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Improving adult mortality data collection through household surveys and population censuses: a set of recommendations

Background document
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Introduction: The need for better data on adult mortality

1. In countries which have well-established civil registration system, estimates of adult mortality are routinely generated from data collected through death registration systems. This allows tracking improvements in population health, as well as the impact of epidemics in near real-time (e.g., 1). In other parts of the world however, these systems are often deficient and seldom yield reliable monthly or annual series of vital statistics (2). In the medium to long-term, continuous effort and investment to improve the functioning and completeness of civil registration systems for countries where these are incomplete or unreliable are essential (3,4). Achieving high levels of death registration (>80%) is thus one of the key indicators of progress towards the sustainable development goals (SDGs). In the short-term however, additional data must be collected to fill gaps in civil registration.

2. Surveys and censuses constitute key sources of mortality data in countries with limited CRVS systems. They generate mortality data primarily by asking respondents to report the survival status of (some of) their close relatives (5). Demographers and statisticians then use these data to reconstruct periodic snapshots of recent mortality levels (6). This approach has known limitations. In particular, surveys and censuses are conducted infrequently: Demographic and Health Surveys (DHS) are conducted approximately every 5 years, whereas censuses are (ideally) conducted every 10 years. In the intervals between these inquiries, alternative estimates are rarely available. These data sources thus do not allow mortality estimates on a timely manner.

3. Nonetheless, over the past decades, demographers and statisticians have made considerable progress in refining methods and models to estimate mortality among children under-5 from survey and census data (e.g., 7–9). They have also developed tools to measure maternal mortality among women of reproductive ages (15-49 years old) using similar data sources (10–12). By comparison, other components of mortality at adult ages (e.g., old-age mortality) are often extrapolated from childhood mortality indices and model life tables.

4. There are several reasons why innovations in survey/census methods are needed, that would strengthen and expand the measurement of adult mortality in countries with incomplete civil registration:

   • As under-5 mortality has declined significantly in recent years (13), an increasing proportion of all deaths now occur at adult and older adult ages;
   • With the adoption of the sustainable development goals (SDGs) in 2015, and other global health objectives, several new indicators of progress in population health are related to adult mortality and are not adequately measured by existing surveys and censuses;
   • The direct and indirect effects of the COVID-19 pandemic, and other health crises, on mortality disproportionately affect adults, particularly those at older ages.

5. In this background paper, our main objective is to identify possible recommendations for improving the design and implementation of upcoming surveys and censuses in countries with incomplete civil registration, to produce more timely and reliable data on adult mortality, especially during health crises or disasters. In section 1, we will briefly outline existing methods of data collection on adult mortality, that are often incorporated in surveys and censuses. In section 2, we will describe challenges that have affected the collection and analysis of survey/census data on adult mortality. We will consider the impact of the COVID-19 pandemic on these challenges. In section 3, we will review the new data needs
created by the adoption of the SDGs and the spread of the COVID-19 pandemic. In section 4, we will review recent innovations in the collection and analysis of survey/census data on adult mortality. Some of these innovations address key data gaps and have been thoroughly tested. They are prime candidates for implementation in upcoming surveys and censuses in countries with incomplete civil registration. Other methodological innovations are in earlier stages of development. Their potential benefits however justify further testing. Based on discussions in the preceding sections, in section 5, we will then formulate a list of possible recommendations for the improvement of survey/census data on adult mortality. Section 6 lists areas that experts are invited to provide input on, and section 7 is a brief description about the next steps following the Expert Group Meeting.

6. It has to be outlined that fine-tuning censuses and surveys may not be used as a replacement for a fully functioning civil registration. The newly launched United Nations model of the UN Legal Identity Agenda – a holistic approach to civil registration, vital statistics and identity management, whereby all countries are urged to ensure universal registration of all vital events, such as births and deaths, translated into regular, comprehensive and granular vital statistics and ascertaining legal identity to all from birth to death – clearly underscores the multi-dimensional importance of implementing this model in terms of producing not only accurate quantification of fertility and mortality; it encompasses constructing the backbone of contemporary national statistical systems, opening the doors for a full exercise of basic human rights and enabling conferring legal identity to all.
1. Brief review of methods used for estimating adult mortality through surveys and censuses

8. In demographic analysis, “adult” mortality usually refers to deaths that occur at ages 15 years and older. Some analysts reserve the term “adult” mortality for the age range stretching from 15 to 59 years old, whereas mortality above age 60 is referred to as “old-age mortality”. In this background paper, we adopt the former definition of adult mortality, and we consider that old-age mortality is a subset of adult mortality. The key summary indicators of all-cause mortality at adult ages include primarily $45q_{15}$, i.e., the life-table probability of dying between the ages of 15 and 59 years old, and $20q_{60}$, i.e., the life-table probability of dying between the ages of 60 and 79 years old.

9. The methods used to generate estimates of adult mortality typically fall into two categories: direct and indirect. Direct methods are those that require information on deaths and the population at risk over a well-defined period, both classified by age and sex. They use these data to calculate death rates in a standard manner, i.e., by dividing a number of events by a count of person-years lived. Indirect methods, on the other hand, do not require detailed data on ages and dates of deaths. Instead, they rely solely on information about the survival status (alive or not) of some of the relatives of an index person (e.g., a survey respondent). In conjunction with various assumptions about population dynamics, indirect methods allow inferring conditional probabilities of surviving between two adult ages. There are several technical overviews of direct and indirect methods for the estimation of adult mortality, including in particular the manual on Tools for Demographic Estimation, publicly available at: http://demographicestimation.iussp.org/

1. Figure 1: example of questions asked about siblings during SSH, adult and maternal mortality module of the DHS

1.1. Direct methods

10. In recent years, direct methods have become the predominant approach to estimating adult mortality from survey or census data. Two methods, in particular, are frequently implemented: siblings’ survival histories (SSH) and recent household deaths (RHD). Both methods begin by enumerating a well-defined population, by age and sex. In doing so, the SSH method focuses on the maternal siblings of a survey respondent, whereas the RHD method focuses on members (former) of a respondent’s household. Then, both the SSH and RHD collect essential information on the deaths that have occurred among these population (i.e., age at death and date of death/time since the death). The resulting SSH
and RHD data can then be used to estimate mortality rates directly: the reported deaths form the numerators of age-specific mortality rates, whereas reported data on ages and dates are used to calculate the numbers of person-years lived at risk of dying in the enumerated populations (denominators).

11. SSH begin by asking respondents to list all their maternal siblings, i.e., brothers and sisters born to the same biological mothers. After establishing this list, the interviewer asks a series of questions about each reported sibling (figure 1). First, they assess the sex and survival status of each sibling (alive or not). Second, they gather data on the age of surviving siblings, and on the age at death and date of death of deceased siblings. SSH are usually recommended for inclusion in (relatively) small sample surveys, particularly in countries with high fertility (10). This is so because, in such settings, respondents frequently report on the survival of multiple siblings, thus generating a surrogate siblings' dataset that is much larger than the initial sample of respondents. Most SSH datasets have been collected as part of the DHS program, in samples ranging from 5,000 to up to 40,000 households. To date, more than 200 DHS have included this data collection module. SSH have also been collected in other survey programs including the World Health Surveys (WHS), and the Multiple Indicator Cluster Surveys (MICS).

12. RHD, on the other hand, usually begin with the collection of a complete household roster, that is a nominative list of all the usual members of a household (or list of persons who were present at the household including visitors). For each listed resident, interviewers collect data on gender and age, as well as possible socioeconomic characteristics (e.g., education). Whereas SSH data recorded deaths among siblings irrespective of their date of occurrence, RHD questions only ask household informants to list the (former) usual members of the household who have died during a recent time period. The length of this reference period is usually 12 months. For each death, RHD also collects additional information such as age at death or date of death. Collecting RHD has been recommended practice in population censuses since 1997, when the principles and recommendations for the 2000 rounds of censuses were issued (14).

13. RHD have also been collected in DHS, as well as the Population-Based HIV Impact Assessment (PHIA), a cross-country survey program aimed at tracking global progress against the HIV epidemic (15,16). Some large sample surveys, such as the Bangladesh Maternal Mortality and Healthcare Survey (BMMS) in Bangladesh or the National Family and Health Survey in India, have also collected RHD repeatedly. Figure 2 provides an example of the collection of RHD in surveys and censuses.

14. SSH data constitute the primary source of data on adult mortality for many countries with limited civil registration (12,17) SSH data have also been used to evaluate the effects on population health of
major global health initiatives, conflicts and disasters. For example, SSH were used to track how many deaths were averted by the US President’s Emergency Plan for AIDS relief (PEPFAR) in focus countries (18), or to evaluate the toll of wars and genocides on several continents (19). RHD have been used extensively to measure progress in reducing maternal mortality (11,20). In countries where large-scale surveys or censuses have included RHD in conjunction with more detailed questions about the timing of deaths among women of reproductive ages, RHD have allowed computing sub-national estimates of maternal mortality (21). This is an essential insight for maternal and adult health programs, as it allows better targeting scarce resources in preventing maternal deaths. Recently, RHD have also been used to investigate socioeconomic differentials in adult mortality, e.g., differences in life expectancy between castes in India (22,23).

