Mortality data collection via mobile phone surveys:

opportunities and challenges

RaMMPS

Rapid Mortality Mobile Phone Surveys

ACKNOWLEDGEMENTS

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CORRESPONDENCE

Correspondence about this document can be sent to rammps@lshtm.ac.uk.

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RaMMPS
Rapid Mortality Mobile Phone Surveys

For more information about RaMMPS, please visit: www.lshtm.ac.uk/rammps

Credit (front cover): UNIKIN

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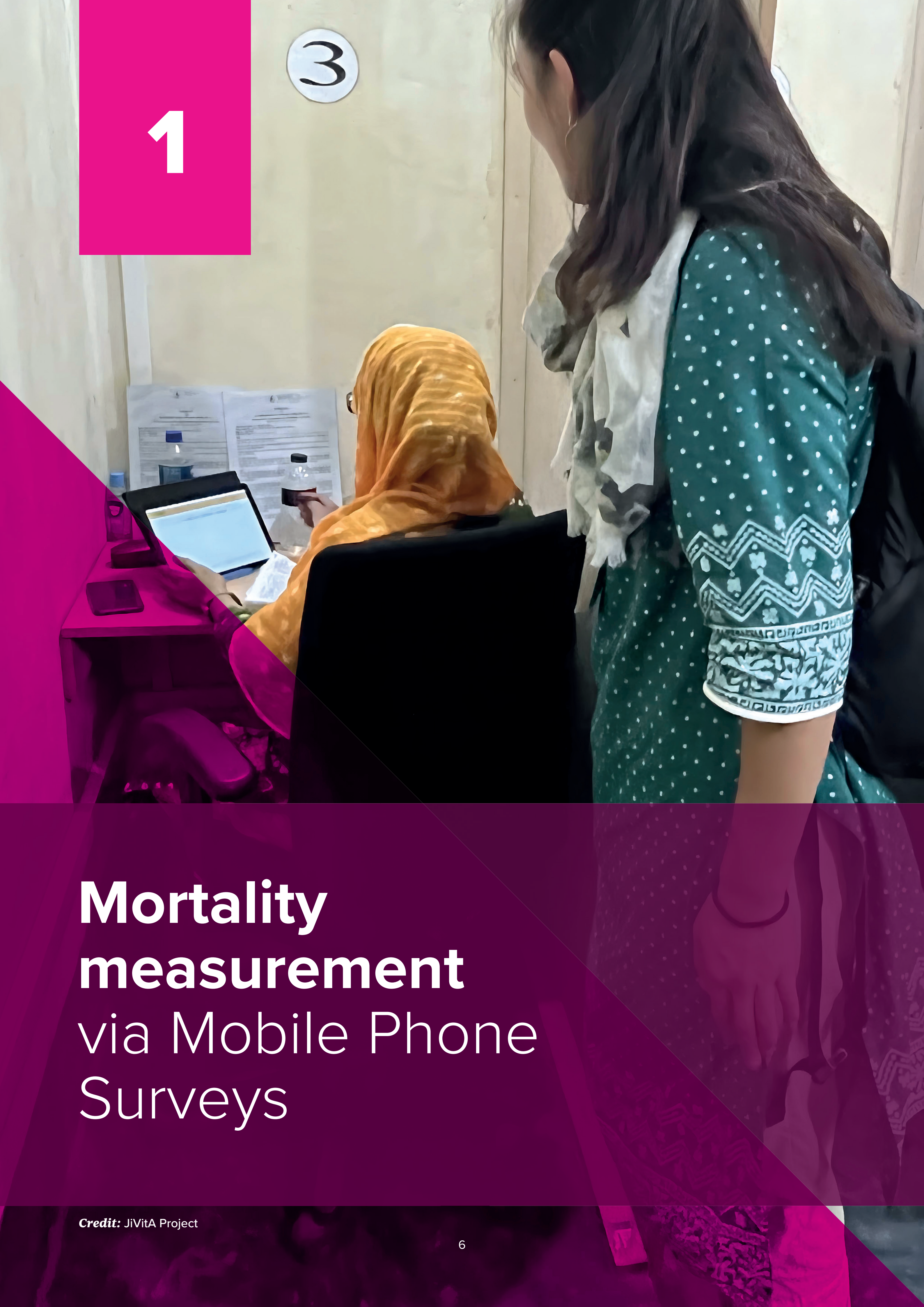
Acronyms and abbreviations

CATI:	Computer Assisted Telephone Interview
COVID-19:	Coronavirus Disease 2019
CRVS:	Civil Registration and Vital Statistics
DHS:	Demographic and Health Survey
DRC:	Democratic Republic of the Congo
EHCVM:	Enquête Harmonisée sur les Conditions de Vie des Ménages
FBH:	Full Birth Histories
FPH:	Full Pregnancy Histories
GSM:	Global System for Mobile communications
HDSS:	Health and Demographic Surveillance System
HIV:	Human Immunodeficiency Virus
ICDDR,B:	International Center for Diarrheal Diseases, Bangladesh
IEDCR:	Institute of Epidemiology Disease Control and Research
INS:	Instituto Nacional de Saúde Mozambique
INSD:	Institut National de la Statistique et de la Démographie
IPOR:	Institute of Public Opinion Research
ISSP:	Institut Supérieur des Sciences de la Population
IVR:	Interactive Voice Response
LMIC:	Low and Middle Income Country
LSHTM:	London School of Hygiene and Tropical Medicine
LSMS:	Living Standards Measurement Study
MEIRU:	Malawi Epidemiology and Intervention Research Unit
MICS:	Multiple Indicator Cluster Survey
MPS:	Mobile Phone Survey
NYU:	New York University
PHC:	Population and Housing Census
PHIA:	Population-Based HIV Impact Assessment
PMA:	Performance, Monitoring and Accountability
RaMMPS:	Rapid Mortality Mobile Phone Surveys
RDD:	Random Digit Dialling
SMS:	Short Message Service
SSH:	Sibling Survival Histories
TBH:	Truncated Birth Histories
TPH:	Truncated Pregnancy Histories
U5MR:	Under-five Mortality Rate
UClouvain:	Université Catholique de Louvain
UNICEF-USA:	US Fund for UNICEF (United Nations Children's Fund)
UN-IGME:	United Nations Inter-agency Group for Child Mortality Estimation
UNIKIN:	University of Kinshasa
USAID:	United States Agency for International Development
WHS:	World Health Survey
WPP:	World Population Prospects



1

Mortality measurement via Mobile Phone Surveys

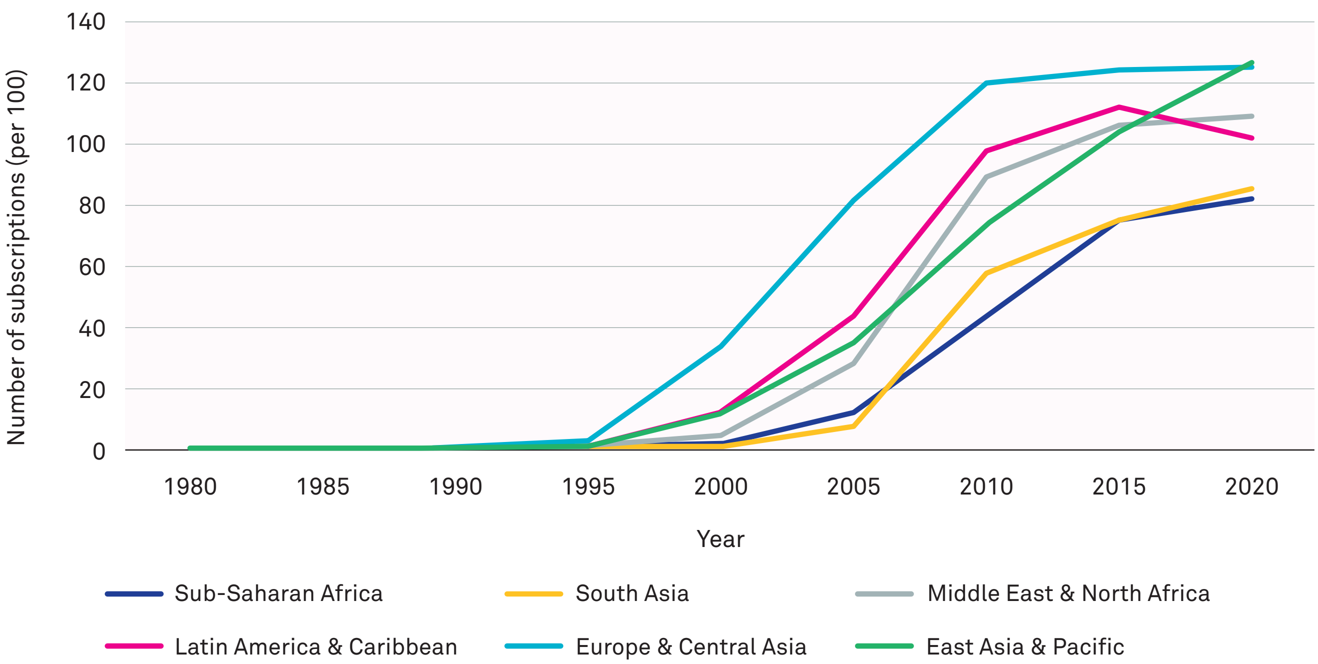
Credit: JiVitA Project

Mobile Phone Surveys (MPS) offer an alternative to face-to-face surveys for mortality data collection, and are useful when in-person fieldwork is hindered or considered too costly. This report covers the feasibility of mortality MPS, and highlights a number of specific methodological and practical considerations in their design and administration.

As the penetration of mobile phones around the world increases *(Figure 1)*, so does the prospect of using them as a modality for administering surveys (Leo et al. 2015). The Ebola and Covid-19 outbreaks provided the impetus to investigate the use of mobile phones for mortality monitoring because of the need for timely and high-quality mortality data. This is especially relevant for Low and Middle Income Countries (LMICs) because the data architecture to estimate the (mortality) impact of these outbreaks were either not available or of questionable quality (Msemburi et al. 2023).

A performant Civil Registration and Vital Statistics (CRVS) system is the gold standard for generating timely, accurate and continuous vital statistics, but in many LMICs these systems have not reached the level of performance to fulfil that function (Lopez et al. 2020). In those settings, mortality estimates are derived from population censuses, household surveys and sample registration systems. However, during the Covid-19 pandemic, face-to-face data collection was often interrupted, demonstrating that such methods are highly vulnerable during crises, just when mortality monitoring is crucial to assess impact and to inform effective policy responses (DHS Program 2020; MICS undated). MPS are also easier and cheaper to implement, but our experience with mortality MPS is limited and there remain unresolved methodological questions concerning acceptability, sample selection

Figure 1: **Mobile cellular subscriptions per 100 people, by region**



Notes: This graph illustrates the number of subscribers per 100 individuals and is sometimes also referred to as the mobile phone penetration rate. This indicator can exceed 100, and is to be distinguished from the mobile phone ownership rate, defined as the fraction of individuals who own a mobile phone. Source: https://data.worldbank.org/indicator/IT.CEL.SETS.P2 bias, and data quality more generally. Some of these questions are addressed in other guides for the design and implementation of MPS (Dabalen et al. 2016; Henderson et al. 2020; The World Bank 2020; Gourlay et al. 2021). Our aim is to complement these resources with a specific focus on MPS for mortality data collection and estimation. In doing this, we draw heavily from the experience accrued during the first three years of the Rapid Mortality Mobile Phone Surveys project (RaMMPS, *Box 1*).

