A systematic global assessment of the completeness and quality of household death reporting in censuses and surveys since 2000

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Abstract

Suboptimal mortality data from civil registration and vital statistics systems in many countries mean that data on household deaths (e.g. for the preceding 12 months) are collected in censuses and surveys. However there are concerns that these data underreport deaths. This is the first global assessment of completeness of household death reporting, assessing data from 82 censuses in 56 countries and 26 surveys in 21 countries since 2000. Median completeness of reported household deaths in censuses was 89% (inter-quartile range (IQR) 66-102%) surveys was 96% (IQR 80-124%). Completeness was similar for males and females and was substantially lower where date of death was asked (census median 73%, IQR 53-91%) than not asked (census median 93%; IQR 74-110%); differences remained after controlling for other covariates. There are major completeness and quality issues with data from household deaths questions in censuses and surveys. Increased investments in CRVS systems should be a priority.

1. Background

Reliable routine all-cause mortality data disaggregated by age and sex are a fundamental cornerstone of evidence to inform population health monitoring and policy. These data are used to calculate several important population health indicators, such as adult mortality probabilities, life expectancy and years of life lost, that help understand mortality and cause of death patterns in a population, to track progress to national and international goals, and to provide evidence of the mortality impact of pandemics and natural disasters. The optimal source of such data should be a high quality civil registration and vital statistics (CRVS) system, that registers all (or almost all) deaths in a population and compiles these data to produce timely mortality statistics (AbouZahr et al. 2015). However, the COVID-19 pandemic demonstrated that many countries' governments do not have CRVS data of sufficient quality and timeliness to measure excess mortality. In March 2022, there was no routine mortality data available for 2020 or 2021 in 84 of 194 countries, while only 73 countries had full national data for that period (World Health Organization 2022).

While a longer-term goal to improve mortality data should be to strengthen CRVS systems, which is the objective of multiple international projects, attaining complete death registration could take years or even decades to occur for many countries (World Bank and World Health Organization 2014). In the interim, many countries have sought to measure all-cause mortality by using population censuses or household surveys that ask respondents to report on the deaths that occurred in their household, as well as sex and age at death. Censuses commonly collect mortality data not only of household deaths but also parental survival (orphanhood), summary birth histories (i.e. number of children ever born and children still living), and additional questions about the timing of female death in reproductive age relative to pregnancy or birth to ascertain pregnancy-related deaths. Surveys also collect more detailed birth history data, sibling survival data and also ask further questions related to the timing of the death from pregnancy or birth.

Questions about deaths in the household have been included in progressively more censuses over recent decades, from eight countries in Africa in the 1970 census round to 76 countries globally in the 2010 round (Hill et al. 2018, Technical Advisory Group on COVID-19

Mortality Assessment Working Group 2 2022). Beginning with the United Nations’ (UN) Principles and Recommendations for Population and Housing Censuses Revision 2 was published in 2008, household deaths in the previous 12 months or other period before the census has been a core topic (United Nations Statistics Division 2008, United Nations Statistics Division 2017, Hill et al. 2018). The UN recommend that a question asks the number of deaths in the household in the past 12 months (or other time period related to a festive or historic date in the country), with additional questions of the deceased’s name, sex, age at death and date of death (day, month, year) (United Nations Statistics Division 2017). This information is provided by the head of the household or household reference person, who is commonly an older male. A recent review found that 76 of the 195 countries that conducted censuses in the 2010 round had included the household deaths questions, mostly in sub-Saharan Africa and Latin America and the Caribbean (Technical Advisory Group on COVID-19 Mortality Assessment Working Group 2 2022). That review found that all of the 76 censuses asked the sex and age of the deceased (with some also asking for date of birth of the deceased), 65 used a 12 month reference period, but only 26 used the date of death question. One issue with having these recommended questions included in censuses is that many countries are reluctant to change questionnaires or want to ensure the least number of questions are included. Eighteen of 55 countries that have completed 2020 round censuses have included the household deaths questions (Technical Advisory Group on COVID-19 Mortality Assessment Working Group 2 2022).

Despite household deaths questions being used in many censuses and surveys throughout the world, little is known about the quality of data they collect, in terms of completeness at all ages but also by specific age group and sex. There are concerns about under-reporting of deaths for various reasons, including sensitivities that make respondents reluctant to report deaths, poorer recall of deaths the longer the time since occurrence, misreporting of age at death, non-representation of deaths of people in single-person households and in institutional settings, and that some households dissolve after a death due to disputes over inheritance or because of sudden reduction in income (United Nations Statistics Division 2014, Wak et al. 2017, Lankoande et al. 2022, Technical Advisory Group on COVID-19 Mortality Assessment Working Group 2 2022). Consistency and clarity of the definition of a household is also an issue, otherwise there can be confusion about whether migrants or extended family, should be included, which can result in over- or under-reporting of deaths (Wak et al. 2017). Accurate inclusion of deaths within the reference period is also important, otherwise the issue of "telescoping" of deaths outside the reference period can occur if the date of death is not asked or reported incorrectly (Lankoande et al. 2022, Technical Advisory Group on COVID-19 Mortality Assessment Working Group 2 2022). For surveys, the accuracy of mortality statistics is affected by sampling uncertainty, especially at ages with relatively lower risk of mortality and for subnational measurement; this can be overcome with increasing the reference period, although accuracy of death reporting for longer recall periods may decline. Further, clustering of deaths can also adversely affect sampling uncertainty, especially in emergencies (Working Group for Mortality Estimation in 2007). As with any census or survey, adequate training of enumerators is important to improve the accuracy of data collected.