1.2. Indirect methods

15. Some censuses and surveys also collect data on adult mortality, by asking whether the parents of respondents or household members are still alive. Demographers have developed an indirect method to transform these data into estimates of several indicators of adult mortality (24–27). It requires computing the proportions of respondents whose mother/father is alive by age of the respondent. Then, orphanhood data allow measuring the conditional probability that a parent survived after the birth of the respondent for a duration equal to the age of the respondent. That is, the available orphanhood data allow estimating \[ \frac{l_{\alpha+n}}{l_{\alpha}} \] where \( \alpha \) is the mean age of childbearing, \( n \) is the age of the respondent at the time of the survey/census, and \( l_{\alpha} \) is the number of surviving members of the life table at age \( \alpha \). Estimates of the mean age at childbearing might be obtained from other sections of the census/survey questionnaires, or from other sources.

16. In many surveys such as the DHS, orphanhood questions are solely asked if the household member is younger than 15 or 18 years old. These data might be used to estimate early adult mortality, e.g., up to age 35 years old for women and up to age 45 or 50 years old for men (28). Then, survival to older adult ages might be inferred via the use of model life tables. The orphanhood information collected during the DHS and other surveys is also often used to investigate the sociodemographic characteristics of orphans (29,30), and/or track the effects of health interventions on the living arrangements of children (31,32). In other surveys and censuses, respondents might also be asked to state whether their own parents are still alive, and/or whether the parents of all other household members (regardless of their age) are still alive. These data allow estimating adult mortality over a wider age range.

17. While the orphanhood method is now less commonly used than SSH and RHD to estimate mortality rates at adult ages, it has provided important insights into the levels and trends of adult mortality in many countries with incomplete death registration. For example, orphanhood data helped identify the rapid rise in adult mortality associated with the HIV epidemic in eastern and southern African countries (33). In some settings, this approach might also provide estimates that are more reliable than those obtained from direct methods (34). Recently, the indirect orphanhood method has been used to investigate rural-urban disparities in adult mortality in African countries (35), as well as socioeconomic differentials in adult mortality in India (36).
2. Challenges related to data collection and estimation

18. In most countries with largely complete civil registration, data from death records provide the information needed to calculate the numerator of death rates, whereas denominators are obtained from census data or population registers. In such settings, the main issues associated with the measurement of (all-cause) adult mortality include delays in data processing in civil registration systems. In countries with incomplete CRVS data, but where the coverage of death registration is sufficiently high, and recent census data are available, a similar approach can be adopted, with adjustments for incomplete death registration and census enumeration (37). In countries where mortality statistics are produced primarily from survey and/or census data, challenges are more diverse and complex. The data required to estimate mortality rates are often generated retrospectively, every few years. This frequency is too low to track mortality trends in a timely manner. In addition, the estimates produced from retrospectively collected data are vulnerable to selection bias and reporting errors. Surveys that include questions about adult mortality also often have limited sample sizes. In this section, we review these challenges, and discuss how they might have been amplified by disruptions caused by COVID-19 and other health crises.

1. 2.1 Low-frequency data collection

19. The surveys and censuses which collect adult mortality data in countries with limited civil registration only occur periodically. Typically, DHS are conducted every 5 years in the countries that participate in the program. In some countries, continuous DHS might be conducted annually (e.g., Senegal). However, the questions on adult mortality have not been included every year in these countries. Censuses are conducted normally every 10 years, per recommendations. In many countries, however, the interval between two censuses might be longer due to planning complexities, difficulties in securing required funds and/or other events that might delay implementation (e.g., conflicts, natural disasters, epidemics).

20. Figure 3 shows the example of Guinea, where a large Ebola outbreak occurred between the end of 2013 and May 2016. In this country, adult mortality data have primarily been collected during household surveys that have included SSH modules, such as DHS and MICS. RHD data have also been collected during the 2014 census and the 2016 MICS. Some of the most recent surveys (e.g., 2018 DHS) have not included the collection of SSH or RHD data, despite the need to evaluate the total death toll of the Ebola outbreak. The shortest interval between 2 surveys that collected SSH data was 4 years (2012-2016). SSH and RHD have not been collected in the country for more than 6 years. It is thus unclear how mortality rates have changed during the post-Ebola recovery period, and during the COVID-19 pandemic.
**Figure 3: example of data availability via surveys and censuses, Guinea, 1990-2022.**

*Notes:* the 2014 census of Guinea included RHD data. The PHIA and WHS programs have not collected data in Guinea.

DHS: Demographic and Health Surveys; MICS: Multiple Indicator Cluster Surveys; MIS: Malaria Impact Surveys.

### 2.2 Selection bias

21. Systematic errors might exclude some members of the population of interest or events from an enumeration or a sampling frame. Selection bias occurs when these excluded members have different outcomes (e.g., mortality) than the rest of the population. Survey and census data on adult deaths are at risk of selection bias because they are collected retrospectively, from interviews with individuals who have survived until the date of data collection (38). Some deaths that have occurred in the past cannot be reported in such inquiries. For example, imagine a family residing in a country with limited civil registration. In this family, there are 4 siblings born to the same biological mother. Two of these siblings died in childhood more than 20 years ago, and the other two siblings died at adult ages during a recent epidemic that occurred <1 year ago. If we had complete records of recent deaths, then the latter two events would be included in the numerator of the mortality rate, and the person-years lived by the deceased siblings prior to their death would be included in the denominator. When such records are unavailable, we rely on SSH to estimate recent adult mortality levels. Yet, the experience of this family would not be reflected in SSH, because there is no survivor who might report it during a survey interview. As a result, the two recent deaths would be left out of the survey’s universe.

22. Selection bias affects all survey and census methods for measuring adult mortality. In the case of RHD, selection bias might emerge if a household dissolves after the death of one of its members. In the case of one-person households, an increasingly frequent form of living arrangement, this is inevitable;
but even in larger households, the death of a member might precipitate household dissolution. This might be the case, for example, due to a sudden reduction in available income, or disputes over inheritance. Deaths that have occurred in households that subsequently dissolved cannot be reported during a census or survey that collects RHD. Selection bias might also stem from the omission of deaths that occur in institutional settings (e.g., retirement homes, prisons). Indeed, whereas most censuses enumerate the institutional population, few attempt to list recent deaths in such populations.

23. Orphanhood data is affected by multiple forms of selection bias. Adults who have never had children, for example, are not represented in orphanhood data; nor are those whose children have died prior to the survey/census date. If the survival experience of such adults differs from the experience of adults whose children might be included in a survey or census, then estimates of adult mortality based on orphanhood data will be biased. More generally, in sample surveys, selection bias might occur if there is clustering of deaths within families, i.e., a smaller than expected number of families experienced a disproportionate number of deaths. Such clustering might occur, for example, if siblings compete for family resources (38,39), if siblings and parents influence each other, or if they share other risk factors (e.g., genetic traits, early-life experiences) for specific causes of adult deaths. If that is the case, then low-mortality families might be over-represented in survey datasets when more than one family member (e.g., sibling/child) might be interviewed (as is the case in DHS and other household surveys).

24. Selection bias might be exacerbated during epidemics and other crises such as conflicts, when the correlation of survival between relatives or household occupants rapidly increases. In settings affected by large HIV epidemics, especially prior to the large-scale roll-out of treatment and prevention, the survival of mothers and children might be (strongly) correlated due to the vertical transmission of HIV. In such populations, survey and census data on orphanhood exclude deaths of parents whose children also died prior to data collection, resulting in estimates of adult mortality that were often too low (33). Similar issues affected the measurement of child mortality from birth histories (40). During Ebola epidemics, many patients receive care at home, from parents, siblings or other relatives (41,42). In that process, they often transmit the virus, thus affecting the survival prospects of their relatives (43). Households and families most affected by an Ebola outbreak might thus be under-represented in surveys and censuses. The COVID-19 pandemic presents similar challenges for survey and census data on adult mortality: with high intra-household attack rates, the correlation in survival between members of the same family or household might have increased.

25. Demographers and statisticians have investigated the impact of selection bias on adult mortality estimates derived from survey and census data. The key concern is that, in the presence of selection bias, adult mortality data might lead to estimates that are too low (6,28), especially in surveys where multiple respondents from the same family might be interviewed. In the case of orphanhood data, the effects of selection on estimates of adult mortality might be low (44), except in settings affected by generalized HIV epidemics. Adjustment procedures have been developed that account for multiple forms of selection bias in SSH data (38,45,46).

2.3 Reporting errors

26. Reporting errors occur when the data on relatives or household members reported by respondents differ from the “true” survival experience of these groups of individuals. Helleringer et al. (47) identified 4 types of reporting errors that affect SSH data:
• **List errors** occur when the reported list of siblings differs from the true family of a respondent. Respondents asked to report SSH may thus not list all their true maternal siblings (omission), or they may include others who are not their true maternal siblings (addition, or “erroneous inclusion”).

• **Vital status errors** occur when a respondent reports that one of her live siblings is dead at the time of the survey, or when she reports that a deceased sibling is alive at the time of the survey.

• **Age errors** refer to respondents’ inaccurate reporting of the current age or age at death of one of their true siblings.

• **Date errors** refer to respondents’ inaccurate reporting of the year in which their sibling(s) died.

27. Figure 4 below provides examples of reporting errors. Mary is a potential “addition”: she appears in the list reported by the respondent, even though she is not a true sibling of the respondent. John and Julie are “omissions”: they were left out of the list provided by the respondent. The age of Paul is misreported during SSH (35 vs. 32, “age error”), whereas the age of Peter is correctly reported. James’ age at death is misreported during SSH (27 vs. 24, “age error”) as is his date of death (2001 vs. 2004, “date error”). There are no vital status errors in this reported list of siblings.