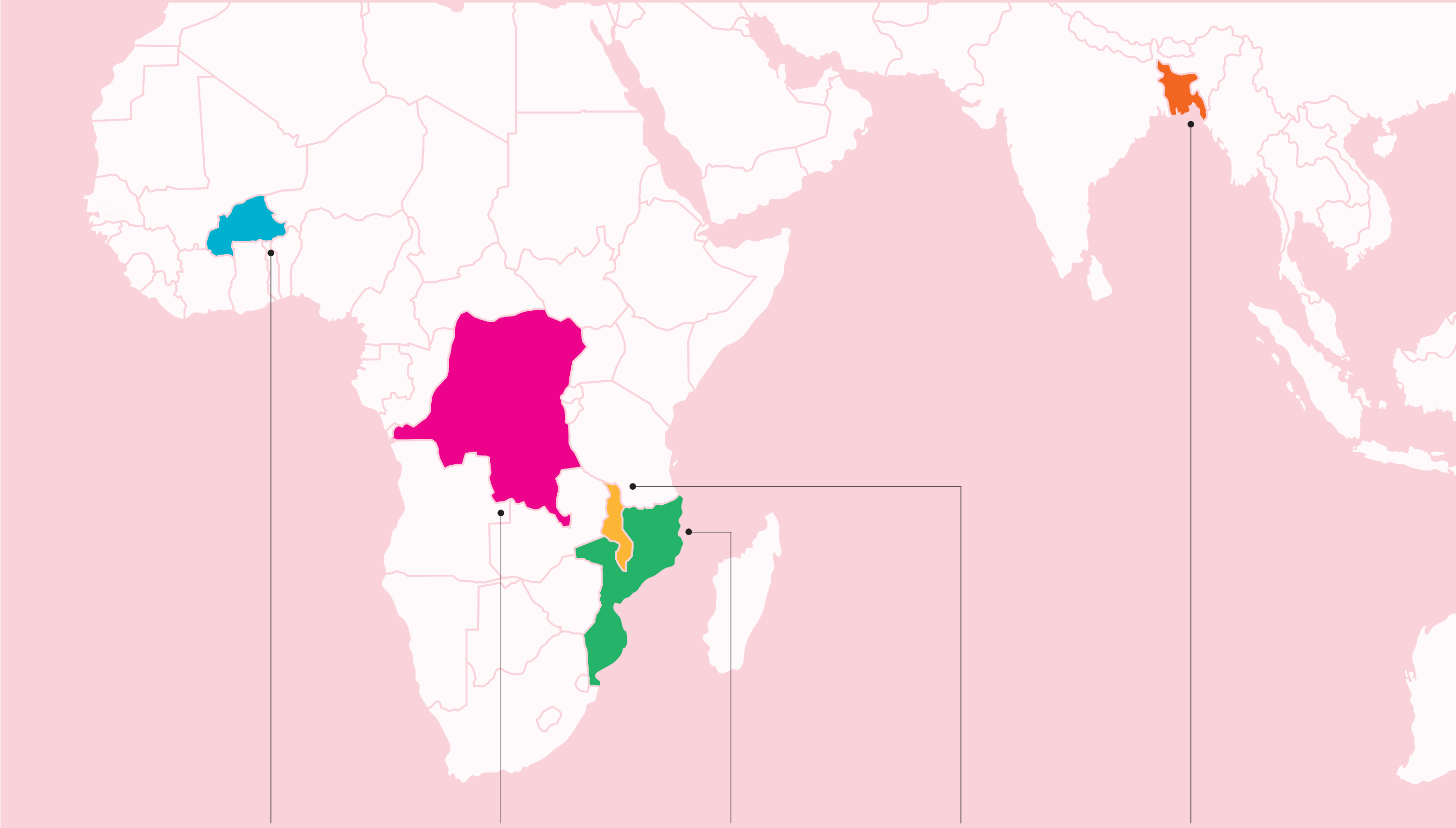
This report covers the acceptability of mortality MPS and highlights a number of gender-specific considerations in their conduct *(Section 2);* sampling strategies, sampling selection bias in mortality MPS estimates, and methods to alleviate bias *(Section 3);* and the survey instruments that can be used to collect mortality data over the phone *(Section 4).*

Credit: Louis Leeson/LSHTM

Box 1: The Rapid Mortality Mobile Phone Surveys (RaMMPS) project

The RaMMPS project was launched in December 2020 as a collaboration between 9 implementing partners supported by the London School of Hygiene and Tropical Medicine, Johns Hopkins Bloomberg School of Public Health, UC Louvain, and New York University – Abu Dhabi. Surveys were implemented in five countries: Bangladesh, Burkina Faso, the Democratic Republic of Congo, Malawi and Mozambique. In most countries, this consisted of a national survey, and a number of validation sub-studies. The overall aim of the project was to develop and apply tools for estimating mortality via MPS. The five RaMMPS shared broad objectives and approach, but also varied in terms of sampling strategy, fieldwork operations and survey instruments. This heterogeneity was intentional to leverage context-specific attributes of each setting and to gain insight into the strengths and weaknesses of the different approaches.

Figure 2: RaMMPS countries and implementing partners



Burkina Faso

- Institut Supérieur des Sciences de la Population (ISSP)
- Institut National de la Statistique et de la Démographie (INSD)

Democratic Republic of Congo

- University of Kinshasa School of Public Health (UNIKIN)

Mozambique

- Instituto Nacional de Saúde (INS)

Malawi

- Malawi Epidemiology and Intervention Research Unit (MEIRU)
- Institute of Public Opinion and Research (IPOR)

Bangladesh

- Institute of Epidemiology Disease Control and Research (IEDCR)
- International Center for Diarrheal Diseases, Bangladesh (icddr,b)
- The JiVitA Project

2

Acceptability, ethics and gender considerations for a mortality MPS

Credit: icddr,b

2.1 ACCEPTABILITY AND EMOTIONAL DISTRESS

Recalling the death of a household member or relative is a potentially distressing topic for a survey interview. In face-to-face data collection, interviewers can ensure that respondents are in an appropriate, quiet and confidential setting, build rapport with respondents, and they can pick up on visual cues indicating when the respondents may be upset and respond accordingly. In an MPS, the enumerator has little control over the circumstances wherein respondents engage with the survey, and visual cues to their emotional state are unavailable. While introducing the study and before seeking the respondents' consent to participate, it is therefore important that enumerators take the time to ensure that respondents are made aware of the possibly unsettling nature of the questions, and of any risks and benefits that may accrue to them or the wider community through their participation.

Role play is a particularly useful tool to train enumerators in various interview scenarios, and to describe the purpose and content of the survey. As is common in research, the consent script should clearly describe the nature of the interview, which in this case should include a statement that the respondent will be asked to recall the details of household members and relatives who have passed away. For example, ***"In our interview, I will ask you information about your household members and close relatives and this will include details about family members who may have passed away. Remembering and discussing the illness and death of relatives may cause feelings of sadness, and you are free to pause or interrupt the interview at any time. If that happens, please do let me know. You can also choose not to answer some of the questions that I will ask you. I can also call you back at a later time if you like, or, refer you to a trained counsellor in case some of the questions that I ask upset you".***

Even after consent has been obtained, it is important to pause between sets of questions to ensure that the respondent is comfortable continuing with the interview given their circumstances. This is illustrated by the following exchange – transcribed from an audio-recorded interview – between an enumerator *(E)* and a 35-year-old female respondent *(R)* in the Malawi RaMMPS. The respondent took the call from her friend's place and once they reached the pregnancy history section of the questionnaire, she asked to complete the interview at a later time.

> **E:** *"Now I would like to ask you about the births and pregnancies that you have had in your life. Eeh, before I do that, I would like to confirm that you are in a place where I can comfortably ask you these questions."*
>
> **R:** *"Aah, – [laughs briefly] – no."*
>
> **E:** *"Eeh!"*
>
> **R:** *"No, ask me those questions another day".*

Credit: icddr,b

During data collection, it is good practice to organise enumerator refresher training and debriefing sessions at regular intervals. This is not only important to ensure data quality, but also to look after the wellbeing of both enumerators and respondents participating in mortality MPS. It is very encouraging, however, that the mortality MPS only rarely triggered negative emotional reactions. In the Malawi RaMMPS, we included a number of debriefing questions at the end of the interview, and over 98 percent of the respondents indicated that the survey questions did not upset them. The acceptability of a mortality MPS was also corroborated in a non-inferiority trial where a mortality survey was compared to a socio-economic survey that did not include questions on mortality *(Box 2)*.

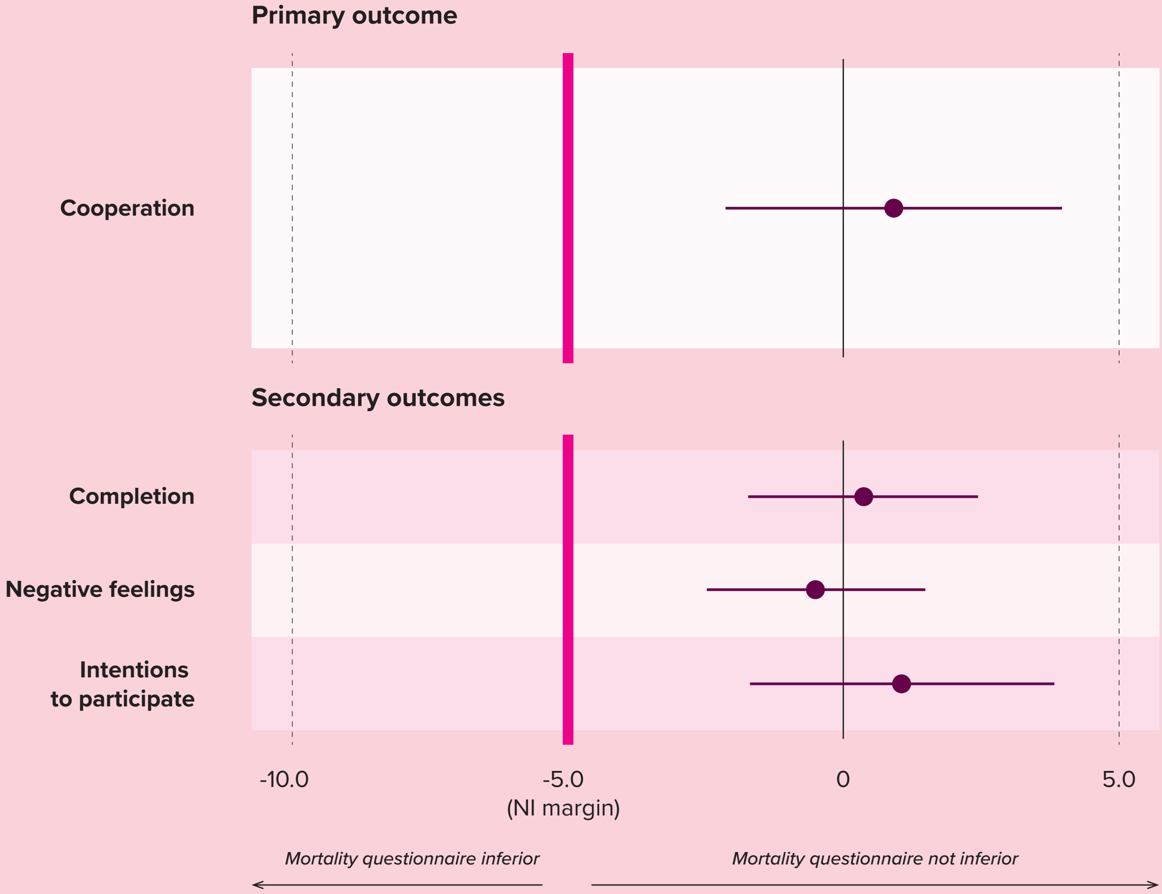
Box 2: Mortality MPS acceptability

Credit: IPOR

To formally establish the acceptability of a mortality MPS, we conducted a non-inferiority trial among a random sample of mobile phone users in Malawi (Chasukwa et al. 2022). In this study, participants were randomly allocated to an interview about their recent economic activity, or a survey on recent deaths in their family. The primary trial outcome was the cooperation rate, or, the number of completed interviews divided by the number of respondents who were invited to participate. Secondary outcomes included self-reports of negative feelings and stated intentions to participate in future interviews. We called more than 7,000 unique numbers and reached 3,054 mobile subscribers. In total, 1,683 mobile users were invited to participate. The remainder were either not eligible or disengaged with the survey during the eligibility screening questions. The difference in cooperation rates between those asked to participate in the mortality survey and those asked to answer questions about economic activity was 0.9 percentage points (95% CI: -2.3, 4.1), which satisfied the non-inferiority criterion *(Figure 3)*.

The frequency of self-reported negative feelings was low (<3 percent), and it was similar for respondents who received the economic and the mortality questionnaires. Respondents who reported a recent death during the interview did, however, experience stronger negative emotions than other respondents, but mostly reported that these had passed by the end of the interview. Psychological support was offered to participants who either self-reported negative feelings during the interview debriefing questions, or, whom interviewers identified as emotionally distressed. The few respondents who chose to speak with the clinical psychologist in the study team did not require further support thereafter.