Studies that have assessed the completeness of household deaths data in censuses and surveys have revealed varied findings. Some studies have compared census deaths to Health and Demographic Surveillance System (HDSS) sites that collect high quality deaths data. Analysis of 2006 Burkina Faso census household deaths data linked to deaths in Nouna HDSS showed that census deaths were 21% lower for males and 32% lower for females, resulting in census life expectancies that were four years higher for males and eight years higher for females than in the HDSS; census deaths were 40-50% lower at ages 75 years and above and over 50% lower for female infants (Lankoande et al. 2022). Comparison of 2002 and 2013 Senegal census data with HDSS data however found that resultant life expectancies at birth were broadly similar between each data source type (Masquilier et al. 2016). Similarly, comparison of crude death rates in 2010 Ghana census data with a HDSS found they were almost identical, however age-specific death rates in the census above age 65 years were significantly lower than in the HDSS (Wak et al. 2017). Analysis of the completeness of female deaths at ages 15-49 years for two censuses in nine countries in sub-Saharan Africa, South Asia and Southeast Asia showed low completeness (calculated as an average of three death distribution methods), ranging from 15% in Cambodia to 81% in Zambia, with average completeness just over 50% (Hill et al. 2018). An assessment of the 2007 Survey of Population Change in Vietnam estimated completeness of household death reporting to be 69% for males and 54% for females, while the 2015-16 CRVS Survey in Nepal revealed completeness of household death reporting to be 75% in 2015 but just 54% for the earlier period of 2014 (Ngo et al. 2010, Pandey and Adair 2022).

Even where household deaths data reported in censuses and surveys are incomplete, they have been widely used to estimate all-cause mortality by age and sex. Large global mortality estimation studies have used these data, adjusted for completeness measured by death distribution methods, as one source to estimate adult mortality (15-59 years) which is then input into model life tables to estimate complete life tables (GBD Demographics Collaborators 2020, United Nations Population Division 2019). Individual countries have also used a similar approach to estimate life tables based on a census (Department of Population 2015). However, a concern with death distribution methods is that they are inaccurate at measuring completeness because they are based on assumptions of population dynamics (e.g. closed to migration) which may not applicable to contemporary populations (Murray et al. 2010, Adair and Lopez 2018). Any inaccuracy in the estimate of completeness would adversely affect the reliability of the adjusted mortality statistics. Hence, household deaths data would be of most use for producing mortality statistics if they are complete, or close to complete.

There has been renewed interest in the use of household deaths data to fill the evidence gap for mortality from the COVID-19 pandemic. In India, a household deaths question was included in a phone survey which was used with other sources to estimate over three million excess deaths from June 2020-July 2021, the highest in the world and 6-7 times higher than official figures (Jha et al. 2022). Furthermore, given that many countries collect household deaths data in censuses or surveys, and will continue to do so in future, it is important to conduct a systematic assessment of the completeness and quality of these data to assess their utility as sources of mortality statistics and to potentially inform efforts to improve question design and implementation. No previous studies, to our knowledge, have conducted a comprehensive assessment of these data, which is surprising given these are a topic recommended for inclusion in censuses by the UN.

This study hence undertakes a systematic assessment of the completeness and quality of household death reporting in censuses and surveys since 2000 using available data. Completeness is assessed against both UN and GBD estimates of total deaths by sex. The analysis also compares completeness based on whether the date of death was asked, to assess the impact of reporting of deaths outside the stated reference period. The quality of household death reporting is assessed using the age-specific ratio of reported to estimated total deaths for that age group. The findings of the study will fill a large knowledge gap about the completeness of household death reporting in censuses and surveys.

2. Methods

This study analyses reporting of deaths by households in population censuses and surveys from 2000 to 2021. Reporting of deaths by households refers to where questions were asked of the respondent to report the number of deaths in their household within a defined period of time (mostly 12 months before the census or survey), as well as the sex, age at death and (but not necessarily including) date of death of the deceased. Data were obtained from searching for censuses and surveys where household deaths questions were known to have been included in the questionnaire. Individual country census and survey reports, the IPUMS International database, United Nations Statistics Division (UNSD) Demographic Statistics database, Global Burden of Disease (GBD) deaths database and Demographic and Health Surveys (DHS) data were searched to find reported household deaths data; country reports were selected instead of other sources if both were available (Global Burden of Disease Study 2020, ICF 2022, IPUMS International 2022, United Nations Statistics Division 2019). We extracted data on the number of reported household deaths by (where available) sex and five-year age group. Where the reference period for deaths was greater than 12 months, we extracted data of deaths for the most recent 12 month period if possible.

Data for a total of 82 censuses from 56 countries and 26 surveys from 21 countries were compiled (Table 1). Over half (44) of the 82 censuses and also over half (15) of the 26 surveys were conducted in countries in the sub-Saharan African super-region (as classified by the GBD), followed by Southeast/ East/ Central Asia, Oceania (19 censuses, 3 surveys) and Latin America and Caribbean (11 censuses, 3 surveys). Data were available by sex in 68 censuses and 23 surveys and by age in 66 censuses and 22 surveys. Date of death was only asked in 27 censuses, was not asked in 45 censuses and for 10 censuses it was unclear because the questionnaire was not available. Date of death was asked in 9 surveys, was not asked in 14 surveys and for 3 surveys the questionnaire it was unclear because the questionnaire was not available. Data were able to be extracted for the most recent 12 months or less in 78 of the 82 censuses and 20 of the 26 surveys. The full list of censuses and surveys, including sources, is shown in Table A.1.

