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EXPANDING THE OWNERSHIP AND USE OF MOSQUITO NETS

Choosing tools and methods for assessment of the quality of household registration for ITN distribution campaigns

June 2021

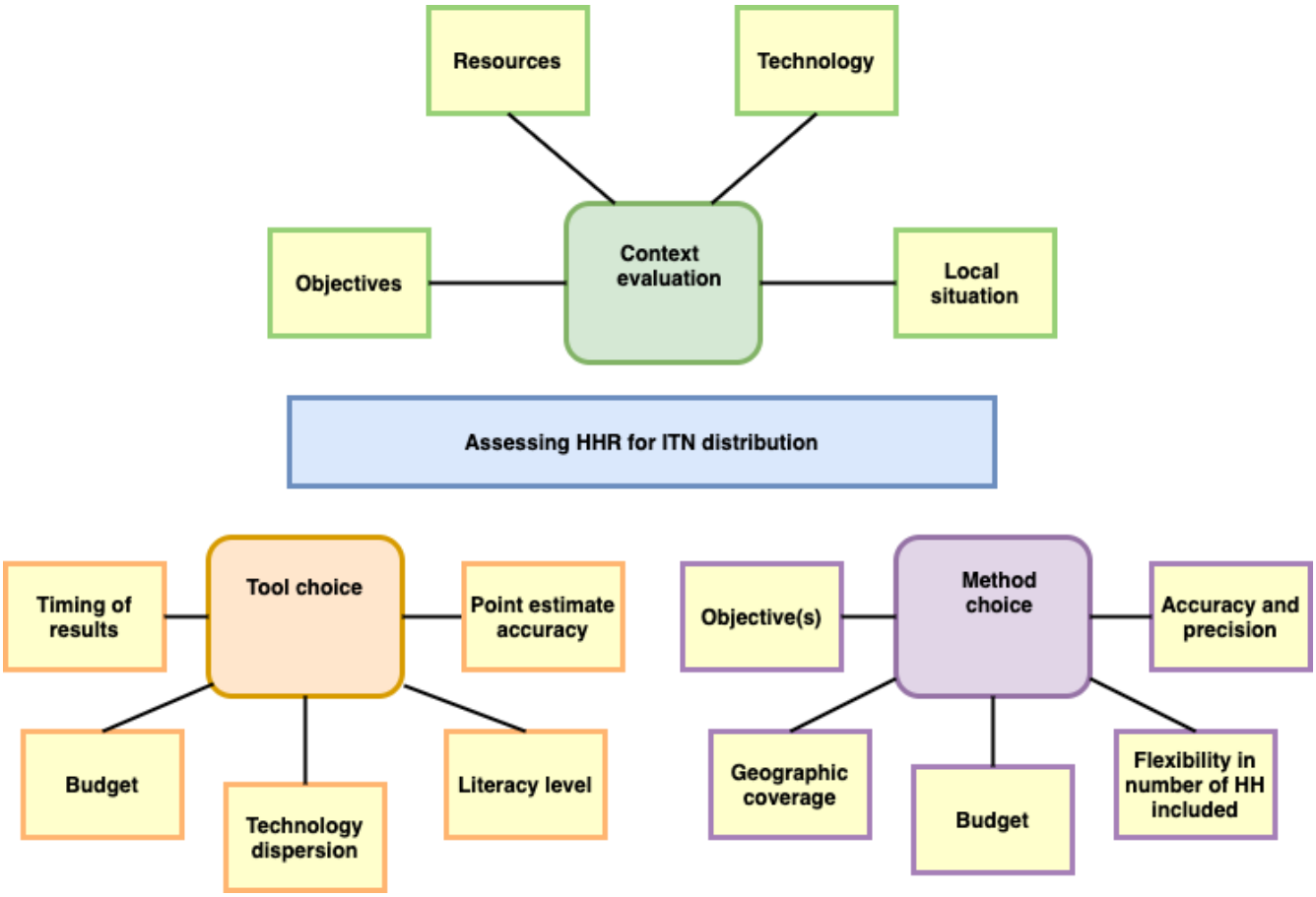
Background

Insecticide-treated net (ITN) use is a key intervention to prevent malaria, and household registration (HHR) has been demonstrated to be the most important factor in households receiving any net or a sufficient number of nets from mass ITN distribution campaigns to achieve universal coverage targets[1]. Assessing the quality of the household registration is a critical activity for national malaria programmes as it will allow them to ensure that all households targeted have been reached, have been registered correctly and received a voucher (where this is the strategy) and will inform any needs for mop-up activities in advance of the ITN distribution to ensure high ITN access is achieved through the campaign.

