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Are there sex differences in completeness of death registration and quality of cause of death statistics? Results from a global analysis

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ABSTRACT

Introduction Recent studies suggest that more male than female deaths are registered and a higher proportion of female deaths are certified as 'garbage' causes (ie, vague or ill-defined causes of limited policy value). This can reduce the utility of sex-specific mortality statistics for governments to address health problems. To assess whether there are sex differences in completeness and quality of data from civil registration and vital statistics systems, we analysed available global death registration and cause of death data.

Methods Completeness of death registration for females and males was compared in 112 countries, and in subsets of countries with incomplete death registration. For 64 countries with medical certificate of cause of death data, the level, severity and type of garbage causes was compared between females and males, standardised for the older age distribution and different cause composition of female compared with male deaths.

Results For 42 countries with completeness of less than 95% (both sexes), average female completeness was 1.2 percentage points (p.p.) lower (95% uncertainty interval (UI) −2.5 to −0.2 p.p.) than for males. Aggregate female completeness for these countries was 7.1 p.p. lower (95% UI −12.2 to −2.0 p.p.; female 72.9%, male 80.1%), due to much higher male completeness in nine countries including India. Garbage causes were higher for females than males in 58 of 64 countries (statistically significant in 48 countries), but only by an average 1.4 p.p. (1.3–1.6 p.p.); results were consistent by severity and type of garbage.

Conclusion Although in most countries analysed there was no clear bias against females in death registration, there was clear evidence in a few countries of systematic undercounting of female deaths which substantially reduces the utility of mortality data. In countries with cause of death data, it was only of marginally poorer quality for females than males.

Key questions

What is already known?

- Recent studies have suggested that there is gender bias in civil registration and vital statistics (CRVS) systems, with less female than male deaths registered and female cause of death data of poorer quality.

What are the new findings?

- In the 42 countries (of a total 112) where death registration was not complete, that is, less than 95%, average completeness was 1.2 percentage points lower for females than males.
- In nine of these 42 countries, female completeness was at least 5 percentage points lower than for males, contributing to the aggregate female completeness for the 42 countries to be 7 percentage points lower than for males.
- For the quality of the cause of death data, garbage causes were consistently higher for females than males, but only by an average 1.4 percentage points.

What do the new findings imply?

- In most countries analysed, there is no evidence of a strong bias against females in death registration nor in the quality of the cause of death data. However, the data did also show that in a small number of countries such biases do exist, which severely reduces the utility of vital statistics in these countries.

INTRODUCTION

Routine and high quality data on the fact and cause of death from a civil registration and vital statistics (CRVS) system should be the primary source of data to provide evidence for health policy and monitor progress to national and international health goals.[1] In particular, accurate statistics on the completeness of registration and differences in this metric between males and females are important given that sex disparities exist in many key morbidity and mortality indicators.[2] CRVS data also are important for legal and administrative purposes, providing families with a certificate of the evidence of death and, in many countries, the cause as ascertained by a physician using an International Medical Certificate of Cause of Death (MCCOD).

Recent studies have suggested that the quality of CRVS data for female deaths are poorer than for male deaths, presenting evidence that fewer female than male deaths are registered.[3 4] This, however, is clouded by the fact that globally about 20% more males than females die each year.[2] There are some reasons though why there may be differences in the completeness of death registration by sex. Gender biases within a country (ie, the social construct of sex) that are represented by social and cultural factors can interact with characteristics of national legal and death registration systems to create barriers and power imbalances against females.[3] For instance, most legal systems incentivise the registration of deaths by demanding a death certificate to allow the transfer of ownership of property and other assets, which often are predominantly owned by males.[3] This can create a greater incentive for the registration of a male than female death, and likely contribute to higher levels of male than female completeness of registration (as a percentage of total deaths). Also, in some countries, more male than female deaths occur in hospitals, where deaths are more likely to be registered or reported; this may also lead to sex differences in death registration.[5]

The MCCOD is the primary source of information on causes of death globally. The attending physician completes a MCCOD with the sequence of events that led to death, often based on a review of the medical records, including imaging, pathology and laboratory investigations.[6] In most countries, the certifying doctor has a professional and legal responsibility to ensure that the MCCOD is completed accurately. A significant challenge with cause of death data is that not all deaths are medically certified, and those which are can be biased due to poor certification practices that result in ill-defined or 'garbage' causes, which comprise a range of diagnoses that are of no use for policy.[7] Some examples of garbage causes include modes of death such as 'heart failure' or symptoms such as 'fever' which could be due to either pneumonia or cancer or many other diseases.

There is evidence from a number of studies that a gender bias exists in detection and treatment procedures for cardiovascular diseases and more generally in medical textbooks.[4 8–11] Gender bias could negatively impact on the quality of cause of death statistics for females if, for example, the quality of medical diagnosis or clinical care provided is poorer than for males. A past analysis of data from the WHO Mortality Database does seem to demonstrate that deaths in females are slightly less likely to have accurate information on cause of death than deaths in males, with the proportion of female deaths having unusable or 'garbage' causes being 2–3 percentage points (p.p.) higher than for male deaths.[4] Depending on prevailing gender norms and other cultural factors, it is to be expected that the tendency to misdiagnose and miscertify causes between sexes may also vary among countries.

Any sex differences in the completeness of death registration or the quality of cause of death data prevent governments from recognising problems and planning effective, gender-sensitive policies.[4] However, since the evidence base for any real sex differences in more than a handful of countries is tenuous, this study analyses the situation for all countries where such data are available. The study does not seek to assess gender bias in diagnosis, care or outcome, which is more suited to a small-scale rather than global analysis such as this. This study used completeness of registration because it is a superior measure of sex differences rather than the ratio of male to female deaths, which past analyses have relied on despite there being a greater number of male than female deaths in almost all countries, which will bias the results.[2 4] For causes of death, we analysed both the extent of garbage causes, and also the severity and the type of garbage, and importantly we standardised for any bias in garbage causes due to the older age and different cause composition of female compared with male deaths.

METHODS

Completeness of death registration

We define completeness of death registration as the percentage of deaths in a population that are registered in the year they took place, divided by the total events that were estimated to have occurred.

For the assessment of completeness of death registration, we used publicly available national routine data of registered or reported deaths from various sources, including the Global Burden of Disease database and the WHO Mortality Database (see online supplemental table S1).[12 13] Brazil and Peru are two countries where the data are from Ministry of Health databases and so are strictly 'reported' rather than 'registered' deaths; however, we use the term 'registered' deaths throughout the manuscript. The database for our study contains sex-specific death registration data of 112 countries from 2015 onwards, which excludes countries with less than 2000 annual estimated deaths because of uncertainty in estimates introduced by small numbers of deaths.

We measured completeness of death registration using the empirical completeness method, which uses inputs of registered crude death rate (registered deaths per 1000 population), under-five mortality rate, percentage of the population aged 65 years and above and completeness of under-five registration (age-specific registration data for children under 5 years where available), all data available or able to be calculated using registration data and data from the Global Burden of Disease (GBD) study.[2 14] This method has been employed in numerous countries to estimate completeness separately for males and females.[15 16] The most recent year of available data for some countries does not disaggregate deaths by sex, so for these, we estimated the sex-specific completeness based on the last year for which data were available. In countries with high HIV mortality (Botswana, Lesotho and South Africa), we calculated completeness by using the GBD estimated total deaths as the denominator

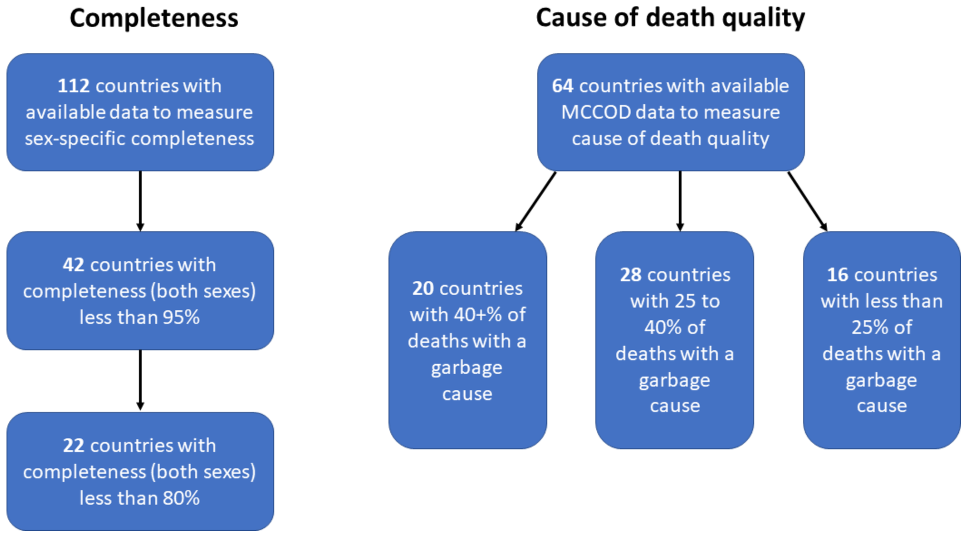

Figure 1 Summary of available data to measure completeness of registration and cause of death quality. MCCOD, Medical Certificate of Cause of Death.

because the empirical completeness method is not suitable for measuring completeness in such countries.[14]

We focused our analysis on the 42 countries with less than 95% completeness for both sexes and the 17 countries with less than 80% completeness for both sexes, because differences in completeness will less likely be present in countries with overall completeness approaching 100% (figure 1). We measured sex differences in completeness by aggregating data for countries in the data set; that is, weighting sex-specific completeness by the number of deaths in each country estimated by the GBD in 2019.[2] One issue with this calculation is that 79% of deaths in countries in our data set with less than 95% completeness for both sexes occur in China and India. To enable comparison where those two countries do not dominate the results, we also calculated the average and median level of sex-specific completeness across countries; that is, by not weighting countries by the number of deaths (ie, treating each country equally irrespective of the number of deaths). Both absolute and relative differences in completeness between the sexes were calculated. We measured the number of additional female deaths that would be registered if females had the same levels of completeness as males, to understand which countries contributed most to sex differences in registration completeness. We also calculated the proportion of unregistered deaths that are male and female, to understand the extent to which future interventions to improve completeness should focus on specific sexes. The aggregate and country-level completeness figures, and differences between female and male completeness, are presented with 95% uncertainty intervals (UIs). The 95% UIs were calculated from 1000 simulations of predicted completeness incorporating uncertainty in the empirical completeness model and in the under-five mortality rate variable; for the three countries where the completeness was calculated using the GBD, we used their published 95% UIs. We describe significant differences in completeness as being where the 95% UI of the difference in completeness does not overlap with zero.

Garbage causes

For measurement of sex differences in the percentage of deaths with a cause that is a garbage cause, we used data from the WHO Mortality Database, which contains data of the underlying cause of death coded to the 10th version of the International Classification of Diseases (ICD-10) by age group and sex.[12] Similar to the previous analysis, we included deaths from 2015 onwards and countries with at least 2000 deaths per annum; this resulted in 64 countries available for analysis. Years of data used for each country for completeness and cause of death analyses is shown in online supplemental table S2.

