Evaluating the feasibility and quality of data collected through rapid mortality mobile phone surveys in Malawi

Abstract

Background: Mobile phone surveys (MPS) are a promising alternative to face-to-face surveys for collecting demographic events data. However, the quality of these data remain uncertain. **Methods:** We conducted a nested MPS (non-random sample, N=1995) within the Karonga Health and Demographic Surveillance System (KHDSS), Malawi. We validate the MPS using individual-level comparisons to understand misreporting and omissions. **Results:** Respondents' MPS age data showed little evidence of heaping, with over 86% reporting own ages within 2 years of their KHDSS record. The MPS captured HDSS deaths of parents, and births and deaths of own children with >90% specificity and sensitivity, and child deaths with 89.5% sensitivity and 98.8% specificity, but overestimated household sizes. There was quality variation within the MPS data, with a higher odds of age misreporting among individuals who were older; interviewed at workplaces/school; or interviewed late in the afternoon. There were also differences in age data quality by interviewer characteristics. **Conclusion**: Despite differences, MPS produced data of comparable quality.

Keywords: Mobile phone surveys; data quality; mortality; fertility; HDSS; low and middle income countries.

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1. Introduction

Accurate and timely data is important as it helps in decision-making. In most high-income countries, well-established civil registration and vital statistics (CRVS) and other administrative systems generate timely high-quality health and demographic data. In Low and Middle-Income Countries (LMICs), however, getting reliable data remains a challenge. In such situations demographic and health data is usually generated from periodic in-person household surveys (e.g., Demographic and Health Surveys (DHS)). Most of these surveys have a lead-in time of several years due to the expenses and logistical challenges involved. During the period of rapid COVID-19 spread, usage of remote methods including mobile phone surveys increased rapidly to fill this information gap in LMICs. This move from traditional face to face/household-based data collection was necessitated because of interaction limitations posed by COVID-19 and the dire need of data for health interventions. Telephone surveys are an established way of collecting data in high-income countries but are relatively new (or recently expanding) in LMICs. Recent mobile phone based initiatives in LMICs have focused on a range of issues including implementation and evaluation of interventions, demographic research (particularly mortality and fertility), and diseases surveillance (1–5). Mobile phone subscriptions are increasing rapidly in Malawi and in LMICs in general (6). For example, the proportion with active phone subscriptions in Malawi increased from 21% in 2010 to 60% in 2021 (7). With rising phone ownership in most LMICs Mobile Phone Surveys (MPS) may present an opportunity for mainstream usage.

For the data generated in phone surveys to be adequate for meaningful research and decision making, it is important to understand how the data is generated and their quality. This paper describes the quality of MPS data relating to mortality and fertility in rural Malawi. Given that mortality data is usually collected from surviving relatives, we focus on quality of data collected retrospectively from surviving adult children, parents, and household members. We focus on reports on survival of relatives, their ages, time of death and ages at death as these are key ingredients in mortality analysis and their accuracy directly affects the resultant mortality estimates (8–10).

2. Methods and Materials

2.1. Data sources and data collection

We use two data sources: (i) a set of validation interviews from the Malawi Rapid Mortality Mobile Phone Surveys (RaMMPS) and (ii) Karonga Health and Demographic Surveillance Site (HDSS) data (11). The Malawi RaMMPS validation phone interviews were conducted with respondents purposefully sampled from the HDSS. A team of 5 interviewers (2 males and 3 females) with extensive experience collecting survey and mortality data including via phone conducted RaMMPS phone interviews (12,13). We use data from RaMMPS to compare number and timing of mortality events to HDSS data as a reference. The HDSS employs a three-way surveillance system involving i) trained community key informants ii) data collectors who follow up to collect detailed histories based on key informants reports and iii) annual HDSS-wide censuses (11,14).

2.2. Sample and sampling methods

RaMMPS sample was generated through non-random sampling among HDSS adults between 18 and 64 years old. As the main aim of RaMMPS was to validate mortality methods, interest was in people who had experienced events of interest. Where possible, we purposively oversampled people with deaths(s) among household members (past 6 months), siblings (last 5 years), parents (last 5 years), and children (last 10 years) for women of reproductive ages.

2.3. Analytical approach

2.3.1. Data linkage

We use data from the HDSS to validate data collected in RaMMPS. RaMMPS and HDSS data were matched by pre-survey generated unique identifiers, but the matches were verified by similarity in parents' names and differences between RaMMPS and HDSS age and sex. Parents names were matched using the default version of *MATCHIT* Stata command (15,16). In this default form *MATCHIT* generates a single similarity score (between 0 and 1) from jaccard scores generated from bigrams made from compared names. If 2 or more of parents' names gave a *MATCHIT* similarity score of 0.7 or more, we considered it a reasonable match and included it for further analysis. We then examined age and sex differences, and excluded those with >10 years difference and sex mismatch.

2.3.2. Analysis

We start by presenting descriptive analysis of the data. These quantitative descriptions are supported by audio recordings from selected cases with big differences in reports. We focus on four key markers of mortality and fertility data deficiencies namely; age misreporting; date misreporting; listing and survival status (classification) errors (8,9).

Age misreporting: Quality of age reporting is the main outcome, as age is generally indicative of the quality of the rest of the data. Firstly, to show preference and/or avoidance of ages ending in specific digits, we calculate Myers Blended Index (17,18). The Myers Blended Index works on the basis that, if no terminal digit is preferred, then there should be approximately equal number of people with ages ending in each of the 10 digits. It has a theoretical range of 0 (no preference) to 90 (all end in one digit). We use the *DemoTools* package in R to compute the indices. Secondly, we look at age differences between age reports in RaMMPS and those in HDSS for respondents. We calculate proportions of respondents whose ages are equal, 1-2, 3-5, 6-10, or more than 10 years apart. Accuracy of parents' age data is reported elsewhere.