![Reported Sibship (SSH)
| Paul, 35 |
| Mary, 33 |
| Peter, 27 |
| James,† 27 (2001) |

<table>
<thead>
<tr>
<th>True Sibship</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paul, 32</td>
</tr>
<tr>
<td>John, 29</td>
</tr>
<tr>
<td>Peter, 27</td>
</tr>
<tr>
<td>James,† 24 (2004)</td>
</tr>
<tr>
<td>Julie, 21</td>
</tr>
</tbody>
</table>

Figure 4: example of reporting errors in survey data on sibling survival

28. Date errors are relevant in the analysis of SSH data on adult mortality, because analysts often analyze data that pertain to a recent reference period before the survey. In analyses of child mortality, this reference period stretches 3-5 years before the survey. In analyses of adult mortality, the reference period is usually longer to ensure that sufficient numbers of deaths are available for analysis (see section on sample size below). In addition, data in this reference period are believed to be more complete than reports of earlier deaths (10).

29. In RHD data, list errors occur when respondents omit to list a recently deceased household members, or erroneously include someone who was not a household member at the time of death. Respondents are often asked to report solely the deaths that have occurred in the past 12 months or since a given date (e.g., since the beginning of 2022, if the census is conducted at the end of 2022). In such interviews, date errors manifest as list errors: for example, a death that has occurred outside of this reference period might be moved into the reference period if it is dated imprecisely (“addition” or “erroneous inclusion”). Similarly, a recent death might be moved out of this reference period if it is reported as having occurred earlier than it did (“omission”). Date errors in RHD data thus solely concern errors in the reported month of death, if informants are asked to provide such information. In orphanhood data, vital status errors might be frequent due to an “adoption bias”: this occurs when
respondents report the vital status of an orphaned child’s foster parents, rather than the vital status of his biological parents.

30. In addition, survey and census data on the circumstances of adult deaths might also be affected by misclassifications when they include questions about the circumstances of deaths. In particular, such errors might affect data on pregnancy-related mortality among women of reporting age (48–50). For example, if a respondent does not know that his/her relative was pregnant when she died, her death might mistakenly be misclassified as not pregnancy-related (“false negative”). On the other hand, respondents might also wrongly state that a death occurred within 42 days of delivery, when in fact it occurred more than 42 days after that date (“false positive”). Misclassifications also affect data on other circumstances of deaths potentially elicited during surveys and censuses, e.g., external injuries or violence (51,52).

31. Reporting errors have potentially complex effects on survey/census estimates of adult all-cause mortality. List errors affect SSH and RHD estimates when the likelihood of omission/addition depends on the vital status of the relative (28). For example, if respondents are more likely to omit their siblings who died at adult ages than their live siblings, adult mortality rates will be underestimated (47). The direction of bias resulting from vital status errors depends on whether respondents are more likely to report deceased siblings as alive, or vice versa. Compared with list errors, however, vital status errors likely have a disproportionate impact on mortality estimates from SSH because they affect only the numerator of mortality rates. In the presence of an adoption effect, on the other hand, adult mortality estimates derived from orphanhood data will be too low (28,33). Errors about the current age of live siblings may affect the denominator of mortality rates. For example, if respondents underestimate the current ages of their siblings, then fewer person-years lived among these siblings will be counted, and (all else being equal) adult mortality rates will be overestimated. The effects of date and age errors about a sibling’s death depend on (1) the magnitude of these errors, and (2) the width of the age interval and the length of the reference period used in calculating adult mortality rates.

32. There are several processes that might lead to reporting errors in survey and census data on adult mortality. First, some deaths might have occurred several years ago, and respondents might only imperfectly recall the details associated with these events (e.g., age at death). Second, respondents might prefer not to disclose certain deaths among their family or household members during an interview. This might occur when deaths are due to stigmatized causes of death, e.g., suicides, infectious diseases such as HIV. Third, interviewers might be tempted to leave out some deaths from the list of relatives they record during the interview. This would allow them to complete the interview faster. They might also misreport the ages at which various deaths might have occurred if sets of questions are only applicable for a specific age group. For example, some surveys in which questions about pregnancy-related deaths are applicable for deaths that have occurred above age 12 or 15, display heaping immediately before these thresholds. Finally, interviewers might occasionally prefer not to ask sections related to deaths, since such sections might – at times – elicit strong reactions from the respondents.

33. Demographers and statisticians have addressed the various types of reporting errors in several ways. They have used smoothing procedures to address heaping and other age or date errors (e.g., 53). They have developed statistical models that address recall issues stemming from memory decay (54). To develop such models and adjustments, analysts frequently compare the reporting of deaths that have occurred at time t, in surveys conducted at time, say, t+3 and t+8. The differences in estimated mortality
rates at time $t$ obtained from each survey is interpreted as measurement of the extent of recall bias, by additional year. Some researchers have also developed new questionnaires to try and reduce several types of reporting errors. Trials of a new SSH questionnaires has been conducted in Senegal (49,55). This new questionnaire included extensive probing and cues provided to respondents. It was successful in generating more complete lists of siblings during surveys. It was subsequently adopted in the adult and maternal mortality module of the DHS. The use of an event history calendar to ascertain ages and dates more precisely was less successful (56). It was not incorporated into the standard questionnaires of major survey programs.

2.4 Limited sample sizes and sampling errors

34. Functioning civil registration systems record all the deaths that occur within an administrative unit. Similarly, mortality data collected during censuses potentially record all the deaths that have occurred in a population over a defined timeframe (e.g., the past 12 months). In surveys, on the other hand, only a subset of the deaths that have occurred in a population are potentially reported. This is the case because surveys are based on samples of the population of interest. The size of the sample, and the underlying levels of mortality, are major determinants of the precision with which mortality rates might be estimated from survey data. All else being equal, a larger survey will yield a more precise estimate of mortality rates. Similarly, for a given sample size, mortality estimates will be more precise in settings with higher levels of mortality.

35. Additional parameters affect the sample size available for analyses of adult mortality generated from survey data. In SSH data, the available sample size is thus not only a function of 1) the number of survey respondents, but also 2) the number of siblings they listed, 3) the probability that these siblings were aged 15 years or older during a recent “reference period” and 4) the length of this reference period. Recent trends in these latter parameters affect available sample sizes in complex ways. Due to fertility declines in many countries, the number of siblings listed by respondents might have declined over time, whereas improvements in childhood survival might have led to a higher proportion of siblings surviving to age 15.

36. In many surveys conducted in countries with incomplete vital registers, the number of households and respondents to survey is set to measure indicators that are not related to mortality, e.g., contraceptive rates. These calculations are made without accounting for recent trends in family size and mortality. The resulting samples are often too small to measure mortality rates precisely for the most recent time periods, because adult deaths remain a rare event (5). For example, in a recent survey in Rwanda, SSH questionnaires only generated <0.05 reports of adult deaths that have occurred within 12 months of the survey per interviewed respondent (57). In an analysis of old-age mortality (age 60 and over) across 8 countries, and using RHD data on more than 300,000 households, researchers only found approximately 75 deaths at older ages per gender (53). To alleviate this concern and generate analytical samples that are large enough, analysts often adjust the length of the reference period used for analysis. Most DHS and similar surveys thus report estimates of the average mortality rates of the past 7-8 years prior to the survey. Some surveys that collect RHD have extended the reference period for such data to 3 years (e.g., NFHS in India).
37. However, even when the reference period for analysis is extended to the 7-8 years prior to the survey, the sample sizes available for analyses in recent surveys might remain limited. In a (very) large survey of more than 40,000 households in Nigeria (DHS 2018), respondents only reported approximately 3,000 adult deaths that had occurred in the 7 years prior to the survey. By comparison, a survey of 9,000 households conducted in Liberia in 2019, only generated approximately 800 SSH reports of adult death having occurred within 7 years of the survey, even though this reference period included a period of high excess mortality during the Ebola epidemic (58). In Guinea (figure 3), the number of households surveyed remained fairly stable over time, despite the large excess mortality prompted by the 2013-2016 Ebola outbreak.
3. Emerging data needs

39. During the period of the Millennium Development Goals (2000-2015), the primary focus of adult mortality measurement remained on reproductive ages, i.e., 15-49 years. These are the ages where maternal mortality occurs (12), and those most affected by excess mortality linked to the HIV pandemic (59). Since then, however, multiple new indicators of adult mortality have garnered interest among the global health and development communities. For example, the monitoring and evaluation framework for the SDGs now list several new indicators that pertain to adult mortality. These include:

- the mortality rate attributed to cardiovascular disease, cancer, diabetes or chronic respiratory disease (3.4.1)
- the suicide mortality rate (3.4.2)
- the death rate due to road traffic injuries (3.6.1)
- the mortality rate attributed to household and ambient air pollution (3.9.1)
- the mortality rate attributed to unsafe water, sanitation and lack of hygiene (3.9.2)
- the mortality rate attributed to unintentional poisoning (3.9.3)
- the number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 population (13.1.1)
- number of victims of intentional homicide per 100,000 population, by sex and age (16.1.1)
- conflict-related deaths per 100,000 population, by sex, age and cause (16.1.2)

40. Indicator 17.19.2 tracks the “proportion of countries that (a) have conducted at least one population and housing census in the last 10 years, and (b) have achieved 100 per cent birth registration and 80 per cent death registration”. It thus partly concerns adult deaths. Other global health objectives also entail a focus on adult deaths. For example, targets set by UNAIDS to end the AIDS epidemic as a global health threat by 2030 include reducing AIDS-related deaths by 90%, whereas the Roll Back Malaria partnership aims to reduce malaria mortality rates by 90% before 2030. Finally, the COVID-19 pandemic has placed fluctuations in adult mortality, and especially in older-age mortality, at the center of public debate.