Figure 3: Differences in study outcomes between mortality and economic questionnaires



Notes: Values of the x-axis are expressed in percentage points. They are calculated as the percent in the group allocated to the mortality questionnaire, minus the percent in the group allocated to the economic questionnaire. Error bars represent two-sided 95 percent confidence intervals around the difference in proportions between study groups. The Non-Inferiority (NI) criterion is met when the confidence interval remains to the right of the non-inferiority margin (red vertical line). Similar results were obtained when calculating one-sided confidence intervals. The cooperation rate was calculated among respondents who were randomized to either the mortality or economic questionnaire, and it was defined as the number of completed interviews divided by the sum of the completed interviews, call-backs, partial interviews and refusals. The completion rate is the number of completed interviews divided by the sum of completed and partial interviews. Source: Chasukwa et al. (2022).

2.2 GENDER CONSIDERATIONS

In many populations, women are less likely to own a mobile phone, especially if they live in a rural area and are of lower-socioeconomic status, and this may require special sampling strategies to ensure their representation *(see also Section 3 and Box 3)*. Gender differences in mobile phone ownership may, however, also be symptomatic of broader societal norms that will affect how women will engage with an MPS, and how an MPS – on a sensitive topic – may impact their safety and wellbeing. This is context specific and needs to be carefully considered in the design of study protocols and enumerator training.

In a series of 32 qualitative interviews that were conducted in conjunction with the Mozambique RaMMPS, women generally expressed a preference for an MPS over in-person data collection, largely because of the reduction in time burden and the ability to continue working and caring for children while participating in the survey (e.g., ***"on the phone we can talk while I also go about my business as we speak"; "coming to the house to talk, it can be difficult, but on the phone we can talk")***. Yet, while the MPS might be easier to manage around other duties, some women mentioned the difficulty they would face in finding a quiet and private location to participate in the interview. Another study in India on the gendered impacts of Covid-19, showed that 65 percent of respondents had their phone on speaker for at least some of the interview and that some women were using the speaker phone at the request of their spouses or in-laws (Alvi et al. 2020). This was found to affect data quality, including response bias. Enumerators will thus have to be sensitive to privacy and safety issues and be trained to deploy appropriate remedial strategies. These could include giving respondents a pretext to switch off their speaker phone, or, a code word or phrase that could be used to break the interview or change the subject. Other options are to re-schedule or abort the interview altogether.

In the RaMMPS qualitative interviews from Mozambique, some women reported that the gender of the interviewer was important to them, because they felt more comfortable talking about sensitive issues such as their pregnancy histories with a woman (e.g., ***"I would answer differently [if it was a man] because with a man, I can't answer everything they're asking")***. In some instances, women also feared that their husband might be suspicious if the enumerator was a man (e.g., ***"it must be a woman... well... if it's a man, my husband might think it's a lover... yes, it must be a woman for me")***. More generally, women expressed the difficulty of trusting the interviewer (e.g., ***"it depends on the questions or the issues because sometimes some questions can make you uncomfortable on the phone due to doubts. Dealing with someone you can't see, you may have doubts, especially now that the world is full of very bad things. You don't know who you're dealing with")***. Research is needed to establish whether community sensitisation prior to the survey can increase trust, potentially through radio or print media campaigns.

Credit: JiVitA Project

3

Sampling in stand-alone and complementary mortality MPS

Credit: UNIKIN

Disparities in mobile phone ownership mean that some groups are harder to reach in an MPS than others. Potential biases arising from such uneven ownership can be mitigated through suitable sampling strategies and post-stratification weighting methods.

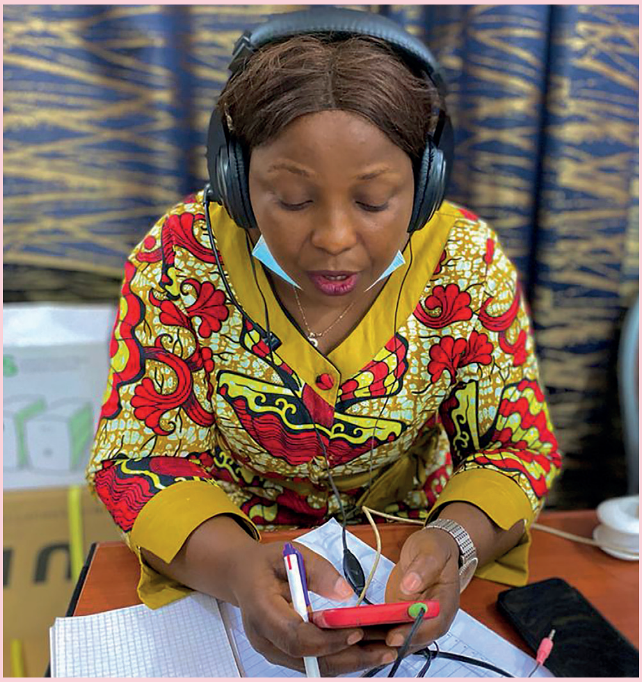
While mobile phone ownership has increased rapidly in recent years, it remains higher among men, urban residents, younger and wealthier individuals (Box 3) (Blumenstock 2012; Alozie and Akpan-Obong 2017; L'Engle et al. 2018; Guzman-Tordecilla et al. 2023). Because these attributes are typically correlated with mortality, the ensuing estimates may no longer be representative of the entire population. In this section we describe sampling strategies to maximise representation and to minimise bias in mortality MPS indicators. We also describe statistical methods to adjust for sample selection bias via post-stratification weighting.

There are two primary sampling approaches for an MPS where the objective is to constitute nationally representative mortality estimates: (i) Random Digit Dialling (RDD); or (ii) sampling from an existing frame of individuals or households with known telephone numbers. In some settings, it may also be feasible to obtain lists of active subscribers from mobile phone operators, third-party suppliers, or even government agencies. Sometimes, mobile phone subscriber lists can be further disaggregated by demographic attributes of the owners, or geography. It remains, however, important to understand the process by which these lists have been compiled and maintained, both in terms of statistical properties and for research ethics purposes.

Box 3: The digital divide

Even though mobile phone penetration has rapidly increased since the early 2000s, important disparities remain. Between 2017 and 2022, mobile phone ownership in sub-Saharan Africa increased from 63 to 69 percent, but the gender gap in mobile phone ownership (defined as the number of male owners minus the number of female owners, divided by the number of male owners x 100) only marginally decreased from 14 to 13 percent. Mobile phone ownership rates and gender differences are also highly variable by country: in Kenya, for example, 93 and 88 percent of men and women owned a mobile phone. Corresponding figures in Ethiopia were 75 and 55 percent, respectively (GSMA 2023).

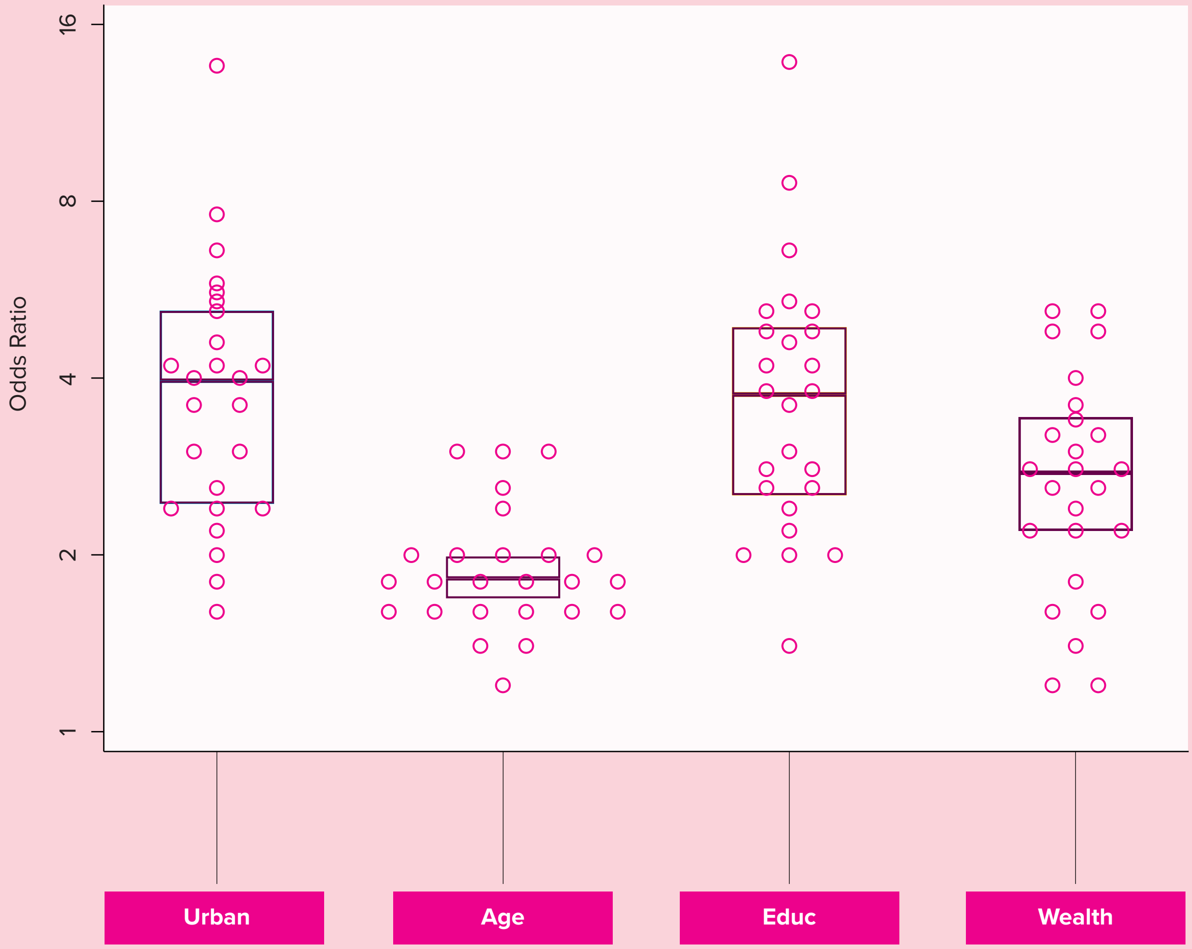
Aside from the geographic and gender disparities, mobile phone ownership is systematically correlated with socio-demographic background characteristics that drive many



Credit: UNIKIN

of the outcomes of interest, including mortality. This is illustrated in *Figure 4*. From the first boxplot, for example, we learn that urban women are up to 13.5 times more likely to own a mobile phone than rural women. Importantly, all the odds ratios across the different Demographic and Health Surveys (DHS) are greater than one, indicating that the positive association between urban residence and mobile phone ownership is systematic. The other boxplots illustrate that the same holds for age (25-35 year old women versus others), education (those with secondary education or higher versus others), and household wealth (those with a score above the median wealth index versus those below the median).

Figure 4: Bivariate associations between women's attributes and mobile phone ownership in 25 Demographic and Health Surveys (DHS)



Notes: Data for women of reproductive age from 25 DHS surveys. Each dot represents the odds ratio for one survey. Variables: Urban (versus rural), Age (25-35 versus younger and older women), Educ (secondary or higher versus lower), Wealth (above versus below the median wealth index score).

Disparities in mobile phone ownership imply that some groups will be more difficult to reach in an MPS survey than others (e.g., women living in rural areas), with downstream implications for representativity of the sample and the external validity of survey results. To counter these possible sources of bias, it is important that efforts are made to ensure that samples are balanced (e.g., by setting quotas for pre-defined population strata) and, where that is insufficient, to use post-stratification methods to adjust estimates after data collection.