Date misreporting: Date of events errors have the potential of moving an event into or out of selected reference period. Using specificity and sensitivity analysis we look at how close parents' dates of death for matched parents in RaMMPS are to dates in HDSS. We further look at distribution of births reported in RaMMPS over calendar months between 2018 and 2022.

Listing errors: Listing errors could occur when people who meet required criteria are excluded, or others who do not meet the criteria are included. We analyze possible inclusion and exclusion errors in RaMMPS by looking at monogamous household size differences between RaMMPS and HDSS and children born to women between 2018 and the date of the interview while mothers had uninterrupted stay in the HDSS.

Survival status misreporting: This occurs when a person who is dead is reported as alive and vice versa. For this analysis we focus on data on parents' survival, and survival status of confirmed births in the last 5 years during mothers' uninterrupted HDSS residency.

2.4. Ethics

The RaMMPS study was reviewed and approved by the National Health Sciences Research Committee in Malawi (NHSRC Ref: 22/05/2918) and LSHTM (LSHTM ethics ref: 26396).

3. Results

3.1. Survey participation

Out of 3,939 sampled HDSS residents, only 51.9% (2,043) were successfully interviewed. Reasons for non-participation were: no phone number identified (n= 293); not attempted (n= 55); ineligible due age (n=10); phone unanswered, unreachable or out of service (n=1,317); refused (n=6); incomplete interviews (n=14); not intended respondent (n=120) or not interviewed due to other reasons (n=79). An additional 50 records have been removed from the analytical sample because they were duplicated (n=3), had age differences of more than 10 years (n = 43) or had different sex recorded in the HDSS (n= 5).

3.2. Participants characteristics and interview circumstances

As shown in Table 1, most participants were females (60.9%), owned the phone used in the interview (69.0%), married (68.6%), had no electricity (70.4%) and lived in homes roofed with corrugated iron sheets (82.9%). Almost all respondents (99.0%) reported having some form of education, with over 93% attending senior primary school and higher. The youngest age group (18-24) was smallest (21.7%), and the oldest 45-64 was biggest (30.1%). Most respondents reported receiving the interview call while home (72.9%). Many interviews were completed late morning (42.7%) or late afternoon (29.2%), with only 4.5% done after 5PM. Despite interviewers being assigned an equal number of telephone numbers and having roughly the same time, interviewers A (17.9%) and C (17.4%) completed fewer than the rest.

[Table 1 here]

3.3. Age and age misclassification for respondents

Overall, both RaMMPS and HDSS showed similarly low Myers' Blended Index for age heaping of 3.3 and 2.5 respectively, suggesting that about 3.3% in RaMMPS and 2.5% in HDSS may have shown preference for different terminal digits. Despite showing overall high correlation with HDSS ages (0.99, p-value <0.001, n=1,995), 47.6% of all interviewed participants had different ages in HDSS (Figure 1), distributed as follows: 34.0% within 2 years; 8.5% 3-5 years difference; 3.0% 6-10 years difference; and 2.1% more than 10 years. Of those with different ages, 70.4% (684/972) had higher ages in HDSS.

[Figure 1 here]

Analysis of selected interview audio recordings showed that huge differences in participants' ages were due to interviewer mis-recording, poor audio quality, lack of sufficient probing or respondents misreporting. For example, despite establishing that respondent (R) below may have been 61 [in 2022], interviewer (I) still recorded 57 against 46 in HDSS. This interviewer also showed no interested in month/day of birth which could have given a more accurate estimate.

I: *How old are you now?*
R: *Me?* [pause] *57*
I: *What year were you born?*
R: *51*
I: *1951?*
R: *Yes.*
I: *1951 or 19 Six 1?*
R: *1961*
I: *Then you are 61 years old.*

3.4. Counts and quality of reports of mortality events among parents, children, and household members

3.4.1. Parents

Amongst parents living in HDSS and those who died, the specificity and sensitivity of RaMMPS to capture deaths was high. For example sensitivity for mothers (N=1,331) was 99.5 (95% CI = 99.1 to 99.9) and specificity 99.7 (95% CI = 99.4 to 99.9). For fathers (N=1,148), sensitivity was 99.4 (95% CI = 98.9 to 99.8) and specificity 99.0 (95% CI = 98.4 to 99.6).

Among parents' who died in RaMMPS, only a small proportion were unable to recall the year of death of their mothers (15/718, 2.1%) and fathers (24/1,219, 2.0%) in RaMMPS, close to 50% of these were not HDSS residents or had no HDSS data on mothers (46.2%) and fathers (47.1%). Among deceased mothers (53.8%) and fathers (52.9%) who were HDSS residents or had data in the HDSS, accurate year of death was reported for 68.1% (269/395) and 67.8% (434/640) for mothers and fathers respectively. 89.8% and 90.1% reported year of death within 2 years for fathers and mothers respectively. We observed relatively high correlation between HDSS and RaMMPS for both mothers (0.80, $p<0.001$, n=395) and fathers (0.86, $p<0.001$, n= 640) [Figure 3]. Generally, there was higher agreement in year of deaths for deaths in the recent past for both mothers and fathers.

[Figure 3 here]

Audio recordings suggest that differences in year of deaths were due to both interviewer and respondent errors, inaccurate responses and calculations, and insufficient probing. In the extract

below, even if the more accurate entry of 1993/94 was recorded, it would have been 13 years earlier.

I: *What year did your father die?*
R: *It's long ago, I can't remember.*
I: *You can't remember? How old were you when he died?*
R: [pause] *I was **20***
I: *You were born in ...*
R: *...**1973***
I: *[calculating] Then he died in **1983**.*
R: *Yes*

3.4.2. Household members

Reported household sizes in RaMMPS were on average larger than in HDSS (Figure 4). The differences in sizes ranged from 1 to 13 members (Figure 4D), with only about 32.3% households having the same number in both records. Including recent visitors (past 3 months) increased the differences in household sizes (Figure 4B and 4C).