Table 1: Summary of census and survey data analysed

	Number of censuses	Number of surveys
Total	82	26
Super-region		
Latin America & Caribbean	11	3
North Africa and Middle East	3	2
South Asia	5	3
Southeast/ East/ Central Asia, Oceania	19	3
Sub-Saharan Africa	44	15
Data available by:		
Sex	68	23
Age	66	22
Date of death asked	27*	9**

* unclear in 10 censuses whether date of death asked in questionnaire

** unclear in 3 surveys whether date of death asked in questionnaire

We calculated completeness of household death reporting as the number of reported household deaths divided by the number of deaths for the same reference period in that country as estimated by the UN World Population Prospects (WPP) and GBD (Global Burden of Disease Collaborative Network 2020, United Nations Population Division 2019). Both the UN and GBD estimate total deaths by separately estimating under-five mortality

(5q0) and adult mortality (45q15 or the probability of dying from 15 to 60 years) and inputting these into a model life table which calculates age-specific mortality rates. Reported household deaths data from censuses and surveys, adjusted for estimated incompleteness, are used as an input into adult mortality calculations, along with (but not always) death registration adjusted for incompleteness, sibling survival data from censuses and surveys and health and demographic surveillance system (HDSS) site data. Completeness was also calculated for each sex. Our focus was on completeness when calculated with UN estimated deaths as the denominator, with the GBD used mainly for comparative purposes. We also assessed quality of data calculated as the ratio of reported household deaths to either UN or GBD estimated total deaths by five-year age group (0-4 years to 80+ years); this is labelled as a ratio rather than as completeness because there is considerable uncertainty in the estimates of age-specific deaths according to both the UN and GBD.

Estimated deaths were calculated for the reference period by weighting annual death estimates by the proportion of the year which was covered by the period. The number of household deaths reported by censuses may be under-reported because of an undercount of the population by the Census. To overcome this issue, we calculated completeness adjusted for the size of the population counted in the Census relative to the population interpolated to the Census date according to population estimates (either UN or GBD estimated population was used depending on which was the source of estimated deaths) (GBD Demographics Collaborators 2020, United Nations Population Division 2019, United Nations Statistics Division 2022). Completeness of reported household deaths data may be biased if the same data was used as an input to estimate adult mortality as part of the estimated deaths analysis of the UN and GBD. For UN death estimation, 18 of 82 censuses and eight of 24 surveys were used as an input in the total deaths estimation, while for GBD death estimation 23 of 82 censuses and 8 of 24 surveys were used. We therefore analysed completeness separately for whether the data source was included in the total deaths estimation analysis.

Completeness and the age-specific ratio of reported household deaths was analysed using summary statistics of distribution: median, inter-quartile range (IQR: 25^{th} to 75^{th} percentile), minimum and maximum. This was examined separately for each sex and age. It was also analysed by whether date of death was asked in the questionnaire to assess the impact of the use of this recommended question.

To disentangle the association of completeness with a range of factors, we conducted a linear regression with covariates of type of data source (census or survey), whether date of death was asked, super-region, Socio-Demographic Index (SDI; a composite measure of income, education and fertility), whether the data was included in the estimated deaths analysis and year (Global Burden of Disease Collaborative Network 2020). The regressions were conducted for completeness separately using UN estimated deaths and GBD estimated deaths, for both sexes and also for sex-specific completeness (with sex as another covariate). In one version of the model we included an interaction between the covariates of data source type and whether date of death was asked. Standard errors were adjusted for clustering within countries. The regression did not include Democratic People's Republic of Korea 2008 Census because the SDI was not available for that country. These analyses were conducted using Stata/SE 17.0 (StataCorp LP 2021). A detailed dataset is available at https://doi.org/10.26188/22191496, a summary dataset for use in analysis is available at https://doi.org/10.26188/22191499 and code for replicating the results in the tables in this article is available at https://doi.org/10.26188/22191505.

3. Results

The median completeness of reported household deaths for both sexes for the 82 censuses was 89% (IQR 66-102%) compared with UN estimated deaths and 85% (64-113%) compared with GBD estimated deaths (Figure 1, Table A.2). There was substantial variation in completeness for individual censuses, ranging from a minimum 21% (Burundi 2008) to maximum 202% (Sudan 2008) for UN estimated deaths and from 22% (Burundi 2008) to 233% (Sudan 2008) for GBD estimated deaths (Table A.3). Results for males and females were relatively similar. For the 68 censuses where sex-specific household deaths data were available, the median completeness for males (UN 88%, GBD 84%) and females (UN 86%, GBD 86%) were similar. The IQRs were also relatively similar to both sexes, being wider for females for GBD estimated deaths (60-115%). The lowest sex-specific completeness was 19% in Burundi 2008 (UN estimated deaths) for females and the highest 257% in Sudan 2008 (GBD estimated deaths) for females. When adjusting for the undercount in censuses, the median completeness for both sexes was slightly higher at 92% (IQR 67-106%) for UN estimated deaths and 86% (IQR 67-116%) for GBD estimated deaths (Table A.4).