This document will guide national malaria programmes and their partners in:

1. Assessing key aspects of the context of the planned HHR
2. Choosing the most appropriate HHR assessment tool
3. Deciding on the most appropriate sampling method

[1] Zegers de Beyl C, Koenker H, Acosta A, Onyefunafoa EO, Adegbe E, McCartney-Melstad A, et al. 'Multi-country comparison of delivery strategies for mass campaigns to achieve universal coverage with insecticide-treated nets: what works best?' Malar J. 2016;15:58.



Context evaluation

The first step in planning to assess the completeness and accuracy of HHR during ITN campaigns is to define the key aspects of the context of the assessment. The information gathered in this context evaluation is essential for identifying the most appropriate tool and sampling method to use in assessment of the quality of HHR.

Objectives

- **Who** – is the motivator for assessment of the quality of HHR: a donor or partner request, or is it internally motivated?
- **What** – is the focus on assessing the quality of HHR: completeness, accuracy or both?
- **When** – are results needed: during HHR, after HHR but before ITN distribution, or prior to a future campaign to inform better HHR in the future?
- **Where** – are results needed: at the national or subnational level? Are certain areas or populations targeted for the HHR assessment for specific reasons or past experiences?
- **Why** – is the assessment done: to ensure quality of programme implementation/return on investment (ROI), improve HHR procedures for present and/or future campaigns, or both?

Resources

- Is a dedicated budget available for assessment of the quality of HHR? How much is this budget? If not, can funding be reprogrammed for this activity? How much?

- Are resources available for assessment of the quality of HHR – printers for paper data collection, phones/tablets for digital data collection, data collection or analysis software already purchased by national malaria programmes or partners, computers for data entry/analysis?
- What skills do staff available to plan and implement the assessment (including those to be involved in developing the protocol or overseeing or conducting the assessment) already have? Literacy, experience with technology and survey methods?
- What are the available sampling frames (including sampling frame used for microplanning or planning of HHR team deployment and any other estimates of the target population available from other programmes, household surveys, or censuses)?

Technology

- What is the coverage and reliability of the internet network in the area of interest? (note: World Bank provides national level data on percentage of population using the internet)[2]
- What is the coverage and reliability of the cellular network in the area of interest?
- What is the penetration of mobile phones? (note: in some countries, the most recent Demographic Health Survey [DHS] collected data on whether female respondents own a mobile phone)[3]
- What is the penetration of smartphones?

Contextual factors/local situation

- What other partners are working on malaria control or other programmes requiring HHR in the area of interest? What are the preferred tools or methods employed by these partners for assessment of the quality of HHR ?
- Are there any gender considerations around assessment of the quality of HHR assessment in the area of interest? Should HHR assessment teams of a certain gender be employed? Should household contacts of a certain gender be sought out?
- What is the definition of a "household" used during the HHR? How are they defined? By household surveys or censuses conducted in the area of the HHR assessment or through an operational definition adopted for the purposes of the campaign?

Tool choice

The second step in planning to assess HHR completeness and accuracy is choosing the tool or tools to be used. A matrix has been developed to support tool selection (Appendix A, Excel file).

In Appendix A, available tools have been categorized into the following paper data collection options, which differ in how data are entered digitally:

- Decentralized data entry (MeasureSMS, community-based data collection)
- Centralized data entry (Excel, Access, specific DHIS2 instances)

Direct digital data collection tool categories include the following, which differ both in how data are collected and by cost:

- Telephone Audio Computer Assisted Self Interview (TACASI) (various TACASI providers)
- Free, open-source smartphone/tablet data collection (various tools)
- Fee-based smartphone/tablet data collection (various tools)

[2] https://data.worldbank.org/indicator/IT.NET.USER.ZS

[3] Rotondi V, Kashyap R, Pesando LM, Spinelli S, Billari FC (2020). 'Leveraging mobile phones to attain sustainable development'. PNAS June 16, 2020. 117 (24) 13413-13420.