[Figure 4 here]

Similarly, reported number of household deaths "over the past 3 months" in RaMMPS (80) were substantially higher than those captured in HDSS over 91 days before survey (12; 9 of which were also reported in RaMMPS). Among all the RaMMPS deaths, only 21/80 were matched by name to HDSS household deaths, however 12 of these happened before the period of interest according to HDSS. Just over 96.3% of those without a death in HDSS reported accurately in RaMMPS (i.e. no death), compared to 66.7% (8/12) of those with a recorded death in HDSS who reported accurately (Figure 4*).

[Figure 4* here]

Some recordings suggested that participants may have been in different households than the ones they were sampled from or part of polygamous families. As can be seen from the extract below, this woman seems to have changed households recently:

I: *Who is the head of your household?*
R: *Where I am now? My husband.*
…
I: *Apart from the child you have reported, how many other people stay in your household?*
R: *Where we are now? We are 17.*
I: *Apart from you, there are 17 people?*
R: *Yes.*

3.5. Children ever born and deaths amongst children

3.5.1. Completeness of birth reports in RaMMPS between 2018 and 2023.

After removing records for women who had no recorded births in RaMMPS and HDSS between 2018 and 2023, 520 births from 442 women, and 504 births from 428 women remained in RaMMPS and HDSS data respectively. 418 of these women had records in both datasets: 10 women (11 births) were only in HDSS and 22 women (24 births) only in RaMMPS within the period. These 32 women are not included in the analysis below.

3.5.1.1. Does the number of births per woman within the reference period match?

Of the 418 women with recorded births in both datasets within the period, 401 (95.9%) had same number of babies born in both records (464), 9 (~2.2%) had more children born in HDSS, and 8 (1.9%) had more in RaMMPS. The RaMMPS questionnaire had high sensitivity (89.4; 95% CI = 86.4 to 92.4) and specificity (98.6; 95% CI = 97.4 to 99.7) to capture births recorded in the HDSS since 2018.

3.5.1.2. Do sex of child and survival status match across sources?

Focusing on the 401 women (464 live births) who had equal number of children in both records, less than 1% (3 children) had mis-specified sex in RaMMPS when matched by birth order. The RaMMPS questionnaire had sensitivity of 98.7 (95% CI: 97.7 to 99.7) and specificity close to 100% to capture the true sex of children as recorded in HDSS. On the other hand, 2.8% of children had misclassified vital statuses (n=13; 6 dead only in RaMMPS, 7 dead only in HDSS). These corresponded to sensitivity of 87.2 (95% CI: 84.7 to 90.7) and specificity of 98.5 (95% CI: 97.4 to 99.6).

3.5.1.3. Reporting of dates and ages

Even though 55 (11.9%) children didn't have the same year of birth in the 2 records, patterns of month of birth were similar (Figure 5). In both data sources births were higher in May, July, and October, and lower in September, December, August, and February.

[Figure 5 here]

Reported ages of children showed high agreements in both records, with 86.4% of the records having the same age (in completed years) in both records (Figure 6). Only 62/464 (13.6%) births had different age: 30 (6.5%) were younger and 32 (6.9%) older in RaMMPS compared to their age in HDSS. Similarity in reported ages seemed to improve as the children grew older.

[Figure 6 here]

Close to 80% and more than 90% had same month and year of birth respectively as recorded in HDSS, with Full Pregnancy Histories (FPH) performing relatively better than Truncated Pregnancy Histories (TPH) (Figure 7).

[Figure 7 here]

3.6. Regression analysis results: Quality of age reports

Figure 8 shows the results of logistic regression for the effect of respondent, interview, and interviewer factors on reporting exact same age while controlling for marital status, sex, wealth, and interviewer sex. There was strong evidence suggesting that participants aged 25-34 (aOR 1.52, p-value 0.007); 35-44 (aOR 1.64, p-value 0.002) and 45-64 (1.47, p-value 0.017) had higher odds of reporting own ages different from HDSS compared to the youngest age group (18-24). We found no evidence to support differences by education. There was strong evidence to support that workplace/school calls were likely to produce different ages compared to home calls. Similarly, despite odds ratios increasing with time of interview, only those conducted after 5PM had significantly higher odds (aOR 1.94, p-value = 0.005) of producing defective age data compared to early morning calls. By Interviewer, A's age reports corresponded less frequently with HDSS than other interviewers.

[Figure 8 here]

4. Discussion

Surveys are usually the main source of demographic and health data in LMICS. Increasing ownership of mobile phones provides an opportunity for cheaper, quicker, and easier data collection through phone surveys. In this study, we assess the quality of demographic data generated from phone surveys by comparing it to data collected over the past 21 years in the Karonga HDSS in Malawi for the same individuals. Overall, the correspondence between RaMMPS and HDSS data in terms of age reports for respondents, parental survival and birth histories was high. Data on year of death for matched parents was better for recent deaths. Among matched women of reproductive ages, the majority had same number of births in both datasets during their HDSS residency between 2018 and 2022. Data on survival of these children over this period was also of high quality. Data on household composition was markedly different across the two datasets, with RaMMPS generally overestimating household sizes and reported more household deaths.

Unlike other mobile phone studies and other studies conducted in Malawi and elsewhere (12,19–21), there was little evidence of extensive age heaping for respondent's own age. One aspect that may explain lower age heaping in RaMMPS (KHDSS) compared with other mortality MPS studies could be the respondents' previous survey experience. Participants in this study were chosen because they are subject to ongoing surveillance and ad-hoc research studies. They are, therefore, more likely to have been asked similar questions several times in the recent past, as such their own ages may be easier to recall. This, therefore, might explain why parents ages are not of same quality (paper in preparation), as these are not frequently asked, on top of it being already a harder question to answer considering its retrospective nature. Audio recording data highlight that some of the errors could potentially have been prevented with more probing, careful recording, and calculations.