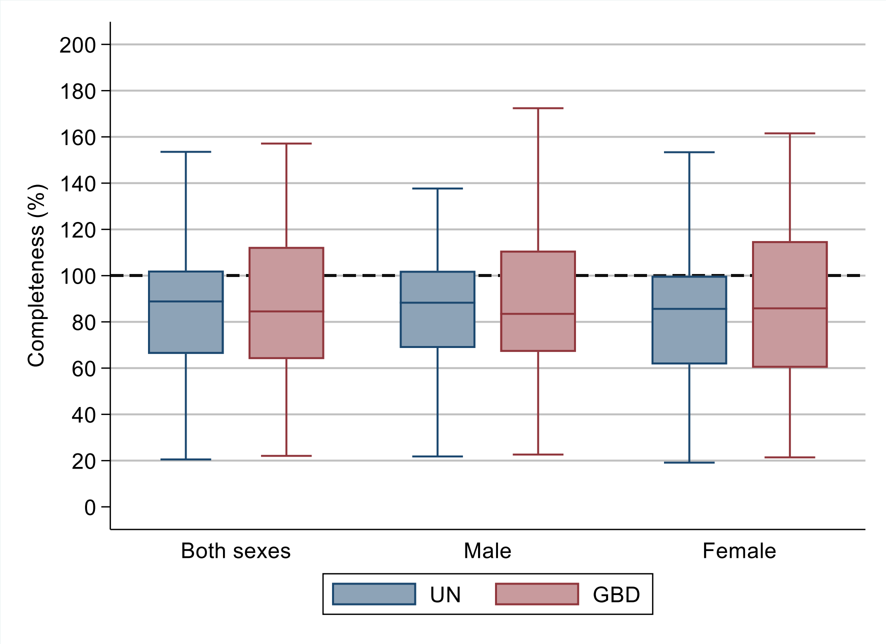

Figure 1: Box plots of completeness (%) of reported household deaths (UN and GBD estimated deaths), by sex, censuses, 2000-2021

Box shows inter-quartile range (25th to 75th percentile), with middle horizontal line showing the median. Excludes outside values. In all box charts, adjacent lines show the highest value within the range p75 to p75 + 1.5 * IQR and the lowest value within the range p25 to p25 – 1.5 * IQR.

For surveys, the median completeness of reported household deaths for both sexes was slightly higher than for censuses, at 96% (IQR 80-124%) compared with UN estimated deaths and 101% (IQR 76-128%) compared with GBD estimated deaths (Figure 2, Table A.2). Although the IQRs were wider than for censuses, the minimum (Botswana 2006 Demographic Survey: UN 51%, GBD 46%) and maximum (2010 Zambia Living Conditions Monitoring Survey: UN 180%, GBD 185%) completeness were not as extreme (Table A.3). The median completeness for males (99%) was higher than for females (91%) when compared with UN estimated deaths but was similar for GBD estimated deaths (males 103%, females 102%).

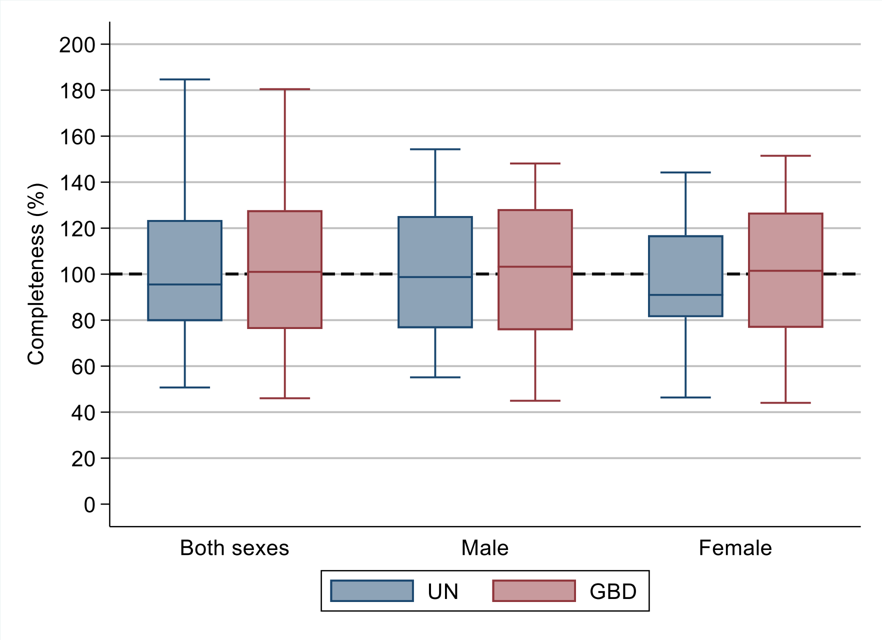

Figure 2: Box plots of completeness (%) of reported household deaths (UN and GBD estimated deaths), by sex, surveys, 2000-2016

Box shows inter-quartile range (25th to 75th percentile), with middle horizontal line showing the median. Excludes outside values.

In censuses where the date of death was asked in the questionnaire, the completeness of reported household deaths was 20 percentage points (p.p.) lower (median 73% compared with UN estimated deaths; IQR 54-90%) than for censuses where the date of death was not asked (median 93%; IQR 74-110%) (Figure 3, Table A.2). Notably, the median completeness where date of death was asked was almost identical to the 25th percentile of censuses for where date of death was not asked. The difference in median completeness was larger for females (date 70%, no date 91%) than for males (date 78%, no date 88%) (Figure A.1). Similar results for both sexes were found when compared with GBD deaths (Figure A.2). Notably, the minimum and maximum completeness for censuses where the date of death was asked (34-108%) were much narrower than for those where it was not asked (21-202%); similar findings were revealed for males and females and also completeness calculated compared with GBD estimated deaths. Even larger differences by whether date of death was asked were found for surveys, with a median of 85% (IQR 78-90%) compared with UN estimated deaths where date of death was asked and 122% (IQR 92-133%) where it was not asked, and again a much wider variation for where date of death was not asked (Figures 3, A.3). Similar findings for completeness of surveys when compared with GBD estimated deaths are shown in Figure A.4.