The quality of the cause of death data was evaluated in terms of the extent of garbage causes in the data, using the same methodology and garbage code typologies as in the software ANACONDA (see online supplemental table S3 for further details).[17–19] In the first typology investigating the type of error, if the proportions of total deaths in each error category are much higher for females than males, it might reflect gender biases and should be further investigated. Similarly, in the second typology where the garbage codes are grouped according to their severity (the potential impact they could have for misguiding policy), if the proportion of deaths in the 'very high' and 'high' categories are higher for females than males then this could be a sign of further gender bias beyond just the overall level of garbage. Other indicators of poor quality cause of death data are the percentage of deaths with an unspecified age or sex, and the percentage of deaths with a biologically implausible cause; we did not include these in our analysis because they comprised less than 1% of deaths in almost all countries in the database.[20]

In each country, we calculated the differences in the percentage of female deaths compared with male deaths that are in each garbage cause category after standardising for differences in age and cause distribution (six broad causes of death (group 1 causes (communicable, neonatal, maternal and nutritional) (ICD-10 codes

A00-B99, O00-P99 and J00-J229), cardiovascular diseases (I00-I99), cancers (C00-D48), other non-communicable diseases (D49-H99, J23-N99 and Q00-Q99), injuries (S00-T99, V00-Z99), R-coded (symptoms, signs and ill-defined conditions: R00-R99)) between the two populations. The standardisation of garbage was conducted separately for each country. The male garbage percentage was standardised to the female age-cause distribution of deaths in the country. That is, the male age-cause-specific garbage percentage was multiplied by the proportion of total female deaths that are in each age-cause grouping, and the sum of these age-cause-specific products is the age-cause standardised male garbage percentage. This standardisation is necessary to reduce potential bias in results due to the different age and cause structure of female and male deaths. It is well known that females are more likely to survive to older ages than males, where identifying causal pathways leading to death is a more challenging task for doctors than at younger ages.[21] For example, garbage causes such as 'age-related physical debility' are more likely to be reported, while the heightened presence of comorbid conditions at these ages can lead to increased reporting of conditions that are not underlying causes of death, such as sepsis and heart failure. Standardising for cause is similarly important, as deaths from certain cause groups may be more likely in one sex and also more likely to result in a garbage cause (eg, 'heart failure' is commonly misclassified from cardiovascular diseases such as ischaemic heart disease). The analyses were conducted within different levels of overall garbage (40+%, 25<40%, <25%; figure 1). The 95% UIs of garbage were calculated from 1000 simulations that assume the garbage cause proportions have a binomial distribution. We also describe significant differences in garbage as being where its 95% UI does not overlap with zero.

RESULTS

Completeness of registration

For all 112 countries with data to enable calculation of sex-specific completeness, aggregate female completeness (84.5%, 95% UI 82.2%–86.6%) is 3.2 p.p. lower (95% UI −6.1 to −0.2 p.p.) than male completeness

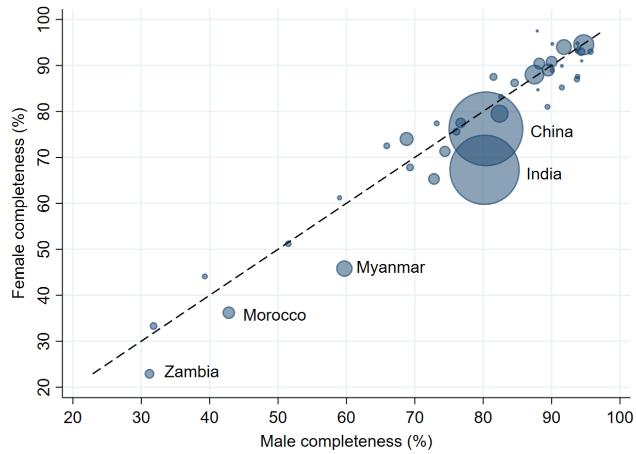

Figure 2 Female vs male completeness by country, countries with completeness for both sexes of less than 95%. Dashed line indicates equality of male and female completeness. Marker size indicates estimated deaths in country in 2019.

(87.7%, 85.5%–89.4%) (table 1, figure 2). When considering only the 42 countries with completeness for both sexes of less 95%, the difference widens to 7.1 p.p. (−12.2 to −2.0 p.p.; female 72.9% (68.7%–79.6%), male 80.1% (76.5%–83.0%)). These results, however, are significantly impacted by India and China (the two largest markers in figure 2), which comprised almost 80% of deaths in 2019 in these 42 countries. For the 17 countries with completeness of less than 80%, the female completeness is 8.1 p.p. lower (−14.0 to −2.2 p.p.). Results for all countries are shown in online supplemental table S4A,B).

For the 42 countries with completeness of less than 95% for both sexes, females have only slightly lower registration completeness, being an average 1.2 p.p. lower (−2.5 to −0.2 p.p.) and a median 0.5 p.p. lower (−1.9 to −0.8 p.p.) (table 2). Of these 42 countries, female completeness is lower than male completeness in 25 countries, at least 5 p.p. lower in nine countries, but only significantly lower (ie, 95% UI of difference in completeness does not overlap with zero) in seven countries; female completeness is significantly higher in four countries (online supplemental table S4A). Including only countries with

Table 1 Summary results of male and female completeness (%), aggregate analysis (ie, weighted by number of deaths in each country)

	Completeness by sex (%)		
Completeness (both sexes)	Female	Male	Absolute difference† (p.p.)
All countries* (n=112)	84.5 (82.2–86.6)	87.7 (85.5–89.4)	−3.2 (−6.1 to −0.2)
Less than 95% (n=42)	72.9 (68.7–76.6)	80.1 (76.5–83.0)	−7.1 (−12.2 to −2.0)
Less than 80% (n=17)	70.4 (65.6–74.6)	78.6 (74.5–81.8)	−8.1 (−14.0 to −2.2)

Results in parentheses are 95% uncertainty intervals. Over 90% of deaths in countries with completeness of less than 80% occur in China and India.
*Countries with sex-specific data.
†Female–male.
n, number of countries; p.p., percentage points.

Table 2 Summary results of male and female completeness, country-level analysis (ie, not weighted by number of deaths in each country)

	Average country completeness (%)		Absolute difference* (p.p.)	
Completeness (both sexes)	Female	Male	Average	Median
Less than 95%	77.6 (76.7–78.7)	78.8 (78.0–79.9)	−1.2 (−2.5 to −0.2)	−0.5 (−1.9 to −0.8)
Less than 80%	60.0 (57.8–61.9)	62.0 (59.9–63.8)	−2.0 (−4.8 to −0.9)	−0.4 (−4.4 to 3.6)

Country-level average and median. Results in parentheses are 95% uncertainty intervals.
*Female–male.
p.p., percentage points.

completeness of less than 80%, the average absolute difference in completeness is 2.0 p.p. (−4.8 to −0.9 p.p.), with a median of 0.4 p.p. (−4.4 to −3.6 p.p.); much lower than the completeness weighted by the number of deaths in each country.

The countries where female completeness is lowest compared with male completeness are Myanmar (−13.9 p.p., −25.2 to −1.6), followed by India (−12.9 p.p., −22.8 to −3.5), Libya −8.4 p.p. (−29.2 to 16.4), Zambia (−8.3 p.p., −16.0 to −0.5) and Nepal (−7.6 p.p., −14.2 to −0.9) (table 3).

In countries with registration completeness of less than 95%, if female deaths had the same level of completeness as males, there would be 790 541 (223 886–1 370 427) more female deaths registered, or 9.6% more (2.7%–16.7%; compared with 8.22 million) (online supplemental table S5). This difference is mostly attributable to India, where if female deaths had the same completeness as males, there would be 566 780 more female deaths registered (153 136–1 011 116, or 72% of the total difference) (online supplemental table S5). Other countries where there would be a large increase in the absolute number of female registered deaths if they had the same completeness as males are in China (183 874 more, −185 360–547 899) and Myanmar (26 747, 3126–48 871). In several countries, there are more male than female deaths that are unregistered despite male completeness being similar or even higher than for females; this is because estimated total male deaths are higher than total female deaths. However, in India, 59% of unregistered deaths are female.

Quality of cause of death data

Female garbage is an average 1.4 p.p. higher (1.3–1.6 p.p.) than for males in the 64 countries with data, with a median of 1.4 p.p. (1.3–1.5 p.p.) (table 4, figure 3). The female garbage cause percentage is however higher in 58 countries and significantly higher in 48 countries (ie, 95% UI in the difference in garbage causes does not overlap with zero), with male garbage only higher in six countries and significantly higher in two countries. The highest sex difference is found in Malta where the female garbage is 5.5 p.p. (2.6–8.3 p.p.) higher than for males. The absolute difference between female and male garbage is similar irrespective of whether the level of garbage for both sexes is high or low. Full garbage results for all countries are presented in online supplemental tables S6, S7 and S8. The completeness of the MCCODs with the cause of death data, for each sex as a percentage of estimated deaths in the country, is above 90% for most countries and with minimal differences between males and females (online supplemental table S9).

The slightly higher female garbage is evenly distributed across the different levels of garbage severity, being relatively low in the 'very high' and low' categories compared with the contribution to differences in overall garbage

Table 3 Individual country completeness by sex, countries with female completeness at least 5 percentage points lower than for males

Country	Year	Female (%)	Male (%)	Absolute difference* (p.p.)
Myanmar	2017	45.8 (36.6–53.3)	59.7 (50.8–67.6)	−13.9 (−25.2 to −1.6)
India	2018	67.3 (58.5–74.9)	80.2 (74.2–85.0)	−12.9 (−22.8 to −3.5)
Libya	2017	81.0 (63.8–92.6)	89.4 (73.6–98.1)	−8.4 (−29.2 to 16.4)
Zambia	2018	22.9 (18.1–28.3)	31.2 (25.3–36.7)	−8.3 (−16.0 to −0.5)
Nepal	2017	65.3 (61.1–70.0)	72.8 (67.9–77.5)	−7.6 (−14.2 to −0.9)
Republic of Moldova	2019	87.0 (82.5–90.5)	93.7 (91.4–95.3)	−6.7 (−11.6 to −2.6)
Morocco	2016	36.2 (27.8–45.6)	42.8 (32.1–53.9)	−6.6 (−20.8 to 7.8)
Mongolia	2019	87.6 (83.8–90.6)	93.8 (91.5–95.5)	−6.3 (10.4 to −2.4)
Paraguay	2017	85.2 (79.4–89.2)	91.5 (87.6–94.1)	−6.3 (−12.4 to −0.1)

Results in parentheses are 95% uncertainty intervals.
*Female–male.
p.p., percentage points.

Table 4 Summary results of male and female garbage (age-cause standardised), country-level analysis

	Average country garbage (%)		Absolute difference (p.p.)*	
Garbage (both sexes)	Female	Male	Average	Median
All (n=64)	34.7 (34.6–34.8)	33.3 (33.2–33.3)	1.4 (1.3–1.6)	1.4 (1.3–1.5)
40%+ (n=20)	51.3 (51.1–51.4)	49.7 (49.6–49.9)	1.5 (1.3–1.7)	1.4 (1.2–1.7)
25<40% (n=28)	32.8 (32.6–33.0)	31.1 (30.9–31.3)	1.7 (1.4–1.9)	1.4 (1.2–1.6)
<25% (n=16)	19.8 (19.6–20.0)	18.7 (18.6–19.9)	1.1 (0.8–1.3)	1.2 (0.9–1.4)

Male garbage % standardised to female age-cause death distribution. Country-level average and median. Results in parentheses are 95% uncertainty intervals.
*Female–male.
n, number of countries; p.p., percentage points.

(table 5). According to type of garbage, the majority of the higher female garbage is found in the categories 'Insufficiently specified' and 'Intermediate causes' (table 6), the two categories which also comprise most of the garbage.

DISCUSSION

This analysis provides evidence that in 42 countries with completeness of death registration for both sexes of less than 95%, female completeness is only an average 1.2 p.p. lower than for males. In only nine out of the 42 countries completeness of death registration for females is at least 5 p.p. lower than for males, and in only seven countries where completeness is significantly lower. In these countries, completeness for males (80%) was 7 p.p. higher than for females (73%), mainly due to the significant differences found in some large countries, particularly India which accounts for almost three-quarters of the aggregate disparity. When restricting the analysis to countries with completeness of less than 80%, aggregate completeness for females is 8 p.p. lower than for males, and an average 2.0 p.p. lower. Aggregate differences in completeness between females and males are only 3 p.p. if all 112 countries with sex-disaggregated data are included.

