Trial of PermaNet 3-barrier bednets as part of an operational distribution programme in Haut-Katanga province, DRC (BBnets)

Study protocol v2.2 29/02/24

amendments made to:

sections referring to multiple collection periods (there will only be one 3 month epidemiological data collection period and) one entomological collection period and the total data collection period will be up to 5 months rather than 7 months

bioavailability testing removed

Revised timeline added

appendix D to indicate that only a single mosquito collection will be performed.

Appendix G added showing actual distribution of nets to clusters

Study protocol v2.1 amendments following LSTM ethical review and changes to accommodate altered timelines. Replacement of objective 4. Version date 18/09/23

Version 2: objective added version date 23/06/23

Version 1: original draft version date 23/03/23

Contacts

LSTM (project design, management, funding acquisition)

David Weetman (david.weetman@lstmed.ac.uk)

Janet Hemingway (janet.hemingway@lstmed.ac.uk)

Philip McCall (philip.mccall@lstmed.ac.uk)

KSPH (project design, management implementation)

Josue Zanga (josuezanga1979@gmail.com)

Nono Mvuama (donmvuama@yahoo.fr)

PNLP (control programme oversight)

Florian Kyabululo (floriankyabululo@gmail.com)

SANRU (net distribution)

Patrick Kanku (patrick.kanku@sanru.cd)

AMF (net provision)

Julian Austin (julianaustin@againstmalaria.com)

Vestergaard (net manufacture)

Melinda Hadi (meh@vestergaard.com)

Summary

A two-armed cluster randomised trial comparing PermaNet 3 with PermaNet 3-barrier bednets (P3-BBnets) is presented associated with a programmatic distribution of bednets in Haut Katanga province, southern DRC, which has taken place according to our specified distribution plan in May-June 2023. BBnets are identical to PermaNet 3 except for the addition of a longitudinal upright barrier, which contains the same ingredients (deltamethrin and PBO) as the roof of a PermaNet 3, and significantly enhances insecticide resistant mosquito killing capacity. The study will take place within health zones of the Lubumbashi area of Haut Katanga. Health areas within the health zones are randomised to receive the 300,000 P3-BBnets available, with all others receiving PermaNet 3. Training in hanging instructions for BBnets were provided to community health workers, who performed household distribution of all nets and additional hanging materials for the BBnets, which the trial team have supplied. The primary outcome variable for the study is prevalence of malaria recorded by routine testing of visitors at their first ante-natal clinics (ANC1), which provides an efficient and economical method for data collection. Visitors will be recruited by health centre staff to give their permission to take a rapid diagnostic test (RDT) for malaria and will be treated with artemisinin combination therapy (ACT) if positive; they will also be asked to complete a short questionnaire. All 21 health areas receiving P3-BBnets will be monitored for ANC1 malaria prevalence, as well as 42 areas receiving PermaNet 3. This design provides power to detect a 25% reduction in malaria prevalence attributable to P3-BBnets compared to PermaNet 3 as a reference. Data will be recorded over a continuous survey period of 3 months within the first year after distribution, during which surveys to characterise the malaria mosquito vector community and their insecticide resistance will also be performed, along with assessments of the hanging of bednets and questionnaires to assess user perceptions of the nets they have received. The physical and chemical integrity of nets, and their bioefficacy will also be assessed.

Funding and support

Nets have been provided by Vestergaard and AMF. Funding for the trial is available from ERDF and UKRI-SIPF awards to LSTM. SANRU and the PNLP are providing support for the programmatic distribution. Ethical permission and sponsorship will be provided by LSTM, and ethical permission from University of Kinshasa.

Lay summary

Background

Performance of insecticide impregnated nets treated with pyrethroid insecticide is challenged by widespread pyrethroid resistance in *Anopheles* malaria vectors. New generation nets combine an additional insecticide or resistance-blocking molecule 'PBO' to combat resistance, but a more novel approach is to modify the physical design of the bednet to increase capacity to kill mosquitoes. LSTM have designed a patented barrier bednet, which adds an 40cm upright longitudinal section hanging above the roof of the bednet. The barrier intercepts mosquitoes during their typical flight paths when seeking to blood feed from sleepers under nets, increasing mosquito-net/insecticide contact. In partnership with the bednet producers, providers, distributors and malaria control programme bednets have been produced which are identical to the successful and widely distributed PermaNet 3, but with the added barrier, which incorporates both pyrethroid insecticide and PBO present on the roof of a PermaNet 3. In laboratory tests, these 'P3-BBnets' are shown to kill significantly more insecticide resistant mosquitoes than unmodified PermaNet 3, but the impact of P3-BBnets on malaria prevention has yet to be tested.

Overall Aim
The overall aim of the project is to evaluate the capacity of P3-BBnets to prevent malaria in comparison to unmodified PermaNet 3, in a cluster randomised trial as part of a programmatic distribution of bednets in Haut Katanga, Democratic Republic of Congo (DRC). Entomological surveillance will involve collections to characterise the *Anopheles* vector community and insecticide resistance profiles.

Methods in Brief
300,000 P3-BBnets are provided as part of a programmatic distribution of approximately 4.5 M bednets to Haut Katanga province, with health areas within the city of Lubumbashi randomly allocated to receive P3-BBnets, with all others receiving PermaNet 3. In common with a recent LSTM- and University of Kinshasa-led trial in Sud Ubangi province, DRC, the primary outcome measured will be malaria prevalence in consenting women attending their first antenatal clinic appointment, during which they receive a malaria test and receive artemisinin combination treatment if positive, and complete a short questionnaire to assess bednet possession and usage. The study design is capable of detecting a 25% reduction in malaria in P3-BBnets vs. P3, within an overall 12-month window after net distribution. One round of entomological collections will characterise the malaria vector community and perform insecticide resistance testing. We will also gather information via questionnaires on bednet use and perceptions from randomly-selected households and we will also collect a sample of bednets from houses to assess their physical and chemical durability and capacity to kill mosquitoes.

Index

i. List of Abbreviations

ii. Glossary

1. Background

1.1 Insecticide treated bednets: standard and new generation

1.2 Barrier bednets

1.3 Trial designs for comparative assessment of bednets

1.3.1 Antenatal clinic-based assessment of malaria prevalence

1.3.2 Malaria and bednet distributions in DRC

2. Study design

2.1 Overview of the operational cRCT BBnet trial

2.2 Justification for the research

2.3 Study setting

2.4 Sample size

2.5. Cluster allocation and bednet distribution

2.5.1 Health area enrolment

2.5.2 Training

3. Recruitment

3.1 ANC clinic visitors

3.2 Household surveys

4. Study Outcome Variables

4.1 ANC1 malaria prevalence

4.1.1 Recording periods and baseline data

4.1.2 Secondary epidemiological outcome

4.2. Survey of mosquito community

4.2.1 Rationale for entomological surveillance

4.2.2 Number of houses surveyed

4.2.3 Collection routine

4.2.4 Molecular analyses of species and resistance

4.3 Net durability

4.4 Assessment of bednet hanging and user perceptions by questionnaires

4.5. Insecticide resistance quantification

5. Data analysis

5.1 Epidemiological data

5.2 Household survey data

6. Data recording, management and confidentiality

7. Ethical considerations

7.1 Vulnerable groups

7.2 Household surveys

8. Safeguarding

9. Dissemination

10. Project timeline

11. References

12. Appendices

Appendix A PIS and consent form: ANC recruitment

Appendix B PIS and consent form: Household survey

Appendix C PIS and consent form: net durability assessment

Appendix D Household mosquito collections

Appendix E Antenatal clinic questionnaire

Appendix F Household questionnaire

Appendix G Actual distribution of nets among clusters

i. List of Abbreviations

AMF	Against Malaria Foundation
BBNet/P3-BBnet	PermaNet 3 Barrier Bednet
DRC	Democratic Republic of Congo
HPLC	High performance liquid chromatography (for chemical assessment of insecticide and PBO content of nets)
ITN	Insecticide-treated bednet net
IRS	Indoor residual spraying (of insecticide)
KSPH	Kinshasa School of Public Health
LLIN	Long lasting insecticidal nets
NMCP/PNLP	National Malaria Control Programme
LSTM	Liverpool School of Tropical Medicine
PBO	Piperonyl butoxide (synergist to block mosquito resistance)
SANRU	Rural Health Program of DRC who distribute nets
WHO	World Health Organisation

ii. Glossary

Barrier net	patented design; here, a PermaNet 3 augmented with an extra netting on the roof
New-generation nets	bednets that combine pyrethroid with an additional active ingredient to enhance killing of pyrethroid resistant mosquitoes
Pyrethroid	main class of insecticides used on bednets
Standard net	basic bednet treated with a pyrethroid only

1. Background

1.1 Insecticide treated bednets: standard and new generation

Distribution of long-lasting insecticide impregnated nets (LLINs) has been the basis of malaria prevention in Africa, accounting for the majority of the reduction in disease prevalence seen over the last two decades. LLINs work by protecting the individual who sleeps under the net, but crucially also protecting the community in which the nets are distributed by killing the mosquitoes that try and feed on individuals sleeping under the net. Pyrethroid resistance in *Anopheles* malaria vectors is now widespread across Africa and evidence suggests that pyrethroid resistance can impact the effectiveness of LLINs (Protopopoff et al. 2018). Whilst nets remain in good condition, personal protective efficacy can persist because the LLIN still acts as a physical barrier to stop biting, but the community effect from mosquito mortality is lost where resistance frequency and level are high. Despite concerns over the impact of pyrethroid resistance, standard pyrethroid-only nets remain widely distributed, primarily owing to their low cost and the aim of programmes to provide universal coverage of nets (at least one per two sleepers) on limited budgets. However, newer dual-treated nets are increasingly distributed following recent trial successes, some incorporating a second insecticide such as chlorfenapyr, Interceptor G2 (Mosha et al. 2022; Accrombessi et al. 2023) alongside pyrethroid or an insecticide synergist piperonyl butoxide (PBO) plus pyrethroid, which acts to block metabolic resistance enzymes which can cause pyrethroid resistance (Protopopoff et al. 2018; Staedke et al. 2020). The basic cost of manufacturing these nets, especially IG2 nets, is higher than pyrethroid-only nets, increasing costs of mass distribution campaigns. In addition, the volume of next-generation LLINs that can be manufactured to order may also be limited by insecticide availability, creating problems for timing of distribution programmes.

1.2 Barrier bednets

An alternative way in which LLIN effectiveness could be enhanced is by altering the design of the net to increase capacity to kill mosquitoes as they seek human hosts for blood-feeding. A design developed at the Liverpool School of Tropical Medicine provides such a design modification and exploits the characteristic behaviour of *Anopheles* malaria vectors to traverse the roof of a bednet seeking entry whilst often making limited contact with the net roof (Parker et al. 2015, 2017). Addition of a small vertical barrier above the roof of the net intercepts mosquitoes during their flight paths, increasing their contact with the net and its active ingredients. Laboratory trials at LSTM and experimental hut trials in Burkina Faso have shown such ‘barrier bednets’ (BBnets) significantly increase mortality of pyrethroid resistant mosquitoes, with modelling predicting substantial additional protective benefit against malaria (Murray et al. 2020). The BBnet design is patented and requires minimal change from existing LLIN manufacturing processes and limited behavioural change by users. BBnets offer a rapid, safe, and affordable method to extend LLIN lifespan in the fight against malaria. However, epidemiological effectiveness of BBnets has yet to be assessed.

Following experimental work and mathematical modelling to explore shape and treatment options, in collaboration with the leading net manufacturer Vestergaard, LSTM developed a BBnet ready for evaluation in a field trial. Essentially, the design is a PermaNet 3 (P3) bednet with a vertical barrier made from the same material as the P3 roof (Fig. 1). PermaNet 3 is a long-lasting insecticidal net (LLIN) with the pyrethroid deltamethrin on the sides and deltamethrin plus PBO on the roof and, in the case of the P3-BBnet case, also on the barrier. Comparison of two possible P3 barrier shapes, a short T (above the sleeper’s chest, right to left) and a longer, longitudinal ‘L‘ barrier (above the entire sleeper, head to toe) with a standard P3, were performed in a large insectary bioassay at LSTM under simulated natural conditions to accurately measure performance. Results consistently

showed that the longitudinal 'L' barrier variant was significantly more lethal than the T variant and the PermaNet 3 bednet (Fig. 1), giving approximately 30% higher mortality. In partnership with LSTM and Against Malaria Foundation, Vestergaard has produced this BBnet design, which thus represents a variant of the widely-distributed pyrethroid-PBO PermaNet 3. The PermaNet 3-BBnet (P3-BBnet; Fig. 1) is identical to a PermaNet 3 except for the addition of a 40 cm high longitudinal barrier attached to the roof, which is made from the same material and impregnated in the same way as the roof of the PermaNet 3 and has the same WHO-prequalification (PQ) status (https://extranet.who.int/pqweb/vector-control-product/permanet-30). The current trial will compare the epidemiological effectiveness of P3-BBnets to PermaNet 3.