3.1 RANDOM DIGIT DIALLING (RDD)

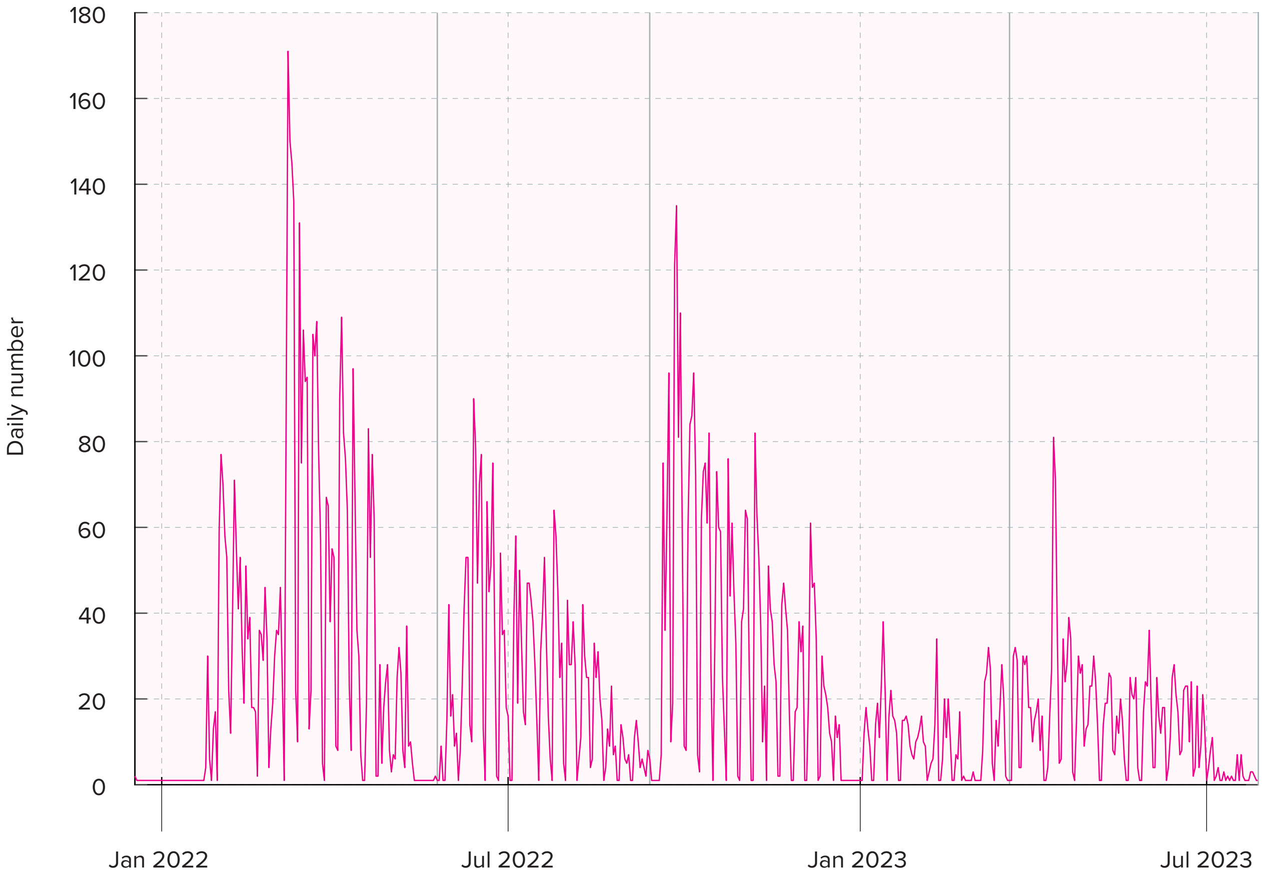
RDD is a method to generate a random set of phone numbers based on the mobile phone numbering structure of the country and the prefixes that are used by each mobile network operator. The remaining digits are generated randomly to constitute the sample. Trained call centre operators then call these numbers and conduct Computer-Assisted Telephone Interviews (CATI). With RDD, it is often necessary to constitute stratified quota samples to ensure that the interviewed set of respondents is representative on several key characteristics including age, sex, and locality, based on prior knowledge of the distribution of the population on these characteristics (e.g., from a census or household survey). For monitoring quotas in each stratum, enumerators then initiate the CATI with a short eligibility screening prior to the start of the formal interview. Once the quota for a particular stratum is filled, the stratum is locked and respondents with these attributes are no longer eligible to participate. This approach has elsewhere been described as RDD with active strata monitoring (Labrique et al. 2017). Protocols may also allow for intra-household referrals or banking of numbers for later use whenever the person picking up the phone is not eligible him or herself. The latter can be particularly useful whenever data collection is stretched over a longer period and quotas are re-set at regular intervals.

RDD can be resource intensive because it typically requires many call attempts to identify working telephone numbers and reach eligible respondents. The high level of potential non-response due to inactive numbers needs to be factored in when budgeting for the survey, and accurate para-data relating to call attempts should be collected to calculate response rates. To filter numbers that are not in use, one could seek collaboration with mobile

Credit: IPOR

phone operators to sample from a list of active subscribers, or, work with a third party provider that screens numbers through verification against the Home Location Register, a database of authorized subscribers on the Global System for Mobile (GSM) communication network. Even then, enumerators will have to make many call attempts to reach eligible respondents and complete an interview. This may become an important constraint in populations with low and unequal mobile phone penetration, and whenever quotas for the easiest to reach respondents are filled. This is illustrated in ***Figure 5.*** At the start of each fieldwork block, quotas were re-set and fieldworker productivity was high. Over time, and as quotas filled up, it became increasingly more difficult to reach eligible respondents and the number of completed interviews per day declined.

Figure 5: **Number of completed interviews per day over four data collection periods in the Malawi RaMMPS**



Notes: The number of completed interviews displayed here does not include mobile phone numbers that were first screened via an IVR survey. Source: Malawi RaMMPS.

To improve efficiency and concentrate the effort of enumerators on call attempts that have a higher chance of success, one could choose to screen numbers via an automated process such as a Short Message Service (SMS) survey or an Interactive Voice Response (IVR) survey. SMS or IVR surveys can be useful to ensure or improve the representation of population subgroups with lower mobile phone ownership rates ***(Box 4).***

Box 4: Improving the recruitment of hard-to-reach populations using Interactive Voice Response (IVR) screening surveys

IVR surveys are a method for fielding automated telephone surveys by utilising a series of pre-recorded prompts and key-pad responses by the respondent (Gibson et al. 2017). The automated nature of IVRs makes them a useful tool for reaching a large number of individuals rapidly but they are typically only used for short surveys. In the Malawi RaMMPS, an IVR survey was fielded with the primary intent to identify eligible rural respondents as they were more difficult to reach than urban respondents *(Table 1).*

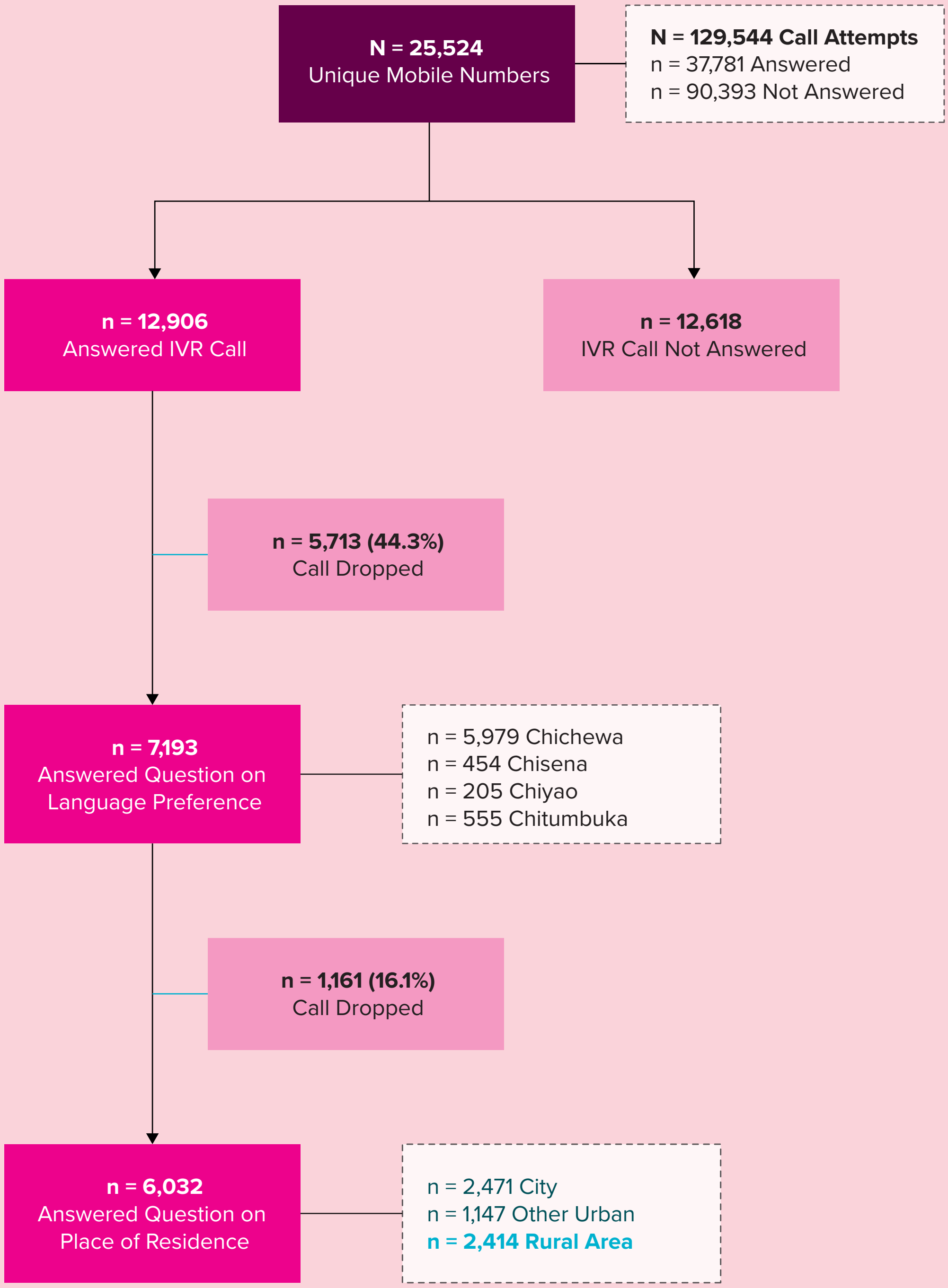
Table 1: Progress towards filling sample quotas after the first two periods of data collection, Malawi RaMMPS

	Male		Female		Total
Age Group	**Urban**	**Rural**	**Urban**	**Rural**	
18 – 49	97.5%	108.3%	92.9%	**43.6%**	70.2%
50 – 64	92.9%	**54.5%**	82.1%	**36.3%**	52.4%
Total	96.8%	100.5%	92.1%	**43.0%**	68.4%

Following a brief introduction, respondents in the IVR survey were invited to declare their preferred language of communication, followed by a question to indicate whether they lived in an urban or rural area. Among 25,524 mobile phone numbers included in the IVR survey, 50.6 percent were answered. Of those that were answered, 55.7 percent went on to answer the language question, indicating engagement with the survey. *Figure 6* illustrates IVR call attempts and call outcomes. Among those who responded to the language question, 84.8 percent also answered the question about the type of place of residence. Overall, the yield of rural respondents from the IVR survey was 9.5 percent of the unique mobile numbers called, at a cost of USD 8.91 per rural number. All the rural respondents identified through the IVR process were later invited to participate in a mortality MPS CATI interview.

While IVR screening surveys entail a non-negligible additional cost, they reduce the time that enumerators invest in dialling inactive numbers or ineligible respondents. In addition, CATI refusal rates for the IVR screened numbers are also lower than for the numbers that were not screened.

Figure 6: Call attempts and outcomes from an IVR survey in the Malawi RaMMPS aimed at identifying rural respondents



Source: Tlhajoane et al. (2024).

3.2 SAMPLING FROM EXISTING SAMPLING FRAMES

Another sampling approach is to begin with a prior census, survey or surveillance system where mobile phone numbers were collected. This approach is expected to elicit the highest response rates because participants have already shared their phone number – with consent to use their number for future research or surveillance – and are therefore primed to expect a call. Sampling from prior studies has the additional advantage that background information on households and respondents may be available from the parent data source even though it is important to ensure that the identity of the respondent or household is the same. A downside of this method is that one may be constrained by the design or sample structure of the existing study, and any flaws will be inherited by the MPS.