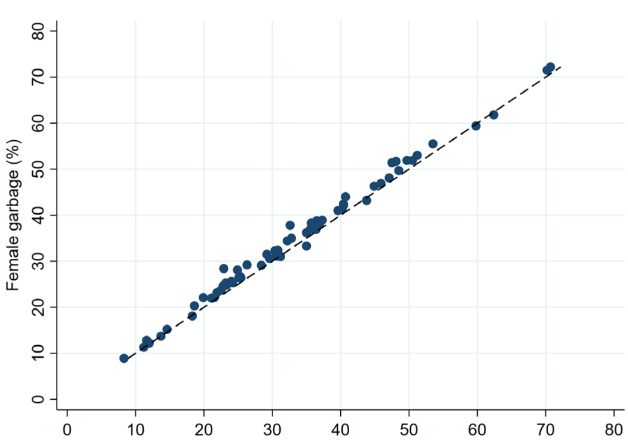

Figure 3 Female vs male garbage (age-cause standardised) by country. Dashed line indicates equality of male and female garbage.

Lower completeness of female compared with male death registration can reduce the value of sex-disaggregated mortality statistics that are evidence for governments of pressing health problems, for example excess mortality from COVID-19. To better understand how and why sex differences in death registration occur, future research should focus on investigating the sizeable sex differences that exist in a handful of countries. The sex differentials in death registration in specific countries are likely to have several origins that vary by country and which need to be investigated and documented to motivate government action to reduce them. In general, apart from inheritance, insurance and pension claims, there are few incentives to register a death, and in many countries, these incentives would more likely apply to male than female deaths. In addition, because of longer life expectancy, females often survive their husbands and become single households, which may mean there is no one to register their death.[22] Another reason may be that in some countries a higher proportion of male deaths occurs in hospitals and therefore are certified and more likely to be registered than community deaths.[5] Finally, a higher proportion of males than females die from injuries and assaults, a cause group commonly subject to police investigation and hence deaths that are more likely to be registered.[23] The countries with much higher male than female completeness occur in a range of regions outside of Western Europe and North America, being found in populations in South Asia (India and Nepal), Southeast Asia (Myanmar), Central Asia (Mongolia), North Africa (Libya and Morocco), sub-Saharan Africa (Zambia), South America (Paraguay) and Eastern Europe (Republic of Moldova). Interestingly, not all these countries rank poorly on gender issues, and three (Moldova, Libya and Mongolia) are all ranked in the top 50% of countries in the United Nations Development Programme's Gender Inequality Index.[24]

Analysis of cause of death data by sex for the 64 countries, standardised by age and cause, demonstrates that, on average, garbage causes of death are 1.4 p.p. higher in females compared with males. This slightly higher level of garbage

Table 5 Female and male (age-cause standardised) garbage by severity, 64 countries

All	All	Very high	High	Medium	Low
Female average (%)	34.7	15.7	4.3	3.4	11.4
Male average (%)	33.3	15.3	3.9	3.1	11.0
Average difference* (p.p.)	1.4	0.4	0.4	0.3	0.4
Median difference* (p.p.)	1.4	0.2	0.4	0.3	0.3

Male garbage % standardised to female age-cause death distribution. Country-level average and median.
*Female–male.
p.p., percentage points.

causes among females is remarkably consistently across countries, with over 90% of countries having a higher fraction of female than male garbage in the cause of death data. There is no clear pattern in the sex differences by whether countries have high or low levels of garbage. Notably, the higher garbage of females is not systematically attributable to more severe levels of garbage nor the type of garbage. Previous research has identified a gender bias in both diagnosis and treatment procedures for cardiovascular diseases and non-reproductive organ cancers, but our data set was not able to identify the precise pathways that such biases would impact on sex differences in causes of death and so further research is needed in this area.[9 25–27]

The strengths of this analysis include using the largest currently available data set to evaluate global sex differences in completeness of death registration and pattern and extent of garbage coding, as well as standardising differences between sexes for any biases due to age and cause. While previous analyses have investigated overall differences in causes of death among males and females, our study has analysed the contribution of specific types of garbage to observed differences between males and females, thus providing more insight into sex differentials in mortality data.[3 4]

Our study has several limitations. First, many low-income and middle-income countries could not be included due to lack of access to their data or because the data are either not publicly available or do not exist. We only have sex-disaggregated death registration data for 112 countries and medically certified cause of death data for 64 countries, reflecting the poor state of death statistics globally and emphasising the need for improved availability of sex-disaggregated data. The countries for which we do not have data are disproportionately those that rank poorly on gender indicators, so whatever data they have available may show a worse picture on sex differences in mortality data than shown by our study.[24] In India, MCCODs are only available for around one-fifth of all deaths (essentially hospital deaths), and 62% of MCCODs are for deaths of males, similar to what is found for registered deaths.[5 28] Of the reported causes of death, the proportion assigned a cause in the R chapter of ICD (Symptom Signs and Abnormal Clinical Findings not elsewhere classified, ie, one component of garbage) is almost the same for males (13%) and females (14%). Due to only a small proportion of deaths being medically certified in such countries with large differences in registration completeness, the results may not reveal the full extent of sex disparities.

In recent years, several regional and global initiatives, including the Data for Health Initiative, have focused on improving death registration and cause of death certification.[1] Initiatives such as these are important to ensure that countries have CRVS systems that are able to produce vital statistics of sufficient quality for policy use and that they do not discriminate against females. Reduction in true sex differences in death registration and the quality of cause of death data should be addressed by interventions, including removing disincentives such as a fee to register deaths and enabling registration closer to where people live. Countries that have an active process of initial notification of deaths by institutions or a formal agent, such as community health workers (which are mostly females), rather than relying on the family, are likely to increase death registration and reduce bias towards not registering female deaths.[3 29] Advocacy and education about the importance of death registration will

Table 6 Female and male (age-cause standardised) garbage by type, 64 countries

Country	All	Symptoms, sign, ill-defined	Impossible	Intermediate	Immediate	Insufficiently specified
Female average (%)	34.7	4.8	1.6	11.8	1.5	15.0
Male average (%)	33.3	4.9	1.7	11.2	1.5	14.0
Average difference* (p.p.)	1.4	0.0	0.0	0.6	−0.1	1.0
Median difference* (p.p.)	1.4	0.0	0.0	0.4	0.0	0.9

Male garbage % standardised to female age-cause death distribution. Country-level average and median. Further information about types of garbage are shown in online supplemental table S3.
*Female–male.
p.p., percentage points.

raise awareness and interest of its benefits other than just for transfer of assets (which disproportionately favours males in some countries). Also, training doctors in medical certification of causes of death will decrease the proportion of garbage causes, especially originating from heart diseases, and thereby disproportionately improve the quality of information on the causes of female deaths. In countries where a high proportion of deaths occur at home, low-cost interventions such as linking notification of the fact of death to registration and initiation of a verbal autopsy interview will help promote death registration, including that of females.[30 31] Increases in registration of male deaths are also important to improve overall levels of completeness, especially given that our analysis showed that in many countries more male than female deaths are unregistered. To improve the use of death registration data, countries should also publish all mortality indicators disaggregated by sex, where possible.

CONCLUSION

Our study did not find evidence of a systematic and significant bias in registering female compared with male deaths, except in seven countries. In these countries, the utility of the vital statistics for policy and planning is severely reduced because of undercounting of female deaths. We also did not find, at the global level, any clear difference in the quality of cause of death data between males and females, irrespective of the level of the proportion of garbage causes. Given the current global drive to improve CRVS systems, availability of sex-disaggregated death registration and MCCOD data in more countries will enable an analysis such as this to better reflect and monitor potential gender bias in global deaths. Future analyses should also seek to minimise the influence of other factors, such as the differing age and cause structure of male and female deaths, to assess the true situation of sex differences in death registration and cause of death data quality.

Contributors TA developed the analytical methods, conducted the data analyses, contributed to the drafts and edited the final draft. USH contributed to the drafts and edited the final draft. LM contributed to interpretation of the data and made substantive edits to the drafts. RJ conceptualised the study, contributed to the drafts and edited the final draft.

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Supplementary file

Table S1: Death registration/reporting and cause of death data sources used

Argentina	3	Lebanon	3
Albania	1, 2	Lesotho	6
Algeria	1, 2	Libya	3
Armenia	1, 3	Lithuania	3
Australia	3	Luxembourg	1, 3
Austria	3	Malaysia	1
Azerbaijan	1, 2	Malta	1, 3
Bahrain	4	Mauritius	3
Belarus	1, 3	Mexico	1, 3
Belgium	1, 3	Mongolia	1, 3
Bolivia (Plurinational State of)	5	Montenegro	1, 2
Bosnia and Herzegovina	3	Morocco	3
Botswana	1, 2	Myanmar	12
Brazil	7, 2	Nepal	13
Bulgaria	1, 3	Netherlands	1, 3
Cabo Verde	1	New Zealand	1, 3
Canada	1, 3	Nicaragua	1, 3
Chile	1, 3	North Macedonia	1
China	8	Norway	1, 3
Colombia	1, 3	Oman	4
Costa Rica	3	Panama	1, 3
Croatia	1, 3	Paraguay	3
Cuba	3	Peru	14
Cyprus	3	Philippines	2
Czechia	3	Poland	1, 3
Denmark	1, 3	Portugal	3
Dominican Republic	1	Qatar	4, 3
Ecuador	2	Republic of Korea	1, 3
Egypt	3	Republic of Moldova	1, 3
El Salvador	2	Romania	1, 3
Estonia	1, 3	Russian Federation	3
Fiji	9	Rwanda	15
Finland	1, 3	Serbia	1, 3
France	2	Singapore	3
Georgia	3	Slovakia	1, 3
Germany	1, 3	Slovenia	3
Greece	2	South Africa	2
Guatemala	2	Spain	1, 3
Guyana	1	Sri Lanka	1
Hungary	1, 3	Suriname	1

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Iceland	3	Sweden	3
India	10	Switzerland	1, 3
Iran (Islamic Republic of)	1, 3	Tajikistan	16, 3
Iraq	1	Thailand	3
Ireland	1, 3	Trinidad and Tobago	1
Israel	1, 3	Tunisia	1
Italy	1, 3	Turkey	3
Jamaica	1, 3	Turkmenistan	3
Japan	1, 3	Ukraine	3
Jordan	1, 3	United Arab Emirates	4
Kazakhstan	1, 3	United Kingdom	1, 3
Kenya	1, 2	United States of America	2
Kuwait	3	Uruguay	3
Kyrgyzstan	2	Uzbekistan	1, 3
Lao People's Democratic Republic	11	Venezuela (Bolivarian Republic of)	1
Latvia	1, 3	Zambia	17

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Table S2 Year of data used for completeness of death registration and quality of cause of death analyses

Country	Registration	Cause of death
Albania	2019	-
Algeria	2017	-
Argentina	2018	2018
Armenia	2019	2018
Australia	2018	2018
Austria	2019	2019
Azerbaijan	2019	-
Bahrain	2015-18	-
Belarus	2019	2018
Belgium	2019	-
Bolivia (Plurinational State of)	2019	-
Bosnia and Herzegovina	2016	-
Botswana	2018	-
Brazil	2016	2018
Bulgaria	2019	2018
Cabo Verde	2018	-
Canada	2018	2017
Chile	2018	2018
China	2019	-
Colombia	2019	2017
Costa Rica	2019	2019
Croatia	2019	2017
Cuba	2017	2017
Cyprus	2018	2018
Czechia	2019	-
Denmark	2019	2018
Dominican Republic	2019	-
Ecuador	2018	2017
Egypt	2019	2019
El Salvador	2016	-
Estonia	2019	2019
Fiji	2017	-
Finland	2019	-
France	2018	-
Georgia	2019	2019
Germany	2019	2018
Greece	2018	2017
Guatemala	2018	2017
Guyana	2019	-
Hong Kong SAR	-	2017
Hungary	2019	2019