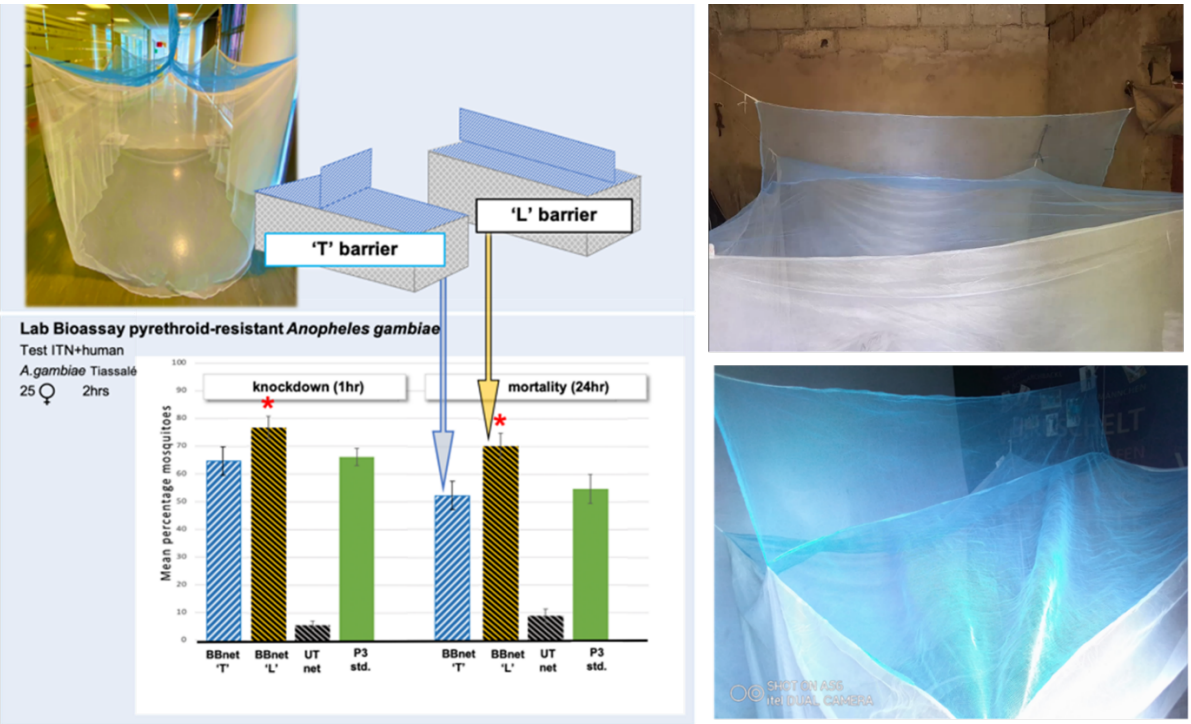


Figure 1. Left side: Demonstration of enhanced entomological effectiveness of the P3-Bbnet ('L' barrier style) compared to an alternative ('T'-barrier) variant and a PermaNet 3 (P3) for knockdown and killing of pyrethroid resistant *Anopheles gambiae*. Right side P3-Bbnets hanging in situ during a pilot trial in Kinshasa. The upright section suspended above the net is the barrier, which along with the roof of the net contains PBO + pyrethroid, while the sides have pyrethroid only.

1.3 Trial designs for comparative assessment of bednets

Cluster randomised control trials (cRCTs), with cross-sectional surveys of cohorts recruited specifically for malaria testing for the trial, are the gold standard for assessing effectiveness of LLINs. However, such LLIN RCTs are expensive, and also to date have compared new generation nets to standard pyrethroid-only nets as a reference. With increasing deployment of new generation nets, comparisons to standard nets will become less relevant because programmatic decisions will often be between different types of new generation nets, especially in areas of high pyrethroid resistance (WHO 2023). Comparison between new generation nets represents a greater challenge because each is likely to have a substantially greater impact on malaria than standard nets. Consequently, larger study sizes (in terms of numbers of clusters) will be required to achieve statistical power to demonstrate a significant difference. With a typical cRCT design, this will further increase trial costs, and limit wider testing across a range of transmission settings.

1.3.1 Antenatal clinic-based assessment of malaria prevalence

A simpler, pragmatic operationally-embedded approach to evaluate LLINs is to use malaria prevalence rates in pregnant women attending their first Ante-Natal Clinics (ANCs) as a primary trial outcome measure. A review by van Eijk et al. (2015) showing a strong correlation ($r \approx 0.85$) between observed survey prevalence and prevalence in pregnancy. Work in DRC using a Medicins Sans Frontieres-supported programme testing ANC visitors with rapid diagnostic tests produced promising results for using such data as an informative correlate of wider population prevalence (Hellewell et al. 2018). In a large-scale trial in Sud Ubangi province, northern DRC (2020-2023) involving approximately 40% of ANCs province-wide we have applied the MSF model embedded within a programmatic distribution of bednets by Against Malaria Foundation, the DRC national malaria control programme (PNLP), SANRU, and the Sud Ubangi provincial health service. Almost 1.9 million nets were distributed, approximately half of which were pyrethroid-only PermaNet 2 and half PermaNet 3, with randomised allocation to large health zone clusters (N=16). We detected a comparable level of benefit of PermaNet 2 vs PermaNet 3 to a previous successful operationally-embedded cRCT, which used a child cohort for malaria assessment as its primary endpoint (Staedke et al. 2020), but at substantially lower trial cost. The current trial aims to apply the same ANC-based primary endpoint for comparative evaluation of the epidemiological impact of P3-BBnets and PermaNet 3, with a key modification being distribution randomised at a lower level of subdivision (health areas) to allow the enhanced study power required.

1.3.2 Malaria and bednet distributions in DRC

The DRC is among the highest burden malaria countries, with preventative malaria control reliant primarily on LLINs; with IRS (spraying) campaigns rarely attempted to date beyond highly focal commercial activities. Country-wide LLIN distributions occur at the province-level (N=26) on an approximately 3-year rolling basis and increasingly involve new generation nets. Many parts of the country have relatively weak local infrastructure and capacity and transport links are often problematic. Documentation of the insecticide resistance status of DRC vectors is improving (Lynd et al. 2018; Wat'senga et al. 2018, 2020) but remains relatively sparse. However, there is a general pattern of widespread pyrethroid resistance in the major malaria vectors *An. gambiae*, although information on the other dominant malaria vector, *An. funestus*, is extremely limited. Populations of *An. gambiae* in DRC often possess both extreme frequencies of knock down resistance mutations at the pyrethroid target site and metabolic resistance mechanisms, which are at least partially blocked by PBO (Njoroge et al. 2022). *Anopheles funestus* on the other hand are primarily reliant on P450 enzymes and therefore are expected to be more susceptible to the effects of PBO (Barnes et al. 2017). The current trial is embedded within a province-wide distribution of PermaNet 3 (PBO+pyrethroid ITNs) in Haut Katanga province, southern, DRC.

2. Study design

2.1 Overview of the operational cRCT BBnet trial

LSTM have partnered with AMF, Vestergaard, Kinshasa School of Public Health, SANRU and the DRC-PNLP to run a two-armed cRCT in Haut Katanga province (Fig. 2) to compare the performance of the P3-BBnet with PermaNet 3. The trial is allied to a programmatic distribution of approximately 4.5 million insecticide treated nets in quarter 2 2023. The vast majority of the nets are PermaNet 3, with 300,000 P3-BBnets distributed as part of the programme. The trial will use as its primary epidemiological outcome measure malaria prevalence of women tested as they visit their first ante-natal clinic (ANC1). ANC1 visitors will receive a rapid diagnostic test for malaria and be provided with artemisinin combination therapy (ACT) treatment if the test is positive. The study team will liaise with staff at the health centres to collect these data from consenting visitors, along with additional

information provided by questionnaires to the ANC1 visitors. Anonymous summary health record data will be collected from participating health centres to provide pre-distribution baseline for the study. Cross-sectional surveys will assess the hanging of P3-BBnets and user perceptions, collect a subsample of nets for assessment of physical integrity, chemical content, and insecticide bioavailability, and collect mosquitoes for characterisation of the local vector population, infection and blood meals taken in each species, and insecticide resistance testing. Owing to a very high projected sampling effort required for adequate power, the trial will not include comparative entomological endpoints (i.e. between-arm comparisons of abundance, mosquito *Plasmodium* infection rate). Data collection for the trial is projected to run for a period of up to 5 months.

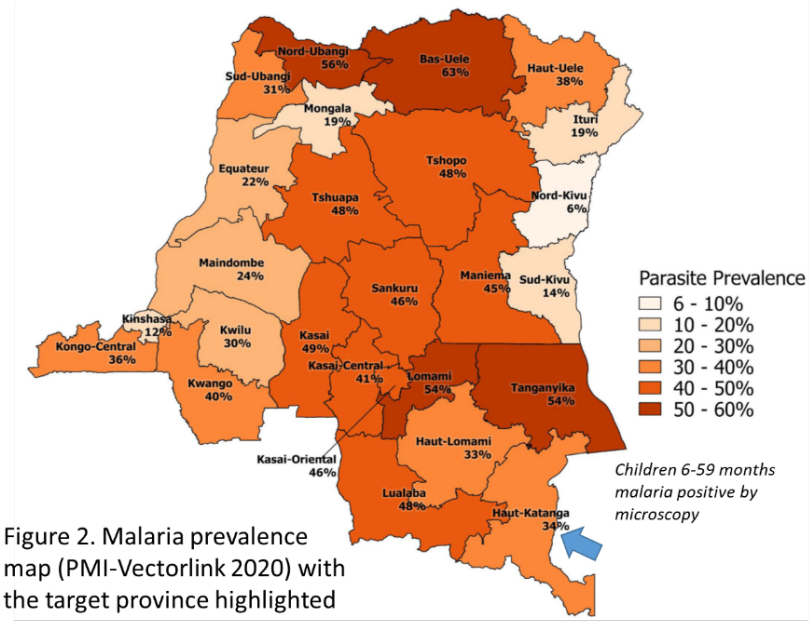


Figure 2. Malaria prevalence map (PMI-Vectorlink 2020) with the target province highlighted

2.2 Justification for the research

The P3-BBnet design offers a safe and affordable method to extend LLIN lifespan in the fight against malaria. Entomological results in laboratory and field experimental hut trials have shown the promise of P3-BBnets but this will the first epidemiological test of their effectiveness. Embedding the trial into a programmatic distribution of 300,000 P3-BBnets alongside a much larger distribution of PermaNet 3, coupled with ANC-based monitoring of malaria prevalence, provides an efficient and cost-effective pragmatic methodology for the trial.

2.3 Study setting

Haut Katanga is a south-western province of DRC with a population of approximately 7.5 million people (2021 data), within an area of approximately 132,500 km^2. The largest city is Lubumbashi, the second largest city in DRC, with a 2015 population estimate of around 1.8 million people. Haut Katanga has 27 health zones; these are subdivided into a total of 359 health areas (median per zone=15; range=6-20). Health zones are organised into five supervision axes: Lubumbashi (13 zones); Likasi (5 zones); Pweto (5 zones); Mitwaba (3 zones) and Sakania (1 zone). Pyrethroid resistance data (*An. gambiae s.l.*) for the province suggest moderate-high prevalence to deltamethrin (and other pyrethroids, not shown), which is quite well blocked by the synergist PBO (Fig. 3); a constituent of PermaNet 3 and P3-BBnets. Total malaria case rates (approximated as total cases/ health zone population) are moderately seasonal across Haut Katanga's health zones, with approximately twofold variation across the year, and only slightly lower estimated case rates within Lubumbashi's health zones (Fig. 4). Owing to this comparability, and to reduce logistical demands arising from poor

transport links, the trial will focus on health zones in Lubumbashi, in which the density of health areas is highest permitting access to many health areas on a limited geographical scale. In addition, the greater expected robustness of household walls in more urban, compared to rural, settings

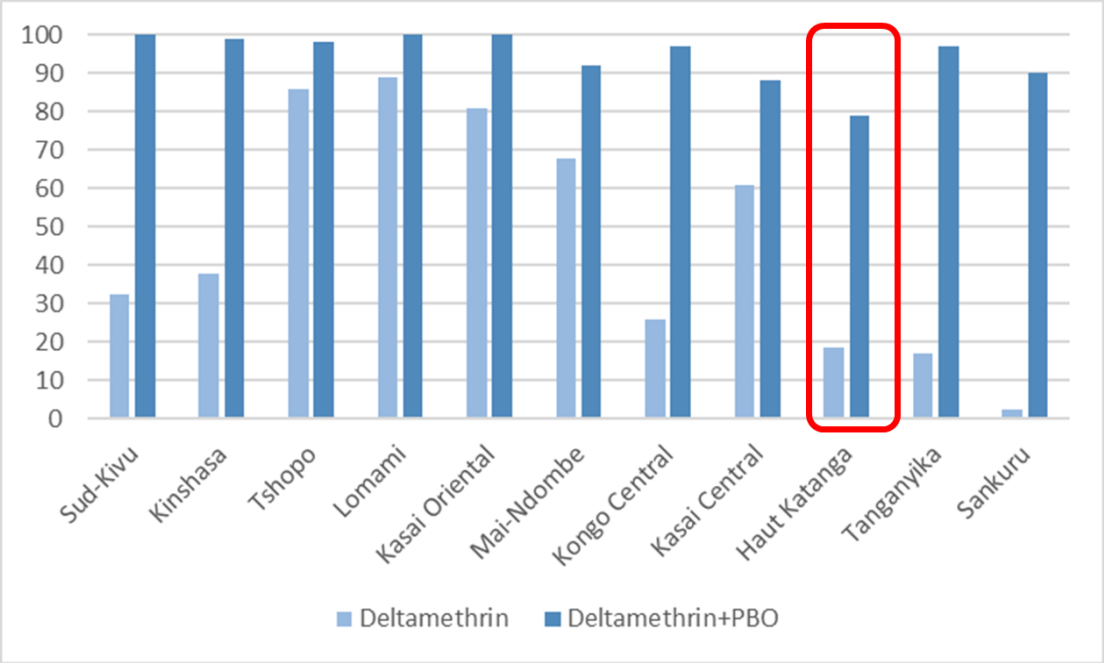


Figure 3. Insecticide resistance bioassay data for the pyrethroid insecticide deltamethrin with and without the synergist PBO from the PMI-Vectorlink programme. Haut Katanga results are highlighted.