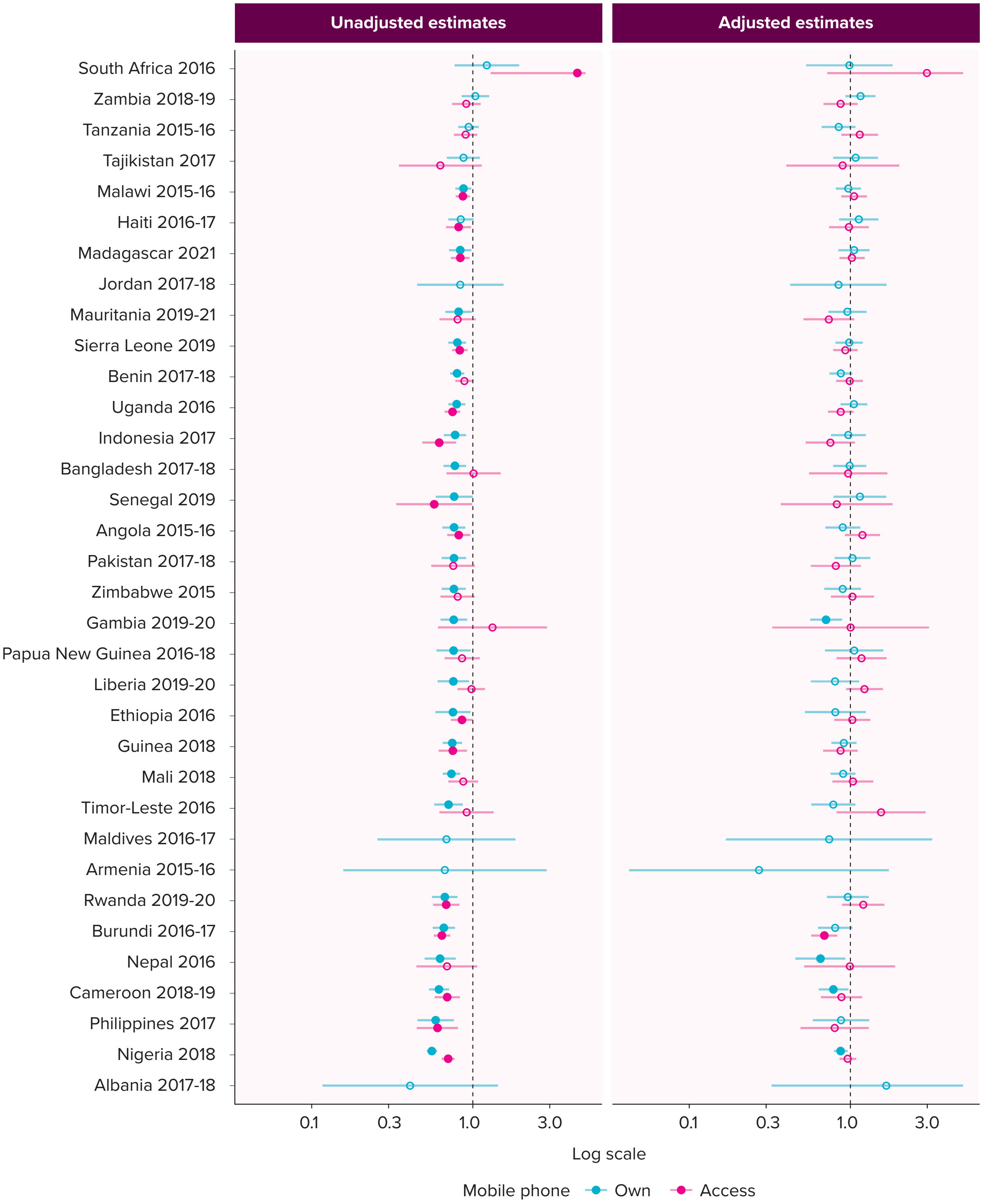
Credit: Louis Leeson/LSHTM

3.3 SAMPLE SELECTION BIAS

Sample selection bias can result from limitations of the sampling frame because MPS are by design restricted to individuals who have access to or own a mobile phone and these are unlikely to be representative of the entire population *(see **Box 3**).* Selective non-participation (e.g., refusals) can exacerbate this problem. As discussed before, stratification at the sampling stage can mitigate sample selection bias, and in ***Section 3.4*** we discuss post-stratification weighting as a statistical method for correcting estimates after the fact. It is, however, also important to realise that sample selection will not affect all demographic and health indicators in the same manner, and that post-stratification weighting will not always provide the required correction.

For mortality indicators, Sánchez-Páez and colleagues identified downward bias in the under-five mortality rate (U5MR) estimates if they were to be derived from a subsample of mobile phone owners (with a median U5MR ratio of owners to non-owners of 0.78) (Sánchez-Páez et al. 2023). After they adjusted for sociodemographic background characteristics that are typically used as weighting variables (e.g., age of the respondent, type of place of residence, education, household wealth), the difference in the mortality estimates between mobile phone owners and non-owners largely disappeared *(**Figure 7**).* Another study using data from Sibling Survival Histories found that estimates of adult mortality (here 45q15) in the subsample of people who owned a mobile phone deviated from the full population estimate in only 5 out of 25 DHS (Ahmed et al. 2024). In four of those five cases, adult mortality estimates were slightly lower for mobile phone owners, and adjustment for background characteristics of the respondent helped to reduce differences between the estimates from the full sample and the subset of mobile phone owners. However, in this case, adjustment did not offer a full correction for the bias, nor was it always in the expected direction.

Figure 7: **Association between mobile phone ownership (access) and under-five mortality (unadjusted and adjusted rate ratios from Poisson regression)**



Notes: Filled markers mean that estimates are statistically significant at the 95% confidence level. Adjusted estimates are obtained after statistical controls for marital status, education, wealth and place of residence in the models. Source: Sánchez-Páez et al. (2023).

In comparison to mortality indicators, selection bias in fertility and reproductive health measures may be even more difficult to correct. A study in Burkina Faso showed that modern contraceptive use was over-estimated in an MPS, and that adjustment for sociodemographic background characteristics did not correct bias (Greenleaf et al. 2020). This finding was corroborated by a study using birth history data from 34 DHSs in LMICs, which showed that fertility estimates would be biased downward if they were to be derived from a sample of mobile phone owners. Again, this bias could not be rectified through adjustment for socio-demographic background characteristics (Sánchez-Páez et al. 2023).

These examples show that both bias and the success of post-stratification methods to correct for sample selection bias – where it exists – will be variable. For mortality estimates, adjusting for socio-demographic background characteristics may be sufficient to alleviate selection bias. For indicators that are an expression of one's preferences in addition to personal attributes and living conditions (e.g., fertility and contraceptive use), adjustment for socio-demographic background characteristics appears to be insufficient to recover full population estimates. Further, it is worth noting that surveys can be used to collect information about the respondents themselves, but the respondent often also acts as a proxy informant for relatives and other household members. This is typically the case for mortality modules because respondents cannot report on their own vital status. Whenever mortality estimates are derived for individuals who do not co-reside with the respondent (as is the case for siblings), selection bias will be smaller, but the respondent's attributes will not be as potent to correct this bias where it exists.

3.4 POST-STRATIFICATION WEIGHTING

Careful sampling procedures, including the imposition of quotas for specific population strata, can ensure that the sample is representative in terms of key respondent attributes (e.g., age, sex, and place of residence), but it is often insufficient to fully counter sample selection bias where it exists. Post-stratification weighting is an additional – ex post facto – tool to correct or minimize bias in the ensuing estimates. To that end, a wide range of methods have been developed, including matching, iterative proportional fitting (a.k.a. raking) and propensity score weighting (Smith 1991). It is beyond the scope of this report to review all of these methods in detail, but it is worth keeping in mind that: (i) the easiest method (raking) often performs equally well as more sophisticated statistical procedures; and (ii) the availability of the appropriate weighting variables is often more important than the weighting method itself (Mercer et al. 2018).

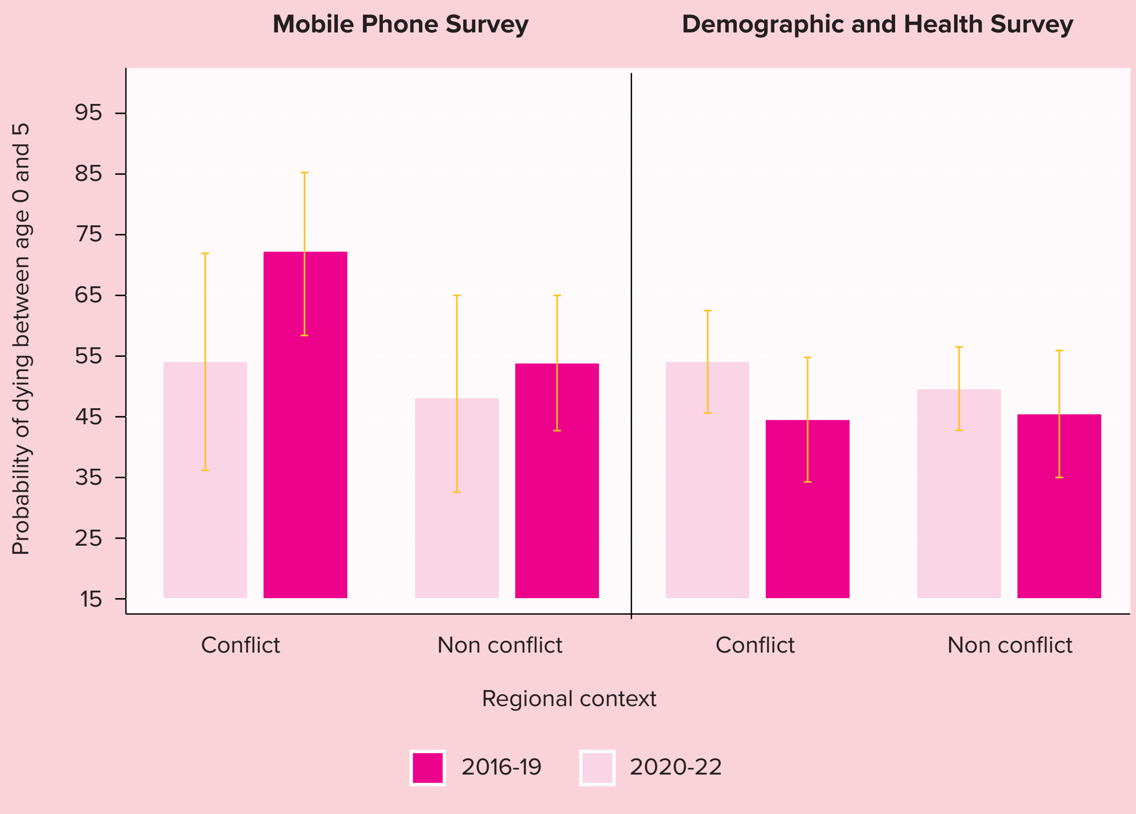
To implement raking, one needs a population-representative dataset from which the population distribution of the weighting variables can be derived (e.g., sex and education). The procedure iteratively adjusts the weights for each case until the weighted sample marginal distributions align with the population values for each of those variables. As discussed above, recovering population estimates may not be feasible for all demographic indicators of interest, and – where possible – it is recommended to a-priori test the weighting procedure in a population representative dataset with data on mobile phone ownership and the required information to compute the indicator.

Box 5: MPS for tracking mortality in humanitarian crises

MPS may be particularly useful as a means of tracking mortality during humanitarian crises when populations are harder to reach, and other data collection streams may be suspended. These situations may coincide with peaks in mortality that require timely information to plan relief efforts.

In Burkina Faso, for example, armed insurgency and resulting population displacement has increased since 2019. We used RaMMPS and DHS data to compare child mortality in conflict-affected areas and more peaceful areas before and after March 2020 *(Figure 8).* Even though the Burkina Faso RaMMPS was not powered to detect regional differences in mortality, initial results suggest that under-five mortality increased after March 2020 in conflict affected areas. This pattern was absent in DHS data; most likely because the DHS was unable to operate in the worst-affected areas.

Figure 8: Under-5 mortality trends in peaceful and conflict affected areas, by data source (Burkina Faso)



Source: Burkina Faso RaMMPS and 2021 Burkina Faso DHS.

In another context, we re-contacted RaMMPS respondents living in districts that were affected by Cyclone Freddy in Malawi in March 2023. Over 5,000 follow-up CATI interviews were completed and solicited information on population displacement, injuries sustained as a result of the cyclone and mortality. This example illustrates that an MPS platform can be used in crisis situations when rapid response and evidence-gathering are crucial.