Iceland	2019	2019
India	2018	-
Iran (Islamic Republic of)	2019	-
Iraq	2017	-
Ireland	2019	-
Israel	2019	2018
Italy	2019	2017
Jamaica	2019	-
Japan	2019	2018
Jordan	2017	-
Kazakhstan	2019	2017
Kenya	2019	-
Kuwait	2017	2017
Kyrgyzstan	2017	-
Lao People's Democratic Republic	2019	-
Latvia	2019	2018
Lebanon	2019	2019
Lesotho	2019	-
Libya	2017	2017
Lithuania	2019	2019
Luxembourg	2019	2017
Malaysia	2018	-
Malta	2019	2017
Mauritius	2019	2019
Mexico	2019	2017
Mongolia	2019	-
Montenegro	2019	-
Morocco	2016	-
Myanmar	2017	-
Nepal	2017	-
Netherlands	2019	2018
New Zealand	2019	-
Nicaragua	2018	2018
North Macedonia	2019	-
Norway	2019	-
Oman	2015-18	2017
Panama	2019	2017
Paraguay	2018	2017
Peru	2019	2017
Philippines	2017	-
Poland	2019	2018
Portugal	2018	2018
Puerto Rico	-	2017
Qatar	2015-18	-
Republic of Korea	2018	2019

Republic of Moldova	2019	-
Romania	2019	2018
Russian Federation	2019	-
Rwanda	2019	-
Serbia	2019	2017
Singapore	2019	2019
Slovakia	2019	-
Slovenia	2019	2019
South Africa	2016	-
Spain	2019	2017
Sri Lanka	2019	-
Suriname	2018	-
Sweden	2018	2018
Switzerland	2019	2017
Tajikistan	2018	-
Thailand	2019	2019
Trinidad and Tobago	2019	-
Tunisia	2017	-
Turkey	2019	2019
Turkmenistan	2015	-
Ukraine	2019	-
United Arab Emirates	2019	2019
United Kingdom	2019	2019 (Scotland only)
United States of America	2018	2017
Uruguay	2017	2017
Uzbekistan	2019	-
Venezuela (Bolivarian Republic of)	2017	-
Zambia	2018	-

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Table S3: ANACONDA typologies of garbage causes

Error type	**Unusable codes**
Type 1	Symptoms, signs and ill-defined conditions: predominantly R codes (R00-R99) in ICD-10
Type 2	Impossible as underlying causes of death: includes conditions such as such as essential hypertension and atherosclerosis
Type 3	Intermediate causes of death: diseases or injuries which are sue to an underlying cause of death
Type 4	Immediate causes of death: final step in a morbid process, including cardiac arrest or respiratory failure
Type 5	Insufficiently specified causes within ICD chapters: e.g. ill-defined site of cancer or ill-defined injuries
Garbage severity	**Explanation**
Level 1 (very high)	These are causes where the underlying COD can belong to any of three broad cause groups (communicable disease, non-communicable disease or injury). For example, fever which may be due to a communicable disease such as tuberculosis, non-communicable disease such as cancer, or after an injury leading to infection.
Level 2 (high)	These are causes for which the underlying COD is likely to belong to one or two of the three broad cause groups; for example, 'essential (primary) hypertension'.
Level 3 (medium)	These are causes for which the underlying COD is likely to be within the same ICD chapter, for example, 'unspecified cancer'.
Level 4 (low)	These are diagnoses for which the underlying COD is likely to be confined to a single disease or injury category. For example, unspecified road traffic injury would still be assigned as a death due to a road traffic injury, and not to some other category.

Sources:

Naghavi M, Richards N, Chowdhury H, Eynstone-Hinkins J, Franca E, Hegnauer M, et al. Improving the quality of cause of death data for public health policy: are all 'garbage' codes equally problematic? BMC medicine. 2020;18(1):55-. doi: 10.1186/s12916-020-01525-w. PubMed PMID: 32146899.

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Table S4a: Completeness of registration (%) by sex, excluding countries with 100% completeness

Country	Year	Both (%)	Female (%)	Male (%)	Difference** (p.p.)
Armenia	2019	97.4	98.0 (97.2 – 98.6)	96.8 (95.3 – 97.8)	1.2 (-0.1 – 2.9)
Thailand	2019	96.9	96.2 (94.6 – 97.3)	97.4 (96.2 – 98.2)	-1.2 (-3.0 – 0.5)
Kazakhstan	2019	96.6	96.8 (95.4 – 97.8)	96.5 (94.8 – 97.6)	0.3 (-1.5 – 2.2)
Croatia	2019	96.5	96.5 (95.0 – 97.6)	96.5 (94.9 – 97.6)	0.0 (-1.8 – 2.0)
Brazil	2016	96.4	96.3 (94.8 – 97.4)	96.4 (94.7 – 97.6)	0.0 (-2.0 – 2.0)
North Macedonia	2019	96.3	97.0 (95.7 – 97.9)	95.7 (93.7 – 97.1)	1.3 (-0.6 – 3.5)
Turkmenistan	2015	95.7	96.2 (94.6 – 97.4)	95.3 (93.1 – 96.8)	0.9 (-1.3 – 3.4)
Turkey	2019	95.4	96.1 (94.5 – 97.3)	94.9 (92.5 – 96.5)	1.3 (-1.0 – 3.8)
Kyrgyzstan	2017	95.2	95.6 (93.7 – 96.9)	94.9 (92.6 – 96.6)	0.6 (-1.9 – 3.3)
Tunisia*	2017	95.2	98.5 (97.9 – 99.0)	92.6 (89.4 – 95.0)	5.9 (3.5 – 9.1)
Albania	2019	95.0	95.7 (93.9 – 97.0)	94.5 (92.0 – 96.2)	1.2 (-1.3 – 4.0)
Oman	2015-18	95.0	95.0 (92.9 – 96.5)	95.0 (92.7 – 96.6)	0.0 (-2.7 – 2.7)
Mexico	2019	94.6	94.5 (92.7 – 95.8)	94.7 (93.0 – 96.2)	-0.3 (-2.6 – 2.1)
El Salvador	2016	94.5	93.0 (89.9 – 95.6)	95.7 (93.1 – 97.4)	-2.7 (-6.5 – 0.8)
Trinidad and Tobago	2019	94.2	94.8 (93.0 – 96.2)	93.8 (91.1 – 95.6)	1.0 (-1.6 – 3.9)
Panama	2019	93.9	93.7 (91.5 – 95.2)	94.0 (91.8 – 95.7)	-0.3 (-3.0 – 2.5)
Guatemala	2018	93.7	93.0 (89.0 – 96.0)	94.3 (90.0 – 96.9)	-1.3 (-6.4 – 3.9)
Kuwait	2017	93.5	93.0 (89.7 – 95.4)	93.7 (90.6 – 95.7)	-0.7 (-4.7 – 3.1)
Iran (Islamic Republic of)*	2019	92.8	94.0 (92.7 – 95.2)	91.8 (90.2 – 93.2)	2.2 (0.2 – 4.2)
Malta	2019	92.8	91.0 (86.7 – 93.9)	94.4 (91.4 – 96.4)	-3.5 (-8.2 – 0.7)
Fiji*	2017	92.2	94.7 (92.6 – 96.2)	90.1 (86.2 – 92.9)	4.6 (1.1 – 8.7)
Cabo Verde*	2018	92.1	97.5 (96.8 – 98.1)	87.9 (84.2 – 90.8)	9.6 (6.6 – 13.4)
Mongolia*	2019	91.3	87.6 (83.8 – 90.6)	93.8 (91.5 – 95.5)	-6.2 (-10.5 – -2.4)
Guyana	2019	90.8	89.9 (86.5 – 92.5)	91.5 (88.1 – 94.0)	-1.6 (-5.8 – 2.8)
Republic of Moldova*	2019	90.5	87.0 (82.5 – 90.5)	93.7 (91.4 – 95.3)	-6.7 (-11.6 – -2.7)
Algeria	2017	90.4	90.8 (88.3 – 92.9)	90.0 (86.9 – 92.3)	0.7 (-2.7 – 4.3)

Jamaica	2019	89.6	88.9 (85.5 – 91.7)	90.1 (86.8 – 92.7)	-1.2 (-5.6 – 3.0)
Colombia	2019	89.3	89.0 (85.5 – 91.6)	89.5 (86.2 – 92.2)	-0.6 (-4.7 – 3.8)
Paraguay*	2018	88.8	85.2 (79.4 – 89.2)	91.5 (87.6 – 94.1)	-6.3 (-12.4 – -0.7)
Uzbekistan	2019	89.2	90.4 (87.0 – 93.2)	88.2 (84.3 – 91.3)	2.2 (-2.6 – 7.0)
Philippines	2017	87.7	88.0 (83.8 – 90.9)	87.5 (82.7 – 90.8)	0.6 (-4.7 – 6.1)
Suriname	2018	86.5	84.7 (80.1 – 88.7)	88.0 (83.5 – 90.9)	-3.3 (-9.0 – 2.3)
Libya	2017	85.8	81.0 (63.8 – 92.6)	89.4 (73.6 – 98.1)	-7.8 (-29.2 – 16.4)
Ecuador	2018	85.3	86.2 (81.6 – 89.7)	84.6 (79.9 – 88.4)	1.5 (-4.4 – 7.4)
Azerbaijan	2019	84.2	87.5 (82.6 – 91.0)	81.5 (76.1 – 86.1)	5.9 (-0.5 – 12.7)
Nicaragua	2018	82.8	83.2 (76.3 – 91.4)	82.6 (73.6 – 92.5)	0.7 (-12.2 – 15.9)
South Africa	2016	81.0	79.5 (71.0 – 85.9)	82.4 (74.0 – 88.5)	-2.9 (-13.3 – 8.0)
China	2019	78.7	76.2 (70.1 – 81.6)	80.4 (74.0 – 85.8)	-4.2 (-12.4 – 4.2)
Peru	2019	77.1	77.5 (71.9 – 82.6)	76.7 (69.5 – 82.1)	0.9 (-7.2 – 9.1)
Bolivia (Plurinational State of)	2019	75.8	75.6 (68.5 – 81.5)	76.1 (69.4 – 81.4)	-0.5 (-9.5 – 8.4)
India*	2018	75.7	67.3 (58.5 – 74.9)	80.2 (74.2 – 85.0)	-12.8 (-22.8 – -3.5)
Jordan	2017	75.0	77.4 (65.0 – 88.0)	73.2 (62.0 – 83.0)	4.2 (-12.7 – 20.0)
Iraq	2017	73.1	71.3 (64.8 – 77.6)	74.4 (67.5 – 80.2)	-3.1 (-12.0 – 6.0)
Kenya	2019	71.1	74.0 (66.6 – 80.2)	68.8 (59.6 – 76.3)	5.1 (-5.6 – 16.2)
Nepal*	2017	69.4	65.3 (61.1 – 70.0)	72.8 (67.9 – 77.5)	-7.6 (-14.2 – -0.9)
Tajikistan	2018	68.8	72.5 (65.8 – 78.2)	65.9 (58.5 – 72.4)	6.5 (-2.8 – 16.1)
Dominican Republic	2019	68.7	67.8 (59.0 – 75.0)	69.3 (61.3 – 76.1)	-1.5 (-12.2 – 9.0)
Botswana	2018	60.0	61.2 (49.2 – 75.0)	59.0 (48.6 – 71.6)	2.2 (-15.5 – 19.8)
Myanmar*	2017	53.3	45.8 (36.6 – 53.3)	59.7 (50.8 – 67.6)	-13.8 (-25.2 – -1.6)
Lao PDR	2019	51.4	51.2 (41.7 – 59.6)	51.5 (42.2 – 60.6)	-0.5 (-13.1 – 12.6)
Lesotho	2019	41.5	44.1 (36.1 – 55.7)	39.3 (33.9 – 46.1)	4.8 (-6.5 – 16.4)
Morocco	2016	39.8	36.2 (27.8 – 45.6)	42.8 (32.1 – 53.9)	-6.4 (-20.8 – 7.8)
Zambia*	2018	39.0	22.9 (18.1 – 28.3)	31.2 (25.3 – 36.7)	-8.3 (-16.0 – -0.5)
Rwanda	2019	32.5	33.3 (25.0 – 42.3)	31.8 (23.5 – 42.0)	1.4 (-11.4 – 13.7)

Note: Figures in parentheses are 95% uncertainty intervals.* 95% uncertainty interval of difference in completeness between the sexes does not overlap with 0. ** Female – male.