41. We detail below how this renewed focus on adult mortality in global health and development initiatives creates new data needs, which might be addressed by surveys and censuses in countries with incomplete death registration.

Emerging data need #1: Achieving better coverage of older age groups

42. Knowledge of mortality above age 50 or 60 years old is important for all the indicators listed above, but especially for indicator 3.4.1. Yet old-age mortality is currently a “blind spot” in mortality measurement methods that rely on survey and census data (60). For example, SSH and RHD data generated during surveys are often too sparse to estimate indicators such as 30q50 or 20q60 (53). The indirect orphanhood method also becomes increasingly imprecise in those age groups. Even census data on RHD might frequently miss deaths that occur at those older ages, especially if they occur in one-person households where a significant proportion of older adults might reside (61).

43. As a result, global estimates produced by the UN Population Division often use model life tables to extrapolate indicators of old-age mortality from data on child and early-adulthood mortality (62). This is problematic because the relationship between indicators of child/early adult mortality and indicators of
old-age mortality is highly variable. In particular, it might be different in developed and developing countries. Yet, the overwhelmingly majority of data sets on which model life tables are built originate in developed countries based on their mortality experience in the past. New and/or improved methods to generate survey and census data on mortality data at older ages are thus needed.

44. For ease of reference, improving the quality and timeliness of adult mortality data availability is also covered under this emerging data needs #1.

Emerging data need #2: Documenting risk factors of adult deaths

45. Several of the new SDG indicators are cause-specific mortality rates (e.g., 3.4.1 or 3.6.1). In countries with limited civil registration and death certification, verbal autopsies (VA) are the main tool used to determine causes of (adult) deaths (63). However, VA questionnaires are often deemed too long to integrate in major surveys, and especially in censuses. VA inquiries might be conducted during follow-up studies, e.g., among a sample of deaths reported during a survey or census (64,65). Work on shortening VA questionnaires, and automating the interpretation of VA data, is currently under way. The use of such methods has however primarily been tested in civil registration offices and demographic surveillance systems, rather than in surveys and censuses (66).

46. As a substitute, surveys and census have sought to determine key circumstances of deaths, through a small number of simple questions. These questions might serve as a proxy indicator for the measurement of causes of deaths. For example, most surveys and censuses of adult mortality now include three questions about the deaths of women of reproductive age:

- Was (name) pregnant when she died?
- Did (name) die during delivery or childbirth?
- Did (name) die during 42 days (or 2 months or 6 weeks) of giving birth?

47. These questions allow classifying deaths as pregnancy-related or not, and calculating pregnancy-related mortality ratios, which are widely used as a proxy indicator of maternal mortality. DHS and other surveys have also included questions about injuries and other accidental circumstances of deaths. For example, Obermeyer et al. (51) used data from the World Health Survey to measure the number of conflict-related deaths over a long period.

48. Currently, estimates of several of the cause-specific indicators required to track progress towards the SDGs are solely available through global burden of disease studies (67). They are produced by extrapolating from data collected in small, often non-representative areas, or in other countries where data are available. Documenting additional circumstances of deaths through surveys and follow-up surveys using census data might help better track the new SDG indicators, as well as those stemming from other global health and development initiatives. Some of these circumstances might be risk factors that are strongly associated with specific causes of deaths (e.g., smoking and CVD or cancer). They might also be results of recent diagnostic tests that might help clarify contributing causes of death (e.g., HIV or Malaria test results).

Emerging data need #3: Tracking socioeconomic disparities in adult mortality

49. The adoption of the SDGs, and associated commitments to “leave no one behind”, has resulted in an emphasis on disaggregated data. Ideally, trends towards SDG targets should be monitored in small
areas, as well as in key population groups (e.g., by gender, age, socioeconomic status and/or educational level). However, current survey and census datasets have important limitations that might prevent tracking socioeconomic disparities in adult mortality rates. Some of these limitations are specific to survey data; others similarly affect surveys and censuses.

50. First, survey datasets are often too small to allow disaggregating adult mortality data by age, sex or other characteristics. For example, the aforementioned Liberia DHS only elicited a total of 392 deaths of women of reproductive ages, and among those 92 were reported as pregnancy-related. This resulted in fewer than 10 pregnancy-related deaths reported in several age groups. Such sample sizes lead to large confidence intervals around estimates of age and sex-specific mortality rates, and limited statistical power to test for differences in mortality between population groups.

51. Second, surveys seldom document the location where siblings or parents of respondents reside or resided before death. This presents important challenges in estimating rural/urban differentials in adult mortality, measuring heterogeneity in mortality rates between small areas, or in linking estimated mortality rates to environmental factors (e.g., air pollution). Analysts often make the simplifying hypothesis that respondents and their siblings or parents reside in the same administrative areas. However, this hypothesis is often violated: in many families, some siblings might reside in rural areas, whereas others have migrated to (large) cities and others have migrated internationally.

52. Finally, surveys and censuses only document a few individual characteristics of recently deceased individuals, e.g., their age and sex. This provides limited opportunities to investigate other, potentially important, socioeconomic differentials in adult mortality. For example, in many settings with available CRVS data, educational differentials in adult mortality are often particularly large (68). Some studies have used a proxy strategy to explore educational differences in adult mortality using survey data collected in countries with limited CRVS: they used data on the educational level of the respondent as a proxy for the educational level of his/her family members (69). In a recent study in Bangladesh and Malawi, however, this assumption did not hold: educational levels were often highly heterogeneous within families (Figure 3).

53. In such a context, proxy strategies would likely lead to underestimating the extent of mortality inequalities associated with education (“attenuation bias”). Asking respondents to report some of their relatives’ socioeconomic characteristics might help better measure mortality differentials using survey or follow-up survey using RHD data collected from censuses.
Figure 3: similarity in educational levels between siblings,  
Source: survey of the Matlab Health and Demographic Surveillance System population, 2019 (n = 2,121).  
Notes: the width of each bar is proportional to the distribution of educational levels among survey respondents. The figure only includes respondents and their siblings who have reached age 20.

Emerging data need #4: Measuring (recent) short-term fluctuations in mortality

54. Since the beginning of the COVID-19 pandemic, mortality analyses have emphasized the measurement of excess mortality, i.e., the difference between the number of deaths from all causes observed in a given timeframe, and the number of such deaths that might be expected based on historical trends (70). The estimation of excess mortality relies on monthly or weekly series of death records, in conjunction with various statistical models designed to calculate the expected level of mortality (71). Demographers and statisticians have called for the more rapid release of such vital statistics (72), and cross-country databases documenting excess mortality trends have become publicly available (73,74).

55. Information about current levels of excess mortality is essential in protecting population health during an epidemic. Excess mortality provides a more robust picture of the impact of the epidemic than other available datasets and metrics. For example, commonly reported counts of COVID deaths rely on medical diagnostics and PCR testing. The coverage of such systems is often imperfect, and varies greatly over time and between countries (75). The true number of excess deaths prompted by the COVID-19 pandemic might be larger by orders of magnitude (74,76). Monitoring excess mortality also allows assessing whether the COVID-19 pandemic has “indirect effects” on population health. Such effects occur when there are sudden increases in deaths from non-COVID causes, such as cancer, cardiovascular
diseases or other infectious diseases. This might occur because of disruption to healthcare services, or due to increasing difficulties in sustaining livelihoods, for example.

56. In countries with limited civil registration, information about excess mortality is not available in a timely manner, at the national or sub-national levels (for example, see figure 3 in Guinea). Even in retrospective surveys and censuses, the data required to estimate excess mortality associated with an epidemic or another crisis is seldom available. This is due to several factors:

57. Survey sample sizes are often too small to detect fluctuations in mortality associated with a recent epidemic. For example, In Guinea (figure 3), the MICS surveys that was conducted shortly after the Ebola outbreak was declared over included approximately 8,000 households. This sample size only allowed measuring average adult mortality rates for a reference period of 7-8 years prior to the survey: it elicited too few deaths in the more recent period during which the Ebola outbreak was ongoing.

58. Surveys and census questionnaires often do not elicit the required level of detail and precision about the timing of deaths. In measuring excess mortality, statistical models often control for the week or month of death. This allows accounting for seasonality, and other sources of temporal variations in recorded mortality. In surveys however, SSH rarely ask respondents to report their sibling’s month of death. In censuses, asking the year and month of death in RHD is recommended practice. This recommendation has however not been implemented systematically in the most recent rounds of censuses. Even when it is included in surveys and censuses, the reported month of death might be missing or misstated. This might affect estimates of excess mortality derived from such retrospective data.

59. In RHD, the reference period often does not cover (the entirety of) the recent epidemics or health crises that have prompted short-term fluctuations in mortality. As a result, surveys and censuses might not fully document the impact of such events on population health. For example, many surveys and censuses collect RHD by asking the deaths that have occurred to household members in the past 12 months. In the context of the COVID-19 pandemic, this might only cover some of the epidemic waves caused by specific variants of the virus.

Emerging data need #5: Measuring completeness and gaps in death registration and health information systems

60. Strengthening civil registration and vital statistics systems (CRVS), as well as other data systems, is now increasingly perceived as a key investment in health and development data. Indicators of progress towards CRVS-related goals focus on the completeness of death registration, i.e., the number of registered deaths divided by the total number of deaths in the population. To measure the completeness of death registration, analysts frequently compare the number of deaths available in CRVS databases to an expected number of deaths derived from global estimates (77). Other available methods are “death distribution methods”, which compare the age distribution of the population of interest, and the distribution of deaths obtained from CRVS.