On the basis of your assessment of the quality of HHR context evaluation results, you will be asked to provide scores for the following five criteria. Scores can range from zero to five, with zero indicating that the criterion is not relevant to your situation and five indicating it is the most relevant or important factor to consider. Each criterion should be considered independently, such that the same score can be indicated for multiple criteria as appropriate (i.e. all five criteria can have the same score or different scores).

- **Need same/next day results** – the importance of having HHR assessment results in real- or almost real-time to guide improvements to ongoing HHR or correct HHR estimates prior to ITN distribution; a score of five means that having same or next-day results from the HHR assessment is a top priority.
- **Budget size** – the level of budget available, or able to be reprogrammed if planning takes place early enough, for HHR assessment; a score of five means the budget is available and sufficient for HHR assessment.
- **Level of technology dispersion/access** – availability of internet, mobile phones and/or smartphones in the area where the HHR assessment will take place; a score of five means that there is sufficient access to internet, mobile phones and/or smartphones in the HHR quality assessment area to collect data or to obtain reliable population estimates using telephone surveys. Research[4,5,6] has shown population estimates derived from mobile phone survey data in countries with mobile penetration at or above 75 per cent can be broadly representative of the population with proper weighting, while populations with lower mobile penetration produce progressively less reliable estimates.
- **Need low-literacy solution** – the degree to which low-literacy solutions will be needed for assessing the quality of HHR; a score of five means that finding a low-literacy solution is essential to the success of the HHR assessment.
- **Need accurate point estimates** – the importance of having accurate, reliable point estimates of HHR coverage and accuracy; a score of five means accurate point estimates are a top priority.

A total score will be automatically calculated for each tool category, with the highest score indicating the tool category suggested for use in your assessment of the quality of HHR. The choice of a specific tool within the indicated category should be driven by context evaluation results. For instance, hardware and software that have already been purchased or used by the national malaria programme or other planning partners are a good choice, as staff will already be familiar with them, and purchase costs will be mitigated or eliminated.

Method choice

The final step in planning to assess HHR completeness and accuracy is choosing the sampling strategy to use. A matrix similar to the one created for aiding tool choice has been developed to support sampling method selection (Appendix B, Excel file).

In Appendix B, potential sampling strategies have been categorized as follows:

- Simple random sampling (randomly selecting households from the entire population included in HHR without any stratification)
- Convenience sampling (for example, easiest households to reach geographically – closest to main roads, etc.)

[4] Sibai AM, Ghandour LA, Chaaban R, Mokdad AH (2016). 'Potential use of telephone surveys for non-communicable disease surveillance in developing countries: evidence from a national household survey in Lebanon'. BMC Med Res Methodol 16**,** 64. https://doi.org/10.1186/s12874-016-0160-0

[5] Leo B, Morello R, Mellon J, Peixoto T, Davenport S (2015). 'Do mobile phone surveys work in poor countries?' CGD Working Paper 398. Washington, DC: Center for Global Development. http://www.cgdev.org/publication/do-mobile-phone-surveys-work-poor-countries-workingpaper-398

[6] L'Engle K, Sefa E, Adimazoya EA, Yartey E, Lenzi R, et al. (2018) 'Survey research with a random digit dial national mobile phone sample in Ghana: Methods and sample quality'. PLOS ONE 13(1): e0190902. https://doi.org/10.1371/journal.pone.0190902

- Easy access group sampling (includes antenatal care clinics [ANC] or school surveillance)
- Purposeful sampling (includes enhanced supervision of lots or clusters with poor previous HHR performance or that are suspected to have performed poorly in HHR being assessed)
- Random digit dialling (paired with TACASI tool)
- Fixed percentage sampling (selection of a fixed percentage of the population covered by the HHR; includes Against Malaria Foundation [AMF] 105 per cent monitoring)
- Multi-stage probability sampling cluster surveys (includes 2018 guidance on expanded programme on immunization [EPI] cluster surveys)
- "Classic" lot quality assurance sampling (LQAS) with lot-level corrective action (classifies HHR completeness and/or accuracy as appropriate or not and takes any corrective action at the lot level)
- "Clustered" LQAS with cluster-level corrective action (classifies HHR completeness and/or accuracy as appropriate or not and takes any corrective action at the lower cluster level; includes third day delay method)

A more in-depth description of each methodological category and its strengths and weaknesses is provided in the next section.