Table S4b: Countries with 100% completeness of registration

Country	Year	Country	Year	Country	Year
Argentina	2018	Germany	2019	Qatar	2015-18
Australia	2018	Greece	2018	Republic of Korea	2018
Austria	2019	Hungary	2019	Romania	2019
Bahrain	2015-18	Iceland	2019	Russian Federation	2019
Belarus	2019	Ireland	2019	Serbia	2019
Belgium	2019	Israel	2019	Singapore	2019
Bosnia and Herzegovina	2016	Italy	2019	Slovakia	2019
Bulgaria	2019	Japan	2019	Slovenia	2019
Canada	2018	Latvia	2019	Spain	2019
Chile	2018	Lebanon	2019	Sri Lanka	2019
Costa Rica	2019	Lithuania	2019	Sweden	2018
Cuba	2017	Luxembourg	2019	Switzerland	2019
Cyprus	2018	Malaysia	2018	Ukraine	2019
Czechia	2019	Mauritius	2019	United Arab Emirates	2019
Denmark	2019	Montenegro	2019	United Kingdom	2019
Egypt	2019	Netherlands	2019	United States of America	2018
Estonia	2019	New Zealand	2019	Uruguay	2017
Finland	2019	Norway	2019	Venezuela (Bolivarian Republic of)	2017
France	2018	Poland	2019		
Georgia	2019	Portugal	2018		

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Table S5: Population, total deaths, and unregistered death analysis, by country

	Population 2019*		Total deaths 2019*		Estimated unregistered deaths 2019**		Proportion of unregistered deaths (%)		Additional or less female deaths registered if same completeness as males (95% UI)***
Country	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	**Female**	**Male**	
Mexico	63,828,360	61,111,816	322,750	415,674	17,842	21,823	45.0	55.0	897 (-6,916 – 8,505)
El Salvador	3,324,974	2,931,169	17,835	22,364	1,245	954	56.6	43.4	484 (-152 – 1,181)
Trinidad and Tobago	691,278	696,179	5,184	6,581	269	408	39.7	60.3	-53 (-204 – 83)
Panama	2,064,870	2,095,587	8,572	11,225	540	672	44.6	55.4	27 (-202 – 247)
Guatemala	9,135,175	8,641,315	41,828	52,993	2,935	3,027	49.2	50.8	546 (-1,598 – 2,663)
Kuwait	2,055,100	2,371,462	2,945	7,068	207	445	31.7	68.3	21 (-90 – 138)
Iran (Islamic Republic of)	41,480,404	42,817,476	166,629	224,485	9,942	18,308	35.2	64.8	-3,647 (-6,981 – -381)
Malta	219,820	219,401	1,827	1,953	165	108	60.4	39.6	64 (-13 – 150)
Fiji	449,354	461,895	3,353	4,066	178	403	30.6	69.4	-155 (-289 – -35)
Cabo Verde	279,737	283,826	1,524	1,976	38	239	13.6	86.4	-147 (-204 – -101)
Mongolia	1,716,545	1,671,045	9,812	15,047	1,221	932	56.7	43.3	614 (241 – 1,031)
Guyana	389,347	381,359	2,890	3,794	291	323	47.3	52.7	44 (-77 – 162)
Republic of Moldova	1,929,060	1,759,131	19,868	21,130	2,577	1,324	66.1	33.9	1,332 (535 – 2,302)
Algeria	20,646,056	21,201,234	94,327	106,784	8,712	10,687	44.9	55.1	-729 (-4,312 – 2,744)
Jamaica	1,415,048	1,395,705	9,536	10,122	1,054	997	51.4	48.6	115 (-289 – 534)
Colombia	24,426,692	23,349,986	112,508	134,171	12,380	14,037	46.9	53.1	610 (-4,025 – 4,988)
Uzbekistan	16,868,874	16,808,222	91,030	112,568	8,739	13,280	39.7	60.3	-2,000 (-6,425 – 2,400)
Paraguay	3,423,147	3,507,308	14,599	19,572	2,163	1,664	56.5	43.5	922 (100 – 1,832)
Philippines	55,284,444	56,858,320	273,645	365,156	32,933	45,816	41.8	58.2	-1,401 (-15,143 – 11,535)
Suriname	291,065	284,823	1,972	2,399	301	287	51.2	48.8	66 (-45 – 179)
Libya	3,256,680	3,478,863	13,698	17,962	2,602	1,897	57.8	42.2	1,155 (-2,435 – 4,340)
Ecuador	8,832,155	8,756,237	41,348	51,183	5,720	7,887	42.0	58.0	-651 (-3,303 – 1945)

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Azerbaijan	5,136,802	5,141,873	34,264	40,865	4,283	7,550	36.2	63.8	-2,047 (-4,372 – 182)
Nicaragua	3,297,317	3,213,047	12,652	16,545	2,130	2,884	42.5	57.5	-76 (-1,707 – 1,305)
South Africa	28,360,934	27,227,490	245,600	276,203	50,432	48,710	50.9	49.1	7,119 (-20,029 – 33,270)
China	697,528,832	724,821,568	4,426,896	6,226,552	1,051,724	1,220,656	46.3	53.7	183,874 (-185,360 – 547,899)
Peru	16,962,012	17,033,386	71,105	81,328	15,981	18,926	45.8	54.2	-566 (-6,075 – 4,779)
Bolivia (Plurinational State of)	5,999,165	6,012,585	37,356	38,554	9,106	9,231	49.7	50.3	162 (-2,844 – 3,196)
India	677,520,832	713,186,112	4,389,254	5,002,295	1,435,915	990,525	59.2	40.8	566,780 (153,136 – 1,011,116)
Jordan	5,422,048	6,214,669	13,785	18,480	3,115	4,951	38.6	61.4	-578 (-2,756 – 1,746)
Iraq	20,550,292	21,569,198	75,203	104,412	21,616	26,768	44.7	55.3	2,336 (-4,537 – 9,009)
Kenya	25,162,982	25,064,728	132,745	161,143	34,519	50,356	40.7	59.3	-6,963 (-21,891 – 7,554)
Nepal	15,918,575	14,497,807	87,761	105,570	30,489	28,670	51.5	48.5	6,655 (-3,344 – 16,668)
Dominican Republic	5,410,452	5,471,403	29,275	41,270	9,434	12,656	42.7	57.3	457 (-2,691 – 3,633)
Tajikistan	4,693,532	4,798,882	21,427	27,276	5,893	9,309	38.8	61.2	-1,420 (-3,490 – 603)
Botswana	1,188,021	1,150,701	9,539	11,633	3,704	4,765	43.7	56.3	-203 (-1,833 – 1,438)
Myanmar	28,377,050	26,299,852	192,763	228,169	104,445	91,968	53.2	46.8	26,747 (3,126 – 48,872)
Lao People's Democratic Republic	3,560,620	3,597,630	19,580	24,877	9,546	12,054	44.2	55.8	58 (-1,591 – 1,661)
Lesotho	1,058,540	1,033,048	14,733	17,781	8,229	10,791	43.3	56.7	-712 (-2,437 – 969)
Zambia	9,220,897	9,016,785	53,227	70,128	41,038	48,248	46.0	54.0	4,418 (-1,471 – 10,297)
Morocco	17,874,360	18,077,826	104,209	123,915	66,485	70,897	48.4	51.6	6,863 (-8,340 – 22,380)
Rwanda	6,517,521	6,170,597	33,337	35,235	22,250	24,021	48.1	51.9	-477 (-4,827 – 3,994)
Total									790,541 (223,886 – 1,370,427)

* According to Global Burden of Disease (GBD) 2019. ** Calculated as: most recent completeness figure x 2019 total deaths. *** Calculated as: (male completeness x female 2019 total deaths) – (female completeness x female 2019 total deaths). UI: Uncertainty interval.

Table S6: Garbage cause percentage , by country

Country	Year	Difference (Female – male)*	Female (%)	Male (%) (age-cause-standardised)
Average		**1.4 (1.3 – 1.6)**	34.7 (34.6 – 34.8)	33.3 (33.2 – 33.3)
Oman	2017	1.5 (-0.5 – 3.5)	72.2 (70.6 – 73.7)	70.7 (69.4 – 71.9)
Egypt**	2019	1.3 (1.1 – 1.6)	71.5 (71.3 – 71.6)	70.2 (70.0 – 70.3)
United Arab Emirates	2019	-0.6 (-2.9 – 1.6)	61.7 (59.9 – 63.7)	62.4 (61.2 – 63.6)
Libya	2017	-0.4 (-2.0 – 1.1)	59.4 (58.2 – 60.6)	59.8 (58.9 – 60.8)
Argentina**	2018	2.0 (1.7 – 2.3)	55.5 (55.3 – 55.7)	53.5 (53.3 – 53.7)
Thailand**	2019	1.8 (1.5 – 2.1)	53.0 (52.8 – 53.3)	51.2 (51.1 – 51.4)
Lebanon**	2019	1.4 (0.4 – 2.5)	51.9 (51.1 – 52.7)	50.5 (49.8 – 51.2)
Mauritius**	2019	2.2 (0.4 – 4.0)	51.9 (50.6 – 53.3)	49.7 (48.5 – 51.0)
Guatemala**	2017	3.6 (2.9 – 4.3)	51.7 (51.1 – 52.2)	48.1 (47.6 – 48.5)
Greece**	2017	3.9 (3.4 – 4.5)	51.4 (51.0 – 51.8)	47.5 (47.1 – 47.9)
Bulgaria**	2018	1.2 (0.6 – 1.9)	49.7 (49.3 – 50.2)	48.5 (48.0 – 48.9)
Peru**	2017	1.0 (0.4 – 1.5)	48.1 (47.7 – 48.5)	47.1 (46.7 – 47.5)
Georgia**	2019	1.1 (0.2 – 2.0)	46.9 (46.3 – 47.6)	45.9 (45.2 – 46.5)
Serbia**	2017	1.4 (0.8 – 2.0)	46.3 (45.9 – 46.7)	44.9 (44.5 – 45.3)
Japan**	2018	-0.7 (-0.9 – -0.5)	43.2 (43.0 – 43.3)	43.8 (43.7 – 44.0)
Turkey**	2019	3.3 (3.0 – 3.6)	44.0 (43.8 – 44.3)	40.7 (40.5 – 40.9)
Portugal**	2018	2.0 (1.4 – 2.6)	42.4 (42.0 – 42.8)	40.4 (40.0 – 40.8)
Uruguay**	2017	1.6 (0.6 – 2.7)	42.1 (41.3 – 42.8)	40.4 (39.7 – 41.2)
Poland**	2018	1.1 (0.8 – 1.4)	41.3 (41.1 – 41.5)	40.2 (40.0 – 40.4)
Romania**	2018	1.4 (1.0 – 1.8)	41.0 (40.7 – 41.3)	39.6 (39.3 – 39.9)
Brazil**	2018	1.6 (1.5 – 1.8)	38.9 (38.8 – 39.0)	37.3 (37.2 – 37.4)
Hong Kong SAR**	2017	2.3 (1.4 – 3.2)	38.8 (38.1 – 39.5)	36.5 (36.0 – 37.1)
Panama	2017	1.2 (-0.2 – 2.6)	38.1 (37.1 – 39.1)	36.9 (36.0 – 37.8)
Cyprus**	2018	2.6 (0.9 – 4.3)	38.3 (37.0 – 39.6)	35.7 (34.5 – 36.9)
Republic of Korea**	2019	0.5 (0.1 – 0.8)	36.9 (36.7 – 37.2)	36.4 (36.2 – 36.7)
Israel**	2018	1.4 (0.5 – 2.3)	37.0 (36.3 – 37.6)	35.6 (35.0 – 36.2)
Paraguay**	2017	1.2 (0.1 – 2.3)	36.2 (35.4 – 37.1)	35.0 (34.3 – 35.7)
Kuwait**	2017	5.1 (2.8 – 7.6)	37.8 (35.9 – 39.7)	32.7 (31.3 – 34.1)
Puerto Rico**	2017	-1.7 (-2.8 – -0.6)	33.3 (32.5 – 34.0)	35.0 (34.3 – 35.7)
Armenia**	2018	2.2 (1.1 – 3.4)	35.0 (34.2 – 35.9)	32.8 (32.0 – 33.6)
Ecuador**	2017	2.2 (1.6 – 3.0)	34.4 (33.9 – 34.9)	32.2 (31.7 – 32.6)
Spain**	2017	1.6 (1.3 – 1.9)	32.4 (32.2 – 32.6)	30.8 (30.6 – 31.0)
Italy**	2017	1.9 (1.7 – 2.1)	32.3 (32.1 – 32.4)	30.4 (30.2 – 30.5)
Kazakhstan	2017	0.2 (-0.3 – 0.7)	31.3 (30.9 – 31.6)	31.0 (30.7 – 31.4)
Luxembourg	2017	-0.2 (-3.1 – 2.6)	31.0 (29.0 – 33.0)	31.2 (29.2 – 33.3)
Denmark	2018	0.5 (-0.2 – 1.3)	31.1 (30.5 – 31.7)	30.6 (30.0 – 31.1)
Singapore**	2019	2.4 (1.1 – 3.6)	31.5 (30.6 – 32.5)	29.2 (28.3 – 30.0)
Netherlands	2018	1.0 (0.6 – 1.5)	30.6 (30.3 – 30.9)	29.6 (29.3 – 29.9)
Chile**	2018	0.7 (0.1 – 1.2)	29.1 (28.7 – 29.5)	28.4 (28.1 – 28.8)