61. Both approaches have important limitations. Death distribution methods require data that may not have been collected recently (e.g., census). They also make strong assumptions about migration. Methods that use a modelled benchmark, such as the Adair-Lopez method (77), often rely on child mortality estimates to infer the completeness of death registration. Their assumptions might be less
robust during a pandemic like COVID-19 that disproportionately affects mortality among older people. Finally, none of these methods allow obtaining disaggregated estimates of the completeness of death registration. This is a significant gap in efforts to improve the coverage of CRVS through targeted interventions.

62. Other methods to measure the completeness of civil registration rely on direct questions asked during surveys and censuses. This is the standard approach to measuring birth registration rates. DHS, MICS and other surveys thus routinely ask whether children under age 5 have their birth registered, and whether they possess a birth certificate (78). In conjunction with statistical methods for capture-recapture studies (79), such data allow estimating the completeness of civil registration, as well as differences in completeness between administrative units or population groups. If applied to death registration, these data and techniques could greatly enhance our understanding of gaps in the reporting of deaths.

63. Besides CRVS, surveys and censuses might also help assess the completeness of other data sources on mortality, in particular those generated by health facilities and health information systems. Such sources cover a selective subset of the population, i.e., those whose death occurs at the health facility, rather than at home. Since they are based on a complete enumeration, or a representative sample, of the population of interest, surveys and censuses (based on follow-up survey) might help assess the specificities of the deaths that occur in health facilities. This might be done by comparing the distribution of various characteristics of deaths that occur at home vs. health facilities (80).
4. A review of innovations in the collection of adult mortality data in surveys and censuses

65. Addressing the emerging data needs and overcoming the challenges outlined earlier requires a more consistent implementation of existing recommendations for the collection and analysis of survey/census data. For example, the UN already recommends collecting data on dates of deaths in the RHD question in population censuses, yet only one-third of recent censuses (2005-2014) have collected such data (81). Identifying strategies to promote the adoption of this and other recommendations in national censuses is an important area of work.

66. Addressing other limitations and needs requires new or refined methods in the collection of survey and census data on adult mortality. In this section, we review possible innovations that may shed light on ways to strengthen the use of surveys and censuses for adult mortality monitoring. For each innovation, we describe the method, outline its strengths and weaknesses, and discuss its potential in being used broadly in surveys and censuses implemented in countries with limited CRVS systems. Note that the adoption of a particular innovative approach at the national level depends on (a) national priorities in addressing the emerging data needs outlined in section 3; (b) the existing structure and capacity of national statistical systems, in particular in terms of census and survey data collections; and (c) the level of maturity of the innovations in terms of whether they have been tested at large scale in countries. These considerations will also be discussed in detail in the section.

4.1 Reformulating or adding questions

4.1.a. Expanding reference periods, covering older age groups

67. SSH, RHD and orphanhood questions are long-established instruments. The wording of SSH questions used in the DHS has recently evolved (Figure 1, also see (82)), to allow gathering more complete lists of respondents’ siblings. Other variations of adult mortality questions include a) an extension of the reference period in RHD data when more detailed information is needed for estimating excess mortality due to health crises, and b) the collection of full parental survival histories.

Extending RHD reference period

68. While the recommended practice in censuses is to collect data on deaths of the past 12 months, several large-scale surveys have successfully collected data on deaths of the past 36 months. This is the case for example of the National Family and Health Survey (NFHS) in India (83), as well as more recent data collection platforms such as the Sierra Leone Sample Registration System (84). Surveys conducted by Médecins sans Frontières (MSF) in refugee camps or other crisis settings have also used a 3-year reference period (85).

69. In the current context, extending the RHD reference period would allow generating mortality data for a larger proportion of the ongoing COVID-19 pandemic. This would provide data on excess mortality during some of the earlier waves of the pandemic (e.g., Delta), in countries where other data collection systems (e.g., CRVS, PCR testing) might have failed to adequately measure the total death toll of the pandemic. The extension would benefit both censuses and surveys when there is a natural disaster (e.g., earthquake and Tsunami) or a disease outbreak in the country. The extended period should be carefully considered so it is aligned with the timeline of the incident.
70. Extending the RHD reference period also increases the statistical power available for analyses in surveys as it increases the number of deaths in the sample. It might allow exploring recent trends in mortality for regular mortality monitoring.

71. The main drawbacks associated with the extension of the reference period include the possibility of increased recall errors, and a heightened risk of selection bias due to household dissolution. It is necessary to do analytical studies on the impact of such extension on data quality and how the potential biases and recall errors can be adjusted for RHD data collected over few years.

Collecting full parental survival histories

72. The orphanhood questions included in surveys and censuses require model life tables, as well as strong assumptions, to generate estimates of old-age mortality (e.g., 20q60). They also produce imprecisely dated, and potentially outdated, estimates. In addition, major surveys such as DHS and MICS only ask the questions to children up to 15-18 years of age, which greatly limits its use for mortality estimation.

73. Most censuses collecting data on orphanhood do not restrict the question to children and this is also recommended by the United Nations (14). Asking adults about the survival of their parents could facilitate the comparisons and the reconstruction of trends in mortality. In countries where HIV prevalence is high, adult mortality estimates derived from parental survival are biased by the transmission of HIV from mothers to children and the lower fertility of seropositive mothers. It is possible to adjust for these biases (59). However, estimates derived from parental survivorship statistics collected among adults are less biased than those obtained from young respondents.¹

74. Adding follow-up questions about age of surviving parents, and dates of death and age at death of deceased parents, might enable more direct estimates of old-age mortality, similar to estimates produced from SSH data. This approach has been used in a survey of mortality in Vietnam (86) conducted in 1991. It allowed reconstructing estimates of excess mortality during periods of war (e.g., 1965-1975).

75. While asking survival of parents to all household members has been adopted in censuses and could be extended to surveys, additional questions on age of surviving parents, dates of death and age at death of deceased parents would need to be further tested and the burden to respondents carefully considered.

4.1.b. Asking questions about socioeconomic characteristics

76. RHD and SSH often only elicit minimal information about recently deceased household members or siblings. This makes it difficult to use survey or census data to investigate differentials in mortality associated with socioeconomic characteristics. With RHD data, analysts may solely explore mortality differentials that are associated with household characteristics, e.g., geographical location or wealth. They do not have, however, the data necessary to explore mortality differentials associated with characteristics that might vary between individuals of the same household. In such situations of missing

¹ Suggestions to improve the collection of data on adult mortality in DHS surveys, available at Suggestions_for_DHS_adult_mortality_module_IMT-PG.pdf (ihsn.org)
data, analysts must revert to strong assumptions about the similarity of family or household members (69).

77. Several experiments are under way that have tested the inclusion of questions about educational attainment of siblings. Initial results are very encouraging (Box 1). A parallel example could be referred to socioeconomic characteristics asked to (past) household members emigrated to another country. In the 2010 round of censuses around one-third of the countries that included a module on emigration also included questions on educational attainment (87). Unfortunately, very little information is available on the quality of those data. Further experiments and testing should be considered in countries for wider adoption of the additional questions on socioeconomic characteristics of deceased that could be collected in surveys including follow-up surveys using RHD data collected from population censuses. It is also important to ensure that the additional information to be collected is of national policy interest, as

### Box 1: asking questions about siblings’ education during surveys in Bangladesh.

As a part of a multi-country project on the measurement of adult mortality, a team of iccdr,b and NYU demographers investigated whether survey respondents accurately report the educational level of their adult siblings, and whether this improves our assessments of mortality differentials, relative to a proxy strategy where we assume that all siblings in a family share the educational level of the survey respondent.

The study took place in Matlab HDSS. It enrolled >2,000 respondents, who were asked about the highest level of schooling they had completed, and how many years of schooling they had completed at that level. They were also asked to complete a SSH questionnaire, which included questions about the educational level of reported siblings. These questions were asked regardless of the vital status of the sibling.

There were very limited amounts of missing data on the educational level of siblings. This occurred for 0.9% of live siblings, and 1.8% of deceased siblings. Among this latter group, the percentage with missing data increased slightly with time since the death. Asking questions about education only added ≈20 seconds of data collection time per reported sibling.

The study then compared estimates of mortality differentials obtained using the proxy and direct approaches. The proxy strategy, i.e., the only currently possible measurement strategy suggested that there were no differentials in adult mortality associated with educational levels. The direct strategy (based on the inclusion of questions about siblings’ education) highlighted sharp differences in the risk of adult death between educational groups (Table B1).

<table>
<thead>
<tr>
<th>Measurement strategy</th>
<th>Proxy strategy</th>
<th>Direct strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>No schooling</td>
<td>1 (ref)</td>
<td>1 (ref)</td>
</tr>
<tr>
<td>Primary school</td>
<td>1.01</td>
<td>0.86*</td>
</tr>
<tr>
<td>Secondary school</td>
<td>1.10</td>
<td>0.76***</td>
</tr>
<tr>
<td>Higher levels</td>
<td>1.11</td>
<td>0.59***</td>
</tr>
</tbody>
</table>

**Table B1: measures of educational differentials in adult mortality, by measurement strategy.** The table presents results from Cox regression models of the likelihood of death, in which sibling’s education was a covariate. Numbers are hazard ratios, where a number <1 indicates a reduced risk of death relative to the reference group. ***p<0.001, **p<0.01, *p<0.05
in the case for the education question about emigrants in national censuses when brain drain has been a major national policy concern for migrant sending countries.