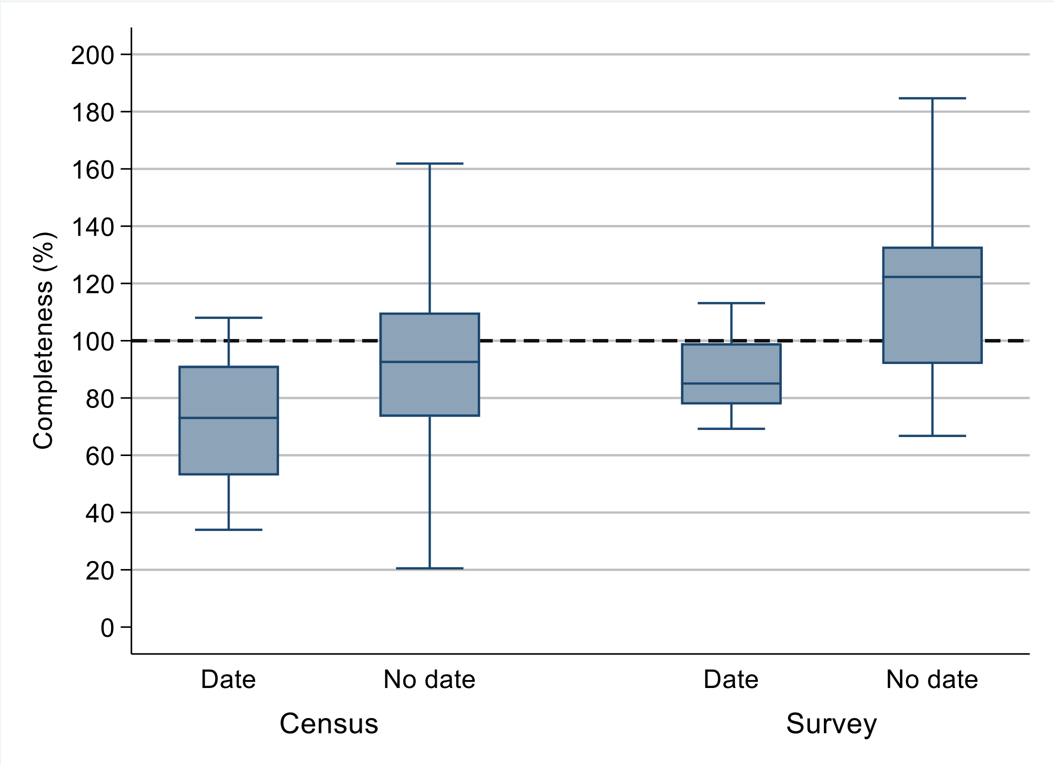

Figure 3: Box plots of completeness (%) of reported household deaths (UN estimated deaths), by whether date of death asked, censuses and surveys, 2000-2021

Box shows inter-quartile range (25th to 75th percentile), with middle horizontal line showing the median. Excludes outside values.

A potential bias in the results is that a census or survey was a data source included in the analysis to estimate deaths by either the UN or GBD. For UN estimated deaths, the median completeness was almost the same for whether a census (included 88%, not included 90%) or survey (included 95%, not included 96%) was included in the estimation of deaths or not; IQRs are similar too (Table A.5). However, when the ratio was calculated based on GBD estimated deaths, the median is much higher and the IQR narrower when the census (median: included 105%, not included 79%; IQR: included 81-115%, not included 62-106%) or survey (included 123%, not included 90%; IQR: included 109-139%, not included 72-117%) was included rather than not.

The first linear regression model in Table 2 confirms that the completeness of reported household deaths to UN estimated deaths was higher where the date of death question was asked compared with not asked (-0.211 or 21.1 p.p.; predicted values holding other variables at means: no date 98.3%, date 77.2%; no date 27% higher relatively) in model 1. However, SDI, super-region, data source type, data included in estimated deaths analysis and year were all had confidence intervals that overlapped with zero. When an interaction term for data source type by whether date of death asked was included in model 2, survey predicts a higher completeness than census where date of death was not asked (0.207 or 20.7 p.p. higher; predicted: census 93.2%, survey 113.9%) although the difference was smaller where date of death was asked (0.207 - 0.066 = 0.141 or 14.1 p.p.; predicted values: census 73.9%, survey 88.0%). Date of death being asked also predicted a lower completeness for censuses (-0.193 or -19.3 p.p.; predicted: no date 93.2%, date 73.9%; no date 26% higher relatively) and surveys (-0.193 – 0.066 = -0.259, or -25.9 p.p.; predicted: no date 113.9%, date 88.0%; no date 29% higher relatively), compared with it not being asked. Table A.6 shows that the results from the same model using completeness calculated using GBD estimated deaths was very similar, except that inclusion of the data source in the analysis of estimated deaths increased completeness (model 2 0.150 or 15.0 p.p. higher) and Southeast/ East/ Central Asia, Oceania was lower compared with Latin America (-0.262 or -26.2 p.p. in model 2).

Table 2: Results of linear regression of completeness of reported household deaths (UN estimated deaths), both sexes, 2000-2021

Covariates	Model 1		Model 2	
	Coef.	**95% CI**	**Coef.**	**95% CI**
Socio-Demographic Index	0.260	-0.333 - 0.852	0.375	-0.172 - 0.922
Super-region (Ref: Latin America & Caribbean)				
North Africa and Middle East	0.125	-0.429 - 0.678	0.185	-0.382 - 0.752
South Asia	-0.122	-0.320 - 0.076	-0.110	-0.305 - 0.085
Southeast/ East/ Central Asia, Oceania	-0.139	-0.325 - 0.046	-0.136	-0.327 - 0.054
Sub-Saharan Africa	-0.003	-0.181 - 0.175	0.024	-0.151 - 0.199
Data source type (Ref.: Census)				
Survey	0.114	-0.023 - 0.250	0.207	0.004 - 0.410
Date of death asked (Ref.: No)				
Yes	-0.211	-0.358 - -0.064	-0.193	-0.339 - -0.047
Unclear	-0.041	-0.259 - 0.176	0.126	-0.055 - 0.308
Data source type x date of death asked				
Survey x Yes	-	-	-0.066	-0.330 - 0.198
Survey x Unclear	-	-	-0.675	-1.049 - -0.300
Data included in estimated deaths analysis (Ref: No)				
Yes	0.023	-0.125 - 0.172	0.021	-0.128 - 0.170
Year	-0.010	-0.022 - 0.002	-0.013	-0.024 - -0.001
Constant	20.892	-3.259 - 45.044	26.175	3.167 - 49.183

* p<0.05, ** p<0.01. N=107, countries=61. Coef.: Coefficient. CI: Confidence interval. Confidence intervals adjusted for clustering within country.