Croatia**	2017	2.8 (2.1 – 3.6)	29.2 (28.6 – 29.7)	26.4 (25.8 – 26.9)
Slovenia**	2019	3.2 (2.0 – 4.4)	28.1 (27.3 – 29.0)	24.9 (24.1 – 25.8)
Germany**	2018	1.4 (1.2 – 1.6)	26.7 (26.6 – 26.8)	25.3 (25.2 – 25.4)
Sweden**	2018	1.0 (0.4 – 1.5)	26.4 (26.0 – 26.8)	25.4 (25.0 – 25.8)
United States of America**	2017	1.3 (1.2 – 1.4)	26.4 (26.4 – 26.5)	25.1 (25.1 – 25.2)
Malta**	2017	5.5 (2.6 – 8.3)	28.4 (26.3 – 30.5)	22.9 (20.9 – 24.9)
Mexico**	2017	1.5 (1.3 – 1.7)	25.6 (25.4 – 25.7)	24.0 (23.9 – 24.2)
Switzerland**	2017	1.1 (0.5 – 1.8)	25.3 (24.8 – 25.7)	24.1 (23.7 – 24.6)
Costa Rica**	2019	2.1 (1.0 – 3.2)	25.3 (24.4 – 26.1)	23.2 (22.5 – 23.9)
Austria**	2019	1.4 (0.9 – 2.0)	24.8 (24.4 – 25.2)	23.3 (22.9 – 23.8)
Czech Republic**	2019	1.7 (1.2 – 2.2)	24.9 (24.5 – 25.2)	23.2 (22.9 – 23.6)
Colombia**	2017	1.8 (1.4 – 2.1)	24.6 (24.3 – 24.9)	22.8 (22.6 – 23.1)
Cuba**	2017	1.2 (0.7 – 1.7)	23.7 (23.3 – 24.0)	22.5 (22.1 – 22.8)
Australia**	2018	1.3 (0.9 – 1.7)	23.2 (22.9 – 23.5)	21.9 (21.6 – 22.1)
Canada**	2017	0.6 (0.3 – 0.9)	22.1 (21.9 – 22.4)	21.5 (21.3 – 21.7)
Iceland	2019	0.9 (-2.4 – 4.3)	22.0 (19.6 – 24.4)	21.0 (18.8 – 23.5)
Nicaragua**	2018	2.1 (1.1 – 3.2)	22.1 (21.3 – 22.9)	19.9 (19.3 – 20.6)
United Kingdom, Scotland** ***	2019	1.7 (1.0 – 2.3)	20.3 (19.8 – 20.7)	18.6 (18.2 – 19.1)
Belarus	2018	-0.2 (-0.6 – 0.2)	18.1 (17.8 – 18.4)	18.3 (18.0 – 18.6)
Latvia	2018	0.6 (-0.2 – 1.4)	15.2 (14.6 – 15.8)	14.6 (14.0 – 15.2)
Estonia	2019	0.1 (-1.1 – 1.2)	13.7 (13.0 – 14.5)	13.7 (12.9 – 14.5)
Lithuania**	2019	1.2 (0.6 – 1.9)	12.8 (12.4 – 13.3)	11.6 (11.1 – 12.1)
Hungary	2019	0.2 (-0.2 – 0.6)	12.2 (11.9 – 12.4)	12.0 (11.7 – 12.2)
Republic of Moldova	2018	0.1 (-0.5 – 0.8)	11.3 (10.9 – 11.8)	11.2 (10.7 – 11.6)
Finland**	2018	0.6 (0.2 – 1.1)	8.9 (8.6 – 9.3)	8.3 (7.9 – 8.6)

Note: Figures in parentheses are 95% uncertainty intervals.
* Percentage points.
** 95% uncertainty interval of difference in garbage causes between the sexes does not overlap with 0.
*** For the United Kingdom, only cause of death data by age group for Scotland are available in the WHO Mortality Database.

Table S7: Garbage severity by sex, by country

		Female minus Male (p.p.) (age-cause-std.) (positive means higher garbage for females v males)					Female Garbage severity (%)					Male Garbage severity (%) (age-cause-standardised)				
Country	**Year**	**All**	**Very high**	**High**	**Medium**	**Low**	**All**	**Very high**	**High**	**Medium**	**Low**	**All**	**Very high**	**High**	**Medium**	**Low**
Average		**1.4**	**0.4**	**0.4**	**0.3**	**0.4**	**34.7**	**15.7**	**4.3**	**3.4**	**11.4**	**33.3**	**15.3**	**3.9**	**3.1**	**11.0**
Median		**1.4**	**0.2**	**0.4**	**0.3**	**0.3**	**32.4**	**12.7**	**3.7**	**3.3**	**10.5**	**31.1**	**12.4**	**2.9**	**2.9**	**10.2**
Oman	2017	1.5	0.7	0.2	0.6	0.0	72.2	54.5	7.3	4.1	6.2	70.7	53.7	7.1	3.6	6.2
Egypt	2019	1.3	-0.4	0.6	0.1	1.0	71.5	46.5	13.9	1.9	9.2	70.2	46.8	13.3	1.8	8.2
United Arab Emirates	2019	-0.6	-1.4	0.6	0.5	-0.3	61.8	50.4	4.2	4.5	2.7	62.4	51.8	3.6	4.0	3.0
Libya	2017	-0.4	-1.4	0.5	0.3	0.2	59.4	44.1	4.5	2.2	8.6	59.8	45.5	4.0	1.9	8.4
Argentina	2018	2.0	1.4	0.1	0.9	-0.4	55.5	27.2	4.2	6.5	17.5	53.5	25.7	4.1	5.6	18.0
Thailand	2019	1.8	1.0	-0.1	0.0	0.9	53.0	33.6	3.8	2.9	12.7	51.2	32.6	3.9	2.9	11.8
Lebanon	2019	1.4	1.2	-0.4	0.4	0.2	51.9	36.5	5.7	3.0	6.7	50.5	35.3	6.1	2.6	6.4
Mauritius	2019	2.2	-0.9	0.4	0.1	2.6	51.9	12.9	3.0	5.5	30.5	49.7	13.7	2.6	5.4	27.9
Guatemala	2017	3.6	0.4	0.1	0.6	2.4	51.7	21.6	4.7	3.8	21.6	48.1	21.2	4.6	3.2	19.1
Greece	2017	3.9	1.5	0.6	0.7	1.1	51.4	21.2	9.0	2.8	18.4	47.5	19.6	8.4	2.1	17.3
Bulgaria	2018	1.2	-0.2	0.2	0.2	1.0	49.7	32.4	4.2	2.1	11.0	48.5	32.6	3.9	1.9	10.1
Peru	2017	1.0	0.2	-0.1	0.5	0.5	48.1	21.9	5.0	3.7	17.4	47.1	21.8	5.2	3.2	16.9
Georgia	2019	1.1	0.4	0.0	-0.1	0.7	46.9	22.6	5.7	2.1	16.5	45.9	22.2	5.7	2.2	15.8
Serbia	2017	1.4	0.0	1.2	0.0	0.3	46.3	14.1	9.5	2.6	20.1	44.9	14.1	8.4	2.6	19.8
Japan	2018	-0.7	-0.3	0.0	0.6	-0.9	43.2	27.8	1.5	3.5	10.4	43.8	28.2	1.5	2.9	11.3
Turkey	2019	3.3	1.2	0.6	0.1	1.5	44.0	23.1	2.3	2.7	15.9	40.7	21.9	1.8	2.6	14.4
Portugal	2018	2.0	0.8	0.5	0.3	0.3	42.4	15.6	5.5	4.8	16.5	40.4	14.8	4.9	4.5	16.2
Uruguay	2017	1.6	0.7	0.3	0.4	0.4	42.1	21.0	3.8	6.4	10.8	40.4	20.3	3.5	6.1	10.5
Poland	2018	1.1	-0.1	0.8	0.4	-0.1	41.3	22.1	10.1	2.4	6.6	40.2	22.2	9.3	2.0	6.7