4.1.c. Asking questions about risk factors of adult deaths

78. A similar strategy might help document (some of) the risk factors associated with the likelihood of adult deaths. Additional questions might pertain to behaviors that place adults at risk of ill-health. They might also inquire about recent diagnoses of illnesses or health conditions associated with an increased risk of death. These questions might be asked about surviving and deceased relatives/household members, thus allowing the direct calculations of mortality risk ratios. They might also be asked solely about deceased relatives/household members, as in the case of questions about pregnancy-related deaths. In this context, these data would allow calculating the proportion of deaths presenting a specific risk factor. This information can then be incorporated into global models cause-specific mortality rates (88).

79. Some of the questions that might be included to document risk factors are already asked about current household members in many surveys. This is the case, for example, of questions about disability, alcohol consumption or smoking. Disability is a key determinant of adult mortality. It is also a core topic in censuses, measured using questions about 6 domains (e.g., walking, seeing). In the most recent NFHS survey in India, household informants were also asked whether each (adult) member of their household “smoked or used tobacco in any form” and “drank alcohol”. Such factors and behaviors account for a large proportion of adult deaths. They might be reliably reported by household informants or SSH respondents because they are directly observable. They might also be less affected by social desirability bias and stigma, because informants would be reporting about a third party.

80. A recent study in Malawi also attempted to determine the HIV status of the deceased siblings of survey respondents (89). Such information could help measure the excess mortality associated with this disease. In this study, the added HIV questions were:

- Has (NAME OF THE DECEASED) been tested for HIV prior to death?
- (if yes) What were the results of his/her most recent HIV test?
- (if not) How likely do you think it is that (NAME OF THE DECEASED) was infected with HIV?

81. These data yielded largely complete data on the HIV status of respondents’ deceased siblings, particularly those who died recently (i.e., within 8 years of the survey). Among that group, only approximately 6% of deaths had unknown HIV status. When evaluated against verbal autopsies and health records, the adjusted sensitivity of survey data on HIV status of the deceased was high (0.78–0.82). There were few false positive reports of the HIV status of deceased siblings (specificity = 0.96–0.98). Asking the HIV questions only took 0.4 minute (=25 seconds) per deceased sibling. The high reliability of such data on HIV status might be due to a) the scale-up of HIV testing in that area of Malawi, and b) recent declines in HIV-related stigma.

82. Depending on the epidemiological context, similar questions might be included about diseases and conditions ranging from infectious diseases such as tuberculosis or Malaria, to chronic conditions like hypertension. Such questions are routinely included in verbal autopsies, but have not been tested in surveys. In the current context of the COVID-19 pandemic, additional questions about COVID diagnoses prior to death might help better measure the overall death toll of the pandemic.
4.1.d. Questions about registration status and place of death

83. Surveys and censuses that collect data on adult deaths might be useful platforms to monitor progress towards more complete CRVS systems, and to measure access to healthcare services during terminal illness or following accidents. Out of 76 countries that asked RHD in their censuses in the 2010 round (2005-2014), 9 included an additional question on death registration (81). Surveys in India or Bangladesh also elicited similar information (e.g., see (90–93)).

84. Collecting data on death registration presents challenges. Some respondents might not be aware of the death registration requirements and processes. There are also other processes that might “resemble” the civil registration of deaths, for example the death certificates produced at health facilities, the obtention of burial permits or the recording of deaths in Church registers. Interviewers must be careful to properly differentiate between these different sources of paperwork related to deaths. In doing so, they might rely on examples of death certificates produced by civil registration offices. Similarly, some individuals might have complicated therapeutic trajectories during terminal illness. They might thus be in-and-out of health facilities, or might visit multiple facilities (including traditional doctors) prior to death.

85. In multiple studies, questions on registration status elicited fairly complete reporting on the registration status of recent deaths. They yielded estimates of the completeness of death registration that were on par with those obtained from death distribution methods or modelled benchmarks. Compared to those other methods, however, they had the advantage of allowing measurement of differentials in registration rates between population groups. For example, in Bangladesh, survey questions about death registration documented large gender gaps in death registration; they also highlighted that death due to accidents might be registered at a higher rate, even among male deaths. In Senegal, death registration was positively associated with household wealth and with the age at death of the deceased.

86. The data on registration status generated by surveys and censuses have also helped to better ascertain motivations and barriers to death registration in countries with limited CRVS. In several surveys, in particular, follow-up questions were inserted that asked respondents to state why the death of their relative was registered (or not). These data showed that in Bangladesh, for example, limited knowledge of death registration was major barrier to the registration of deaths. This information might help better design and target interventions to increase the completeness of CRVS.

87. Two out of the 76 countries that included RHD in their 2010 round of censuses included a question on location: one country asked whether the deceased person died in home or hospital (Bangladesh) and Botswana asked for the deceased person’s usual place of residence at time of death. It is not clear whether the location question was asked in surveys. Before making recommendations about an additional question on location it is important to have a good understanding on whether location refers to where deaths occurred - at home, hospital or somewhere else; or to the place of usual residence of the deceased. In addition, as learned from the experience of population censuses, ascertain the usual residence of an individual is often a challenging task.
4.2 Collecting data on adult mortality by mobile phone

88. Mobile phone surveys (MPS) are inquiries in which respondents are interviewed remotely, by phone (94). They present multiple advantages over in-person inquiries such as household surveys. Their logistics are often less complicated, because MPS interviewers either work from a call center, or even from their homes. Study teams can also be trained remotely, if needed (95). MPS can thus be repeated (much) more frequently than in-person inquiries, e.g., on a monthly or even weekly basis. They are thus better suited than in-person surveys to monitor short-term fluctuations in mortality. MPS can also be sustained during periods of epidemics or conflicts, when household-based inquiries might be too risky or might not be allowed due to lockdowns, physical distancing and other restrictions on mobility.

89. Since the beginning of the COVID-19 pandemic, a large number of MPS have been conducted in almost all countries due to lock down measures that have stopped most face-to-face interviewing during the pandemic. Some of these MPS have followed-up samples of respondents that had been previously recruited during an in-person visit (96–99). This includes, for example, the high-frequency surveys launched by the World Bank in several African countries (100). This program seeks to re-interview participants in the latest pre-pandemic Living Standards Measurement Study (LSMS), to document how they fared during the pandemic. Other MPS have recruited new samples of mobile phone users by drawing from an integrated sample frame with phone numbers for households, random digit dialing (101); or from a list provided by telecommunication company or a private institute. These latter samples are recruited entirely by phone, without any prior in-person visit.

90. Several MPS have included questions about mortality. During the Ebola epidemic in west Africa, an MPS in Monrovia, the capital city of Liberia asked randomly selected mobile phone users about recent deaths in their households, using an abridged RHD questionnaire (102). MSF also used an MPS to assess the level of mortality in areas of Cameroon affected by protracted conflict (103). Since the beginning of the COVID-19 pandemic, MPS surveys in India and Bangladesh have also monitored RHD (91,92), as well as mortality among hospital patients with chronic conditions (104). In addition, a question about recent COVID deaths was included in a large phone survey, which allowed estimating that the death toll related to the COVID-19 pandemic in India might be 6–7 times larger than officially reported (90).

92. Despite the need for timely data on mortality in countries with limited civil registration, these mortality-related MPS remain isolated. MPS conducted since the beginning of the COVID-19 pandemic have predominantly focused on measuring changes in poverty, economic activity, education or health-seeking behaviors (105). This missed opportunity to collect more timely mortality data in countries with limited death registration is due to several concerns about the feasibility of including questions about deaths in MPS. These include:

- Concerns that mortality-related questions might be too sensitive to ask by phone, particularly among samples of mobile users with whom researchers have not had prior contacts (e.g., random digit dialing);
- Concerns that mortality-related questions might take too long to collect in MPS;

1. ________________

2 More information can be found in The COVID-19 impact survey monitoring dashboard: Task Force on COVID-19 and household surveys — Intersecretariat Working Group on Household Surveys (un.org)
Concerns that interviewers might not be able to probe and cross-check answers obtained by phone, thus resulting in poor-quality data on mortality.

Concerns about bias, including coverage bias (exclusion of the population segment that does not have access to a telephone, either mobile or landline) and non-response bias (such that those not successfully interviewed in MPS are substantially different from those interviewed).

93. However, a recent randomized trial of the inclusion of mortality-related questions in MPS dispelled most of these concerns (box 2, 102). Compared to a “control” questionnaire on economic activity, a questionnaire that included RHD, SSH and parental survival histories elicited similarly high levels of participation and completion. It did not elicit negative reactions from participants (e.g., distress) at a higher rate than the economic questionnaire. In that trial, collecting mortality data required 2-4 minutes per reported death, depending on the inclusion of questions about symptoms and use of healthcare services prior to death.

94. The experiment showed that mortality-related MPS also have the potential to reach population groups that might be excluded from other data collections systems. In the Malawi trial, close to two thirds of the deaths reported during the MPS had not been registered with the National Registration Bureau, i.e., the organization in charge of civil registration in the country. MPS might also fill gaps in other mortality surveillance systems possibly set up to monitor the death toll of the COVID-19 pandemic and other health crises. These systems often entail extracting data about deaths from registers at health facilities, or tallying the number of burials taking place at local cemeteries.

95. Compared to facility-based or community-based surveillance of mortality that is often complex to set up and requires significant investments in data acquisition, MPS is less costly and is fast in producing data. By using questionnaires similar to those used in prior household surveys and censuses, the data generated by mobile phone surveys might be compared with previous mortality estimates (90). Due to the growing penetration of mobile phones in more remote areas, MPS have the potential to help assess mortality trends in areas seldom covered by other rapid surveillance systems (e.g., rural or semi-urban areas).