When sex-specific completeness was analysed with linear regression and a sex variable was added to the model, the results remained mostly very similar (Table A.7). The sex variable had 95% confidence intervals that overlapped with zero. The primary changes were that year was negative (model 2: a decline in completeness of 1.9 p.p. for every year over the period) and Southeast/ East/ Central Asia, Oceania was predicted lower completeness compared with Latin America in model 1 (-0.219 or 21.9 p.p. lower). Results for GBD estimated deaths were mostly similar, except that the coefficient for whether date of death asked was similar but overlapped with zero (model 2 only; interacted with census) (Table A.8). Also, where the data source was included in the estimated deaths analysis increased completeness.

The ratio of reported household deaths to UN estimated deaths showed a similar age pattern for censuses and surveys, although with slightly more pronounced differences by age for surveys (Figure 4). The ratio increased from 0-4 years to peak at ages 5-9 years (100% for censuses, over 120% for surveys) before declining steadily to older ages, reaching 60% at ages 75-79 years for censuses and 64% for surveys. The IQR at ages less than 40 years was approximately 60-120% for censuses and 80-140% for surveys. There was a final increase to age 80+ years by over 20 p.p. to be over 80% for censuses and by 15 pp. to be just under 80% for surveys. The ratio of reported household deaths to GBD estimated deaths was much higher at younger ages, reaching over 140% for censuses and over 180% for surveys, before a sharper decline with age to a similar level at the oldest ages to what was found for completeness based on UN estimated deaths. The age pattern of the ratio of reported household deaths to UN estimated deaths for censuses was similar for males and females at younger ages, but with the ratio for males being higher from ages 40 years onwards and reaching 95% for 80 years and above compared with 81% for females (Figure A.5). For surveys, the age pattern of the ratio for males was similar to censuses, except that there was not as large an increase at the oldest ages, however the ratio for females was well in excess of 100% at younger ages and has a sharper decline at older ages thereafter (Figure A.6)

The age pattern of the ratio of report household deaths to UN deaths was much different between whether a census asked the date of death or not (Figure 5). Where the date of death was not asked, there was a pronounced age pattern of the ratio for both sexes which reaches over 120% at 5-9 years and then as low as 60% at older ages before increasing to almost 100% at 80+ years. Where the date of death was asked, however, the ratio varies between 60% and 80% with no clear age pattern. Similar differences were found for surveys, with the ratio where date of death was not asked being well over 100% at all ages less than 40 years before declining to less than 80% at 60 years and above (Figure A.7). There was again no clear age pattern for surveys where date of death was asked, with the ratio varying around 80% over all ages.