Vital status errors were nearly non-existent for parental survival. However, our observed patterns of date errors are similar to those observed in face to face studies on adult mortality elsewhere, typically arising from recall errors (8,22). Some differences can be due to misidentification errors, where participants may report on people who are not their biological parents. Errors were, however, minimal for births over the last 5 years. Our observed specificity and sensitivity were comparable to those observed in non-MPS validation of neonatal and postnatal mortality via birth histories in Guinea-Bissau (9).

Despite other modules producing data of reasonably good quality, the RaMMPS household module overestimated household sizes and elicited more deaths. RaMMPS participants at times reported deaths that happened outside the reference period. Other errors may be due to differences in how households are defined (or understood) in RaMMPS versus in HDSS and migration within and outside the HDSS. Additionally, where enumerators have a chance to observe in HDSS, RaMMPS enumerators purely relied on what respondents reported.

Similar to analysis of DHS surveys in SSA, self-age reports were rougher for older participants (23). As both interviewers and respondents are more likely to be more fatigued as the day goes, the worsening of age data with time were not very surprising. Differences in data quality by interviewers were also observed in other studies (24). We suspect differences in behaviors, work ethic and circumstances in which they undertook the work may have contributed to this (25). The lack of noticeable differences by education goes against previous research evidence, which shows that the more educated usually provide data of higher quality. However, this could probably be explained by our unique set of respondents, who are generally more exposed to research of this kind, and therefore, more familiar with the data asked from them.

Strengths and Limitations

The main strength of this work lies in its design and utility. We have been able to link RaMMPS respondents to their HDSS records and evaluate the quality of data generated in MPS. This type of validation study will be key to improving implementation of telephone surveys as they are likely to become more important going forward. Secondly, the usage of audio records to supplement quantitative analysis makes this dataset rich and unique. The audio recordings provide additional insights which can't be obtained from the data and interviewer debriefing.

This study has several limitations. Firstly, even though interviewers were instructed to verify respondents' identity before interviewing them, it is possible that some people may have slipped through the screening questions. Secondly, even though we are comparing information on the same events, the question used to generate the data and the way of data collection is different. Thirdly, we asked about parents and children, some of whom live outside the HDSS. Our comparison could have been more strengthened if the same questionnaire had been used in a face-to-face interview. We also acknowledge validation participants' previous survey experience which may have influenced their response to the survey.

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Figures and Tables

Table 1: Participants and interview characteristics

	Respondents (N = 1995 (%))	
Sex		
Male	780	(39.1%)
Female	1215	(60.9%)
Age group – respondent		
18-24	433	(21.7%)
25-34	482	(24.2%)
35-44	480	(24.1%)
45-64	600	(30.1%)
Highest education		
None/Junior primary	135	(6.8%)
Senior primary	940	(47.1%)
Secondary and higher	920	(46.1%)
Married?		
Married	1368	(68.6%)
Formerly married	324	(16.2%)
Never married	303	(15.2%)
Roofing material		
Grass or other	342	(17.1%)
Corrugated iron	1653	(82.9%)
Electricity		
Yes	589	(29.5%)
No	1404	(70.4%)
Other	2	(0.1%)
Owns phone used		
Yes	1376	(69.0%)
No	618	(31.0%)
Refused	1	(0.1%)
Call location		
Home	1455	(72.9%)
Workplace/ school	191	(9.6%)
Other location	133	(6.7%)
On the road	147	(7.4%)
Market	69	(3.5%)
Time interview ended		
<10:00hrs	472	(23.7%)
10:00-13:59hrs	851	(42.7%)
14:00-16:59hrs	583	(29.2%)
>=17:00hrs	89	(4.5%)
Interviewer		
A	358	(17.9%)
B	421	(21.1%)
C	348	(17.4%)
D	429	(21.5%)
E	439	(22.0%)