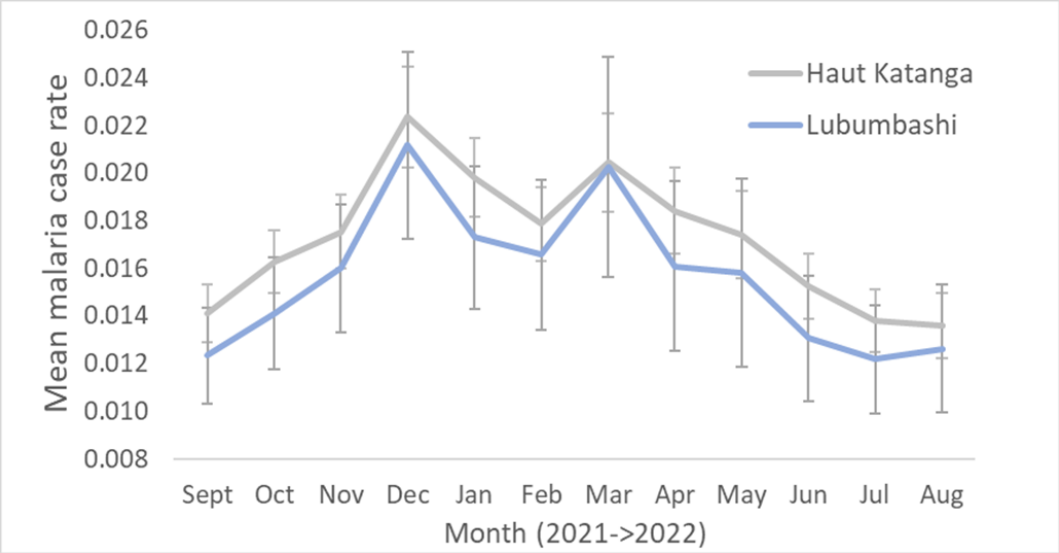


Figure 4. Mean malaria cases (health zone cases/population) per month (with standard errors) in all health zones, and Lubumbashi city health zones

should aid consistent placement of the hooks provided to hang the barrier of the P3-BBnets.

2.4 Sample size

Projected sample size requirements for the number of clusters required were evaluated under two designs, the first with equal numbers of P3-BBnet and PermaNet 3 clusters monitored and the

second with a ratio of 0.5 (P3-Bbnet/ PermaNet 3), reflecting the more limited numbers of BBnets available. This second imbalanced design proved more feasible to provide suitable power and is presented. Calculations are applied with required power = 80%; type I error rate = 0.05; coefficient of variation for clustering of 0.30 (approximating that observed in the Sud Ubangi trial). We assume that 25 ANC1 visitors will be recruited on average per month per cluster. A single monitoring periods of 3 consecutive months is planned, giving an average cluster size of at least N=75.

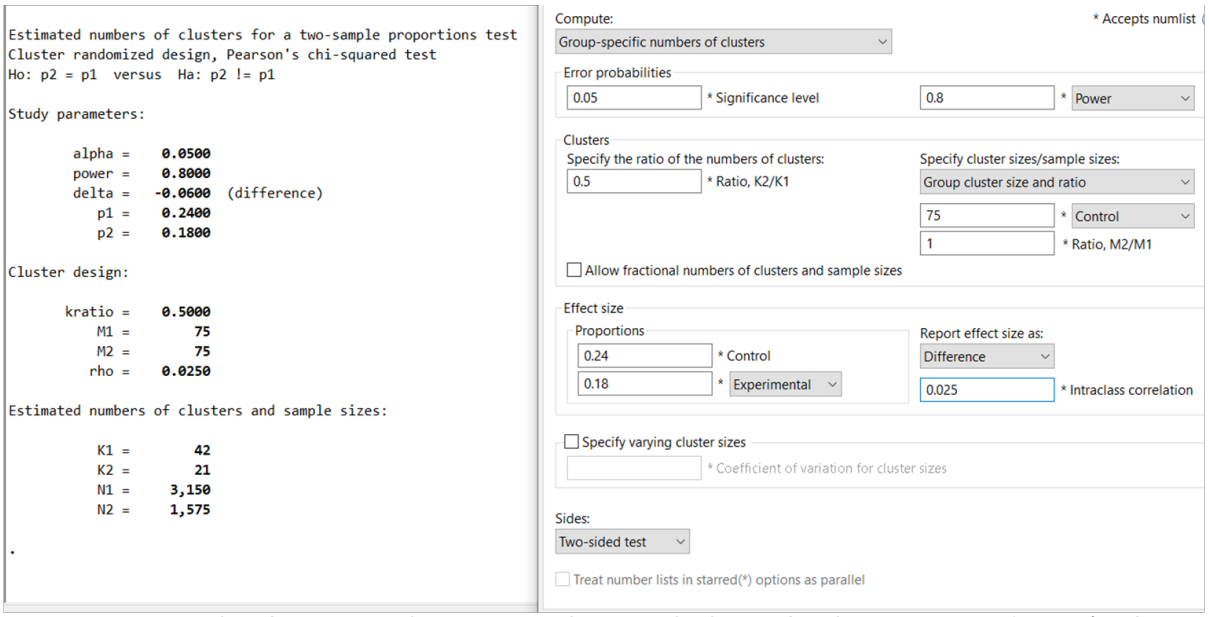


Figure 5. Screenshot from Stata showing sample size calculation for the primary endpoint (malaria prevalence at ANC1s).

The base malaria prevalence for Haut Katanga is taken from available malaria indicator survey (MICS) data (Fig. 2), which in Sud Ubangi corresponded closely with the ANC1 rate we observed in the PermaNet 2 arm. In the Sud Ubangi trial analysis, clusters receiving PermaNet 3 exhibited up to 30% lower prevalence than those receiving standard nets. This is assumed to represent the expected effect size for PermaNet 3, i.e. they will act to reduce malaria prevalence by 30% compared to the prevalence rate of 34% from the MICS (Fig. 2). Sample size calculations are based on a projected *additional* effect of P3-BBnets vs P3 of 25%. Therefore, the prevalence projected in each study arm is PermaNet 3 = 0.24 and BBnet = 0.18. The sample size calculation performed in Stata is shown in Fig. 5 and suggests that with these parameters 21 P3-BBnet clusters and 42 PermaNet 3 clusters are required.

2.5. Cluster allocation and bednet distribution

Health areas from within the designated study health zones which have a functional ANC receiving on average ≥25 ANC1 visitors/month (based on DHIS2 data from September 2021-August 2022), form the list from which clusters were randomly-chosen. We will include all the health areas to which P3-BBnets are distributed as clusters for ANC1 monitoring and twice this number of PermaNet 3 clusters, chosen at random from within the same health zones.

Nine Lubumbashi health zones are identified (Fig. 6), which are wholly within Lubumbashi (this excludes Kipushi and Kafubu), and do not have military encampments (this excludes Kowe and Vangu). Within these nine health zones, health areas will by default receive PermaNet 3 unless randomly chosen to receive P3-BBnets. Table 1 shows the nine health zones including estimated projections of net need. In total, 133 health areas were identified (within the nine health zones)

which receive on average ≥25 ANC1 visitors per month and these were included in the list for allocation to be clusters in the study. Using a random number generator, 30 health areas were chosen, of which the first 21 were proposed for coverage by BBnets, with the additional health areas (random numbers 22-30 in order) serving as additions if sufficient P3-BBnets remain after distribution to the first 21, or as backups in case ANCs in any areas are no longer fully-functional or health centres do not wish to participate. The randomised choice was made by a non-study team member and was communicated to the SANRU distribution team.

Distribution of nets occurred under the standard procedures of the PNLP and SANRU distribution programme, which delivers bednets to health areas for distribution by community health workers. Based on the randomised allocation, each health area received bales of the appropriate bednet for onward distribution to households. Bednets are not routinely distributed with hanging materials, but for the P3-BBnets, string and hooks were provided (by the study team) to promote suspension of the barrier. Community health workers were trained to advise householders on the function of the barrier, its potential advantage and how to suspend it. If the householder decides not to suspend the barrier, the P3-BBnet will still provide protection in the same way as a PermaNet 3, given the identical physical and chemical composition of the net material.

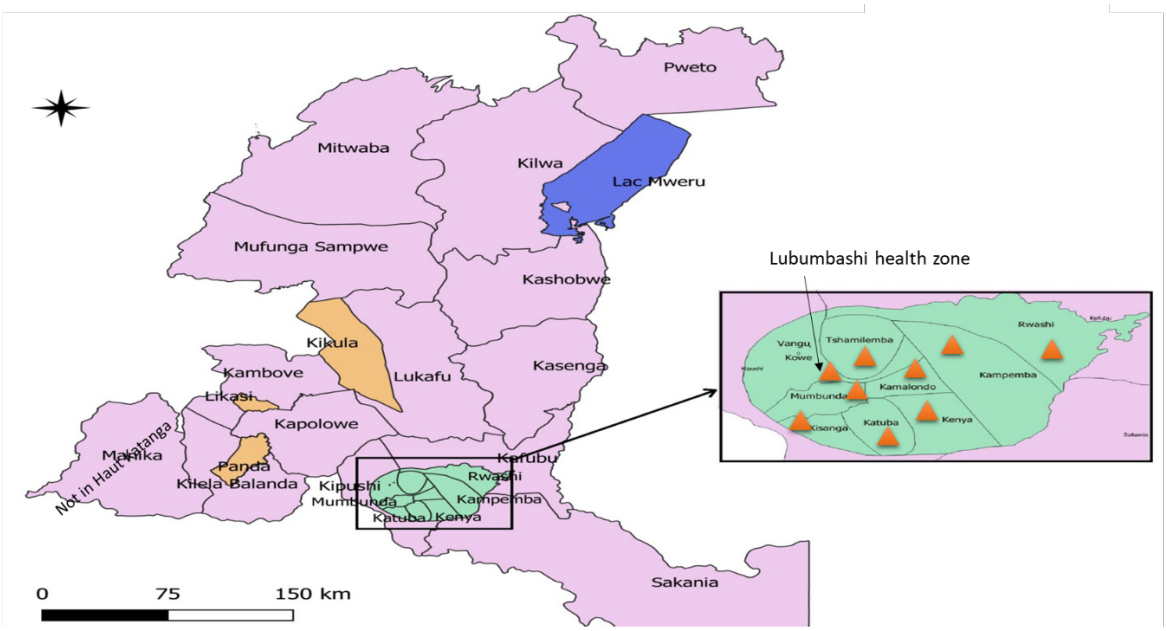


Figure 6. Map of Haut Katanga showing the 27 health areas. Inset shows enlargement within Lubumbashi city. Triangles show the nine health zones included for BBnet random allocation to health areas.

Table 1. Health zones (HZ) within Lubumbashi included in the list for inclusion, with information on the number of health areas and estimates for net need. The right column shows the random choices with the number of health areas that will be covered by Bbnets in the study, allowing for uncertainty in net need estimates. The final distribution list may differ slightly depending on logistical constraints

Possible HZ	Total HA (N=133)	HA (N=21)
Kamalondo	2	0
Kampemba	21	2
Katuba	6	0
Kenya	16	1
Kisanga	15	0
Lubumbashi	17	4
Mumbunda	17	4
Ruashi	25	6
Tshamilemba	14	4
Net need estimate		
lower	1704110	275531
upper	1917124	309972

Note added in V2.2: the final distribution was to 63 health areas as planned but these spanned 7 health zones rather than 9 (see Appendix G).

2.5.1 Health area enrolment

It is planned that all health areas receiving P3-BBnets will be enrolled into the study. Twice the number of health areas that received PermaNet 3 within a specific health zone that is receiving P3-BBnets will be randomly chosen to be enrolled for monitoring in the study. Thus, for example in Kenya health zone (Table 1), which has one P3-BBnet area proposed for inclusion in the study, two PermaNet 3 health areas would be chosen at random from the remaining 15 for inclusion for monitoring. The final decision on PermaNet 3 health areas are chosen will be taken once the final report of the distribution of P3-BBnet locations is received from SANRU. Health centres will be contacted following liaison with the provincial health director followed by medical chiefs of each health zone for involvement in the study. The primary contact point for the study in each health centre will be the nurse responsible for running ante-natal clinics, who will be responsible for recruitment of visitors to the trial.