On the basis of your HHR quality assessment context evaluation results, you will be asked to provide scores for the following eight criteria. As with the tool selection matrix, scores for each criterion can range from zero to five, with zero indicating the criterion is not relevant to your situation and five indicating it is the most relevant or important factor to consider. Each criterion should be considered independently, such that the same score can be indicated for multiple criteria as appropriate (i.e. all eight criteria can have the same score or different scores).

- **Need to assess completeness** – the importance of assessing whether all eligible households were enumerated during HHR; a score of five means that assessing HHR completeness is a top priority.
- **Need to assess accuracy** – the importance of assessing whether actual numbers of sleeping spaces or residents were recorded correctly for each household enumerated during HHR; a score of five means assessing HHR accuracy is a top priority.
- **Need results during HHR** - the importance of having results while the HHR is ongoing to guide improvements to HHR or correct HHR estimates prior to ITN distribution; a score of five means that having results prior to the end of HHR is a top priority.
- **Need to cover a large geographic area** – the importance of assessing HHR quality across a large geographic area; a score of five means that the area where HHR is to be assessed is very large.
- **Budget size** – the level of budget available, or able to be reprogrammed, for HHR quality assessment; a score of five means the HHR assessment budget is available and sufficient.
- **Need flexibility on number of households included** – the importance of being able to choose the number of households to be included in the HHR assessment; a score of five means having the flexibility to include a larger or smaller number of households is a top priority.
- **Need accurate point estimates** – the importance of having accurate, reliable point estimates of HHR coverage and accuracy; a score of five means accurate point estimates are a top priority.
- **Need higher precision** – the importance of having narrow confidence intervals or low variance around estimates of HHR coverage and accuracy, which could be helpful when comparing HHR assessments over time or between programmes or locations; a score of five means higher precision is a top priority.

A total score will be automatically calculated for each method category, with the highest score indicating the method category suggested for use in your HHR assessment. The choice of a specific method within the indicated category should be driven by context evaluation results. It might be helpful, for instance, to draw on resources like staff, data, hardware or software available from other programmes or initiatives that may have recently conducted an HHR in the same area for other purposes.

Method definitions, strengths and weaknesses

Simple random sampling

Summary: Random, non-stratified sampling of households to assess HHR.
Strengths: Can reduce the time needed to develop the sampling strategy when compared with stratified randomized or systematic sampling strategies and allows sight validation of numbers of sleeping spaces or household members.
Weaknesses: Requires large numbers of households to achieve representative sample of all households covered by HHR, which can greatly increase costs, particularly if there is a need to cover a large geographic area. Will not provide accurate or precise estimates without very large sample sizes.
Risk of bias: Bias may be an issue if households try to demonstrate inflated numbers of sleeping spaces or inhabitants to justify inflated numbers of ITNs allocated during HHR.
Recommendation: This sampling method is not recommended.

Convenience sampling

Summary: Non-random, non-systematic sampling of a convenient set of households to assess HHR. For example, selection of households closest to HHR quality assessment team homes or in more accessible areas.
Strengths: Can reduce travel costs for HHR assessment teams and eliminate time needed to develop and implement a randomized or systematic sampling strategy. Allows sight validation of numbers of sleeping spaces or household members.
Weaknesses: Results in a sample of households unlikely to be representative of all households enumerated in the HHR, reducing accurateness of estimates of both HHR completeness and accuracy. Likely smaller number of households leads to lower precision and difficulty covering a large geographic area.
Risk of bias: Estimates of HHR completeness or accuracy may be biased if accessible households were also more likely to have been enumerated during the HHR, or if households closer to the homes of HHR assessment team were more accurately assessed for sleeping spaces or inhabitants because the HHR assessment team was already familiar with these households (selection bias). Bias may also be an issue if households try to demonstrate inflated numbers of sleeping spaces or inhabitants to justify inflated numbers of ITNs allocated during HHR.
Recommendation: This sampling method is not recommended.