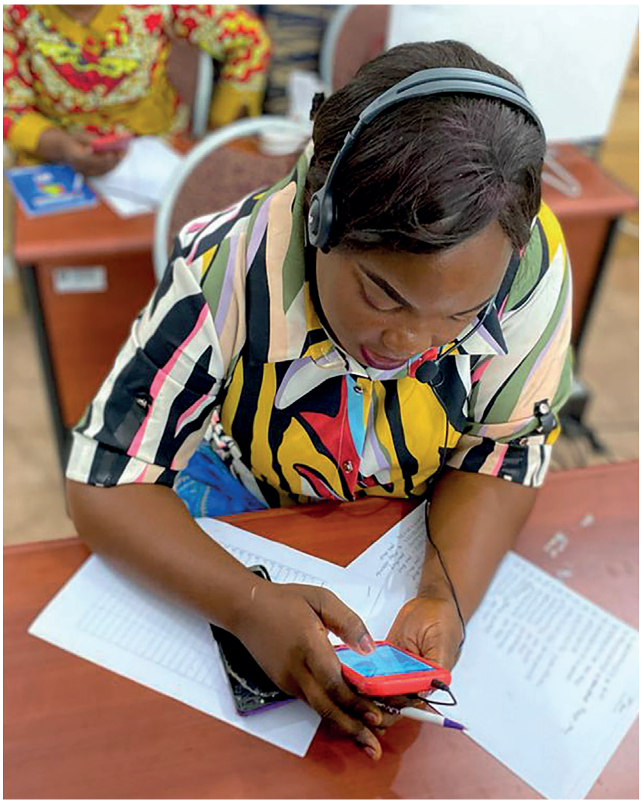
4

Survey instruments for a mortality MPS

Credit: IEDCR

4.1 GENERAL CONSIDERATIONS IN THE CHOICE OF THE MORTALITY SURVEY MODULES

Where complete CRVS is lacking, mortality estimates are derived from censuses and surveys. To that end, various instruments or questionnaire modules can be used to estimate mortality either directly or indirectly. Direct estimates of mortality require detailed data on ages, dates of exposure and dates of death (if applicable), and typically require long survey instruments. Because mortality is a stochastic process and some of this information is reported with error (e.g., *Box 6*), aggregation of estimates over age and/or time may be necessary. Indirect estimation methods depart from simpler and shorter instruments, but the derived estimates are dated and often rest on the assumption of a regular mortality trend. This class of methods is therefore less suitable for monitoring short-term fluctuation in mortality, but workarounds are being developed (e.g., Masquelier et al. 2024).



Credit: UNIKIN

Box 6: Age heaping in MPS

MPS have multiple advantages over in-person surveys that derive from their simpler logistics. In addition, much of the evidence summarized in this report is testimony to the feasibility of mortality MPS and the validity of the ensuing estimates. It is, however, important to remain cognisant of the limitations of MPS and use their data accordingly. We discuss the potential for sample selection bias in *Section 3;* another key element in mortality estimation is the quality or precision with which respondents report ages. *Figure 9* (on the next page) compares the Whipple Index, a standard measure of heaping or digit preference among adults, in a number of MPS and in-person surveys. In virtually all instances, the index was higher in MPSs than in recent household surveys and censuses. This implies that MPS age data are noisier, but it is usually also taken as signal of poorer data quality more generally.

Figure 9: Age heaping (respondent's self-reported age) in MPS versus in-person surveys (1990-2022)

Notes: DHS = Demographic and Health Surveys; LSMS = Living Standards Measurement Study; MICS = Multiple Indicator Cluster Survey; MPS = Mobile Phone Survey; PHC = Population and Housing Census; PHIA = Population-Based HIV Impact Assessment; PMA = Performance, Monitoring and Accountability; WHS = World Health Survey. Some of the MPS data points for Burkina Faso (2021) and all of those for Malawi come from the RaMMPS project. Source: Helleringer et al. (2023).

Another consideration with repercussions for the choice of the survey instrument is the age range for which one wishes to produce mortality estimates. Household death modules are often used for estimating overall mortality (e.g., the Crude Death Rate) whereas questions about the survival status of specific relatives (children, siblings and parents) can be used for estimating mortality in a specific age range (Moultrie et al. 2013).

One further design concern in mortality MPS is the duration of the interview in the sense that longer interviews are more susceptible to interruptions and the respondent's loss of concentration or engagement. The empirical evidence for the latter is not very strong *(Box 7),* but provided that data quality can be upheld, short duration interviews are desirable for the mere reason that they reduce the burden on the respondent and data collection costs.

Without aiming to be exhaustive, we describe in *Section 4.2* some of the survey instruments that have been used in the RaMMPS project, and discuss their strengths and flaws.

Box 7: MPS duration and data quality

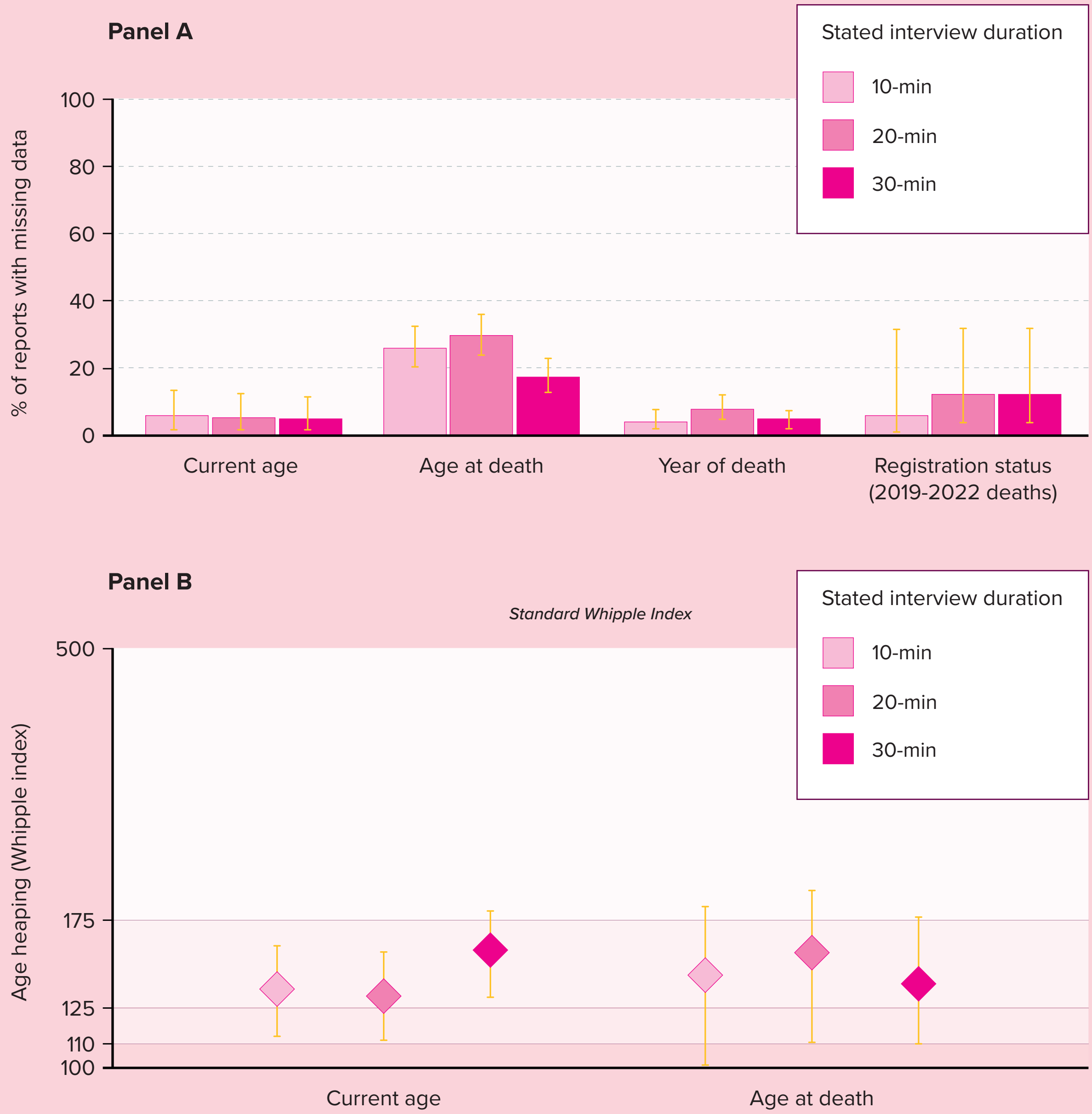
It is generally recommended to limit MPS to 10–20 minutes to maintain high response and participation rates, and to avoid fatigue among both respondents and enumerators (McCarty et al. 2006; von Engelhardt and Jones 2019; Glazerman et al. 2020; MICS 2020; Gourlay et al. 2021). These recommendations are based on prior practice, but have not yet been formally evaluated in a mortality MPS.

Within the Malawi RaMMPS, we conducted a nested study to assess whether surveys of different lengths were associated with any change in survey cooperation and completion rates, and the quality of mortality data (Torrisi et al. 2024). We randomly assigned 2,500 study participants to questionnaires of 10, 20 and 30 minutes. In each of these questionnaire versions, a Parental Survival History module was included at the end. We measured cooperation and completion rates (see *Box 2* for definitions) and conducted a detailed investigation of data quality indices.

In contrast to the existing guidelines, we found high levels of cooperation and completion, even when we increased the interview length to 30 minutes. The cooperation rate was 96.2, 94.7 and 94.0 percent for interviews of 10, 20 and 30 minutes, respectively. Completion was 99.1, 98.0 and 97.3 percent for the surveys of these respective durations. There was no evidence that increasing the length of the survey led to worsening data quality either. For some indicators, longer interviews had lower item non-response (e.g., maternal age at death, *Figure 10*, panel A) and age heaping markers did not differ by interview duration either (*Figure 10,* panel B).

Further research is needed to understand the optimal length of an MPS, and the mechanisms by which attrition or fatigue might arise. These findings indicate that mortality MPS do not necessarily need to be limited to 10-20 minutes, and that in some instances better quality data may be collected in a longer instrument (because more probes or checks can be included).

Figure 10: **Item non-response (panel A) and age heaping (panel B) for data about the respondent's mother in a parental survival history module, by interview duration (Malawi RaMMPS)**



Notes: The Standard Whipple Index is calculated for the ages 23–62 inclusive. Source: Torrisi et al. (2024).

4.2 INSTRUMENTS FOR ESTIMATING OVERALL MORTALITY WITH A SHORT WINDOW OF RETROSPECTION

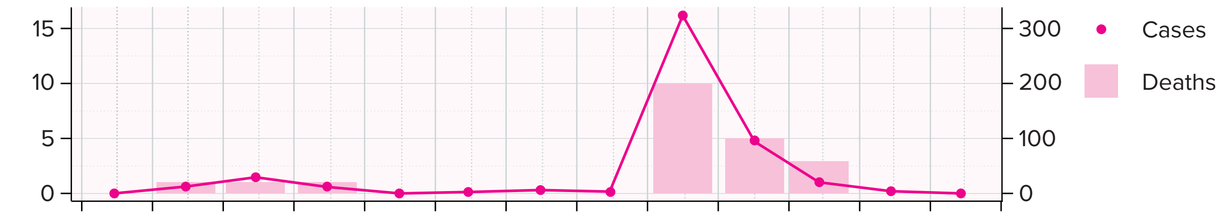
Classic mortality measurement modules from censuses and big household survey programmes are designed to measure mortality for up to a decade before the interview, but in some circumstances mortality fluctuations in the recent past may be of greatest interest. To measure those, instruments with a short window of retrospection may be preferable. In the RaMMPS project, we employed a household memberships and deaths module which used a short questionnaire (~10 questions) to solicit information on the number of current household members and deaths in the last three months to directly estimate the Crude Death Rate. Key difficulties in the design of such an instrument relate to the operational definition of a household and the demarcation of the reference period for mortality measurement, and further methodological work is necessary to validate methods. As an extension, one might expand the reference population to a broader network of individuals (Breen and Feehan 2024).

For mortality surveillance purposes, even simpler methods may also suffice. Just tracking the percentage of households reporting a death in the last (three) month(s) may be sufficient to pick up a signal of excess mortality. In Malawi, for example, we evaluated the perceived change in the number of funerals reported in a sample of 400 MPS respondents (*Figure 11,* panel C) and compared this with cases and deaths reported by the Malawi Public Health Institute (Panel A), and health facility deaths (Panel B). The proportion reporting more funerals increased markedly during the second wave of the Covid-19 pandemic (Feb-Mar 2021), indicating excess mortality that was not otherwise captured in official statistics. Such quick, simple and non-intrusive questions are easy to incorporate in an MPS. Whenever there is any indication of excess mortality, the MPS can be scaled up to collect more detailed information in a larger sample.