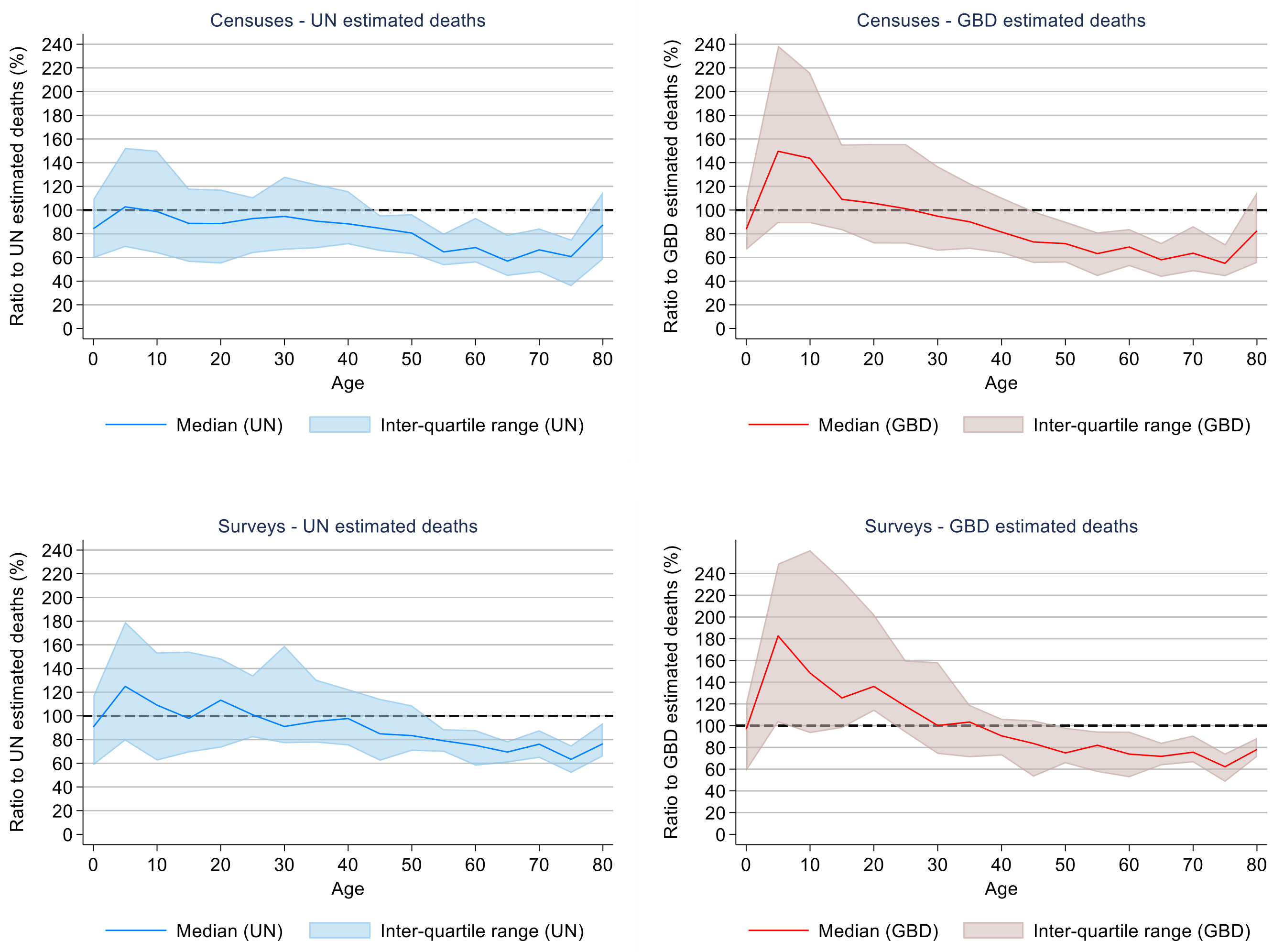

Figure 4: Ratio of reported household deaths to UN and GBD estimated deaths (%), by age at death and data source type, both sexes, 2000-2021

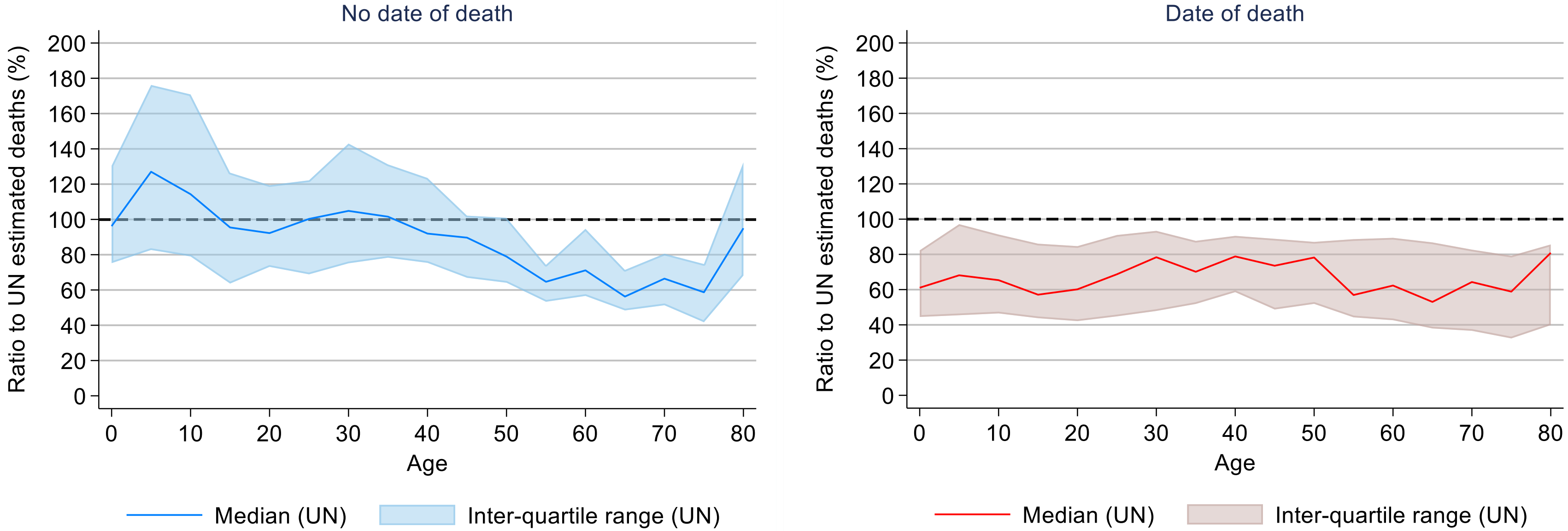

Figure 5: Ratio of reported household deaths to UN estimated deaths (%), by age at death and whether date of death asked, both sexes, censuses, 2000-2021

4. Discussion

This systematic global assessment has revealed large variations in the completeness of household death reporting in both censuses and surveys. Median completeness of household death reporting for censuses (compared with UN estimated deaths) was 89%, being below 66% for one-quarter of censuses and above 102% in another one-quarter, and ranging from just 21% in in Burundi in 2008 to over double (202%) in Sudan in 2008. There was similarly large variation in completeness for surveys, with a slightly higher median of 96% and one-quarter having completeness above 124%. Completeness was similar for males and females and for whether UN or GBD estimated deaths were used as the denominator in calculation of completeness. The ratio of reported to estimated deaths was higher at ages less than 40 years, with over one-quarter of censuses being above 120% and one-quarter of surveys over 140%, before declining to older ages where it reaches a median of just 60% in age groups 65-79 years for censuses, before rising to ages 80 years and above. This wide variation in results suggests that household deaths questions as currently implemented in censuses and surveys around the world are providing unreliable mortality data.

A significant issue with the implementation of household death reporting is that only about one-third of censuses and surveys include a question for the date of death. This study has found that the exclusion of the date of death question from a census results in completeness 27% higher than if it were included, after controlling for other factors in the regression. That is, it appears that there is substantial "telescoping" or inclusion of household deaths that occurred outside the specified reference period if the date of death question has not been asked in a census or survey. Another finding is that there is less variation by age in the ratio of reported to estimated deaths if the date of death was asked; that is, no clear age pattern compared with much higher ratios at younger ages if it were excluded. This could mean that the "telescoped" deaths are more likely to be younger – possibly because child deaths are more readily recollected by respondents, especially due to separate child mortality history questions being included elsewhere in the questionnaire – as well as inclusion of the date of death question being reflective of improved quality of the data collection including training of enumerators; this is also relevant to the lower variation in completeness at all ages if date of death was asked. This is a noticeably different age pattern to the registration of deaths, which is commonly lower for children because there are not as many incentives to register child compared with adult deaths (e.g. for inheritance purposes) (Adair and Lopez 2021). The higher ratio at 80 years and above may indicate that there is overstatement of age at older ages.