96. One of the biggest challenges in carrying out MPS is the lack of statistical infrastructure, i.e., a proper sampling frame with phone numbers to contact respondents (107). The majority of existing MPS were sent to mobile phone numbers that were collected from a previously administered household survey (101,108). Coupled with low mobile phone penetration rate in lower-income contexts and lower response rate in MPS compared to in-person, uncertainty related to the sampling frames will lead to biases in the final estimates. Populations without a mobile phone are likely to be poorer and less educated compared to those with a mobile phone. Such difference could potentially result in underestimated mortality rates because the sample is over-represented by wealthier and more-educated individuals who are more likely to have lower mortality rate. While a recent study suggest that re-weighting technique would help to overcome the coverage and nonresponse bias (110), other

1. Inter-Secretariat Working Group on Household Surveys, Guidance Note on Assessing and Minimizing the COVID Impact on Survey Quality, forthcoming (2022)
researchers remain skeptical about the extent to which re-weighting can ensure the representativeness of the MPS samples (96).

Box 2: the RAMMPS project

The Rapid Mortality Mobile Phone Surveys project is implemented in 5 countries (see below), by a consortium of universities, research centers and national statistical offices.

It is developing and implementing a mobile-phone based approach to generate national mortality estimates, including excess mortality, where civil registration is limited and face-to-face data collection is disrupted (e.g., during epidemics).

RAMMPS includes a series of continuous national surveys of mobile phone users, as well nested validation studies that target the population of health and demographic surveillance sites. The RAMMPS team is also engaged in refining the methodology used to infer mortality rates from surveys of mobile users.

The data generated by RAMMPS is rapidly analyzed and disseminated via dashboards, on a daily basis.

Additional work has shifted from assessments of feasibility to evaluations of the mortality data generated by MPS and the development of new strategies to further improve the resulting estimates. This includes, for example, i) attempts to shorten standard SSH or RHD questionnaires to facilitate their administration in MPS, ii) development of analytical strategies to control for the selectivity of MPS samples (e.g., due to limited phone ownership in some target populations) or iii) validation of reported mortality data. Large-scale implementation projects are under way that address these key questions in multiple countries.
4.3 Increasing effective sample size for adult mortality surveys

97. Sampling errors are often large in surveys of adult mortality, because adult deaths remain a relatively rare event, and the sample size of surveys like the DHS is primarily selected to measure more common events (e.g., fertility). As a result, such surveys generate too few reports of adult deaths to measure mortality rates precisely in the most recent time periods (e.g., in the past year). They are especially under-powered to detect changes in age patterns of mortality, or differentials in mortality between population groups in such recent periods.

98. The main strategy used by demographers and statisticians to address this issue is to increase the length of the reference period for which death rates are calculated (10,28). In analyzing SSH data, they thus produce estimates of average mortality rates for the 6-8 years period prior to the survey. Others have however explored a few alternative strategies to increase the number of deaths reports gathered during surveys, for a fixed sample size.

99. Oversampling strategies, in particular, have recently been proposed, following approaches used for example to increase the number of children under 5 enrolled in MICS surveys. Oversampling has been commonly used in national household surveys to increase sample size for population with certain characteristics (e.g., ethnic minority, migrants, etc.) In the case of mortality, oversampling strategies entail identifying households or families in which recent deaths have occurred, and increasing the probability of selection of the households/individuals that fall in this newly formed stratum. For a fixed sample size (in terms of households or individuals), the number of deaths reported during the survey might be significantly increased by this approach.

100. As an example, a simple oversampling strategy would focus on the second stage of cluster sampling in surveys like the DHS. Imagine that such a survey selects a two-stage cluster sample. In the first stage, it selects enumeration areas (EA) at random. Each EA has 200 households; and among these, 8 have experienced a death in the past 12 months. The survey then selects 25 households per EA at random. On average, this survey will elicit 25 X (8/200) = 1 report of death per EA. On the other hand, if at the time of listing households in each EA, the survey asks informants if a death has occurred in each household, then two sampling strata can be formed: one that includes households with a death, and one that includes households without a death. Statisticians can then increase the probability of selection in the former stratum. This survey might then elicit up to 8 deaths per EA, depending on the probability of selection selecting for the stratum of households with a death.

101. Unfortunately, there are currently no field trials of such oversampling strategies to increase adult mortality counts in household-based surveys. It is thus unclear whether data collection teams might locate adequate informants to obtain reliable reports of deaths during household listing, and whether informants might be willing to provide this information at that stage (i.e., without an opportunity to establish prior rapport). Trials of oversampling strategies are however under way for mobile phone surveys (e.g., in India). There is also additional cost in the additional listing exercises to include households with recent deaths.

102. Network sampling is another strategy devised by demographers to increase the number of deaths reported during surveys. In this approach, rather than eliciting solely the list of a respondent’s siblings (as in SSH) or household members (as in RHD), interviewers ascertain one or several of the respondents’ social networks, e.g., those who are acquaintances or with whom they have shared a meal; then they
ask respondents to list the deaths that have occurred among these networks in the past year. Since these networks are usually much larger than the respondent’s sibship or household, these questions generate a much larger number of reported deaths. In a study in Rwanda, questions about acquaintance networks yielded more than 0.75 reports of deaths that had occurred in the past year, vs. <0.05 such reports per interview for SSH data (57).

103. Network sampling presents several limitations, however. First, the questionnaires required to enable this method are long (figure 6); they often require repetitive series of questions about respondents’ connections with known populations, so that the size of personal networks can be estimated. Network sampling might be difficult to integrate in standard DHS or similar surveys. Second, respondent’s knowledge of the SES characteristics and other risk factors might be more limited than in the case of siblings or household members. Network sampling might thus not be well-suited for measuring differentials in adult mortality, or detecting risk factors associated with adult deaths. Finally, in contexts of epidemics and other crises, the size and structure of personal networks might be significantly affected. In such contexts, changes in the number of deaths elicited by network sampling might be attributable to network changes as well as excess mortality.

104. These new sampling strategies designed to increase the “yield” of survey interviews (i.e., the number of deaths reported per interview), thus require additional experimentation and development. One other way to ensure that adult mortality surveys elicit sufficient reports of deaths to meet emerging data needs is increasing the sample sizes of household surveys significantly. Several newly launched
longitudinal studies have elected to enroll very large samples, so that mortality rates can be measured precisely by age, sex and other important characteristics. This is the case of the Countrywide Mortality Surveillance for Action (COMSA) platforms recently set up in Sierra Leone and in Mozambique. In Sierra Leone, for example, the sample covered >45,000 households (i.e., 5% of the country’s total population) and it generated more than 8,000 reports of deaths that had occurred in the 3 years before the survey. This allowed assessing cause- and age-specific mortality rates (84).

105. As mentioned earlier, the required sample size to solicit sufficient number of adult deaths depends on a number of factors including the adult mortality level and the required level of disaggregation. While sample size for mortality surveys would need to be increased, for as much as permitted by available resources to improve the precision of adult mortality estimates, testing and adopting specific strategies such as oversampling and network sampling should be considered.

4.4 Improving data interoperability and integration

106. Data integration represents a wide range of efforts to make the best use of available data. Many studies use record-linking and statistical model to combine data from different sources to derive improved mortality estimates. These also include current efforts to collect epidemiological data via sero-testing, surveillance of burial sites or collation of hospital data.

107. Notable studies include those aiming to improve mortality data availability at fine geography level (such as county level in the United States). A study combines seven different data sources and employ assembling techniques that combine linear and exponential predictors (CLEP) to harmonize the various data source and generate forecast of short-term death counts at the county level in the US (111). Similarly, model-based estimates of COVID-19 total case and death rates for every county in the US were also estimated from a range of input data, including county-level demographic, race/ethnicity, socioeconomic, and medical comorbidities variables (112).

108. Data integration also provides relevant insights, through triangulation, to the completeness and accuracy of mortality data during the pandemic. In Brazil, Lima Costa and colleagues connect Civil Registry and Ministry of Health Mortality Information System to estimate completeness of national and subnational death reporting using generalized linear models with socio-economic and demographic covariates (113). A study in Burkina Faso uses high-quality mortality data from a Health and Demographic Surveillance System (HDSS) in Burkina Faso to evaluate mortality rates inferred from a national census (114). A similar evaluation study also used the Health and Demographic Surveillance System in Niakhar, Senegal (56).

109. Studies combines mortality data with sero-testing data are typically more interested in estimating the infection fatality rate (IFR). Nonetheless, they also integrate sero-testing data with available sources of mortality data and provide limited insights on their reliability or usability. For instance, the Consumer Pyramids Household Survey (CPHS) in India, a panel survey dataset conducted three times per year, was used to estimate excess deaths in April-August 2020 (115). The authors then juxtapose this estimated excess death rate with estimates from a sero-prevalence survey for the same household dataset, in the state of Karnataka (which has a population of 64 million), to estimate an upper bound for the IFR. Also in India, a study uses local mortality data reported by 12 cities to combine with results of serological testing from self-referred patients using a nationwide chain of private laboratories (116). Axfors & Ioannidis (2022) use official reports of COVID-19 deaths to compile death counts overall and in the
elderly population before integrating the death data with existing seroprevalence studies (117). Beyond the isolated studies, WHO also supported systemic efforts to combine such data towards more comprehensive research and knowledge management in the Eastern Mediterranean region (118).