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Romania	2018	1.4	0.5	0.4	0.1	0.4	41.0	3.9	14.0	2.2	20.9	39.6	3.4	13.6	2.1	20.5
Brazil	2018	1.6	0.3	0.5	0.3	0.6	38.9	13.1	4.8	3.6	17.5	37.3	12.7	4.3	3.3	16.9
Hong Kong SAR	2017	2.3	0.9	-0.1	0.9	0.5	38.8	10.7	1.2	3.3	23.6	36.5	9.8	1.3	2.4	23.0
Panama	2017	1.2	0.4	0.8	-1.0	1.0	38.1	15.3	3.7	3.4	15.7	36.9	15.0	2.9	4.4	14.6
Cyprus	2018	2.6	0.6	1.6	-1.0	1.4	38.3	14.3	5.1	7.0	12.0	35.7	13.7	3.5	8.0	10.5
Republic of Korea	2019	0.5	0.8	0.7	0.0	-1.0	36.9	22.0	3.5	1.6	9.7	36.4	21.3	2.8	1.6	10.7
Israel	2018	1.4	-0.6	1.2	0.5	0.3	37.0	18.4	4.0	4.1	10.5	35.6	19.0	2.9	3.5	10.2
Paraguay	2017	1.2	-0.3	0.2	0.3	1.0	36.2	13.6	4.0	3.9	14.7	35.0	13.9	3.8	3.6	13.6
Kuwait	2017	5.2	5.3	-0.6	1.1	-0.6	37.8	17.5	1.4	3.2	15.8	32.6	12.2	2.0	2.1	16.4
Puerto Rico	2017	-1.7	-1.9	0.7	-0.4	-0.1	33.3	11.9	3.6	4.0	13.7	35.0	13.8	2.9	4.5	13.8
Armenia	2018	2.2	0.2	1.4	0.5	0.2	35.0	5.7	18.7	1.6	9.1	32.8	5.5	17.3	1.2	8.9
Ecuador	2017	2.2	0.6	0.0	0.4	1.2	34.4	12.2	5.1	2.6	14.5	32.2	11.7	5.1	2.2	13.3
Spain	2017	1.6	1.4	0.6	-0.2	-0.2	32.4	14.0	3.4	6.8	8.1	30.8	12.7	2.8	7.0	8.3
Italy	2017	1.9	0.2	0.5	0.8	0.5	32.3	10.1	4.1	6.0	12.0	30.4	9.9	3.7	5.3	11.5
Kazakhstan	2017	0.2	0.1	-0.1	-0.2	0.5	31.3	11.0	2.0	9.6	8.6	31.0	10.9	2.2	9.8	8.1
Luxembourg	2017	-0.2	-0.3	0.6	0.6	-1.1	31.0	15.7	3.5	4.8	7.0	31.2	16.0	2.8	4.2	8.2
Denmark	2018	0.5	-0.4	0.7	0.7	-0.4	31.1	16.1	3.3	4.1	7.6	30.6	16.5	2.7	3.4	8.1
Singapore	2019	2.4	0.6	-0.1	0.4	1.4	31.5	2.9	0.6	2.1	25.9	29.2	2.3	0.7	1.7	24.5
Netherlands	2018	1.0	-0.2	0.5	0.1	0.6	30.6	14.3	3.3	4.7	8.3	29.6	14.6	2.8	4.6	7.7
Chile	2018	0.7	0.4	0.5	0.2	-0.5	29.1	9.4	5.0	3.4	11.4	28.4	9.0	4.4	3.2	11.9
Croatia	2017	2.8	0.8	0.3	0.6	1.1	29.2	8.1	3.1	2.5	15.5	26.3	7.3	2.8	1.9	14.4
Slovenia	2019	3.2	2.8	0.2	0.3	-0.1	28.1	15.9	2.3	2.3	7.7	24.9	13.1	2.1	2.0	7.7
Germany	2018	1.4	0.9	0.7	0.1	-0.3	26.7	12.6	3.5	3.4	7.1	25.3	11.7	2.8	3.4	7.4
Sweden	2018	1.0	0.1	0.6	0.8	-0.6	26.4	11.4	4.6	3.7	6.7	25.4	11.3	3.9	2.8	7.3
United States of America	2017	1.3	0.0	0.5	0.3	0.4	26.4	11.8	2.7	3.8	8.2	25.1	11.8	2.1	3.5	7.7
Malta	2017	5.5	2.6	-0.2	0.0	3.1	28.4	8.2	1.1	2.0	17.1	22.9	5.6	1.3	2.0	14.0
Mexico	2017	1.5	0.2	0.5	-0.2	1.0	25.6	7.4	3.7	2.2	12.2	24.0	7.2	3.2	2.4	11.2

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Switzerland	2017	1.1	0.9	0.3	0.1	-0.2	25.3	12.5	3.1	3.4	6.3	24.2	11.6	2.8	3.3	6.5
Costa Rica	2019	2.1	0.1	0.5	0.0	1.4	25.3	5.5	4.3	3.0	12.5	23.2	5.4	3.8	3.0	11.0
Austria	2019	1.4	0.2	1.1	0.6	-0.4	24.8	9.4	4.2	3.5	7.6	23.3	9.3	3.2	3.0	7.9
Czech Republic	2019	1.7	0.8	0.7	0.5	-0.2	24.9	11.9	5.3	2.4	5.3	23.2	11.1	4.6	2.0	5.5
Colombia	2017	1.8	0.3	0.2	0.0	1.2	24.6	6.3	2.9	3.1	12.4	22.8	6.0	2.7	3.0	11.1
Cuba	2017	1.2	0.1	0.8	0.4	-0.1	23.7	4.9	5.2	2.2	11.4	22.5	4.8	4.4	1.8	11.5
Australia	2018	1.3	0.0	0.4	0.5	0.4	23.2	8.1	2.3	4.5	8.3	21.9	8.1	1.9	4.0	7.8
Canada	2017	0.6	-0.3	0.4	0.3	0.2	22.1	8.3	2.3	3.5	8.0	21.5	8.5	2.0	3.2	7.8
Iceland	2019	0.9	-0.2	0.7	0.8	-0.4	22.0	10.2	3.2	1.9	6.6	21.1	10.4	2.5	1.1	7.0
Nicaragua	2018	2.1	0.3	0.2	0.0	1.6	22.1	7.0	2.5	1.8	10.7	19.9	6.7	2.3	1.8	9.1
United Kingdom, Scotland*	2019	1.6	0.0	0.0	0.8	0.9	20.3	6.8	1.4	3.9	8.2	18.6	6.9	1.4	3.1	7.3
Belarus	2018	-0.2	0.4	-0.4	-0.2	0.0	18.1	14.4	1.9	1.1	0.7	18.3	14.1	2.2	1.4	0.7
Latvia	2018	0.6	0.1	0.2	-0.3	0.6	15.2	3.9	2.1	1.8	7.4	14.6	3.7	2.0	2.0	6.8
Estonia	2019	0.0	0.1	0.6	0.4	-1.1	13.7	6.2	1.3	4.0	2.1	13.7	6.1	0.7	3.6	3.2
Lithuania	2019	1.2	0.5	0.0	0.2	0.5	12.8	3.8	0.9	1.3	6.8	11.6	3.3	0.9	1.1	6.3
Hungary	2019	0.2	-0.1	0.9	-0.2	-0.4	12.2	3.0	4.9	1.2	3.1	12.0	3.0	4.0	1.4	3.5
Republic of Moldova	2018	0.1	0.1	0.0	0.0	0.1	11.3	1.3	0.7	0.7	8.7	11.2	1.2	0.7	0.7	8.6
Finland	2018	0.6	0.2	0.4	0.3	-0.3	8.9	2.1	1.5	2.2	3.1	8.3	1.9	1.1	1.9	3.4

* For the United Kingdom, only cause of death data by age group for Scotland are available in the WHO Mortality Database. p.p.: percentage points.

Table S8: Garbage type by sex, by country

	Absolute difference* (age-cause-std.) (p.p.)					
Country	**All**	**Symptoms**	**Impossible**	**Intermediate**	**Immediate**	**Unspecified**
Average	**1.4**	**0.0**	**0.0**	**0.6**	**-0.1**	**1.0**
Median	**1.4**	**0.0**	**0.0**	**0.4**	**0.0**	**0.9**
Oman	1.5	0.3	-0.9	0.9	0.1	1.0
Egypt	1.3	-0.4	0.2	0.5	0.0	1.1
United Arab Emirates	-0.6	-1.2	1.0	0.3	-0.6	-0.1
Libya	-0.4	-0.3	0.1	0.1	-1.2	0.8
Argentina	2.0	0.0	-0.1	1.3	0.0	0.7
Thailand	1.8	0.0	-0.7	1.4	0.0	1.0
Lebanon	1.5	0.1	-0.2	1.8	-0.8	0.5
Mauritius	2.2	0.0	-0.3	-1.0	0.0	3.5
Guatemala	3.6	-0.1	0.0	0.6	0.0	3.1
Greece	3.9	0.2	-0.2	1.8	0.2	1.9
Bulgaria	1.2	0.0	-0.1	0.2	-0.2	1.4
Peru	1.0	-0.1	0.0	0.0	-0.1	1.1
Georgia	1.1	0.0	0.2	-0.1	0.1	0.9
Serbia	1.4	0.0	0.2	1.2	-0.4	0.5
Japan	-0.7	0.0	0.0	-0.3	-0.1	-0.4
Turkey	3.3	-0.2	0.1	2.0	-0.2	1.6
Portugal	2.0	-0.1	0.1	1.1	0.0	0.9
Uruguay	1.7	0.1	-0.1	0.0	0.3	1.4
Poland	1.1	0.0	0.0	0.6	0.0	0.5
Romania	1.4	0.0	0.0	0.5	0.0	0.8
Brazil	1.6	-0.1	-0.1	0.8	0.0	1.0
Hong Kong SAR	2.3	0.0	-0.1	0.9	0.0	1.4
Panama	1.2	-0.2	0.5	0.3	0.2	0.4

Cyprus	2.6	0.0	0.3	1.0	0.3	0.9
Republic of Korea	0.5	-0.1	0.1	1.4	-0.3	-0.7
Israel	1.4	0.0	0.0	0.0	0.0	1.3
Paraguay	1.2	0.1	-0.3	0.1	-0.1	1.4
Kuwait	5.1	-0.2	-0.4	5.5	-0.5	0.7
Puerto Rico	-1.7	-0.1	-0.2	-1.2	0.1	-0.3
Armenia	2.2	0.1	0.0	1.2	-0.1	1.0
Ecuador	2.2	0.1	-0.1	0.4	0.0	1.9
Spain	1.6	0.0	0.2	1.1	0.0	0.3
Italy	1.9	0.0	0.1	0.0	0.0	1.9
Kazakhstan	0.2	0.0	0.2	-0.4	0.0	0.4
Luxembourg	-0.2	0.4	-0.1	-0.6	-0.3	0.5
Denmark	0.5	-0.1	0.2	0.2	0.0	0.3
Singapore	2.4	0.1	-0.2	0.9	0.0	1.6
Netherlands	1.0	-0.1	0.1	-0.1	0.0	1.1
Chile	0.7	0.0	0.0	0.7	0.0	-0.1
Croatia	2.8	0.0	0.0	0.5	0.0	2.3
Slovenia	3.2	0.0	0.0	2.6	0.0	0.6
Malta	5.5	0.5	-0.4	2.4	0.0	3.0
Germany	1.4	0.0	-0.1	1.1	0.0	0.4
Sweden	1.0	0.0	-0.1	0.5	0.1	0.5
United States of America	1.0	0.0	-0.1	0.0	0.0	1.1
Mexico	1.5	0.0	-0.1	0.5	0.0	1.1
Switzerland	1.1	0.0	0.1	0.5	0.1	0.4
Costa Rica	2.1	0.0	-0.2	0.4	-0.1	2.0
Austria	1.4	0.0	0.0	0.5	0.0	1.0
Czech Republic	1.7	0.0	0.0	1.2	0.0	0.6
Colombia	1.8	0.0	0.1	0.3	0.0	1.4
Cuba	1.2	0.0	0.0	-0.2	0.0	1.4

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Australia	1.3	0.0	0.0	0.1	0.0	1.2
Canada	0.6	0.0	0.0	-0.1	0.0	0.8
Nicaragua	2.1	0.0	0.0	0.5	0.0	1.6
Iceland	0.9	-0.1	-0.3	0.5	-0.1	0.9
United Kingdom, Scotland	1.6	0.0	-0.1	0.0	0.0	1.7
Belarus	-0.2	0.0	0.0	0.0	0.0	-0.2
Latvia	0.6	0.0	0.0	0.1	0.0	0.5
Estonia	0.0	0.0	0.2	-0.1	-0.1	0.1
Lithuania	1.2	0.0	-0.1	0.4	0.0	0.9
Hungary	0.2	0.0	0.1	0.3	0.0	-0.2
Republic of Moldova	0.2	0.1	-0.1	-0.1	0.0	0.3
Finland	0.6	0.0	0.1	0.0	0.0	0.6

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Table S8 (contd.)