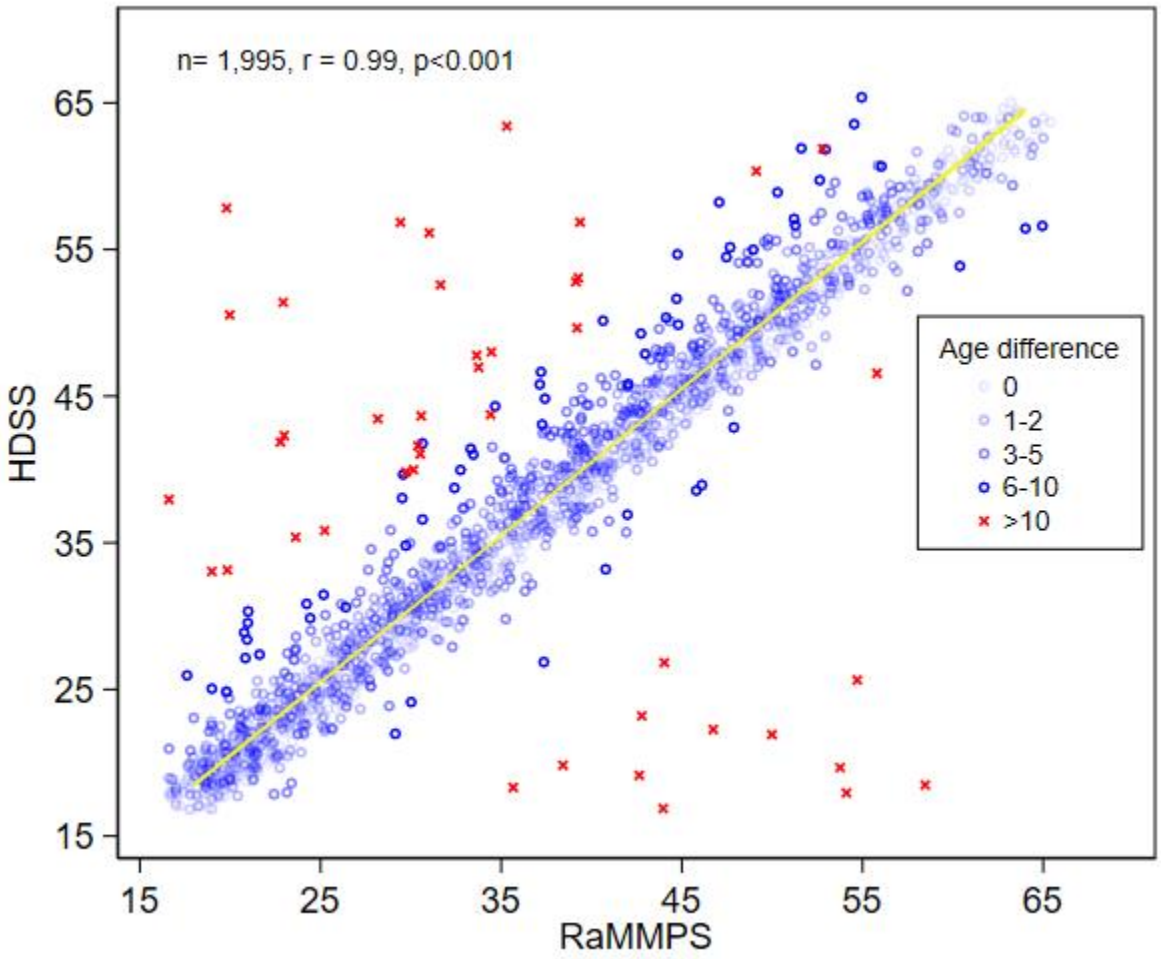

Figure 1: Reported respondent's current ages in RaMMPS and HDSS

Note: *Plot shows jittered scatter points of RaMMPS and HDSS ages. Red crosses (x) are for participants excluded from further analysis due to higher age differences (>10 years) and sex mismatch. Plot also includes a linear fit (excluding xs) with 95% Confidence Interval (CI) in yellow.*

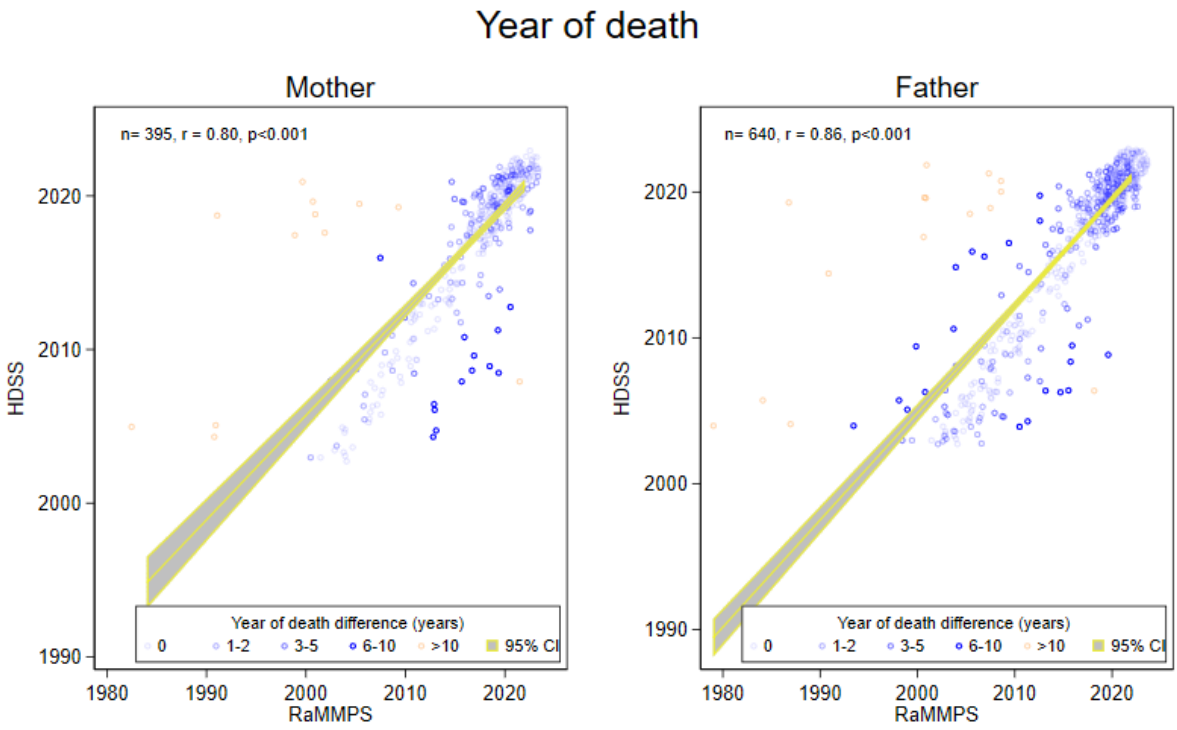

Figure 3: RaMMPS and HDSS agreement in reports for year of death for fathers and mothers.