2.5.2 Training

Training will follow the same model as applied successfully in the trial in Sud Ubangi province. Nurses at health centres responsible for the enrolment of participants into the study will be trained in workshops organized by the KSPH team, in coordination with the PNLP focal point. Training will be provided in ethical recruitment procedures and safeguarding, completion of questionnaires, and data entry into phones (provided by the study team). Given the relatively small geographical scale of the study area, it is feasible that all training may be conducted centrally in one or two one-day workshops.

3. Recruitment

3.1 ANC clinic visitors

The recruitment process at each clinic will occur when women attend their first ANC appointment (scheduled for the second trimester, though in our experience some women attend late). Women will be asked if they would like to be enrolled in the study, the main implication of which for them is

to take an RDT test for malaria (Fig. 7) and to answer a short questionnaire, which should take no more than 15 minutes. Women are given information as soon as they arrive at the clinic and have time to consider until the time of their scheduled appointment. It will be made clear that there is no direct benefit to participation, and that the results are to help evaluate different bednets distributed as part of the provincial programme. If, after asking any questions and discussing with friends or relatives as desired, they agree and sign the consent form, the questionnaire will be administered by health centre staff and the malaria test result added to this form. The form will include no personally-identifiable data. The decision to participate or not will need to be taken within the timeframe of the appointment. The information leaflet and consent form are provided in **Appendix A**.

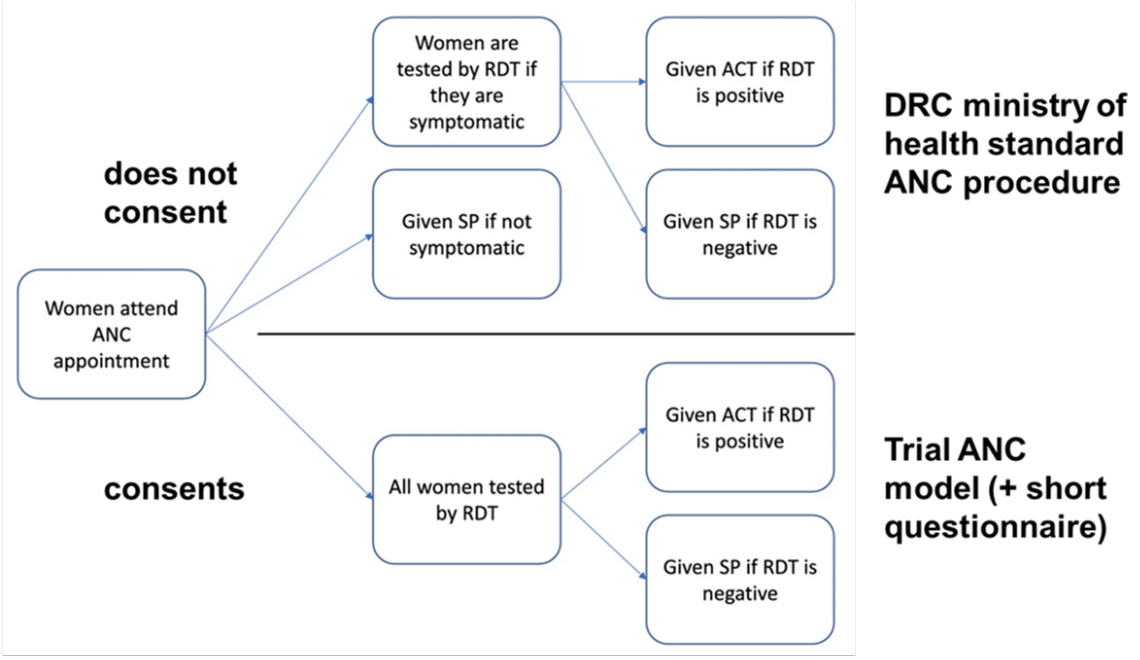


Figure 7. Recruitment and testing protocol for the trial (identical to that implemented in Sud Ubangi 2020-2022). Adapted from an original protocol applied in DRC by MSF (Hellewell et al 2018)

3.2 Household surveys

Following initial contact with community leaders facilitated by health centre staff, boundaries of the health areas will be mapped to delimit the area to be surveyed (and the GPS coordinates of each centre holding an ANC clinic will be recorded). Households within the health area will be visited by study personnel, accompanied by a local resident, typically a member of the community health worker's team. From a starting point, a first house will be chosen and subsequent houses sampled based on separation by approximately 50m. If householders are present, the purpose of the study and nature of the request for participation will be explained to them, and if they are willing to be enrolled the head of the household will be asked to sign a consent form, which will give permission (subject to verbal consent at the time of collection) to visit the house to conduct questionnaires of net use and perceptions. Prospective participants will be given up to 24 hours to decide whether to take part. If they do not wish to take part, or the head of the household is absent or their representative (i.e. an adult family member or other adult living in the same household), a neighbouring house will be approached. The questionnaire will be taken, and net hanging observed, including the position of barriers in houses with P3-BBnets. A photograph of bednets hanging *in situ*, excluding any people, may be taken subject to specific consent from the householder. An equal

number of P3-BBnet and PermaNet 3 houses will be surveyed. The information leaflet and consent form is provided in **Appendix B**. A total of approximately 200 houses will be sampled.

3.3 Entomological collections for indoor-resting mosquitoes

We lack preliminary entomological data from the trial area to inform a meaningful sample size calculation but owing to budget limitations and a smaller effect size expected than in the Sud Ubangi trial, it is unlikely that we will be able to power the trial sufficiently to compare abundance between arms. Therefore, our aim is to perform sampling to capture the vector community diversity across the trial area for which we aim to sample from approximately 10 health areas from the BBNet arm arm chosen using stratified random sampling from those included in the trial. Collections will be performed by the team from Kinshasa School of Public Health. Teams will working in pairs (preferably a male/female combination wherever possible). Collectors will be trained to take informed consent and will use mechanical Prokopack aspiratorsto collect from a target of 20 houses per health area per arm per survey round. Collections will take place in early morning (6-10am) and householders will be requested to keep doors and windows closed as much as possible and to leave bednets in place. Following initial approach householders will have 24h to decide whether they wish to take part. Compensation will not be provided for the collections. The information leaflet and consent form are provided in **Appendix D**. A total of approximately 200 houses will be sampled.

4. Study Outcome Variables

4.1 ANC1 malaria prevalence

Women who visit their first ANC and consent to take part in the study will asked to allow their malaria test result to be recorded and to complete a questionnaire (**Appendix E**) which requests basic demographic information, information on stage of pregnancy and number of previous pregnancies, the type(s) and numbers of bednets and their use, and - *if their household received a BBnet* - the hanging status of the barrier under which they sleep by reference to pictures on the questionnaire form. Additional information will be the health area within which their home is located to identify if this is different from that in which the ANC1 is visited. Test results and questionnaires will be anonymous and no personally-identifiable information will be requested. Data will be recorded onto forms and stored securely at the health facility as well as onto mobile phones to allow prompt electronic transfer to the study team. Monitoring of ANCs will take one during a 3-month window at 7-9 months after the distribution..

4.1.1 Secondary epidemiological outcome

Malaria cases and RDT-confirmed malaria in the population will be approximated as cases per capita using population size estimates from the distribution team for each health area. These will be obtained from routine DHIS2 data for each heath area for comparison of trends with those from the ANC1 data.

4.2. Survey of mosquito community

4.2.1 Rationale for entomological surveillance

Owing to the low expected mosquito catches (≈0.5/house) in houses receiving new PermaNet 3 bednets and high expected standard deviation of catches (≈3x mean) (Sud Ubangi trial data, unpublished data) suitably-powered entomological comparisons of *Anopheles* female abundance to detect an expected reduction of e.g. 30% with BBnets would require more clusters than are present

within the study, or even if clustering is not considered, larger sample sizes than are feasible for this study (N≈2400 houses). Therefore, the aim of entomological sampling will be characterisation of the local malaria mosquito community (species composition, insecticide resistance and mechanisms) rather than comparative assessment of abundance between arms.

4.2.2 Number of houses surveyed

We aim to obtain a target number of *Anopheles* females of at least 100 per survey round, which based on our experience gives an appropriate sample size for estimation of species composition and molecular marker frequencies. The survey will aim to obtain a representative sample from across the trial area. To give a representative sample, 200 houses will be sampled including each of 7 health zone targeting clusters in the BBNet arm. A survey round will be performed during later periods of the trial.

4.2.3 Collection routine

Collections will take place in the morning (6-10am) and householders will be requested to keep doors and windows closed and to leave bednets in place as much as possible. Collections will use Prokopack aspirators and take approximately 20 min/house, providing a standardised methodology for collecting adult mosquitoes. Samples will be transferred to the University of Kinshasa School of Public Health for further processing, including morphological species identification, before transfer of *Anopheles* specimens to LSTM for molecular species identification and detection of *Plasmodium* infection, and molecular resistance diagnostic marker screening using quantitative PCR.

4.2.4 Molecular analyses of species and resistance

Following initial morphological identifications, species identity within morphologically indistinguishable species complexes will be performed using standard PCR diagnostic methods (*An. gambiae* and *An. funestus*) and additional specimens for which molecular identity is uncertain will be confirmed by mitochondrial DNA sequencing. Appropriate resistance diagnostic markers for each major species detected will be screened in the samples using quantitative PCR. Molecular analyses will be performed at LSTM. The frequency of a triple mutant linked with pyrethroid resistance (which is common throughout much of DRC) will be assessed. PBO is expected to block the action of this mechanism and determination of frequency of this mechanism. Voltage gated sodium channel (target site) mutations (at positions 402, 995, 1527, 1570) will also be assessed, and more novel mechanisms may also be assayed. Markers for Cyp6P9a,b and GSTe2 will be screened in *An. funestus*. Molecular analyses will be performed on female *Anopheles* adults collected as part of the routine surveys and also those from the double net and HLC collections (above). *Plasmodium* infection in each specimen will also be assessed. Molecular analyses will be performed using quantitative PCR.

4.3 Net durability

From N=30 houses per arm from the second survey round, one net will be chosen at random for removal and replacement with a new net of the same type for assessment of physical integrity, and chemical content using HPLC. The houses will a subset of those from which entomological collections are performed and no more than 3 houses should be chosen per health area to ensure even coverage. A standard durability monitoring protocol will record holes (and proportionate hole index). Sections of nets (30 x 30 cm) will be cut out to provide net sections for chemical (deltamethrin and PBO) content analysis using HPLC in Liverpool.

4.4 Assessment of bednet hanging and user perceptions by questionnaires

The head of the household or their representative will be asked to take part in completion of a questionnaire (**Appendix F**), to assess their perceptions of the nets provided, any difficulties encountered, and suggestions for improvements either to the nets or the way they are distributed. The sample size is based on that employed in an earlier pilot study of user perceptions conducted by the team in Kinshasa province. During the survey rounds, in all houses which have P3-BBnets the position of the barriers will be recorded by reference to a pictorial scale (**Appendix F)**. Where bednets are hanging, observations will be made with the householder - if they consent - to check consistency with the reported hanging position.

4.5. Insecticide resistance quantification

Pyrethroid phenotypic resistance prevalence/ intensity and PBO synergy

WHO diagnostic dose bioassays will be used to characterise the resistance profile of the *Anopheles* vector community using assays with both deltamethrin alone (the pyrethroid on all nets distributed) and deltamethrin following prior exposure to the synergist PBO. Larvae will be collected from a range of habitats in public spaces and raised to adults in a field insectary. We propose to test 3 different concentrations (+ no insecticide controls) of deltamethrin with and without PBO, using standard WHO tube test procedures on adult mosquitoes (collected as larvae), each of which will be represented by 4 replicate tubes of N=25 female *Anopheles* + control tubes of N=25 females. The plan is shown below.

- Deltamethrin 1x (diagnostic dose)
- Deltamethrin 5x (if 1x does not kill ≥98%)
- Deltamethrin 10x (if 5x does not kill ≥98%)
- Deltamethrin 1x with PBO pre-exposure (if 1x alone does not kill ≥98%%)
- Deltamethrin 5x with PBO pre-exposure (if 5x alone does not kill ≥98%%)
- Deltamethrin 10x with PBO pre-exposure (if 10x alone does not kill 100%)

5. Data analysis

5.1 Epidemiological data

Data will be analysed as both intention to treat and per protocol, which may be important owing to the likely movement of ANC visitors to health centres not in their health area of residence, which will be recorded as part of ANC questionnaires. The primary outcome will be the prevalence of confirmed malaria from the ANC1 visitor surveys, which will be compared between treatment arms using either a generalized estimating equation or generalized linear mixed model with log link function. Covariables from ANC questionnaires may be incorporated into the models where significant. Owing to the difference in the physical appearance of nets, blinding of data collection is not possible but the study arms and health areas will be given random code numbers prior to analysis to facilitate blinding of statistical analysis.