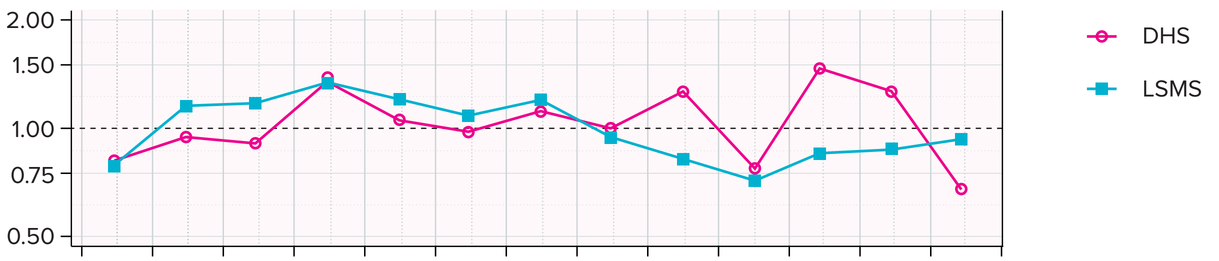
Credit: icddr,b

Figure 11: Official data on Covid-19 cases and deaths (panels A and B), compared with MPS reports of the perceived number of funerals (panel C), Malawi (May 2020-Jun 2021)

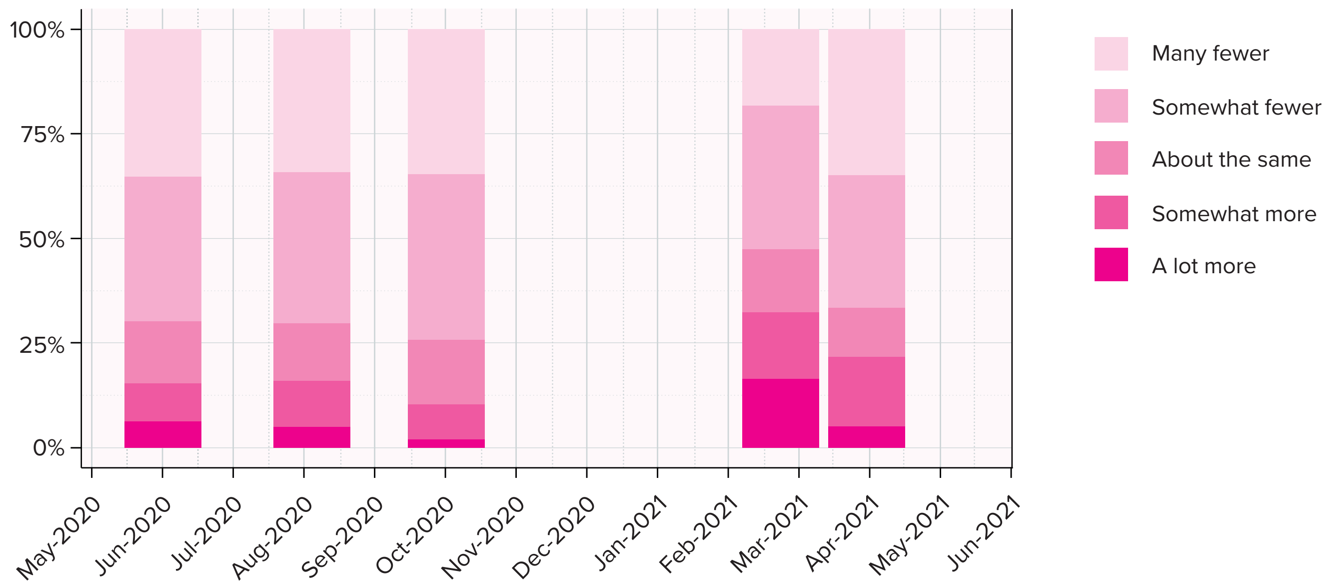
Panel A: Recorded COVID-19 Cases and Deaths (Deaths: left axis; Cases: right axis)



Panel B: Deaths and Discharges (relative to 2019)



Panel C: Perceived Number of Funerals (in past month)



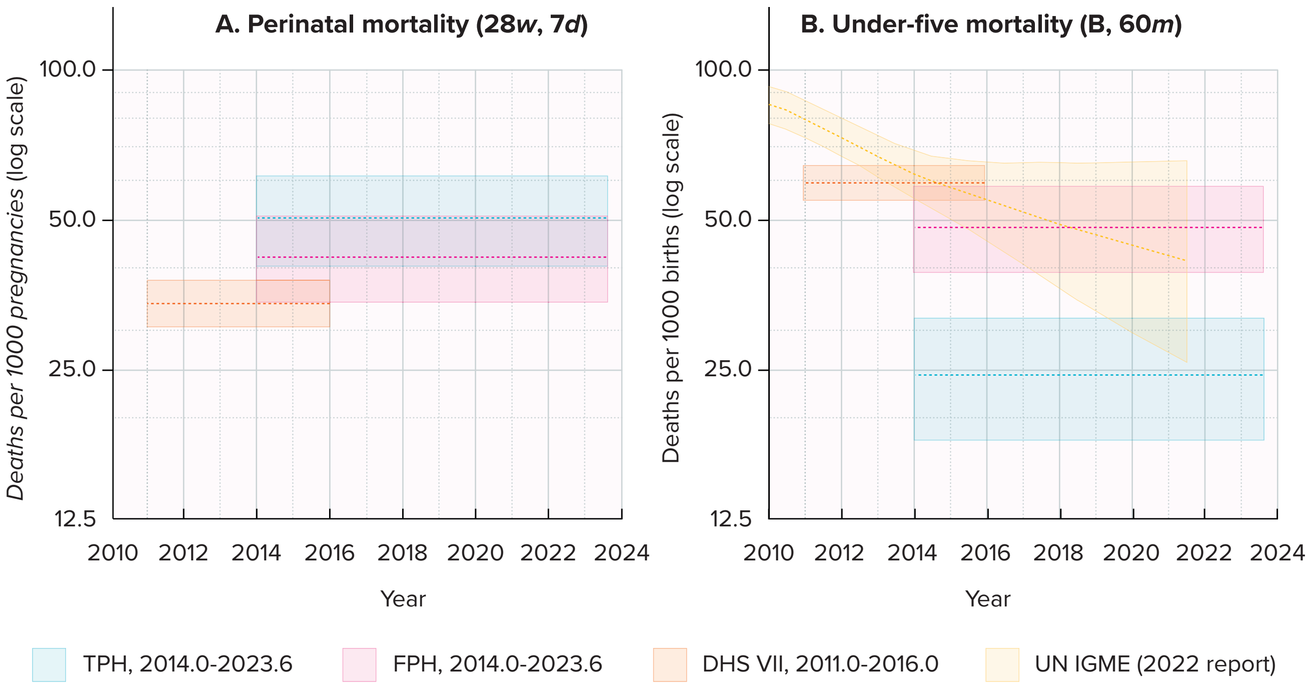
Notes: The data plotted in panel A) were extracted from reports published by the public health institute of Malawi. In panel B), discharge registers were collected by the study team at Karonga district hospital, as well as 2 other lower-level health facilities. The catchment areas of these facilities cover more than 70 percent of the district's population. A study team member independently tallied the discharges recorded in these registers by month, as well as their outcome (i.e., death vs. alive). In panel C), the survey data are plotted by answer categories. In each round of data collection, missing data on this question are omitted from the plot (<1 percent). Since the question asked respondents to evaluate the frequency of funerals 'in the past month', the bars representing survey answers are placed 15 days prior to data collection. Source: Banda et al. (forthcoming).

4.3 INSTRUMENTS FOR ESTIMATING PERINATAL AND UNDER-FIVE MORTALITY

For several decades, survey-based estimates of under-five mortality for LMICs have been generated from Full Birth Histories (FBH) collected from women of reproductive age. In this set of questions, women are asked, in chronological order, details about all their children, including dates of birth, sex and the survival status of each child. This instrument has evolved over the years, and if the objective includes estimating stillbirth and perinatal mortality, the Full Pregnancy History (FPH) instrument is nowadays preferred (Akuze et al. 2020).

The Truncated Birth (or pregnancy) History is an alternative set of questions that is used to collect data in reverse chronological order until a pre-defined truncation period is reached (e.g., 7 years before the survey). This instrument could be appealing for an MPS because the time needed to administer it is shorter. However, there is increasing evidence that TBH are prone to misreporting errors and could lead to underestimation of child mortality (Masquelier et al. 2023). This was corroborated in the Malawi RaMMPS. During fieldwork women of reproductive age were randomly allocated to a Full or Truncated Pregnancy History instrument, which allowed us to compare estimates from both instruments under conditions that were otherwise equivalent (*Figure 12*). Whereas the estimates of perinatal mortality for the two survey instruments are still statistically equivalent (panel A), the difference is more sizable for the probability of dying below the age of five years (panel B). In that case, the Full Pregnancy History (FPH) instrument seems to produce the more plausible estimates, as evidenced by its correspondence with estimates from the 2015-16 Malawi DHS and estimates published by the UN-IGME (Romero Prieto et al. 2023; Reniers et al. 2024).

Figure 12: **Truncated and Full Pregnancy History estimates of perinatal and under-five mortality in the Malawi RaMMPS, compared to estimates from the 2015-16 DHS and the UN-IGME**



Notes: Perinatal mortality is defined as the probability of a pregnancy loss/death between 28 weeks of gestation and 7 days (28w, 7d), and under-five mortality is the probability of dying between birth and 60 months (B, 60m). Source: Malawi RaMMPS.

The example in *Figure 12* rests on a relatively modest sample of ~2,000 women for each of the two instruments. Larger samples would be required to evaluate trends or detect temporal spikes in mortality. One approach that might be considered for expanding the effective sample size for a given set of MPS is to add pregnancy histories for a close confidant of the respondent in addition to pregnancy histories for herself. One of the advantages of this approach is that proxy histories can be collected irrespective of the survival status of the mother, which could be appealing in settings where the survival of mothers and children are correlated (e.g., due to HIV (Bicego et al. 1997)). Other possible applications of proxy histories could be the collection of information on stigmatized behaviours (e.g., pregnancy termination). We trialled the administration of proxy pregnancy histories in the Bangladesh RaMMPS, underscoring their feasibility (Kan et al. 2023).

4.4 INSTRUMENTS FOR MEASURING ADULT AND OLD-AGE MORTALITY IN AN MPS

In a survey, one can ask respondents about the survival status of their (maternal) siblings and/or parents. Information about the survival of siblings can be used to estimate adult mortality (typically between the ages 15 and 60), and information about the survival status of parents can be used to estimate mortality in late adulthood and old age.

Via their inclusion in DHS and other survey programs, Sibling Survival Histories (SSH) have been instrumental for gaining insight into the mortality of adults in many LMICs in the last several decades. In full SSH, (female) respondents aged 15-49 are asked about the sex and age of their surviving maternal siblings. For siblings who have died, information is collected on the time since death and age at death. This detailed information, allows for the direct estimation of mortality by dividing age and period specific deaths by the years of exposure. Many surveys also include questions to identify maternal and violent deaths.

Full SSH modules can be time-consuming to collect, especially in high-fertility settings where sibships can be sizable. In Senegal, the median duration of an interview to collect full SSH and some basic socio-demographic information was 30 minutes (Helleringer et al. 2014). This may render them less suitable for an MPS, but this is yet to be established. Summary SSH are considerably shorter as they only elicit information on the total number of sisters/brothers, and the number of these sisters/brothers who have died (in adulthood). Mortality rates are derived – indirectly – from the proportions of surviving siblings arranged by the age of the respondent (Timæus et al. 2001). While the indirect method has proven useful for filling data gaps and establishing medium-term mortality trends, it is less suitable for estimating contemporaneous mortality in populations affected by humanitarian crises because (i) the ensuing mortality estimates pertain to a reference period up to 15 years before the survey, and (ii) the method rests on the assumption of regular and unidirectional mortality trends.

As an alternative to the indirect method, one could impute the ages and dates of death of siblings from the observed distributions in an auxiliary data source (e.g., a prior DHS), and estimate mortality directly. Another route to bypass the indirect method is to solicit more detailed information about deaths that occurred in the recent past. Both of these options were pursued in the Burkina Faso and Malawi RaMMPS where summary SSH with additional detail on ages and dates for siblings who died since 2019 were collected. *Figure 13* contains RaMMPS adult mortality trends after imputing the sibling ages and time of death, and the estimates for 2019-21 (with imputation of ages of living siblings only). These are compared to the DHS and estimates reported in the World Population Prospects (WPP). Correspondence between the imputed estimates and the external sources is good, but the adult mortality estimates for 2019-21 appear to be biased downwards. This suggests that there is some displacement of deaths outside of the reference period for contemporaneous mortality estimates, and more methodological work is needed to develop an interviewing strategy to circumvent or minimize this problem.