Easy access group sampling

Summary: Collection of information from students or pregnant women on whether an HHR team visited their households during the HHR being assessed, and whether the HHR team accurately captured the number of individuals or sleeping spaces in the household.
Strengths: Can cover a large geographic area and include many households, increasing precision of results. May approximate random or systematic sampling of households with a member attending classes, schools or ANC clinics in the area of the HHR assessment and result in accurate point estimates, particularly of less complex indicators such as HHR completeness, under certain circumstances. Research[7] has shown that schoolchildren's report of bed net use can give a good approximation of household ownership of ITNs with high rates of school/ANC attendance, dedicated time for surveys during regular school day/clinic visit in season with highest attendance, effective training of teachers/clinic staff administering surveys and inclusion of appropriate questions. It is lower cost than large-scale HHR assessment by HHR assessment teams.

[7] Ndyomugyenyi R, Kroeger A (2006). 'Using schoolchildren's reports of bed net use monitored by schoolteachers as a proxy of community coverage in malaria endemic areas of Uganda'. Trop Med Int Health. 2007 Feb;12(2):230-7. doi: 10.1111/j.1365-3156.2006.01767.x

Weaknesses: Schoolchildren may not be accurately informed about whether their household has been registered and are likely to be unable to report data related to HHR accuracy. The time required to train teachers or clinic staff to collect data or to interview sufficient numbers of students or pregnant women is likely too long to permit rapid decision-making during a campaign. Training is likely to take time away from school lessons/clinic visits, and it may take more time to collate results (due to high numbers of classes/clinics involved and likely paper data collection). Often difficult to define catchment area for schools/ANC clinics and may require additional questions and data manipulation to identify particular villages with poor registration. Does not allow for sight validation of numbers of sleeping spaces or household members.
Risk of bias: May lead to biased estimates of HHR completeness if households that are harder-to-reach and less likely to be enumerated are also less likely to have members attending school/ANC clinic (selection bias). Estimates may also be biased if students'/pregnant women's responses are modified to be more socially acceptable or "correct" (observer bias). It is also possible that respondents will more accurately recall whether they had been visited but less accurately recall counts of sleeping spaces or household members from the HHR, a possibility that increases as time between the HHR and its assessment increases (recall bias).
Recommendation: May be a lower-cost option if focus is on assessing HHR completeness, and if area to be assessed has very high school and/or ANC clinic attendance and similar data are routinely gathered from these groups.

Purposeful sampling

Summary: Non-random, non-systematic sampling of households based on certain characteristics. An example is enhanced supervision including assessment of HHR completeness and efficacy, clusters or sampling units believed to be at higher risk for poor HHR due to past performance or other indicators.
Strengths: May be less expensive and faster than other in-person surveys because fewer households are assessed. If clusters, or sampling units, are correctly identified to be at high risk of poor HHR it can quickly identify likely issues during HHR, allowing for mid-HHR correction. Allows sight validation of numbers of sleeping spaces or household members.
Weaknesses: The resulting sample is not representative of all households enumerated in the HHR, reducing reliability of estimates of both completeness and accuracy. A smaller number of households leads to lower precision.
Risk of bias: May lead to biased estimates of HHR completeness and accuracy if the high-risk clusters or sampling units assessed demonstrate lower HHR completeness and accuracy than the entire population of households to be enumerated in the HHR (selection bias). Bias may also be an issue if households try to demonstrate inflated numbers of sleeping spaces or inhabitants to justify inflated numbers of ITNs allocated during HHR.
Recommendation: May be a faster and lower-cost option if poor HHR performance is strongly suspected in certain areas and the objective of your assessment is to improve HHR during enumeration and/or ensure more accurate estimates of ITN needs prior to ITN distribution. Not a good option for assessing overall HHR completeness or accuracy.