5.2 Household survey data

Quantitative data from surveys will be compared among areas (for BBnet barrier suspension) and time points (for BBnet barrier suspension, net durability assessments, and ordinal questionnaire data) using ANOVA, t-tests or non-parametric equivalents as appropriate. For qualitative data, coding will use Atlas.ti v9.

6. Data recording, management and confidentiality

The clinic nursing staff and assistants are familiar with the procedures involved, which are routine, and training will be provided to the appointed member of clinic staff who will be a part of the wider study team and responsible for ensuring the protocol is followed and data recording occurs correctly. The study team will be in contact via telephone with the study-associated member of the clinic staff to emphasise key points and answer queries. The DRC project PI will be responsible for coding the data so that data analysis will be performed blind to the identity of clusters by another member of the study team (at LSTM). Data will be entered into an Access database as soon as possible after data collection. All data collected will be anonymous, and GPS locations of individual houses will not be used in any report or presentation. Any photographs taken will only be taken of bednets and will not show residents.

7. Ethical considerations

7.1 Vulnerable groups

The epidemiological component of the study involves solely pregnant women presenting at their first antenatal clinic, which is expected to be early in their second trimester. Though pregnant women can be classed as a vulnerable group the study is requesting to administer tests which are given routinely to people presenting with a fever and ACT treatment is the WHO and DRC standard for women outside of their first trimester. We will not include pregnant women presenting with severe malaria symptoms, for whom urgent treatment and admission to hospital, as per standard guidelines, would be the priority rather than ANC procedures. Pregnant adolescents (<15 years) are expected to represent a small proportion of the cohort at ANCs and will not be enrolled. However, based on data from DRC as a whole (MPSMRM 2013-14) we estimate that approximately 18% of the ANC visitors are likely to be in the 15-18 (older adolescent) grouping, therefore exclusion would represent a significant source of bias. This cohort does constitute a vulnerable group because of their age but in many cases pregnant women in this cohort will be married and living independently of their parents/ guardians who may not accompany them to the ANC. To allow representative sampling we therefore propose to include pregnant older adolescents with their consent *and* their parental/ guardian consent if present, but with their consent alone if they are not accompanied by a parent or guardian. The questionnaire for the ANC visitors is short and is not designed to request sensitive or personally-identifiable information.

7.2 Household surveys

7.2.1 During visits and surveys, householders may have concerns about their privacy or security of their home.

Mosquito sampling and net hanging evaluation should cause nothing more than mild inconvenience, but if there are very old/ infirm householders we would ensure that they are able and happy to exit a room for a short time during the mosquito collection period. If this is not the case and sampling could not occur without disturbing the resident, we would advise against consent. Interviews will be carried out by personnel experienced in qualitative data collection methods to ensure culturally sensitive approaches are followed to reduce undue stress to participants.

7.2.2 Skin/respiratory irritation from use of the nets distributed or provided as replacements

The nets are distributed by the national malaria control programme and have a very good safety record. Since P3-BBnets are identical in all relevant aspects to PermaNet 3, there is no expectation for any differential safety concerns.

7.2.3 COVID19 transmission

Survey teams will follow current national guidelines on use of masks and gloves as appropriate to avoid any enhanced risk to householders.

8. Safeguarding

The safeguarding issue we identify is Empowerment as it relates to the informed consent procedure. The study population may comprise of individuals with low educational and socio-economic status. For this reason we keep the participant information leaflet as simple as possible, and the study will be explained to participants or householders carefully, being particularly clear about the right to refuse participation without any prejudice to standard care. No incentives or coercion will be used by clinic staff or mosquito collection staff to obtain consent. Nursing staff responsible for recruitment will receive training from the study team to recognise and avoid any possibility of coercion.

9. Dissemination

The findings of the research will be made available to the net distributor AMF, and National Malaria Control Programme for onward dissemination as soon as available, and later published in open access journals. Presentations will be made to key stakeholders in DRC, and findings will be made available to the WHO.

10. Project timeline

Month_Year	Sep_23	Oct_23	Nov_23	Dec_23	Jan_24	Feb_24	Mar_24	Apr_24	May_24	Jun_24
Months after net distribution	4	5	6	7	8	9	10	11	12	
Project month	1	2	3	4	5	6	7	8	9	10
Preparation and training										
Liaison with SANRU, PNLP, health service										
Ethics										
Staff recruitment										
Training of health centre staff										
Collection of GPS for health centres										
Surveys										
ANC monitoring										
Entomology (community collections)										
Householder questionnaires										
Entomological sample processing										
Physical assessment of nets (KSPH)										
Molecular analysis of ento samples (LSTM)										
HPLC analysis of nets (LSTM)										
Analysis and reporting										
Data analysis										
Final reporting										

11. References

Accrombessi M, et al. 2023. Efficacy of pyriproxyfen-pyrethroid long-lasting insecticidal nets (LLINs) and chlorfenapyr-pyrethroid LLINs compared with pyrethroid-only LLINs for malaria control in Benin: a cluster-randomised, superiority trial. Lancet https://doi.org/10.1016/S0140-6736(22)02319-4

Barnes KG, et al. 2017. Genomic Footprints of Selective Sweeps from Metabolic Resistance to Pyrethroids in African Malaria Vectors Are Driven by Scale up of Insecticide-Based Vector Control. PLoS Genet. 13:e1006539. doi: 10.1371/journal.pgen.1006539.

Hellewell J, Walker P, Ghani A, Rao B, Churcher TS. 2018. Using ante-natal clinic prevalence data to monitor temporal changes in malaria incidence in a humanitarian setting in the Democratic Republic of Congo. Malaria Journal 17:312.

Lynd A, Oruni A, van't Hof AE, Morgan JC, Naego LB, Pipini D, O'Kines KA, Bobanga TL, Donnelly MJ, Weetman D. 2018. Insecticide resistance in *Anopheles gambiae* from the northern Democratic Republic of Congo, with extreme knockdown resistance (kdr) mutation frequencies revealed by a new diagnostic assay. Malaria Journal 17:412.

Mosha JF, Kulkarni MA, Lukole E, Matowo NS, Pitt C, Messenger LA, et al. 2022. Effectiveness and cost-effectiveness against malaria of three types of dual-active-ingredient long-lasting insecticidal nets (LLINs) compared with pyrethroid-only LLINs in Tanzania: a four-arm, cluster-randomised trial. Lancet. 399:1227–41.

Murray GPD, Lissenden N, Jones J, Voloshin V, Toé KH, Sherrard-Smith E, Foster GM, Churcher TS, Parker JEA, Towers CE, N'Falé S, Guelbeogo WM, Ranson H, Towers D, McCall PJ. 2020. Barrier bednets target malaria vectors and expand the range of usable insecticides. Nat Microbiol. 5:40-47.

Njoroge H, Van't Hof A, Oruni A, Pipini D, Nagi SC, Lynd A, Lucas ER, Tomlinson S, Grau-Bove X, McDermott D, Wat'senga FT, Manzambi EZ, Agossa FR, Mokuba A, Irish S, Kabula B, Mbogo C, Bargul J, Paine MJI, Weetman D, Donnelly MJ. 2022. Identification of a rapidly-spreading triple mutant for high-level metabolic insecticide resistance in Anopheles gambiae provides a real-time molecular diagnostic for antimalarial intervention deployment. Mol Ecol. 31:4307-4318.

Parker JEA, Angarita-Jaimes N, Abe M, Towers CE, Towers D, McCall PJ. 2015. Infrared video tracking of *Anopheles gambiae* at insecticide-treated bed nets reveals rapid decisive impact after brief localised net contact. Sci Rep. 5:13392.

Parker JEA, Angarita Jaimes NC, Gleave K, Mashauri F, Abe M, Martine J, et al. 2017. Host-seeking activity of a Tanzanian population of *Anopheles arabiensis* at an insecticide treated bed net. Malar J. 16:270.

Protopopoff N, Mosha JF, Lukole E, Charlwood JD, Wright A, Mwalimu CD, et al. 2018. Effectiveness of a long-lasting piperonyl butoxide-treated insecticidal net and indoor residual spray interventions, separate and together, against malaria transmitted by pyrethroid-resistant mosquitoes: a cluster, randomized controlled, two-by-two factorial design trial. Lancet 391: 1577-1588.

Staedke SG, et al. 2020. Effect of long-lasting insecticidal nets with and without piperonyl butoxide on malaria indicators in Uganda (LLINEUP): a pragmatic, cluster-randomised trial embedded in a national LLIN distribution campaign. Lancet. 395:1292-1303.

van Eijk AM, Hill J, Noor AM, Snow RW, ter Kuile FO. 2015. Prevalence of malaria infection in pregnant women compared with children for tracking malaria transmission in sub-Saharan Africa: a systematic review and meta-analysis. Lancet Glob Health. 3: e617-28.

Wat'senga F, Manzambi EZ, Lunkula A, Mulumbu R, Mampangulu T, Lobo N, Hendershot A, Fornadel C, Jacob D, Niang M, Ntoya F, Muyembe T, Likwela J, Irish SR, Oxborough RM. 2018. Nationwide insecticide resistance status and biting behaviour of malaria vector species in the Democratic Republic of Congo. Malaria Journal 17:219.

Wat'senga F, Agossa F, Manzambi EZ, Illombe G, Mapangulu T, Muyembe T, Clark T, Niang M, Ntoya F, Sadou A, Plucinski M, Li Y, Messenger LA, Fornadel C, Oxborough RM, Irish SR. 2020. Intensity of pyrethroid resistance in Anopheles gambiae before and after a mass distribution of insecticide-treated nets in Kinshasa and in 11 provinces of the Democratic Republic of Congo. Malar J. 19:169.

WHO 2023 Guidance on the prioritization of insecticide-treated nets in situations where resources are limited. Available from https://www.who.int/publications/i/item/9789240069428

12. APPENDICES (A-F)

PARTICIPANT INFORMATION SHEET

A. Antenatal clinic appointment visitors v2.1

Version Date 18/09/2023

Study Title: Trial of PermaNet 3-barrier bednets as part of an operational distribution programme in Haut-Katanga province, DRC (BBnets) v2.1

DRC Principal Investigators: Dr Nono Mvuama and Dr Josue Zanga, University of Kinshasha School of Public Health. UK Principal Investigators: Dr David Weetman and Prof Janet Hemingway, Liverpool School of Tropical Medicine.

Funded by UK Research and Innovation Strength In Places Fund, Against Malaria Foundation.

Reviewed by the ethical committees of the Liverpool School of Tropical Medicine, UK and the University of Kinshasa Medical School

Sponsor: Liverpool School of Tropical Medicine, UK

What is the purpose of the study?

The Liverpool School of Tropical Medicine (UK), University of Kinshasa School of Public Health, have partnered with the net manufacturer Vestergaard, the net provider Against Malaria Foundation, and the National Malaria Control Programme to investigate how well insecticide bednets distributed in health zones in Lubumbashi, Haut Katanga may be protecting you and your communities from malaria. We are investigating this by assessing how rates of malaria change in different areas of Lubumbashi receiving different nets. Recent studies in DRC and elsewhere show that malaria parasite infection rates in pregnant women tested at antenatal clinics provide a good indicator for the community.

Why have I been chosen?

You have been asked today to consider joining this study because you are attending your first antenatal clinic appointment during which you will receive a malaria test.

How can I join the study?

After considering the information in this sheet and asking any questions, you will be asked to give your written agreement to be included in the study.

Do I have to take part?

Your participation is entirely voluntary. It is up to you to decide whether to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. You are still free to withdraw at any time and without giving a reason. Your decision to take part or not, will not affect your appointment or the care you receive at the clinic.

What will happen to me if I take part?

For this study we will ask you to take a rapid diagnostic test for malaria and if the test is positive you will receive artemisinin combination therapy. If the test is negative you will receive your standard preventative treatment. We will also ask you to answer some questions during the time you wait for the result. These questions will include the area where you live, how far you have travelled from for your appointment; your age, number of previous pregnancies and information on net hanging. We will not record any information that will allow your test result of answers to be identified to you and you do not have to answer specific questions if you prefer not to.

What are the possible risks and disadvantages of taking part?

There will not be any additional risks to you if you take part in the study. A possible disadvantage is that the appointment may take slightly longer than they would otherwise to permit completion of the questionnaire, but the extra time required will be short since it is unlikely to require more than 15 minutes for completion.

What are the possible benefits of taking part?

The only direct benefit to taking part is that you will find out if you have a malaria infection currently and if so will receive appropriate treatment. Otherwise there is no direct benefit to taking part and we will not be providing compensation because we are not asking you to attend any extra appointments. You will only attend your usual appointment today. Information we get from this study will help us to understand how well insecticide treated bednets are protecting people in your community and will help us to understand which bednets provide the best protection, which will inform future distributions.

What will happen to the results?

Results will be entered into a study database and transferred to the UK for analysis. Paper records including consent forms will be destroyed within 3 years of the study completion. The findings of this study will be made available to the providers of the bednets Against Malaria Foundation, the National Malaria Control Programme. the Ministry of Health, to other stakeholders and decision-makers, and to the wider community by publication in an international journal. No information which will allow your identification will be used in reports or publications. We will provide a summary of the findings to your local health centre for display within 12 months of completion of the trial.

What if I <u>do not</u> want to take part in the study?