	Female Garbage type (%)						Male Garbage type (%) (age-cause-standardised)					
Country	**All**	**Symptoms**	**Impossible**	**Intermediate**	**Immediate**	**Unspecified**	**All**	**Symptoms**	**Impossible**	**Intermediate**	**Immediate**	**Unspecified**
Average	**34.7**	**4.8**	**1.6**	**11.8**	**1.5**	**15.0**	**33.3**	**4.9**	**1.7**	**11.2**	**1.5**	**14.0**
Median	**32.4**	**2.7**	**1.2**	**10.5**	**0.2**	**14.0**	**31.1**	**2.7**	**1.3**	**10.2**	**0.2**	**13.1**
Oman	72.2	32.5	3.2	16.9	8.1	11.5	70.7	32.2	4.1	16.0	8.0	10.4
Egypt	71.5	6.9	2.8	43.8	8.7	9.3	70.2	7.3	2.7	43.2	8.8	8.2
United Arab Emirates	61.8	11.0	11.7	14.9	16.0	8.3	62.4	12.2	10.7	14.5	16.5	8.4
Libya	59.4	18.6	3.2	12.2	13.9	11.5	59.8	18.9	3.1	12.1	15.1	10.7
Argentina	55.5	5.1	3.3	24.2	0.1	22.8	53.5	5.1	3.4	22.9	0.1	22.1
Thailand	53.0	25.2	1.4	10.2	0.0	16.3	51.2	25.2	2.0	8.8	0.0	15.3
Lebanon	51.9	6.9	5.3	17.5	11.3	11.0	50.5	6.8	5.5	15.6	12.1	10.5
Mauritius	52.0	1.2	1.5	9.5	3.5	36.2	49.7	1.2	1.8	10.6	3.5	32.7
Guatemala	51.7	10.6	2.4	10.9	0.2	27.5	48.1	10.8	2.5	10.3	0.2	24.3
Greece	51.4	2.0	6.8	18.2	2.9	21.5	47.5	1.9	7.0	16.4	2.7	19.6
Bulgaria	49.7	3.1	0.7	31.6	1.9	12.4	48.5	3.1	0.8	31.4	2.1	11.0
Peru	48.1	2.8	2.9	17.3	1.4	23.6	47.1	2.9	3.0	17.3	1.5	22.5
Georgia	46.9	14.5	0.7	11.3	0.9	19.5	45.9	14.5	0.6	11.3	0.8	18.6
Serbia	46.3	4.2	0.9	30.7	2.8	7.8	44.9	4.2	0.7	29.5	3.2	7.3
Japan	43.2	13.5	0.7	14.5	0.7	13.8	43.8	13.4	0.7	14.8	0.8	14.2
Turkey	44.0	5.6	1.7	17.6	1.7	17.5	40.7	5.7	1.6	15.7	1.9	15.8
Portugal	42.4	4.7	2.9	12.5	0.0	22.3	40.4	4.8	2.8	11.4	0.0	21.4
Uruguay	42.1	7.9	2.0	12.6	1.4	18.1	40.4	7.8	2.2	12.6	1.1	16.7
Poland	41.3	10.1	0.1	22.1	0.1	8.9	40.2	10.1	0.1	21.4	0.1	8.5
Romania	41.0	1.1	0.2	17.7	0.0	21.9	39.6	1.1	0.3	17.2	0.0	21.0
Brazil	38.9	4.4	2.0	11.6	0.1	20.9	37.3	4.4	2.1	10.8	0.1	19.9

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Hong Kong SAR	38.8	2.8	0.7	8.3	0.1	27.0	36.5	2.8	0.8	7.3	0.1	25.6
Panama	38.1	3.2	2.2	11.5	2.4	18.8	36.9	3.4	1.6	11.2	2.2	18.4
Cyprus	38.3	3.0	1.2	11.3	2.1	20.6	35.7	3.0	0.9	10.3	1.8	19.7
Republic of Korea	36.9	10.8	1.2	10.9	1.8	12.3	36.4	10.9	1.1	9.4	2.1	12.9
Israel	37.0	4.8	1.5	14.8	0.1	15.7	35.6	4.8	1.5	14.8	0.1	14.4
Paraguay	36.2	7.5	1.4	7.9	0.0	19.4	35.0	7.5	1.6	7.8	0.1	18.0
Kuwait	37.8	1.1	1.3	15.9	0.3	19.1	32.7	1.3	1.8	10.4	0.8	18.4
Puerto Rico	33.3	1.1	1.0	12.4	0.3	18.4	35.0	1.2	1.2	13.6	0.2	18.8
Armenia	35.0	1.0	0.7	22.4	0.1	10.9	32.8	0.9	0.7	21.1	0.2	9.9
Ecuador	34.4	5.9	2.5	7.7	0.1	18.1	32.2	5.9	2.6	7.3	0.0	16.3
Spain	32.4	2.0	2.2	13.4	0.0	14.8	30.8	1.9	2.0	12.3	0.0	14.6
Italy	32.3	2.1	1.4	8.6	0.9	19.3	30.4	2.1	1.3	8.7	0.9	17.3
Kazakhstan	31.3	7.0	1.6	5.3	0.1	17.2	31.0	7.1	1.4	5.7	0.1	16.8
Luxembourg	31.0	2.3	2.1	13.7	1.1	11.8	31.2	1.9	2.3	14.3	1.4	11.4
Denmark	31.1	10.0	1.6	6.5	0.4	12.5	30.6	10.2	1.4	6.4	0.4	12.2
Singapore	31.5	0.2	0.4	3.1	0.0	27.8	29.2	0.2	0.6	2.2	0.0	26.2
Netherlands	30.6	3.9	1.7	9.9	1.1	14.1	29.6	3.9	1.5	10.1	1.1	13.0
Chile	29.1	2.5	1.2	10.3	0.1	15.1	28.4	2.4	1.2	9.6	0.1	15.1
Croatia	29.2	1.1	0.6	9.0	0.4	18.1	26.4	1.1	0.6	8.5	0.3	15.8
Slovenia	28.1	2.5	0.3	16.1	0.2	9.1	24.9	2.5	0.3	13.5	0.2	8.5
Malta	28.4	0.5	0.8	8.1		19.0	23.8	0.0	1.2	5.7		16.0
Germany	26.7	2.7	1.2	12.0	0.3	10.6	25.3	2.7	1.3	10.9	0.3	10.2
Sweden	26.4	3.2	1.1	9.0	0.4	12.7	25.4	3.2	1.2	8.6	0.3	12.1
United States of America	26.1	0.7	1.2	10.7	0.6	12.8	25.1	0.8	1.3	10.8	0.6	11.7
Mexico	25.6	1.3	1.5	7.1	0.0	15.7	24.0	1.3	1.6	6.6	0.0	14.6
Switzerland	25.3	3.9	2.2	8.4	1.0	9.7	24.1	3.9	2.0	7.9	1.0	9.3
Costa Rica	25.3	0.6	1.0	6.4	0.4	16.9	23.2	0.6	1.3	6.0	0.4	14.8

Austria	24.8	2.8	0.6	9.5	0.2	11.6	23.3	2.8	0.7	9.1	0.2	10.6
Czech Republic	24.9	1.4	0.4	12.9	1.1	9.1	23.2	1.5	0.4	11.8	1.1	8.4
Colombia	24.6	1.3	1.7	6.0	0.0	15.6	22.8	1.3	1.5	5.8	0.0	14.2
Cuba	23.7	0.7	1.0	7.2	0.1	14.7	22.5	0.7	1.0	7.4	0.1	13.3
Australia	23.2	1.2	1.1	7.2	0.2	13.5	21.9	1.2	1.1	7.1	0.1	12.3
Canada	22.1	1.2	1.2	7.1	0.2	12.5	21.5	1.2	1.2	7.3	0.2	11.6
Nicaragua	22.0	2.2	1.4	5.6	0.1	12.8	19.9	2.2	1.4	5.1	0.2	11.1
Iceland	22.0	1.0	1.0	8.4	0.6	11.0	21.1	1.1	1.3	7.9	0.7	10.1
United Kingdom, Scotland**	20.3	2.5	0.9	3.7	0.1	13.1	18.6	2.5	1.0	3.7	0.0	11.4
Belarus	18.1	11.0	0.1	5.3	0.0	1.7	18.3	11.0	0.2	5.2	0.0	1.9
Latvia	15.2	0.9	0.4	4.8	0.1	9.0	14.6	0.9	0.4	4.7	0.1	8.5
Estonia	13.7	1.4	0.6	5.4	0.2	6.0	13.7	1.4	0.4	5.5	0.4	6.0
Lithuania	12.8	1.1	0.3	3.2	0.0	8.2	11.6	1.1	0.4	2.8	0.0	7.3
Hungary	12.2	0.2	0.5	7.5	0.0	3.9	12.0	0.2	0.4	7.3	0.0	4.1
Republic of Moldova	11.3	0.4	0.1	1.4	0.0	9.3	11.2	0.4	0.2	1.5	0.1	9.0
Finland	8.9	0.5	0.7	2.3	0.0	5.4	8.3	0.5	0.5	2.4	0.0	4.9

* Female – male. * For the United Kingdom, only cause of death data by age group for Scotland are available in the WHO Mortality Database.

Table S9: Completeness of MCCODs (i.e. deaths with a cause) by sex (as a % of estimated total deaths in the country), by country

Country	Year	Both sexes	Female	Male
Oman	2017	95.0	95.3	94.7
Egypt	2019	97.6	98.3	97.0
United Arab Emirates	2019	100.0	100.0	100.0
Libya	2017	85.8	80.9	89.3
Argentina	2018	100.0	100.0	100.0
Thailand	2019	96.9	97.5	96.3
Lebanon	2019	100.0	100.0	100.0
Mauritius	2019	100.0	100.0	100.0
Guatemala	2017	93.2	92.2	94.2
Greece	2017	100.0	100.0	100.0
Bulgaria	2018	100.0	100.0	100.0
Peru	2017	80.6	79.9	81.2
Georgia	2019	100.0	100.0	100.0
Serbia	2017	100.0	100.0	100.0
Japan	2018	100.0	100.0	100.0
Turkey	2019	95.4	94.8	96.0
Portugal	2018	100.0	100.0	100.0
Uruguay	2017	100.0	100.0	100.0
Poland	2018	100.0	100.0	100.0
Romania	2018	100.0	100.0	100.0
Brazil	2018	95.3	95.2	95.4
Hong Kong SAR	2017	100.0	100.0	100.0
Panama	2017	95.2	95.2	95.2
Cyprus	2018	100.0	100.0	100.0
Republic of Korea	2019	92.6	91.1	93.9
Israel	2018	100.0	100.0	100.0
Paraguay	2017	88.8	90.0	87.6
Kuwait	2017	93.5	93.7	93.3
Puerto Rico	2017	96.1	96.9	95.3
Armenia	2018	97.3	96.5	98.0
Ecuador	2017	84.0	83.3	84.7
Spain	2017	100.0	100.0	100.0
Italy	2017	100.0	100.0	100.0
Kazakhstan	2017	96.7	96.2	97.2
Luxembourg	2017	100.0	100.0	100.0
Denmark	2018	100.0	100.0	100.0
Singapore	2019	100.0	100.0	100.0
Netherlands	2018	100.0	100.0	100.0
Chile	2018	100.0	100.0	100.0
Croatia	2017	97.0	96.9	97.1
Slovenia	2019	100.0	100.0	100.0

Germany	2018	100.0	100.0	100.0
Sweden	2018	100.0	100.0	100.0
United States of America	2017	100.0	100.0	100.0
Malta	2017	93.1	94.0	92.2
Mexico	2017	93.6	93.5	93.7
Switzerland	2017	100.0	100.0	100.0
Costa Rica	2019	100.0	100.0	100.0
Austria	2019	100.0	100.0	100.0
Czech Republic	2019	100.0	100.0	100.0
Colombia	2017	88.3	88.9	87.6
Cuba	2017	100.0	100.0	100.0
Australia	2018	100.0	100.0	100.0
Canada	2017	100.0	100.0	100.0
Iceland	2019	100.0	100.0	100.0
Nicaragua	2018	81.8	82.2	81.3
United Kingdom, Scotland*	2019	100.0	100.0	100.0
Belarus	2018	100.0	100.0	100.0
Latvia	2018	100.0	100.0	100.0
Estonia	2019	100.0	100.0	100.0
Lithuania	2019	100.0	100.0	100.0
Hungary	2019	100.0	100.0	100.0

* For the United Kingdom, only cause of death data by age group for Scotland are available in the WHO Mortality Database. MCCOD: Medical Certificate of Cause of Death.