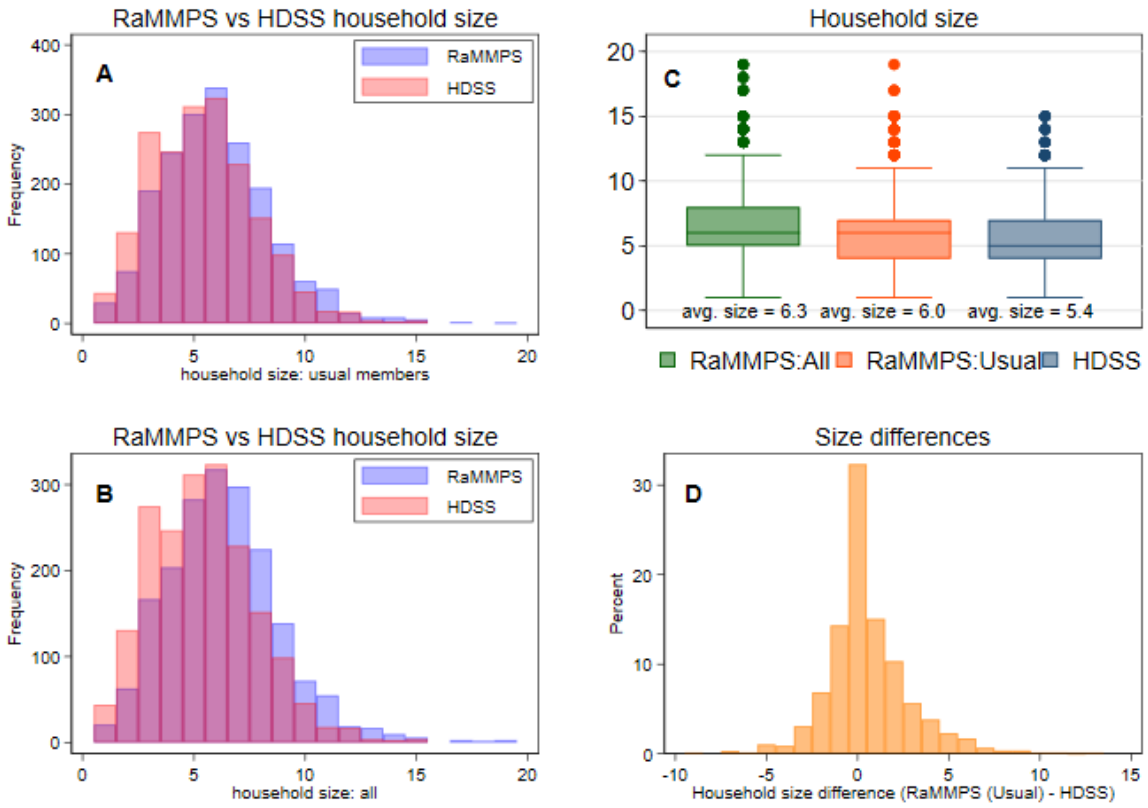

Figure 4: Household composition in RaMMPS vs HDSS.

Note: *Panel A uses data from "How many children below age 5/ and people above 5 are currently living in your household?" questions minus new migrants in the past 3 months. Panel B and D include new migrants and data from extra probing. Panel C used both: usual and all current members. All graphs exclude data for respondents with multiple households, and those who were recorded as out-migrants in HDSS on interview day.*

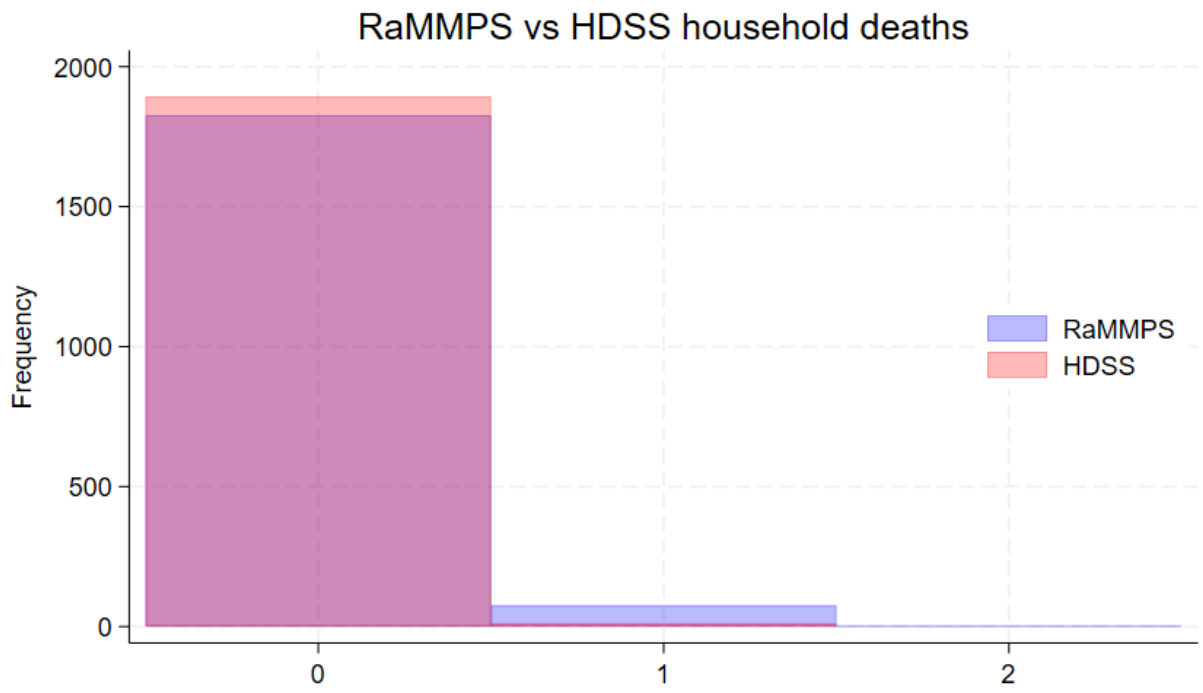

Figure 4*: Household deaths in RaMMPS vs HDSS.
Note: *All graphs exclude data for respondents with multiple households, and those who were recorded as out-migrants in HDSS on interview day.*