Where the date of death was included in the questionnaire, we can make a better assessment of completeness of household death reporting because deaths can be excluded is they were reported to occur outside of the reference period. Overall, household death reporting in censuses and to a lesser extent surveys is incomplete. The median completeness for censuses with the date of deaths questions was 73%, with almost one-quarter having completeness below 50% and only one-quarter having completeness above 90%, while median completeness was surveys was higher at 85% but again only one-quarter had completeness above 90%. The higher completeness for surveys may reflect that better training of the fewer enumerators needed to conduct a survey compared with a census. Incomplete mortality data can be adjusted based on the level of completeness as estimated using existing methods, however death distribution methods are subject to considerable uncertainty. Further, the more incomplete mortality data are, the more unreliable the adjusted mortality statistics will be.

These findings do raise questions as to the utility of continued use of household deaths questions in censuses and surveys. It is noticeable that only one-quarter of the censuses and surveys in our study were included as an adult mortality data source in the UN World Population Prospects and only a slightly higher proportion by the GBD. A concerning finding in our study was that some of the regression models showed a decline in completeness of household death reporting over time. If household deaths questions are to be continued to be used in censuses and surveys, then further efforts need to be made to improve the quality of data collected. As mentioned, an obvious improvement can be to include the date of death question. Clearly this is not included in many censuses because of a desire to keep the questionnaire relatively short for such a large-scale data collection, however there is the potential for them to be included in a long form questionnaire conducted in a sample of the population. For surveys however, which are typically already long questionnaires, there are less reasons for exclusion of these questions.

Surveys also provide a good opportunity to employ more innovative data collection techniques to improve reporting of mortality. One survey in Senegal used recall cues and other methods to assist recollection of deaths of siblings, as well as using an event history calendar to improve the accuracy of reporting of dates (Helleringer et al. 2014). Mobile phone surveys have also become more widely used in the collection of mortality data with encouraging results, especially for reducing omissions of key data like age and date of death (Kuehne et al. 2016, Chasukwa et al. 2022). Electronic data collection can also assist in improving the quality of household death data collected in censuses.(Technical Advisory Group on COVID-19 Mortality Assessment Working Group 2 2022) Improved training of enumerators can also overcome many of the data quality issues identified in this assessment. In Vietnam, the General Statistics Office conducted focus group discussions with data collectors to understand issues with collecting household deaths data in their annual survey (Ngo et al. 2010). They used the results to develop training modules for these enumerators to highlight existing data quality problems, desensitise their perceptions about asking death questions, and to strengthen interviewing techniques and response recording (Ngo et al.

2010). This intervention resulted in a 20% increase in household deaths recorded in the next survey in 2007 (Ngo et al. 2010).

There are some limitations with this assessment. It does not include all censuses nor all surveys where the household deaths questions were known to be asked because household deaths results were not published nor made data available for analysis. However, our finding that completeness does not vary by SDI and, to a lesser extent, super-region of the census or survey gives us confidence that the findings would be generalisable to other countries where we could not assess data. Another issue is the accuracy of UN and GBD estimated deaths, especially by age, for these countries that have no reliably single source of mortality data. The consistency of completeness between whether UN or GBD estimated deaths was used in the denominator provides some reassurance as to the veracity of the findings; or primary analysis was of the distribution of completeness over all censuses and surveys rather than of individual countries. One difference was that the ratio of reported to estimated deaths was higher at younger ages for when GBD rather than UN estimated deaths was used, however given our primary focus was on the results produced from UN estimated deaths we emphasised the findings from the latter. This issue was also relevant to our finding that completeness was higher where the GBD included the data source in its estimated deaths analysis but not so for the UN, so hence this issue did not bias our main findings. Another method to estimate completeness is the empirical completeness method, however this is not recommended to use for countries with high HIV mortality, which includes several of the countries in sub-Saharan Africa in this study, and it cannot measure completeness above 100% because it is based on the logit transformation of the completeness fraction (Adair and Lopez 2018) Finally, while we could assess the impact of inclusion of the date of death question on completeness, we could not examine other issues such as whether deaths are excluded or double-counted because of the use of the household to count death (e.g. single person households excluded, migrants double-counted).

This assessment has found considerable limitations of using household death questions in censuses and surveys to measure mortality. Inclusion of household deaths questions can only be useful where the date of death is asked, otherwise a high proportion of deaths from outside the reference period will be included. Further, there should be significant training of enumerators and use of electronic data collection. Household death reporting is more challenging in censuses because of the scale of data collection, however if household deaths questions are to be included there is scope for them to be included in a questionnaire implemented in a sample of households. Censuses however do have considerable advantages in being able to estimate detailed socio-economic and spatial inequalities in mortality. For surveys, there are more opportunities to implement innovative methods to improve the accuracy of recall of deaths, which is essential if they are to accurately collect mortality data from the COVID-19 pandemic. A limitation of surveys is sampling uncertainty, however increasing the recall period for deaths could adversely affect data quality. Continued implementation of household deaths questions in censuses and surveys, without improvements to how they have been conducted in most countries in the past 20 years, will continue to produce unreliable mortality statistics that are of limited use in filling the gap in mortality evidence caused by suboptimal death registration and hence will remain be an effective investment by governments and donors.

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