Figure 13: **Probability of dying in adulthood (35q15) in the Burkina Faso and Malawi RaMMPS, compared with DHS and World Population Prospects estimates (by sex)**

Notes: Adult mortality is here quantified as the probability of dying between ages 15 and 50 (35q15). The 2021 Burkina Faso DHS and the 2015-16 Malawi DHS were used as auxiliary data sources for imputing sibling ages and times since death. Source: Dianou et al. (2023).

For estimating old age mortality, one can resort to questions about the vital status of parents. Again, summary histories can be used to estimate mortality indirectly from the age-specific proportions of individuals with a surviving father and mother. However, given that one only has two parents, the time needed to collect full information on the ages and – if applicable – dates of death is well within reach of an MPS. Direct estimates can therefore be considered as well, but the data on ages and dates will have to be subjected to rigorous data quality checks. In the Malawi RaMMPS, for example, over one-third of the respondents did not know the age at death of their deceased parent and heaping was considerable. Because these problems are less pronounced for recent deaths, it is recommended to include follow up questions to ascertain whether the death occurred in the recent or distant past.

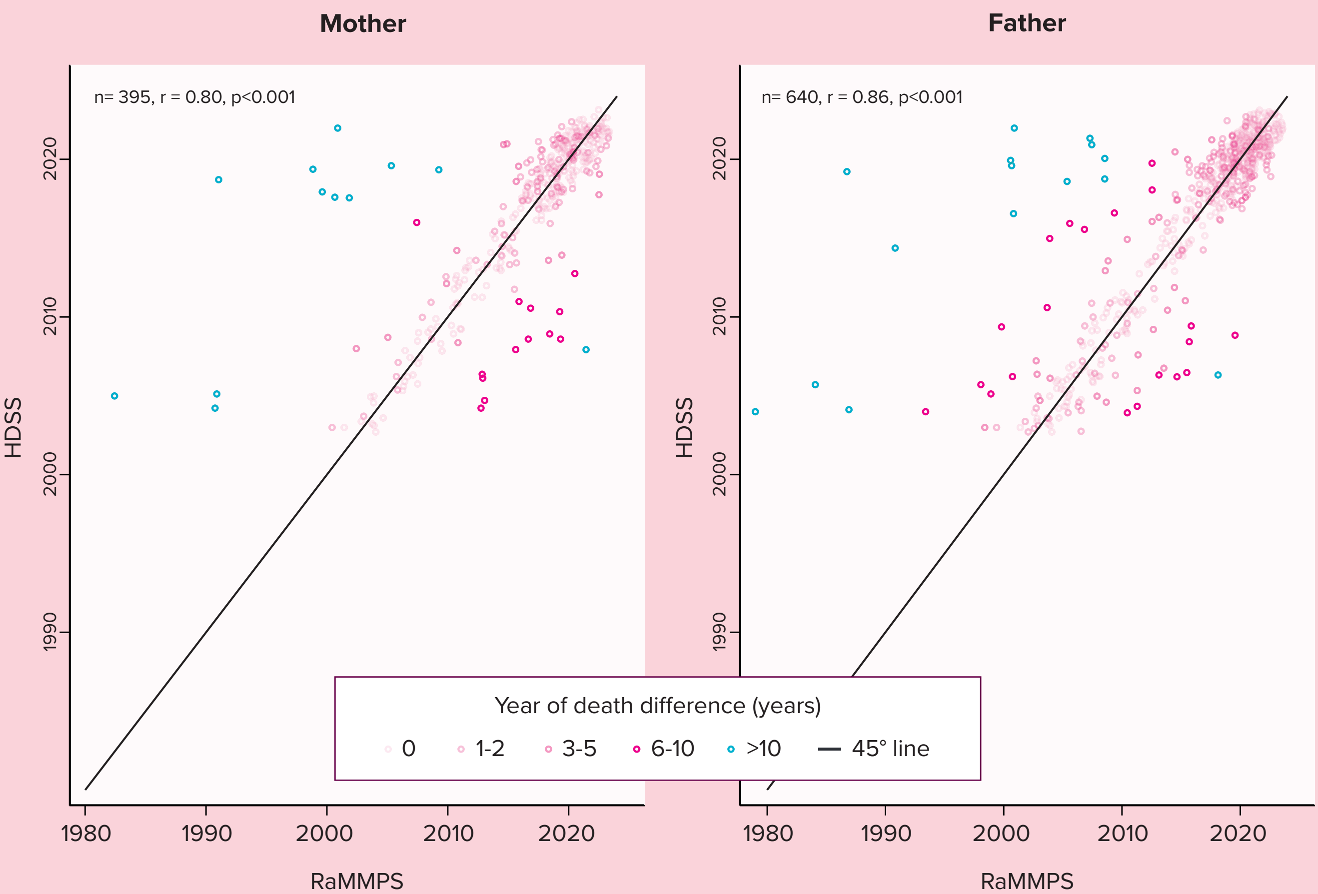
Credit: Louis Leeson/LSHTM

Box 8: MPS-Health and Demographic Surveillance System (HDSS) validation studies

Few high-quality data sources exist against which to validate adult and (especially) old-age mortality MPS data and estimates. To alleviate this, the RaMMPS project implemented a number of validation MPS administered with residents of HDSS. Because HDSS are prospective and generally considered to be of high quality, the comparison of both sources facilitates the evaluation of MPS reporting in terms of the accuracy of dates and events, as well as the derived mortality estimates.

MPS errors in vital status reports of siblings and parents are usually negligible (typically below 5 percent), and the reporting of the dates of these events is also good. This is particularly so for events that occurred in the recent past. This is illustrated in *Figure 14,* which conveys the correspondence in the reported dates of death for fathers and mothers of MPS respondents with HDSS records. This validation work further suggested that the timing and the place from where the respondent takes the call is important. Reporting quality was generally lower when the respondent was at work (or school) and misreporting also increased when the interview was conducted in the evening.

Figure 14: Correspondence between the year of death for parents reported by MPS respondents and Karonga HDSS records (Malawi)



Source: Banda et al. (2024).

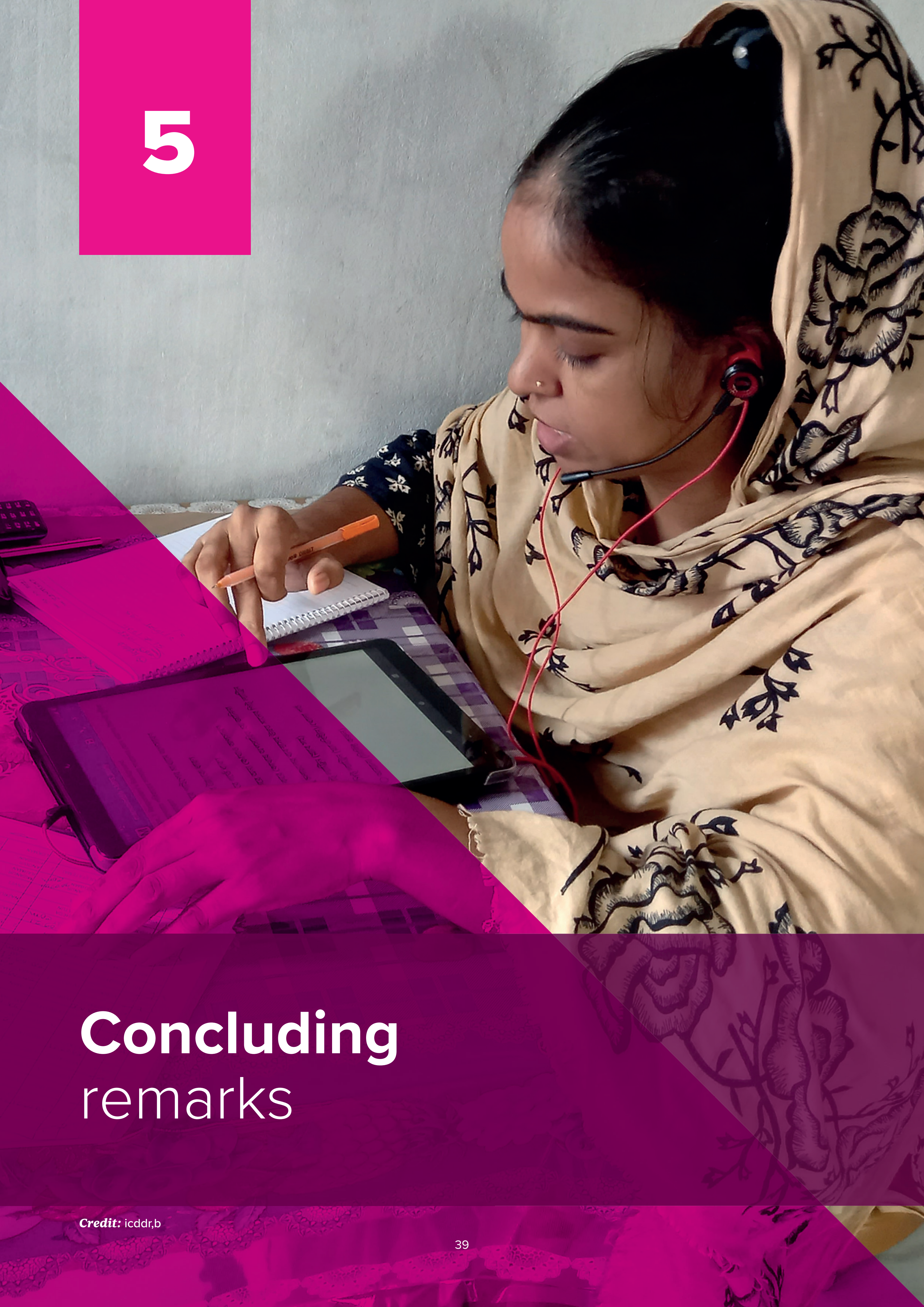
Adult and old age mortality estimates also compare well across sources, and none of the differences are statistically significant *(Table 2)*.

Table 2: Comparison of adult and old age mortality rates from (full) sibling and parental survival histories in a mortality MPS and the MATLAB HDSS, Bangladesh

	MPS Rate /1,000 (95%-CI)	**Matlab HDSS Rate /1,000 (95%-CI)**
Adult mortality (15-59)		
Both sexes	6.7 (6.1-7.3)	7.4 (6.7-8.2)
Male	7.5 (6.7-8.4)	8.2 (7.3-9.2)
Female	5.7 (4.9-6.6)	6.2 (5.2-7.3)
Old age mortality (60+)		
Both sexes	85.7 (80.8-90.9)	79.1 (74.5-83.9)
Male	104.6 (96.9-112.8)	99.8 (92.2-107.9)
Female	68.5 (62.5-75.0)	62.4 (57.0-68.3)

Notes: Siblings and parents reported in the MPS were individually matched to their HDSS record using names. Source: Banglasesh RaMMPS (MATLAB validation study).

The MPS-HDSS validation studies generally indicate that MPS reports are of good quality, but they also have their limitations in the sense that (i) these populations have been regularly exposed to research, and (ii) comparisons are restricted to parents and siblings who also reside(d) in the HDSS area. Because that is in the close vicinity to the respondent him or herself, the latter may be better aware of their vital status and other demographic data.



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Concluding remarks

Credit: icddr,b

Initial results from the RaMMPS project suggest that mortality data collection via an MPS is both feasible and produces plausible mortality estimates. Further methodological assessments and fine-tuning will be necessary, but mortality MPS will have applications to complement existing data sources when more timely data are needed, and to fill gaps when other health information systems are insufficiently performant.

Due to the rapid proliferation of mobile phones in LMICs, MPS are becoming an increasingly viable method for collecting data that would traditionally be gathered through face-to-face surveys and censuses. While MPS are unlikely to replace more conventional data sources, they offer simpler logistics than a traditional household survey. They can also be deployed in situations where enumerator mobility and in-person contact are hindered, including during epidemic outbreaks and humanitarian emergencies. Other applications for mortality MPS stem from the timeliness of the data. Continuous monitoring surveillance can be used as a complement to improve understanding of, and fill gaps in routine administrative data.

To date, our experience with collecting mortality data via MPS has been limited. However, through the RaMMPS project, we have established that these surveys are acceptable, feasible, and can produce plausible mortality estimates. Many of the methodological challenges, including sampling selection bias, can be addressed, and most of the existing mortality instruments from face-to-face surveys can be adapted for an MPS. Nevertheless, there is still much ground to cover in establishing best practices for cost-effective sampling strategies, data collection, and data quality assurance methods. Additionally, novel survey instruments should be considered for the rapid assessment of mortality in even smaller samples than those typically used for demographic surveys.

Credit: UNIKIN

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