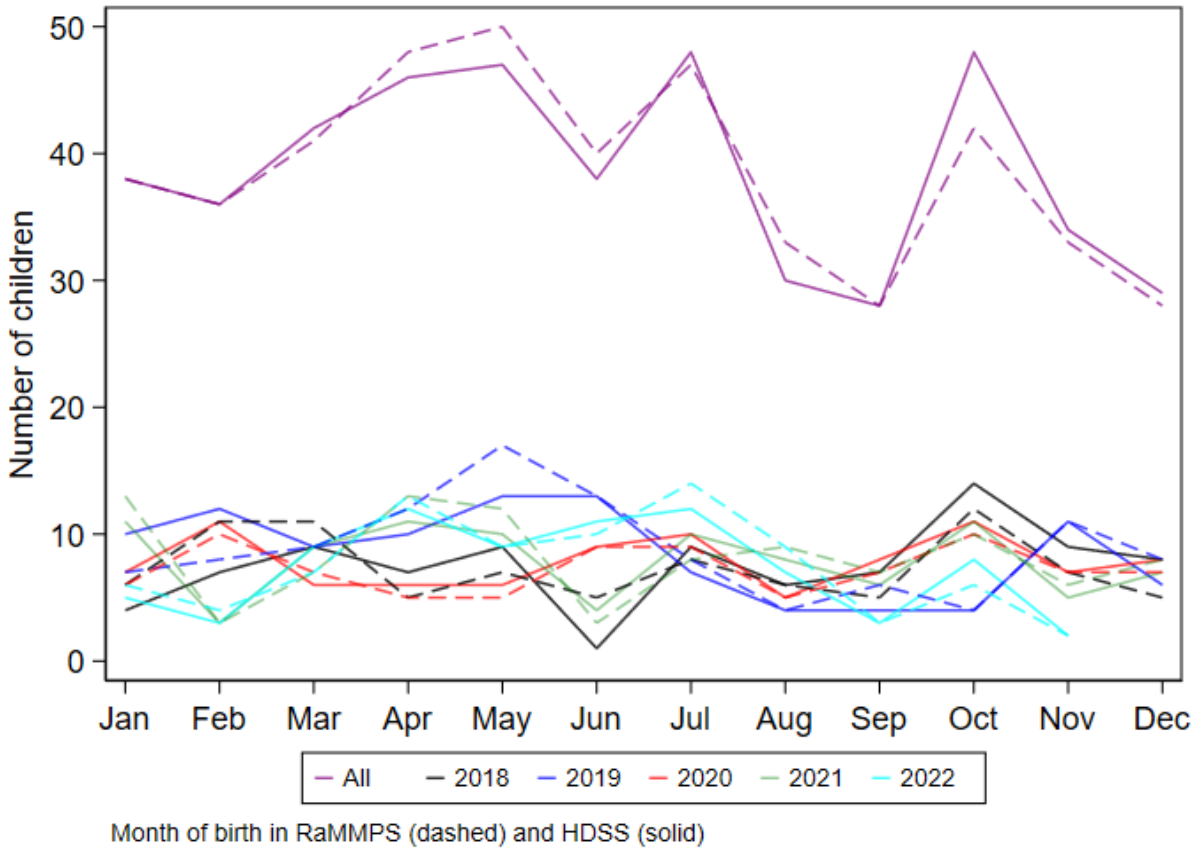

Figure 5: Month of birth reports in HDSS and RaMMPS between 2018 and 2022.

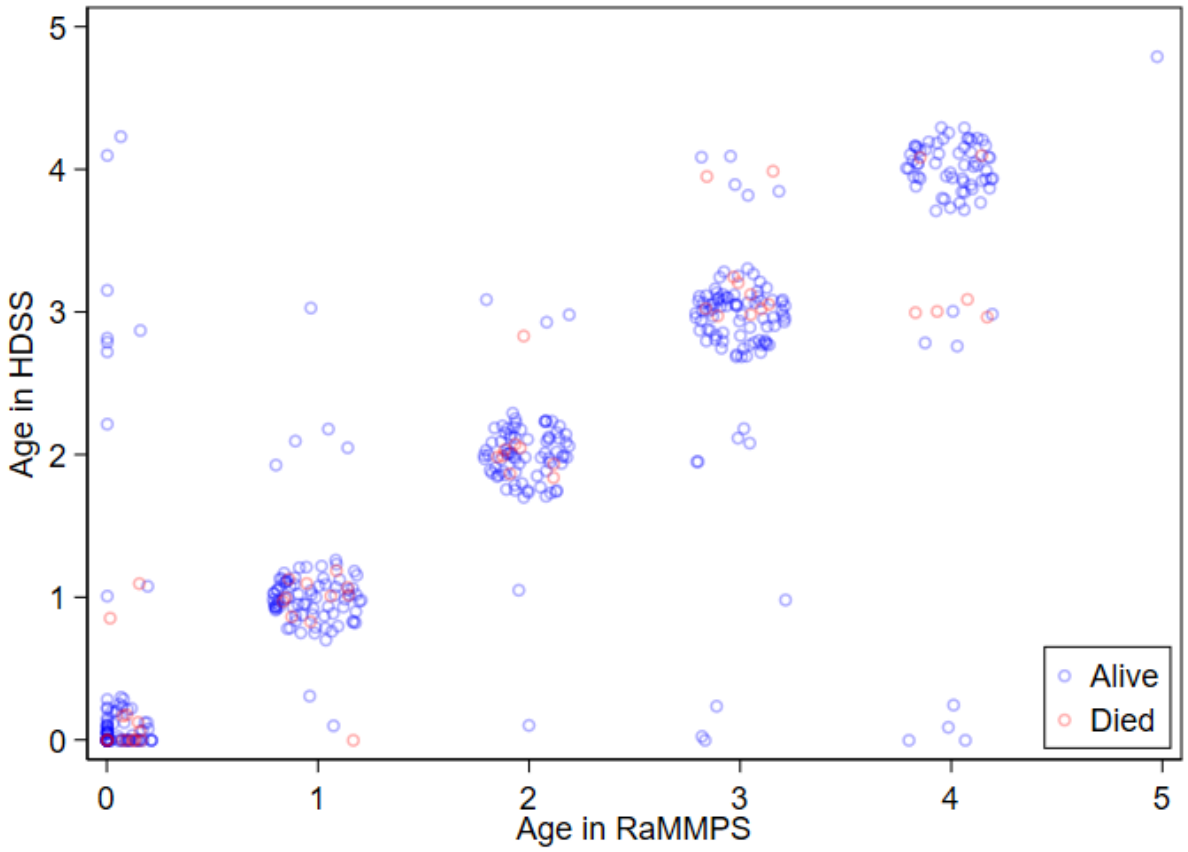

Figure 6: Completed years since birth in RaMMPS and HDSS (2018- 2022)