There is no obligation to take part in the study and you will not be persuaded to do so: this is entirely your decision. If you choose not to take part, you will simply receive the standard antenatal clinic procedures and treatment. Whether you are part of the study or not will have no effect on the care you receive or the bednets your house receives.

What if I <u>do</u> want to take part in the study?

If you wish to take part in the study, after you have asked any questions, we will ask you to sign a consent form to indicate that you understand what the study is about and what will be required from you. If you are between 15 and 18 years old and are attending your appointment with your

parent, guardian or husband (if they are 18 years old or over) we will also ask them to read this sheet and for you both to sign the consent form if you are in agreement.

Further information or concerns

Please feel free to ask the clinic staff about anything that you feel you have not understood or any concerns you may have. You can also contact the study team leaders on the telephone number below:

Dr Nono Mvuama tel: 08977854777

Dr Josue Zanga tel: 0815108117

If you have any complaints about the study and wish to make a complaint to someone not involved in the study team please contact:

Professor Graham Devereux, the chair of the Liverpool School of Tropical Medicine Ethics Committee. Email LSTMREC@lstmed.ac.uk

Thank you for taking the time to read this sheet and for considering joining the study.

Safeguarding

The study team and data collectors are expected to behave ethically and responsibly at all times and follow the Liverpool School of Tropical Medicine and University of Kinshasa code of conduct. This means that they must not ask you for any financial, physical or sexual favours in return for taking part in this research. If you experience any abuse, harassment or neglect by a study team member you can contact the study Safeguarding Lead – Dr Josue Zanga, tel: as above, email: josuezanga1979@gmail.com. You may call this telephone number at any time. You may also raise a safeguarding concern directly with LSTM Designated Safeguarding Officer Philippa Tubb tel: +44 (0)151 705 3744, email: safeguarding@lstmed.ac.uk. LSTM's safeguarding commitment is described on the LSTM Safeguarding webpage: https://www.lstmed.ac.uk/safeguarding

LSTM data protection statement: Whilst you are consenting to participate in the project, which you may withdraw from. Once data has been obtained for the purpose of analysis for example, if you choose to opt out of participating from the study, it may not be possible to remove all data items, such as anonymised data that is used for the analysis. In these circumstances, the legal basis applied in order for LSTM to comply with GDPR is; (1) Article 6(1)(e) (e) Public task: the processing is necessary for you to perform a task in the public interest or for your official functions, and (2) Article 9(2)(j) (j) Archiving, research and statistics is the purpose the processing is being conducted.

SIGNATURE PAGE FOR CONSENT TO PARTICIPATE IN THE STUDY

Study Title: Trial of PermaNet 3-barrier bednets as part of an operational distribution programme in Haut-Katanga province, DRC (BBnets) v2.1

PIS: Antenatal clinic appointment visitors v2.1

I have read /been read the information sheet concerning the study and understand what will be required of me if I take part and I have had the opportunity to ask questions about the study and what will be required of me.

I understand that I am free to refuse to take part and at any time may withdraw from inclusion in this study without giving a reason and without affecting my normal healthcare or that of my family. I voluntarily agree to take part in the study.

PARTICIPANT'S CONSENT

My signature (or thumbprint) below confirms that I freely agree to take part in the study or for a parent/ guardian that I confirm my assent for my daughter's participation.		
		|___|___|/|___|___|/|___|___|___|___|
Participant's Name	**Participant's Signature/Thumbprint**	**Date**
		|___|___|/|___|___|/|___|___|___|___|
Parent/guardian/husband (over 18 years) name (if participant aged <18 and accompanied)	**Parent/ guardian Signature/Thumbprint**	**Date**

IMPARTIAL WITNESS in the event the participant is unable to read

I confirm that I saw the participant being informed about the study and that he/she freely consented verbally and by marking this form confirms to this consent.		
		|___|___|/|___|___|/|___|___|___|___|
Witness Name	**Signature/Thumbprint**	**Date**

DESIGNEE

As an individual properly delegated by the principal investigator, I have fully informed the participant of all relevant aspects of the study, that I have answered any questions arising.		
		|___|___|/|___|___|/|___|___|___|___|
Designee Name	**Signature**	**Date**

PARTICIPANT INFORMATION SHEET

B. Household survey v2.1

Version Date 18/09/2023

Study Title: Trial of PermaNet 3-barrier bednets as part of an operational distribution programme in Haut-Katanga province, DRC (BBnets) v2.1

DRC Principal Investigators: Dr Nono Mvuama and Dr Josue Zanga, University of Kinshasha School of Public Health. UK Principal Investigators: Dr David Weetman and Prof Janet Hemingway, Liverpool School of Tropical Medicine.

Funded by UK Research and Innovation Strength In Places Fund, Against Malaria Foundation.

Reviewed by the ethical committees of the Liverpool School of Tropical Medicine, UK and the University of Kinshasa Medical School

Sponsor: Liverpool School of Tropical Medicine, UK

What is the purpose of the study?

The Liverpool School of Tropical Medicine (UK), University of Kinshasa School of Public Health, have partnered with the net manufacturer Vestergaard, the net provider Against Malaria Foundation, and the National Malaria Control Programme to investigate how well insecticide bednets distributed in health zones in Lubumbashi, Haut Katanga may be protecting you and your communities from malaria. We are investigating this by assessing how rates of malaria change in different areas of Lubumbashi receiving different nets. Recent studies in DRC and elsewhere show that malaria parasite infection rates in pregnant women tested at antenatal clinics provide a good indicator for the community.

Why has my house been chosen?

You have been asked today to consider joining this study because your house is within an area we have identified for surveys to collect information as part of the study. There is no specific reason why your house within the area has been chosen.

How can I join the study?

After considering the information in this sheet you will be asked to give your written agreement to be included in the study, to allow us to complete information in a questionnaire with you, and to observe and record some details on the structure of your house and hanging of bednets.

Do I have to take part?

Your participation is entirely voluntary. It is up to you to decide whether to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. You are still free to withdraw at any time and without giving a reason. Your decision to take part or not, will not affect any form of healthcare you receive.

What will happen if I agree to my household to take part?

If you agree to take part we will ask you to assist us by completing a questionnaire about use of nets and your opinions about the nets you have received as part of the distribution programme. We will also request permission to briefly enter your home to record some details of the structure of your house and the number and hanging of bednets. This should take no more than 30 minutes. We will ask you to sign the consent form and will ask again for your verbal consent on each occasion we visit.

Procedures

We will ask you to assist us with completion of a questionnaire, which will record a few basic structural details of your house such as wall construction material and roofing type, number of rooms, how many people sleep there and how many bednets are used. We will also ask about bednet use and your opinions of the nets you received as part of the distribution programme. We would like to observe and record hanging of bednets if they are currently hung in the house. We may request to take a picture of a hanging bednet under which no-one is present. We will not take any pictures unless you agree.

What are the possible risks and disadvantages of taking part?

There are no risks to you or your household if you take part in the study. The only disadvantage is giving your time to allow completion of the questionnaire and brief entry to the house to record the details above.

What are the possible benefits of taking part?

There is no direct benefit to taking part and we cannot offer to provide compensation. Information we get from this study will help us to understand how well insecticide treated bednets are protecting people in your community and will help us to understand which bednets provide the best protection, which will inform future distributions.

What will happen to the results?

Results will be entered into a study database and transferred to the UK for analysis. Paper records including consent forms will be destroyed within 3 years of the study completion. The findings of this study will be made available to the providers of the bednets Against Malaria Foundation, the National Malaria Control Programme. the Ministry of Health, to other stakeholders and decision-makers, and to the wider community by publication in an international journal. No information which will allow your identification will be used in reports or publications. We will provide a summary of the findings to your local health centre for display within 12 months of completion of the trial.

What if I <u>do not</u> want to take part in the study?

There is no obligation to take part in the study and you will not be persuaded to do so: this is entirely your decision, and you are entirely free to withdraw your consent at any time. Whether you are part of the study or not will have no effect on the care you receive or the bednets your house receives. You are free to refuse entry to collect on any occasion if you have signed the written consent form.

What if I <u>do</u> want to take part in the study?

If you wish to take part in the study, after you have asked any questions, we will ask you to sign a consent form to indicate that you understand what the study is about and what will be required from you. We ask you to explain to any members of your household who are not present at the time

of our initial visit. We will arrange a date for the visit to your house for the collection or if the collection will not occur for any reason we will also notify you of this. You are free to refuse entry to collect on any occasion if you have signed the written consent form.

Further information or concerns

Please feel free to ask the collection team staff about anything that you feel you have not understood or any concerns you may have. You can also contact the study team leaders on the telephone number below:

Dr Nono Mvuama tel: 08977854777

Dr Josue Zanga tel: 0815108117

If you have any complaints about the study and wish to make a complaint to someone not involved in the study team please contact:

Professor Graham Devereux, the chair of the Liverpool School of Tropical Medicine Ethics Committee. Email LSTMREC@lstmed.ac.uk

Thank you for taking the time to read this sheet and for considering joining the study.

Safeguarding

The study team and data collectors are expected to behave ethically and responsibly at all times and follow the Liverpool School of Tropical Medicine and University of Kinshasa code of conduct. This means that they must not ask you for any financial, physical or sexual favours in return for taking part in this research. If you experience any abuse, harassment or neglect by a study team member you can contact the study Safeguarding Lead – Dr Josue Zanga, tel: as above, email: josuezanga1979@gmail.com. You may call this telephone number at any time. You may also raise a safeguarding concern directly with LSTM Designated Safeguarding Officer Philippa Tubb tel: +44 (0)151 705 3744, email: safeguarding@lstmed.ac.uk. LSTM's safeguarding commitment is described on the LSTM Safeguarding webpage: https://www.lstmed.ac.uk/safeguarding

LSTM data protection statement: Whilst you are consenting to participate in the project, which you may withdraw from. Once data has been obtained for the purpose of analysis for example, if you choose to opt out of participating from the study, it may not be possible to remove all data items, such as anonymised data that is used for the analysis. In these circumstances, the legal basis applied in order for LSTM to comply with GDPR is; (1) Article 6(1)(e) (e) Public task: the processing is necessary for you to perform a task in the public interest or for your official functions, and (2) Article 9(2)(j) (j) Archiving, research and statistics is the purpose the processing is being conducted.

SIGNATURE PAGE FOR CONSENT TO PARTICIPATE IN THE STUDY

Study Title: Trial of PermaNet 3-barrier bednets as part of an operational distribution programme in Haut-Katanga province, DRC (BBnets) v2.1

PIS: Household survey v2.1

I have read /been read the information sheet concerning the study and understand what will be required of me if I take part and I have had the opportunity to ask questions about the study and what will be required of me.

I understand that I am free to refuse to take part and at any time may withdraw from inclusion in this study without giving a reason and without affecting my normal healthcare or that of my family. I voluntarily agree to take part in the study.

PARTICIPANT'S CONSENT

My signature (or thumbprint) below confirms that I freely agree to take part in the study.		
		|___|___|/|___|___|/|___|___|___|___|
Participant's Name	**Participant's Signature/Thumbprint**	**Date**

My signature (or thumbprint) below confirms that I agree for photographs of bednets hanging to be taken.		
		|___|___|/|___|___|/|___|___|___|___|
Participant's Name	**Participant's Signature/Thumbprint**	**Date**

IMPARTIAL WITNESS in the event the participant is unable to read

I confirm that I saw the participant being informed about the study and that he/she freely consented verbally and by marking this form confirms to this consent.		
		|___|___|/|___|___|/|___|___|___|___|
Witness Name	**Signature**	**Date**

Study team member

As an individual properly delegated by the principal investigator, I have fully informed the participant of all relevant aspects of the study, that I have answered any questions arising.		
		|___|___|/|___|___|/|___|___|___|___|
Team member name	**Signature**	**Date**

PARTICIPANT INFORMATION SHEET

C. Net durability assessments v2.1

Version Date 18/09/2023

Study Title: Trial of PermaNet 3-barrier bednets as part of an operational distribution programme in Haut-Katanga province, DRC (BBnets) v2.1

DRC Principal Investigators: Dr Nono Mvuama and Dr Josue Zanga, University of Kinshasha School of Public Health. UK Principal Investigators: Dr David Weetman and Prof Janet Hemingway, Liverpool School of Tropical Medicine.

Funded by UK Research and Innovation Strength In Places Fund, Against Malaria Foundation.

Reviewed by the ethical committees of the Liverpool School of Tropical Medicine, UK and the University of Kinshasa Medical School

Sponsor: Liverpool School of Tropical Medicine, UK

What is the purpose of the study?

The Liverpool School of Tropical Medicine (UK), University of Kinshasa School of Public Health, have partnered with the net manufacturer Vestergaard, the net provider Against Malaria Foundation, and the National Malaria Control Programme to investigate how well insecticide bednets distributed in health zones in Lubumbashi, Haut Katanga may be protecting you and your communities from malaria. We are investigating this by assessing how rates of malaria change in different areas of Lubumbashi receiving different nets. Recent studies in DRC and elsewhere show that malaria parasite infection rates in pregnant women tested at antenatal clincs provide a good indicator for the community.

Why has my house been chosen?

You have been asked today to consider joining this study because your house is within an areas we have identified for surveys to collect information and mosquitoes as part of the study. There is no specific reason why your house within the area has been chosen.