Random digit dialling

Summary: Random selection of final digits of phone numbers in the area of interest to call for collection of data on HHR completeness and accuracy using TACASI tools.
Strengths: Significantly less expensive and potentially faster than in-person surveys. Can increase number of households assessed for little additional cost, improving precision of HHR coverage and accuracy estimates, and may avoid responses meant to please interviewers. Research[8] indicates good accuracy for simple indicators, like whether a household has at least one ITN, and statistical methods like post-stratification and

[8] Yukich J, Elisaria E, Wisneiwski J, Worges M, Festo C, Mrema J (2018). 'Mobile phone monitoring of malaria vector control coverage: Technical Report' (MOMOVEC Study Report).

raking[9] (procedures to adjust sample weights to reproduce known population distributions of characteristics like age, sex, and socioeconomic variables, resulting in a closer match between the sample and the population of interest) can be employed to account for non-response.
Weaknesses: The resulting sample is unlikely to be representative of all households enumerated in the HHR, which would bias estimates of both completeness and accuracy. Requires sufficient mobile phone penetration and network coverage in the area of interest. Research[7] indicates less accuracy for more complex indicators, such as numbers of ITNs or sleeping spaces. Is subject to key-pad response entry errors, and calls are often not completed, resulting in more missing data. Analysis is complex. Does not allow sight validation of numbers of sleeping spaces or household members. Data collection can take two to four weeks, depending on required sample size, and it is difficult to target particular regions.
Risk of bias: May lead to biased estimates of HHR completeness and accuracy if respondents are more likely to have been enumerated in the HHR or to have more stable households or sleeping arrangements than non-respondents (selection bias). It is also possible that respondents will more accurately recall whether they had been visited but less accurately recall counts of sleeping spaces or household members from the HHR, a possibility that increases as time between the HHR and its assessment increases (recall bias).
Recommendation: The most feasible option when low/no budget available, particularly when a large geographic area must be covered, but sufficient mobile phone penetration and mobile network coverage are required in the area to be assessed. A good option for assessing HHR completeness under these conditions, less reliable for assessing HHR accuracy.

Fixed percentage sampling

Summary: Sampling of a percentage of HHs enumerated in HHR for assessment of HHR completeness and accuracy, such as in AMF 105 per cent monitoring. Can employ different sampling methods including random, purposeful, convenience and multi-stage sampling and can be used to both measure and classify coverage.
Strengths: Sampling method is flexible and intuitive and allows sight validation of numbers of sleeping spaces or household members, facilitating assessment of HHR coverage and accuracy. Allows inclusion of large numbers of households if HHR covered a large number of HH, increasing precision of HHR coverage and accuracy estimates, and may cover large geographic area depending on sampling scheme.
Weaknesses: May be significantly more expensive and time-consuming for assessment of HHR when compared to other sampling methods, as there is no flexibility in the number of households to be assessed, resulting in larger samples for larger HHR populations. Lack of specification of sampling strategy means simple random sampling can be used, resulting in a sample that is unlikely to be representative of the original HHR, particularly when large numbers of households were enumerated, reducing accurateness of estimates of both HHR completeness and accuracy.
Risk of bias: If original HHR covered large geographic area with low population density, simple random sample of five per cent or lower of households enumerated could result in a sample that is not representative of the entire area of interest (i.e. some areas could be left out entirely), leading to biased estimates of HHR completeness and accuracy if either high or low performing areas are excluded (selection bias). Bias may also be an issue if households try to demonstrate inflated numbers of sleeping spaces or inhabitants to justify inflated numbers of ITNs allocated during HHR.
Recommendation: This option is likely the most expensive at five per cent and only possible with a large available budget for HHR quality assessment. It is not recommended when assessment of HHR completeness is a key objective, as a percentage of enumerated households are revisited, and missed households would thus not be identified. It may be appropriate when the key objective is instead to assess HHR accuracy. Costs can be decreased by choosing lower fixed percentages (i.e. two or one per cent), but simple random sampling of such

[9] Deville, J. C., Särndal, C. E., & Sautory, O. (1993). 'Generalized raking procedures in survey sampling'. Journal of the AmericanstatisticalAssociation, 88(423), 1013-1020.

small percentages would be more likely to result in a non-representative sample, leading to biased estimates of HHR completeness or accuracy.