Note: *"Completed" ages for those who died are calculated from their date of birth as if they were alive at the day of the interview. The scatter points are jittered, i.e., points around (1,1) are all for 1-year olds in both datasets.*

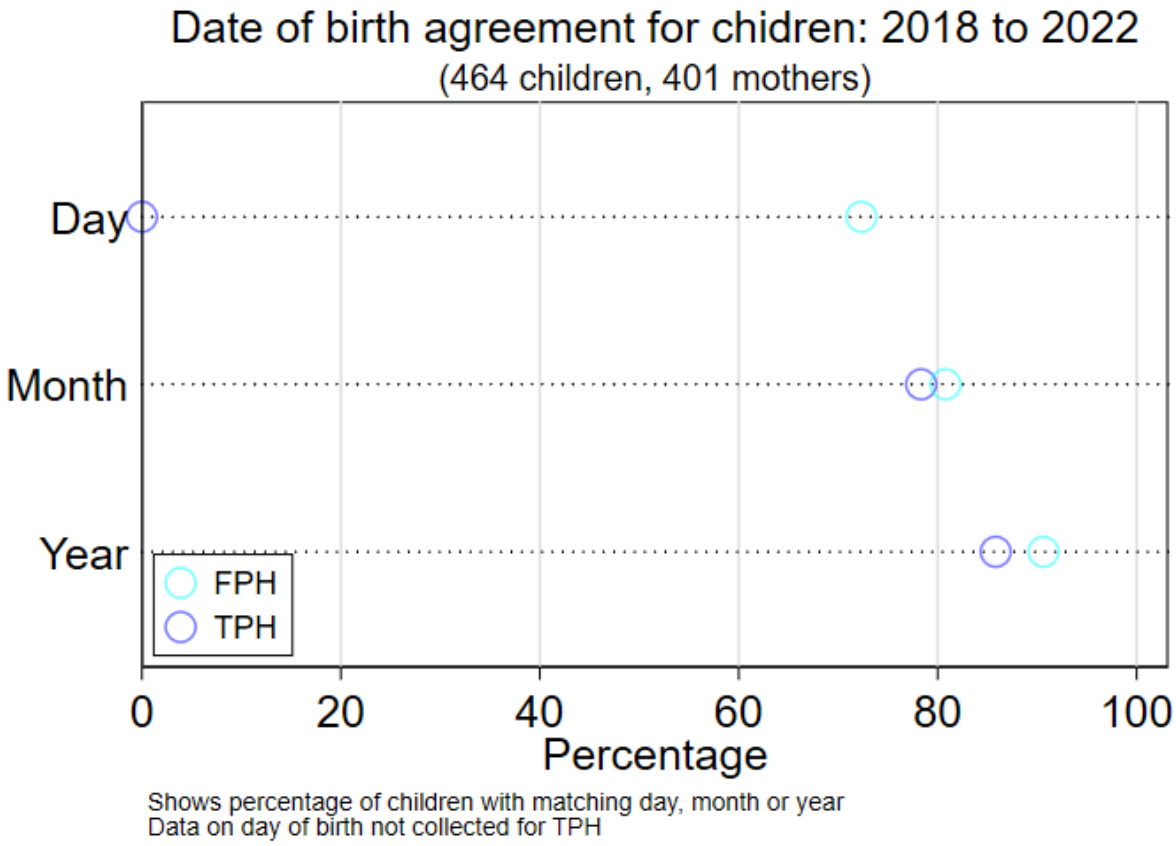

Figure 7: Proportion of children with the same date of birth (day), month of birth (month) year (year) by pregnancy questionnaire used compared to HDSS.

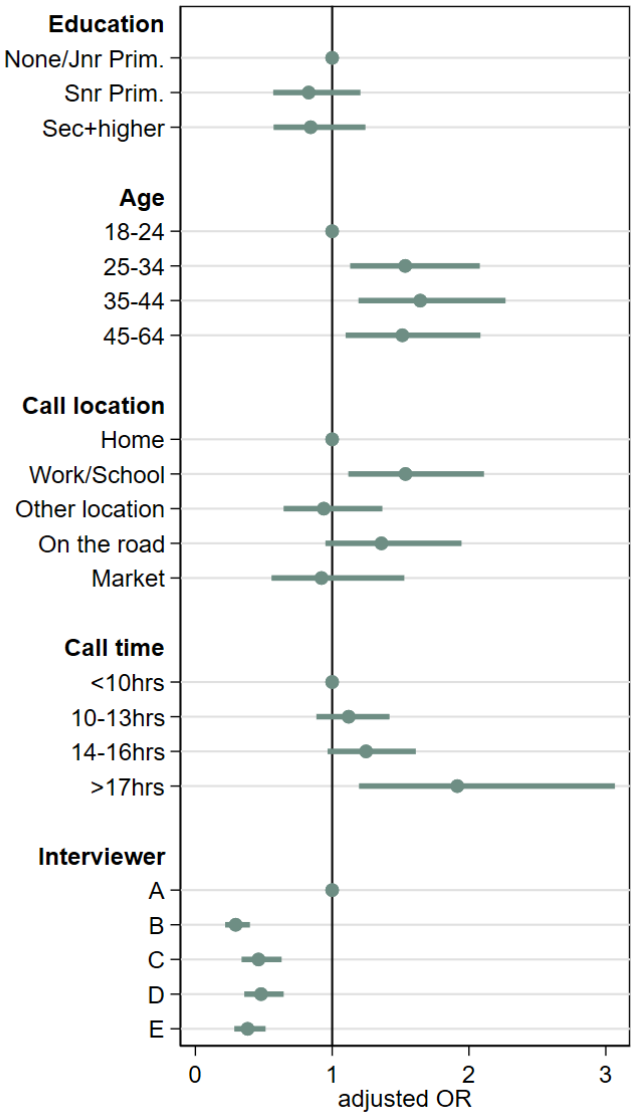

Figure 8: Adjusted Odds Ratios (aOR) for disparity in respondents own age reports