110. Finally, data from burial sites and health facilities (e.g., hospitals) also help generate timely data for mortality related to COVID-19. A study addresses the gaps in national death reporting in India (119) by combining three sources of data: (1) mortality reported from a phone survey, (2) civil registration system in ten states where data are available and reliable, and (3) facility deaths reported through the Government of India’s administrative data. Burial records may also help to quantify excess death due to COVID-19. One example is the use of cremation data in Ontario, Canada combined with a time series model to quantify deviation in cremation trends during the pandemic periods. Excess deaths are found by comparing the trends to baseline cremation records in 2017-19 (120).

111. At the international level, the UN Population Division integrates mortality data from all available nationally representative sources to estimate mortality time series in the World Population Prospects, most recently in the 2022 revision (121). For countries with sparse or deficient mortality data, model life tables were used to estimate mortality rates by single year of age across the full age range (from age 0 to age 130+) and for years 1950 through 2021. To obtain the parameters used to fit the model life table for each year, complete annual time series of child (under-five) mortality and adult (between ages 15 and 60) were estimated for each country. Estimates of child mortality were coordinated closely with the United Nations Inter-agency Group for Child Mortality Estimation4 (IGME). Estimates of adult mortality were derived from complete data on registered deaths by age and sex whenever possible. In other cases, analysts evaluated data from incomplete registration or from questions on RHD or SSH from censuses or surveys. A Bayesian hierarchical model was used to estimate, for each sex, the probability of dying between ages 15 and 60 years (122). In addition to the empirical observations of adult mortality, the model took into account the prevalence of HIV infection, the coverage of antiretroviral therapy and the under-five mortality rate. Mortality from crisis events such as conflicts and battles, mass killings, flooding, cyclones, epidemics, earthquakes, the COVID-19 pandemic, famines, droughts and tsunamis is incorporated into estimates for affected years using a model based on historical data on the sex- and age-specific mortality impact of such events. To account for excess mortality related to the COVID-19 pandemic, sex- and age-specific excess mortality rates during 2020 and 2021 were computed from the WHO’s estimates of excess deaths by sex and age.5 These rates were then added to the baseline mortality rates estimated for 2020 and 2021 in the absence of a pandemic.

112. Successful integration across different data sources demands data interoperability by design. As highlighted by Carletto et al. (127), data interoperability is a key requirement for different data sources to be linked and integrated (123). For example, geocoded surveys and censuses would be helpful to combine these sources and also to integrate with geospatial and remote sensing data. Common questions, concepts and definitions across different data collections also facilitates data integration and cross-validation. This has therefore highlighted as one of the recommendations in section 5. More efforts should also be made to document existing national practices and encourage new studies in

1. 

4 The IGME database, including the complete set of available empirical data used to construct the latest global estimates of under-five mortality, is available at www.childmortality.org.

integrating multiple sources for adult mortality estimates, which would be helpful for other countries to learn from these documented experiences.
5. Initial draft recommendations to improve the availability of timely and high-quality adult mortality data

114. Recommendations to improve availability and timely data on adult mortality through censuses and surveys covered in this Section are made based on discussions in previous sections. While advantages and limitations for each suggestion will be outlined briefly for ease of reference, readers are encouraged to consult earlier sections of the background document for more details.

115. The recommendations proposed here are a mixture of encouraging the adoption of existing international recommendations such as those covered by the Principles and Recommendations for Population and Housing Censuses Revision 3 and suggestions to testing and adopting innovative approaches that have yet been taken in mainstream national censuses and surveys.

116. Table 1 below presents the list of proposed recommendations for censuses and surveys. The proposed recommendations on population censuses provide also information about what questions are currently recommended by the United Nations’ Principles and Recommendations for Population and Housing Censuses (P&R Revision 3) as core or additional and what questions are not included in the P&R Revision 3 (14). New questions will be considered in the next revision of the P&R for 2030 round of censuses that will be completed and submitted to UN Statistical Commission for approval in 2025.

117. Note that not all recommendations are at the same level of “maturity”. Some are already covered in the international recommendations as mentioned above and should be adopted whenever relevant, while some still require extensive testing within national context. Given the national variations in terms of national policy priorities, the level of statistical development, availability of both human and financial resources, and the setup of national statistical systems including the census and survey operations, countries are encouraged to set priorities in implementing the proposed recommendations.

Table 1. Draft recommendations proposal to improve availability of timely and high-quality adult mortality data

<table>
<thead>
<tr>
<th>Proposal</th>
<th>Reference #</th>
<th>Applicable data source (census and/or census)</th>
<th>Rational</th>
</tr>
</thead>
<tbody>
<tr>
<td>Collect month and year of each deceased persons reported in RHD (Recent Household Deaths)</td>
<td>1</td>
<td>Census</td>
<td>Core topic in the Census P&amp;R Revision 3; Improve accuracy in reporting of household deaths; allows monitoring monthly changes in mortality #1: Achieve better coverage of old-age groups</td>
</tr>
<tr>
<td>Collect orphanhood data for all household members regardless of age of persons</td>
<td>2</td>
<td>Census</td>
<td>Additional topic in the census P&amp;R #1: Achieve better coverage of old-age groups</td>
</tr>
<tr>
<td>Expand the reference period for questions on household deaths from one year to two (24 months) or three years (36 months); or a</td>
<td>3</td>
<td>Census</td>
<td>Analysis of changes in the level and pattern of adult mortality during health crises and estimate excess mortality in countries #4: Measure (recent) short-term fluctuations in mortality</td>
</tr>
</tbody>
</table>

Suggested next steps

- Implement the existing international recommendations
- Test and assess the impact of the longer reference period on the quality of data
<table>
<thead>
<tr>
<th>Duration that fits the window of crisis, such as pandemics or natural disasters (earthquake/Tsunami)</th>
<th>Implement the question during or post-crisis</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Include questions on year of death and age at death for the deceased parent</strong></td>
<td>4 Census</td>
</tr>
<tr>
<td><strong>Add question(s) about registration status of reported household deaths to death registration coverage by geographical areas</strong></td>
<td>5 Census</td>
</tr>
<tr>
<td><strong>Collect month and year of each deceased persons reported in RHD</strong></td>
<td>6 Survey</td>
</tr>
<tr>
<td><strong>Collect orphanhood data for all household members regardless of age of persons</strong></td>
<td>7 Survey</td>
</tr>
<tr>
<td><strong>Include questions on year of death and age at death for the deceased parent; and age of parent alive in the orphanhood question</strong></td>
<td>8 Survey</td>
</tr>
<tr>
<td><strong>Add question(s) about registration status of reported household deaths to death registration coverage by geographical areas and key sociodemographic characteristics</strong></td>
<td>9 Survey</td>
</tr>
<tr>
<td><strong>Add questions on basic socioeconomic characteristics (e.g., education) of the deceased</strong></td>
<td>10 Survey</td>
</tr>
<tr>
<td><strong>Add questions about smoking among surviving and deceased household members</strong></td>
<td>11 Survey</td>
</tr>
</tbody>
</table>
Increase survey sample size

Increase survey sample size

12

Survey

Increase the precision of adult mortality estimates; reduce the estimate reference period to 3-4 years (instead of 7-8 years in current status) before the survey collection date for SSH

#1: Achieving better coverage of older age groups

Available resource needs to be allocated

Test innovative sampling frames and approaches

Test innovative sampling frames and approaches

13

Survey

Increase the precision of adult mortality estimates; reduce the estimate reference period to 3-4 years

#1: Achieving better coverage of older age groups

Start with broader testing in different countries

Initiate pilot programmes of mortality-focused high-frequency mobile phone surveys

Initiate pilot programmes of mortality-focused high-frequency mobile phone surveys

14

Survey

Increase timeliness and availability of adult mortality data

#1: Achieving better coverage of older age groups

Solicit interest from countries

Integrate mortality data collection (RHD and orphanhood) in all representative data collections in the country

Integrate mortality data collection (RHD and orphanhood) in all representative data collections in the country

15

All sources

Increase the precision by polling samples together; and improve comparability of data across data sources

#1: Achieving better coverage of older age groups

Improve integration of census, survey data with other data sources

Improve integration of census, survey data with other data sources

16

All sources

Improve overall adult mortality estimates availability, quality and timeliness

#1 - #5

Document existing methodologies and produce guidance

Encourage new studies on data integration to explore the full potential of existing data sources

6. Invitation for comments

118. Experts are invited to provide input on the following aspects:

- Overall structure and content of the paper
- Examples and national practices that can be incorporated into the paper
- Proposed recommendations (section 5), in terms of:
  - Relevance to your national circumstances
  - Feasibility in testing or adopting each of the recommendations
  - Difficulties in adopting each of the recommendations
  - Assign priority in terms of implementation in your country
  - Anything you would like to propose?
- Are you interested in joining the piloting and contributing to further development?
- What guidance and support are needed?

7. Next steps

119. The meeting is expected to agree on a set of proposed recommendations for censuses and surveys to improve the collection of adult mortality data in terms of availability, quality and timeliness. The paper will be revised after the meeting, reflecting input from the experts. The set of recommendations will be further refined following a global consultation with national statistical offices later this year. The revised draft recommendations will be submitted to the UN Statistical Commission. An executive summary presenting the expert group’s recommendations in abridged form, and signed collectively, will be submitted to a peer-reviewed journal for publication and dissemination.
8. REFERENCES


58. Helleringer S, Noymer A. Assessing the direct effects of the ebola outbreak on life expectancy in Liberia, Sierra Leone and Guinea. PLoS Curr. 2015 Feb 19;7:ecurrents.outbreaks.01a99f8342b42a58d806d7d1749574ea.