Multi-stage probability sampling cluster surveys

Summary: Probability proportionate to size (PPS) sampling of larger sampling units, or clusters, followed by further PPS sampling of smaller sampling units and, finally, of HH. Subsequent analyses are weighted to account for the probability of selection, resulting in a random sample. This category includes the sampling methods recommended in the 2018 update to the EPI cluster survey methodology. Previously EPI recommended surveys of 30 clusters each containing seven respondents, with assessment teams selecting HHs to include by standing in the centre of a cluster and spinning a bottle to determine a direction in which to walk to start systematically sampling HHs until reaching seven respondents, and analyses that were assumed to be self-weighting. The 2018 update is assumed throughout this document, as it accounts for PPS by weighting analyses and avoids the sampling bias inherent in spin the bottle sampling, where more central HHs more likely to be sampled may have also been more likely to have been enumerated during the HHR.
Strengths: Can accurately assess both HHR completeness and accuracy with a high level of precision due to selection of a sample representative of the population where HHR was conducted. Allows sight validation of numbers of sleeping spaces or household members, can cover a large geographic area, and allows flexibility in choosing numbers of clusters and households within clusters to power the assessment of different research questions.
Weaknesses: Is more costly and time consuming than methods that do not involve HHR assessment teams revisiting households. Is not as intuitive as some other methods and requires complex weighted analyses.
Risk of bias: Bias may be an issue if households try to demonstrate inflated numbers of sleeping spaces or inhabitants to justify inflated numbers of ITNs allocated during HHR.
Recommendation: If budget is available for this option, it is effective in producing accurate and precise estimates of HHR completeness and accuracy over a large geographic area and allows flexibility in the numbers of clusters and households included to power the assessment to respond to different research questions.

"Classic" LQAS with lot-level corrective action

Summary: Developed in industry, lot quality assurance sampling (LQAS) uses random sampling to classify adequate HHR completeness and accuracy at the level of the sampling unit called a "lot"[10]. Planners can specify the desired sample size and must decide on limits for lots to be considered adequate in terms of HHR completeness and accuracy. In this case, HHR completeness and accuracy is evaluated and corrective measures, such as re-registration, are taken at the lot level. As an example, each district might be treated as a "lot", with e.g. 19 households randomly selected within the district, and a pass/fail threshold set at an upper level of 80 per cent. A lower threshold is set at a level that should not go undetected (e.g. of 50 per cent). This sample size of 19 is small but provides at least 90 per cent sensitivity and 90 per cent specificity for the results.
Strengths: Can classify lots as having adequate or inadequate HHR completeness and accuracy quickly and at lower cost than other methods involving HHR assessment teams, allowing rapid intervention at lot level to obtain more accurate HHR results prior to ITN distribution. Can cover a large geographic area and allows sight validation of numbers of sleeping spaces or household members in each HH. Also allows flexibility in the number of stages, lots, clusters and households included in order to power assessment of various research questions.
Weaknesses: Does not provide point estimates of HHR completeness and accuracy. Sampling method is not as intuitive as other methods, and classification of lots depends heavily on thresholds set for adequate HHR completeness and accuracy. Random selection of 19 households usually requires visiting of 19

[10] https://pdf.usaid.gov/pdf_docs/PNACN935.pdf

villages/communities/settlements. Results from different lots should be reported individually (and not combined) if lots are not selected using probability sampling.
Risk of bias: The selection of lots, clusters and households must each be done randomly (not via convenience sampling) to avoid selection bias. Bias may be an issue if households try to demonstrate inflated numbers of sleeping spaces or inhabitants to justify inflated numbers of ITNs allocated during HHR.
Recommendation: Fast, less expensive method to evaluate a representative sample of the HHR population using HHR assessment teams. Recommended for situations where HHR quality assessment aims to inform more accurate enumeration figures prior to ITN distribution. This 19-household method LQAS will not provide point estimates unless 10 or more lots are combined (if lots were selected using probability sampling). Generally, 200—300 households are needed to get point estimates with confidence intervals of plus or minus 10 per cent or narrower.

