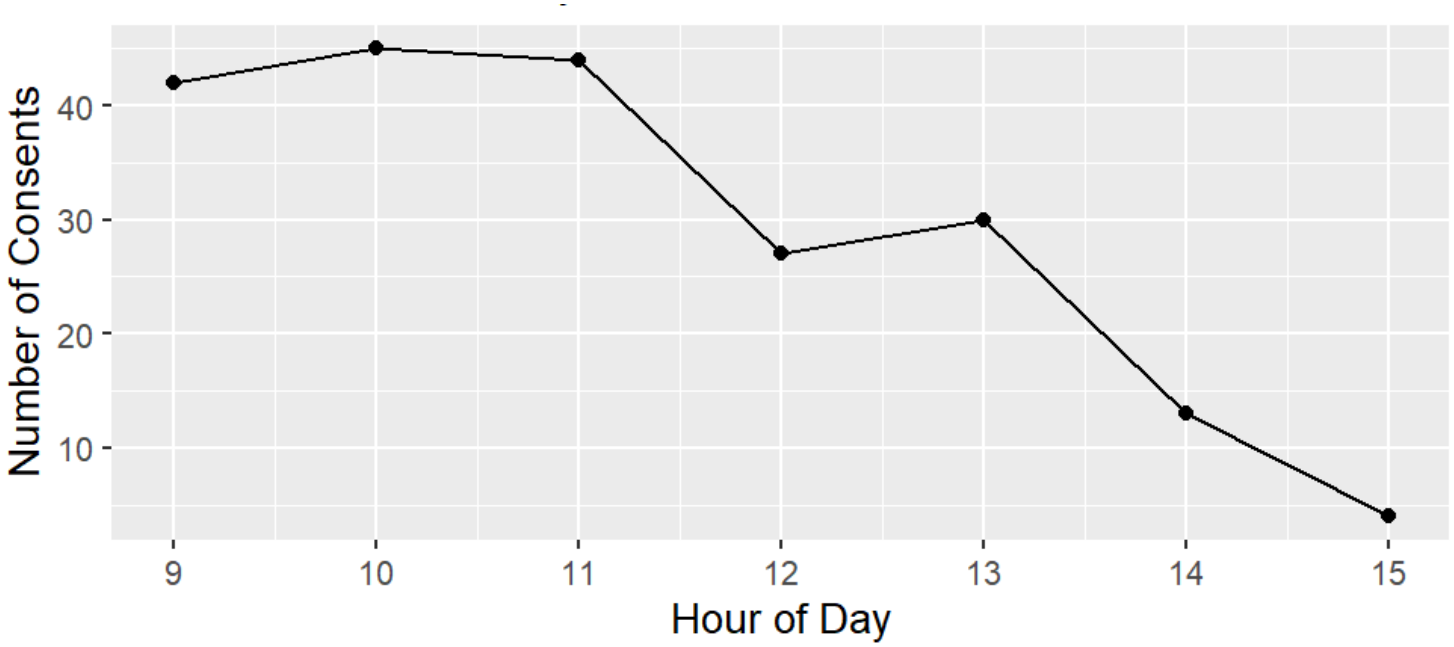


Figure 4

Recruitment trend by hour