How can I join the study?

After considering the information in this sheet you will be asked to give your written agreement to allow collection of one net for further analysis from your property and to be included in the study. We will replace the net with a new one of the same type.

Do I have to take part?

Your participation is entirely voluntary. It is up to you to decide whether to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. You are still free to withdraw at any time and without giving a reason. Your decision to take part or not, will not affect any form of healthcare you receive.

What will happen if I agree to take part?

If you agree to take part we will request permission to enter your house and remove and replace one bednet with a new bednet of the same type. We will ask you to sign the consent form and will ask again for your verbal consent when we visit.

Procedures

We will then choose one bednet at random to remove and replace. The bednet will be returned to our laboratory in Kinshasa. Some sections will be used to test how well mosquitoes are killed by exposure to the net. Sections will also be transported to the Liverpool School of Tropical Medicine (UK) for chemical analysis to determine the amount of insecticide present in the net material.

What are the possible risks and disadvantages of taking part?

There are no risks to you or your household if you take part in the study. The only disadvantage is the minor inconvenience of allowing our study team members into your house for a short time period. If sick or infirm people live in your house who would be sleeping under nets at the time of our visit we advise that you do not agree to take part to avoid their inconvenience.

What are the possible benefits of taking part?

There is no direct benefit to taking part and we cannot offer to provide compensation. Information we get from this study will help us to understand how well insecticide treated bednets are protecting people in Sud Ubangi, and will help us to understand which bednets provide the best protection, which will inform future distributions.

What will happen to the results?

Results will be entered into a study database and transferred to the UK for analysis. Paper records including consent forms will be destroyed within 3 years of the study completion. The findings of this study will be made available to the providers of the bednets Against Malaria Foundation, the National Malaria Control Programme. the Ministry of Health, to other stakeholders and decision-makers, and to the wider community by publication in an international journal. No information which will allow your identification will be used in reports or publications. We will provide a summary of the findings to your local health centre for display within 12 months of completion of the trial.

What if I <u>do not</u> want to take part in the study?

There is no obligation to take part in the study and you will not be persuaded to do so: this is entirely your decision. Whether you are part of the study or not will have no effect on any provision of healthcare or of the bednets your house receives at any time. You are free to refuse entry to collect on any occasion if you have signed the written consent form.

What if I <u>do</u> want to take part in the study?

If you wish to take part in the study, after you have asked any questions, we will ask you to sign a consent form to indicate that you understand what the study is about and what will be required from you. We ask you to explain to any members of your household who are not present at the time of our initial visit. We will arrange a date for the visit to your house or if the visit will not occur for any reason we will also notify you of this. You are free to refuse entry to collect on any occasion if you have signed the written consent form.

Further information or concerns

Please feel free to ask the collection team staff about anything that you feel you have not understood or any concerns you may have. You can also contact the study team leads on the telephone number below:

Dr Nono Mvuama tel: 08977854777

Dr Josue Zanga tel: 0815108117

If you have any complaints about the study and wish to make a complaint to someone not involved in the study team please contact:

Professor Graham Devereux, the chair of the Liverpool School of Tropical Medicine Ethics Committee. Email LSTMREC@lstmed.ac.uk

Thank you for taking the time to read this sheet and for considering joining the study.

Safeguarding

The study team and data collectors are expected to behave ethically and responsibly at all times and follow the Liverpool School of Tropical Medicine and University of Kinshasa code of conduct. This means that they must not ask you for any financial, physical or sexual favours in return for taking part in this research. If you experience any abuse, harassment or neglect by a study team member you can contact the study Safeguarding Lead – Dr Josue Zanga, tel: as above, email: josuezanga1979@gmail.com. You may call this telephone number at any time. You may also raise a safeguarding concern directly with LSTM Designated Safeguarding Officer Philippa Tubb tel: +44 (0)151 705 3744, email: safeguarding@lstmed.ac.uk. LSTM's safeguarding commitment is described on the LSTM Safeguarding webpage: https://www.lstmed.ac.uk/safeguarding

LSTM data protection statement: Whilst you are consenting to participate in the project, which you may withdraw from. Once data has been obtained for the purpose of analysis for example, if you choose to opt out of participating from the study, it may not be possible to remove all data items, such as anonymised data that is used for the analysis. In these circumstances, the legal basis applied in order for LSTM to comply with GDPR is; (1) Article 6(1)(e) (e) Public task: the processing is necessary for you to perform a task in the public interest or for your official functions, and (2) Article 9(2)(j) (j) Archiving, research and statistics is the purpose the processing is being conducted.

SIGNATURE PAGE FOR CONSENT TO PARTICIPATE IN THE STUDY

Study Title: Trial of PermaNet 3-barrier bednets as part of an operational distribution programme in Haut-Katanga province, DRC (BBnets) v2.1

PIS: Net durability assessments v2.10

I have read /been read the information sheet concerning the study and understand what will be required of me if I take part and I have had the opportunity to ask questions about the study and what will be required of me.

I understand that I am free to refuse to take part and at any time may withdraw from inclusion in this study without giving a reason and without affecting my normal healthcare or that of my family. I voluntarily agree to take part in the study.

PARTICIPANT'S CONSENT

My signature (or thumbprint) below confirms that I freely agree to take part in the study.		
		|___|___|/|___|___|/|___|___|___|___|
Participant's Name	**Participant's Signature/Thumbprint**	**Date**

IMPARTIAL WITNESS in the event the participant is unable to read

I confirm that I saw the participant being informed about the study and that he/she freely consented verbally and by marking this form confirms to this consent.		
		|___|___|/|___|___|/|___|___|___|___|
Witness Name	**Signature**	**Date**

Study team member

As an individual properly delegated by the principal investigator, I have fully informed the participant of all relevant aspects of the study, that I have answered any questions arising.		
		|___|___|/|___|___|/|___|___|___|___|
Team member name	**Signature**	**Date**

PARTICIPANT INFORMATION SHEET

D. Household mosquito collections v2.1

Version Date 18/09/2023

Study Title: Trial of PermaNet 3-barrier bednets as part of an operational distribution programme in Haut-Katanga province, DRC (BBnets) v2.1

DRC Principal Investigators: Dr Nono Mvuama and Dr Josue Zanga, University of Kinshasha School of Public Health. UK Principal Investigators: Dr David Weetman and Prof Janet Hemingway, Liverpool School of Tropical Medicine.

Funded by UK Research and Innovation Strength In Places Fund, Against Malaria Foundation.

Reviewed by the ethical committees of the Liverpool School of Tropical Medicine, UK and the University of Kinshasa Medical School

Sponsor: Liverpool School of Tropical Medicine, UK

What is the purpose of the study?

The Liverpool School of Tropical Medicine (UK), University of Kinshasa School of Public Health, have partnered with the net manufacturer Vestergaard, the net provider Against Malaria Foundation, and the National Malaria Control Programme to investigate how well insecticide bednets distributed in health zones in Lubumbashi, Haut Katanga may be protecting you and your communities from malaria. We are investigating this by assessing how rates of malaria change in different areas of Lubumbashi receiving different nets. Recent studies in DRC and elsewhere show that malaria parasite infection rates in pregnant women tested at antenatal clinics provide a good indicator for the community.

Why has my house been chosen?

You have been asked today to consider joining this study because your house is within an area we have identified for surveys to collect information and mosquitoes as part of the study. There is no specific reason why your house within the area has been chosen.

How can I join the study?

After considering the information in this sheet you will be given 24 hours to consider whether you wish to be involved and if you are happy to proceed will be asked to give your written agreement to allow collection of mosquitoes from your property in the near future.

Do I have to take part?

Your participation is entirely voluntary. It is up to you to decide whether to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. You are still free to withdraw at any time and without giving a reason. Your decision to take part or not, will not affect any form of healthcare you receive.

What will happen if I agree to my household to take part?

If you agree to take part, we will request permission to collect mosquitoes in your house in the near future. This should take no more than 20 minutes. We will ask you to sign the consent form and will ask again for your verbal consent on the occasion we visit for collections. We will call at your house at least 24 hours in advance of the collection date to notify you of the proposed collection date and check that this is convenient. We will also record a few basic structural details of your house such as wall construction material and roofing type, number of rooms, and will ask you how many people sleep there and how many bednets are used.

Procedures

On the morning of collection we request that you keep windows and doors closed as much as possible until we have visited to prevent exit of any mosquitoes present. It would be helpful if residents could vacate the property during our collection but one or more of your household members are welcome to remain to observe. Mosquitoes will be collected from rooms in your house using a mechanical suction device which we are happy to demonstrate to you. Collections will take no more than 20 minutes and are planned to occur between 6am and 9am (or by 10am at the latest). Mosquitoes collected will be stored in tubes and later identified, counted, and parasites and insecticide resistance genes within them identified if present.

What are the possible risks and disadvantages of taking part?

There are no risks to you or your household if you take part in the study. The only disadvantage is the possible inconvenience of keeping your house closed until we visit, and the request for most of the members to vacate the property if possible during the collection period. If sick or infirm people live in your house who could not easily vacate the property at the time of collection we advise that you do not agree to take part to avoid their inconvenience.

What are the possible benefits of taking part?

There is no direct benefit to taking part and we cannot offer to provide payment. Information we get from this study will help us to understand how well insecticide treated bednets are protecting people and will help us to understand which bednets provide the best protection, which will inform future distributions.

What will happen to the results?

Results will be entered into a study database and transferred to the UK for analysis. Paper records including consent forms will be destroyed within 3 years of the study completion. The findings of this study will be made available to the providers of the bednets Against Malaria Foundation, the National Malaria Control Programme. the Ministry of Health, to other stakeholders and decision-makers, and to the wider community by publication in an international journal. No information which will allow your identification will be used in reports or publications. We will provide a summary of the findings to your local health centre for display within 12 months of completion of the trial.

What if I <u>do not</u> want to take part in the study?

Your participation is entirely voluntary. It is up to you to decide whether to take part. If you do decide to take part, you will be given this information sheet to keep and be asked to sign a consent form. You are still free to withdraw at any time and without giving a reason. Your decision to take

part or not, will not affect any form of healthcare you receive. You are free to refuse entry to collect on any occasion if you have signed the written consent form.

What if I do want to take part in the study?

If you wish to take part in the study, after you have asked any questions, we will ask you to sign a consent form to indicate that you understand what the study is about and what will be required from you. We ask you to explain to any members of your household who are not present at the time of our initial visit. We will arrange a date for the visit to your house for the collection or if the collection will not occur for any reason we will also notify you of this. You are free to refuse entry to collect on any occasion if you have signed the written consent form.

Please feel free to ask the collection team staff about anything that you feel you have not understood or any concerns you may have. You can also contact the study team leads on the telephone number below:

Dr Nono Mvuama tel: 08977854777

Dr Josue Zanga tel: 0815108117

If you have any complaints about the study and wish to make a complaint to someone not involved in the study team please contact:

Professor Graham Devereux, the chair of the Liverpool School of Tropical Medicine Ethics Committee. Email LSTMREC@lstmed.ac.uk

Thank you for taking the time to read this sheet and for considering joining the study.

Safeguarding

The study team and data collectors are expected to behave ethically and responsibly at all times and follow the Liverpool School of Tropical Medicine and University of Kinshasa code of conduct. This means that they must not ask you for any financial, physical or sexual favours in return for taking part in this research. If you experience any abuse, harassment or neglect by a study team member you can contact the study Safeguarding Lead – Dr Josue Zanga, tel: as above, email: josuezanga1979@gmail.com. You may call this telephone number at any time. You may also raise a safeguarding concern directly with LSTM Designated Safeguarding Officer Philippa Tubb tel: +44 (0)151 705 3744, email: safeguarding@lstmed.ac.uk. LSTM's safeguarding commitment is described on the LSTM Safeguarding webpage: https://www.lstmed.ac.uk/safeguarding

LSTM data protection statement: Whilst you are consenting to participate in the project, which you may withdraw from. Once data has been obtained for the purpose of analysis for example, if you choose to opt out of participating from the study, it may not be possible to remove all data items, such as anonymised data that is used for the analysis. In these circumstances, the legal basis applied in order for LSTM to comply with GDPR is; (1) Article 6(1)(e) (e) Public task: the processing is necessary for you to perform a task in the public interest or for your official functions, and (2) Article 9(2)(j) (j) Archiving, research and statistics is the purpose the processing is being conducted.

SIGNATURE PAGE FOR CONSENT TO PARTICIPATE IN THE STUDY

Study Title: Trial of PermaNet 3-barrier bednets as part of an operational distribution programme in Haut-Katanga province, DRC (BBnets) v2.1

PIS: Household mosquito collections v2.1

I have read /been read the information sheet concerning the study and understand what will be required of me and my household if I take part and I have had the opportunity to ask questions about the study and what will be required of me and my household.

I understand that I am free to refuse to take part and at any time may withdraw from inclusion in this study without giving a reason and without affecting my normal healthcare or that of my family. I voluntarily agree to take part in the study.