"Cluster" LQAS with cluster-level corrective action

Summary: "Cluster" LQAS uses multi-stage random sampling to select households instead of simple random sampling of households in the 19-household "classic" method described in the section above. The results from the "classic" and "cluster" LQAS are of the same type i.e. pass/fail or classification for each lot. Different number of clusters and households per cluster can be used to adjust the sensitivity and specificity of the classification scheme. However, the most commonly used version of the cluster LQAS by WHO uses six clusters of ten households per cluster (60 households total) and a three-level classification system (pass with greater than 90 per cent coverage, intermediate with 80—90 per cent coverage and fail with less than 80 per cent coverage). Similar to the "classic" method, indicators are evaluated and corrective measures, such as re-registration, are taken at the lot level. Third day delay is a particular instance of this method where HHR is paused on the third day to allow lots to be classified as adequate or not based on the first two days of assessment data, allowing immediate corrections at the cluster level to the HHR process. As an example, six clusters may be randomly selected within a district, and 10 households per cluster randomly selected and interviewed. Results from the six clusters can be combined to produce an overall district point estimate of coverage.
Point estimates and confidence intervals from LQAS. Point estimates and confidence intervals can be calculated for a sampling frame if the lots are selected with probability sampling and the number of households is at least 200—300. With a sample of 200 households, confidence intervals of plus or minus 10 per cent are usual when the design effect of the indicator is 2.0. Therefore, confidence intervals will be practical (plus or minus 10 per cent or less) if four clusters of six by ten LQAS lots are combined (total of 240 households). For example, if one cluster of six by ten LQAS lot is done in all four districts in one region, then point estimates and confidence intervals can be calculated for the region.
As in the "classic" version, the results of lots selected with purposeful or convenience sampling should be reported individually and should not be combined with those lots selected with probability sampling or with other lots selected with purposeful or convenience sampling.
Strengths: Can classify clusters as having adequate or inadequate HHR completeness and accuracy more quickly than with classic LQAS and at lower cost than other methods involving HHR assessment teams. Travel time is reduced (e.g. six locations versus 19 in the classic LQAS example) within the district. Can cover a large geographic area and allows sight validation of numbers of sleeping spaces or household members in each HH. Also allows flexibility in the number of stages, lots, clusters and households included in order to power assessment of various research questions. This method also produces meaningful point estimates and confidence intervals at the higher level (in this example, at district level). Therefore, this LQAS method can provide "pass/fail" results at the district or sub-district level and point estimates and confidence intervals at

district or higher levels. Another strength is that a complete WHO field manual is available[11] that allows national programmes to conduct the method without the need for consultants.
Weaknesses: Does not provide point estimates of HHR completeness and accuracy at the lot level. The classification of clusters depends heavily on thresholds set for adequate HHR completeness and accuracy. A statistician may need to be consulted if national programmes want to change the break points (i.e. greater than 90 per cent, 80—90 per cent, less than 80 per cent) for the three-level classification schema in the WHO manual.
Risk of bias: The selection of lots, clusters and households must each be done randomly (not via convenience sampling) to avoid selection bias. Bias may be an issue if households try to demonstrate inflated numbers of sleeping spaces or inhabitants to justify inflated numbers of ITNs allocated during HHR.
Recommendation: Fastest, least expensive (even faster and less expensive than LQAS with lot-level corrective action) method to evaluate a representative sample of the HHR population using HHR quality assessment teams. Recommended for situations where HHR quality assessment aims to inform more accurate enumeration figures prior to ITN distribution, particularly when results are needed quickly and when the budget is more limited. Not recommended for HHR quality assessments with the objective of providing point estimates of HHR completeness and accuracy at the lot level.

Additional considerations

This guidance for selecting tools and methods for assessing the quality of ITN campaign HHR assumes thorough and correct implementation of methods and use of tools outlined in this guidance. Any deviations from the intended use of the tools and methods chosen can carry additional risks of bias and result in different performance levels than those anticipated in this document. For example, sub-population sampling will not produce accurate point estimates of HHR completeness or accuracy if ANC surveillance is carried out in areas with poor ANC clinic attendance or school surveillance in areas with poor school attendance, just as random digit dialling will not produce accurate estimates if conducted in areas with insufficient mobile penetration or an unreliable mobile network. Any multi-stage cluster sampling methods carried out without using PPS sampling at each stage and appropriate weighting of analyses will result in biased estimates of HHR coverage and accuracy. LQAS methods will only be as reliable as the criteria chosen to classify lots or clusters.

[11] https://polioeradication.org/wp-content/uploads/2016/09/Assessing-Vaccination-Coverage-Levels-Using-Clustered-LQAS_Apr2012_EN.pdf