PARTICIPANT'S CONSENT

My signature (or thumbprint) below confirms that I freely agree to take part in the study.		
		|___|___|/|___|___|/|___|___|___|___|
Participant's Name	**Participant's Signature/Thumbprint**	**Date**

IMPARTIAL WITNESS in the event the participant is unable to read

I confirm that I saw the participant being informed about the study and that he/she freely consented verbally and by marking this form confirms to this consent.		
		|___|___|/|___|___|/|___|___|___|___|
Witness Name	**Signature**	**Date**

Study team member

As an individual properly delegated by the principal investigator, I have fully informed the participant of all relevant aspects of the study, that I have answered any questions arising.		
		|___|___|/|___|___|/|___|___|___|___|
Team member name	**Signature**	**Date**

QUESTIONNAIRE v2.1

E. TO BE ADMINISTERED TO PREGNANT WOMEN DURING THEIR FIRST ANTENATAL CLINIC VISIT

Version Date 18/09/2023

Questionnaire number : …….

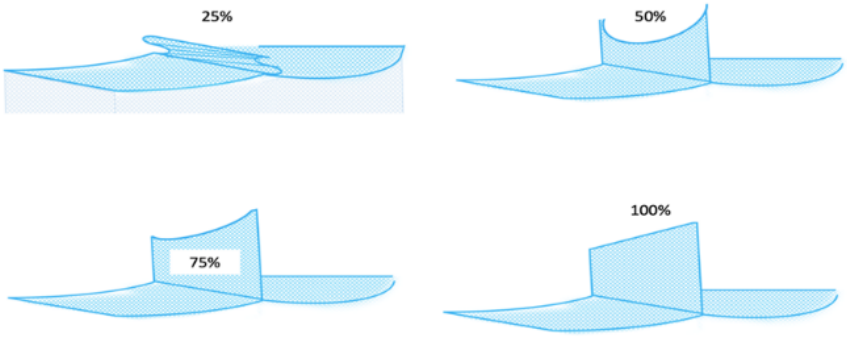
Corresponding ANC sheet number : ……

Line number in the ANC register : ……..

Visit date : /……../……../……..

Question number	Questions	Items	Answer code
Section 1 : Participant details *Note : questions marked * are to be completed by the staff member, rather than being asked*			
Q1.1	Date of birth	/……/……./…….	
Q1.2	Age	…… years	
Q1.3	Occupation		
Q1.4	In which village do you live?		
Q1.5*	Is your village inside this health area or in another health area?	1. This area 2. Another area	
Q1.6*	If in another – which health area?		
Q1.7*	Approximate distance from the		

	village to this clinic?		
Q1.8	How many months pregnant are you?		
Q1.9	How many children have you had previously?		
Section 2 : Prevention and risk behaviour relating to malaria in the household			
Q2.1	Do you use insecticide-treated bednets in the household?	1. Yes 2. No	
Q2.2	If no, ask why?	a. Bednets not delivered to house during distribution campaign b. Bednets available are damaged c. Bednets given to others d. Other reason (please specify) …… ……	
Q2.3	How many LLINs are present in your household?		
Q2.4	Among these LLINs, do you use one regularly?	1. Yes 2. No	
Q2.5	Did you spend last night under an LLIN ?	1. Yes 2. No	
Q2.6	If no – ask why?		
Q2.7	Other than bednets do you use any other method of mosquito control in your home ?	1. Yes 2. No	
Q2.8	If yes, why ?		
Q2.9	Which additional methods do you use?		
Q2.10	What time do you usually go to bed?		

Q2.11	How many people live in your house ?		
Section 3: Questions about P3-BBnets			
Q3.1	Did you receive bednets with a barrier to hang above the net roof as part of the programme	1. Yes 2. No If no, go to section 4	
Q3.2	What is the most common way that the barrier above your way is suspended (refer to picture)	1. 25% 2. 50% 3. 75% 4. 100%	
			
Section 4: MALARIA TEST RESULT			
Q4.1*	What is the result of your malaria test?	1. Positive 2. Negative	

QUESTIONNAIRE v2.1

F. TO BE COMPLETED WITH HEAD OF HOUSEHOLD OR REPRESENTATIVE

Version Date 18/09/2023

Questionnaire number : …….

Visit date : /……../……../……..

Health zone : …….

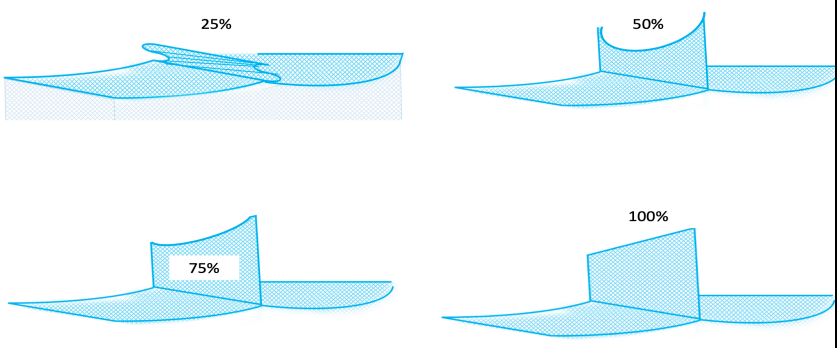
Health Area : …….

Household Identification number:…….

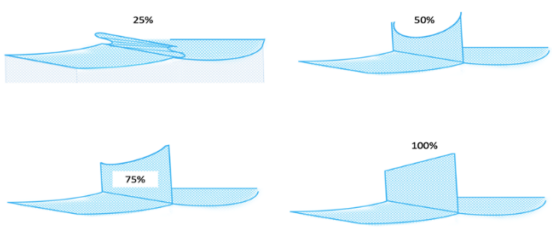
Household GPS coordinates: ……./……

Team members present : ……. …….

SECTION 1: Household questionnaire		
Q1.1	Respondent's relationship to head of household	1. Head of household 2. Partner of head of household 3. Child of head of household 4. Other
Q1.1b	If other, specify	……
Q1.2	What is the total number of people currently in the household including yourself?	/__/__/
Q1.3	What is the total number of sleeping areas (bedrooms or	/___/

	spaces used for sleeping)	
Q1.4	How many LLINs did you receive during the distribution programme?	/___/
Q1.5	How many of these LLINs are available in the household today?	/___/
Q1.6	Have you received or purchased LLINs from other sources?	0. No 1. Yes
Q1.6b	If yes, how many did you receive?	/___/
Q1.7	Do you have BBnets in your house ? (refer to picture below for identification of a BBnet)	0. No 1. Yes
Q1.8	How many BBnets do you have ?	/___/
Q1.9	How many BBnets are used regularly (i.e. most nights) ?	/___/
Q1.10	Do you suspend the barrier of your BBnets 1. always 2. sometimes 3. occasionally 4. never	/___/
Q1.11	If answer to Q10 is s 2-4 : Why is the barrier not suspended ? 1. too difficult 2. takes too long 3. don't have hanging material (string) 4. don't have hooks or nails 5. hooks or nails do not remain in walls 6. broken loops 7. not enough space 8. other	 /___/ /___/ /___/ /___/ /___/ /___/ /___/ /___/
Q1.11 b	If other, specify	…… ……
Q1.12	Do you know what the purpose of the barrier is ? If yes ask ; if answer different from actual purpose mark 'no' and explain the purpose (to kill more malaria mosquitoes as they come to bite sleepers under the net)	0. No 1. Yes
Q1.13	Which picture shows how the barrier should be suspended? 	0. don't know 1. 25%. 2. 50% 3. 75% 4. 100%
Q1.14	If you were offered a choice between a BBnet and a PermaNet	0. BBnet

	3, which is identical apart from the absence of a barrier, which would you choose?	1. P3
Q1.15	Why is this?	

Section 2 : Household observations (to be completed with householder assistance)	
2.1. What are the main materials used for the construction of the house? Mark with an X	
a. Walls	b. Floor
Mud	Earth / sand
Brick	Dung
cement plaster	Ceramic tiles
Cement / Paint	Cement
Other (specify)…… …….	Other (specify) …… ……. .
c. Roof	d. Eaves
Thatch/palm leaves	Opened
Metal	Closed
Other specify :… ……..	Partially open
2.2. BBnets (only to be completed if house has BBnets)	
2.2a. How many BBnets are hanging	/___/
2.2b. How many have a barrier suspended according to each category (refer to picture) 	1. 25%. /___/ 2. 50% /___/ 3. 75% /___/ 4. 100% /___/

2.2c. How many of the nets had a barrier weighed down by clothing ?	/___/
2.2d. How many of the nets did not have hooks or nails present for handing the barrier ?	/___/

Appendix G. Clusters to which nets were distributed

cluster	ZDS	ADS	Net type	Healt zones (where grouped)
1	Ruashi	Kijiba	BB nets	Ruashi-Kampemba
2	Ruashi	Kikunda	BB nets	Ruashi-Kampemba
3	Ruashi	Mukulu	BB nets	Ruashi-Kampemba
4	Ruashi	Kamasaka	BB nets	Ruashi-Kampemba
5	Ruashi	Kawama	BB nets	Ruashi-Kampemba
6	Ruashi	Kalukuluku	BB nets	Ruashi-Kampemba
7	Ruashi	Kizanga	BB nets	Ruashi-Kampemba
8	Ruashi	La Vallee	BB nets	Ruashi-Kampemba
9	Lubumbashi	Tingi tingi	BB nets	Lubumbashi
10	Lubumbashi	Kasapa 1	BB nets	Lubumbashi
11	Kampemba	Safina	BB nets	Ruashi-Kampemba
12	Kampemba	Triangle	BB nets	Ruashi-Kampemba
13	Tshamilemba	Ciment Kat	BB nets	Tshamilemba
14	Tshamilemba	Foire	BB nets	Tshamilemba
15	Tshamilemba	Kigoma Ouest	BB nets	Tshamilemba
16	Kenya	CASOP	BB nets	Kenya
17	Kenya	Moba	BB nets	Kenya
18	Mumbunda	Plateau 1	BB nets	Mumbunda
19	Mumbunda	Maisha	BB nets	Mumbunda
20	Mumbunda	Salama	BB nets	Mumbunda
21	Kisanga	Wantanshi	BB nets	Kisanga
22	Ruashi	Baraka	P3 nets	Ruashi-Kampemba
23	Ruashi	Telecel	P3 nets	Ruashi-Kampemba
24	Ruashi	Congo 2	P3 nets	Ruashi-Kampemba
25	Ruashi	Shindaika	P3 nets	Ruashi-Kampemba
26	Ruashi	Bendera	P3 nets	Ruashi-Kampemba
27	Ruashi	Congo 1	P3 nets	Ruashi-Kampemba
28	Ruashi	Luwowoshi	P3 nets	Ruashi-Kampemba
29	Ruashi	Neo Apostolique	P3 nets	Ruashi-

				Kampemba
30	Ruashi	Orphelinat	P3 nets	Ruashi-Kampemba
31	Ruashi	Orthodoxe	P3 nets	Ruashi-Kampemba
32	Lubumbashi	Kiwele	P3 nets	Lubumbashi
33	Lubumbashi	Gambela 2	P3 nets	Lubumbashi
34	Lubumbashi	Kalubwe 1	P3 nets	Lubumbashi
35	Lubumbashi	Kamatete	P3 nets	Lubumbashi
36	Kampemba	Cité de Jeunes	P3 nets	Ruashi-Kampemba
37	Kampemba	ECASET	P3 nets	Ruashi-Kampemba
38	Kampemba	Emmaûs	P3 nets	Ruashi-Kampemba
39	Kampemba	Kabanga	P3 nets	Ruashi-Kampemba
40	Kampemba	Kamasaka	P3 nets	Ruashi-Kampemba
41	Kampemba	Lapofa	P3 nets	Ruashi-Kampemba
42	Kampemba	Mubindu	P3 nets	Ruashi-Kampemba
43	Kampemba	Njanja	P3 nets	Ruashi-Kampemba
44	Kampemba	Sab	P3 nets	Ruashi-Kampemba
45	Kampemba	Suzanella	P3 nets	Ruashi-Kampemba
46	Tshamilemba	Hewa Bora 2	P3 nets	Tshamilemba
47	Tshamilemba	Rail	P3 nets	Tshamilemba
48	Tshamilemba	Agetraf	P3 nets	Tshamilemba
49	Tshamilemba	Kigoma Est	P3 nets	Tshamilemba
50	Tshamilemba	Kinsense	P3 nets	Tshamilemba
51	Tshamilemba	Quartier Industriel	P3 nets	Tshamilemba
52	Kenya	Lubumbashi	P3 nets	Kenya
53	Kenya	Dilungu	P3 nets	Kenya
54	Kenya	Kenya 1	P3 nets	Kenya
55	Kenya	Upemba	P3 nets	Kenya
56	Mumbunda	Tshamalale	P3 nets	Mumbunda
57	Mumbunda	Mampala 2	P3 nets	Mumbunda
58	Mumbunda	Plateau 2	P3 nets	Mumbunda
59	Mumbunda	Kabulamenshi	P3 nets	Mumbunda
60	Mumbunda	Munua	P3 nets	Mumbunda
61	Mumbunda	Penga Penga	P3 nets	Mumbunda
62	Kisanga	Kasungami 1	P3 nets	Kisanga
63	Kisanga	Kiboko	P3 nets	Kisanga