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Supplementary appendix

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Global minimum estimates of children affected by COVID-19-associated orphanhood and deaths of caregivers: a modeling study Supplementary Appendix

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1 Methods

In this section we provide more details about the methods we use in our analysis. These methods use the link between fertility and mortality first identified by Lokta et al. [1] and are based on a modification of Gregson, Garnett and Anderson [2] and Grassly and Timeaus [3] [4] to translate the AIDS specific work to COVID-19.

1.1 Death data

We extracted COVID-19 death data and excess death data, where possible, from 1 March 2020 through 30 April 2021 for 21 countries (Argentina, Brazil, Colombia, England & Wales, France, Germany, India, Islamic Republic of Iran (I.R. Iran), Italy, Kenya, Malawi, Mexico, Nigeria, Peru, the Philippines, Poland, Russian Federation, Spain, South Africa, the USA and Zimbabwe). We extracted data in 5-year age bands where available, or the smallest age band provided if only larger than 5-years was provided. We chose these countries because they accounted for 76.4% of global COVID-19 deaths up to April 2021, as reported by Johns Hopkins University [5]. If we had both COVID-19 and excess deaths data, we calculated orphans as a result of the larger value between the COVID-19 and excess deaths per age band because we are interested in orphans associated with the pandemic. If only COVID-19 deaths were available, we used that and searched for a multiplication factor in literature to scale our orphans to account for under-reporting in deaths if this was important. For some countries, disaggregated COVID-19 data were not available up to 30 April 2021 so we used the country-specific age-sex ratio from the disaggregated COVID-19 data to weight the additional deaths from the end of data collection to which we took from Johns Hopkins University [5] on 15th May 2021. For the Russian Federation we did not have COVID-19 deaths aggregated into age bands so could not calculate a country-specific age-sex ratio. We therefore assumed a constant attack rate between ages and scaled the reported excess deaths using the COVID-19 infection fatality ratio (IFR) including seroreversion from Brazeau et al. [6].

1.2 Fertility rate

Female fertility rates, or numbers of live births per woman of different ages, are often published for countries e.g. by the United Nations Statistics Division (UNSD) [7] or from Demographic Health Surveys [8]. However, these estimates are often missing for men and are presented for specific years when the surveys were completed. To obtain the best estimations of the number of orphans in 2020/2021, we need both female and male fertility rates at the same level of aggregation as the deaths (5-year age bands) for the years that children currently under the age of 18 would be born (2003-2020). A country specific source was used for England and Wales.

For some countries (Brazil, Colombia, India, Kenya, Malawi, Nigeria, Peru, South Africa and Zimbabwe) it was possible to use the own-child method [9] to calculate both male and female fertility rates where Demographic Health Survey-like data were available. We used the male variation of the own-child method presented by Schoumaker [10] to calculate both the male and female fertility rates from each survey. One of the main adaptations by Schoumaker was that they create an individual data file linking surviving men with surviving children and used the demographics of the other parent, if given, to help match up children with missing parent data. We further adapted this method because we did not adjust our fertility rates to reflect child mortality as we deflate our rates from data to account for children who would have died from other non-COVID causes prior to the years of interest. A summary of our method is given below for calculating male fertility rates over the 5 years previous to the survey data. For female fertility rates, we switch mother for father and women for men.

1. Use the DHS Household Member Recode (PR) to list all the men in the data set.
2. Match the children in the data set to their fathers if they live in the same household.
3. Keep a list of the children whose fathers are not listed and use demographics (child's age and mother's age, if listed) to randomly assign an existing man from the data set to each child without a father.

4. Calculate the number of children born to fathers of different ages in the past 5 years (numerator of fertility rates).
 - (a) Remove any children from the list if their father is dead and for a subset of those whose fathers status is unknown according to demographics.
 - (b) For those men with children, work out the age of each father at the time each child was born.
 - (c) Subset to children born in the past 5 years and calculate the number of children born to fathers in 5-year age bands.
5. Calculate exposure, or time each man spent in each age group, during the past 5 years (denominator of fertility rate).
 - (a) Randomly assign each man in the data set a birth month.
 - (b) Use birth month and age of man to work out time each man has spent in 5-year age bands.
 - (c) Sum up over every man to work out the total man-years in each age band.
6. Divide (4) by (5) to calculate fertility rates.
7. Repeat 4-6 10 times to account for variation in random matching of parents, status of father and birth month.

It is possible to use the same survey to calculate fertility rates for different years by changing the time frame in (4) and (5) if only one survey was completed between 2003 and 2020. We assume fertility is constant over the 5 years we estimate over.

We compared several sources of fertility data for the remaining countries. Fertility estimates were similar between IHME [11] and UN World population prospects (UNWPP) [12] along with live births reported by the United Nations Statistics Division (UNSD) [7]), see Figure 1. Therefore we used UNWPP data for female fertility for these countries because these data are more likely to remain stable over the next few years and UNSD for male fertility because this was the only source.

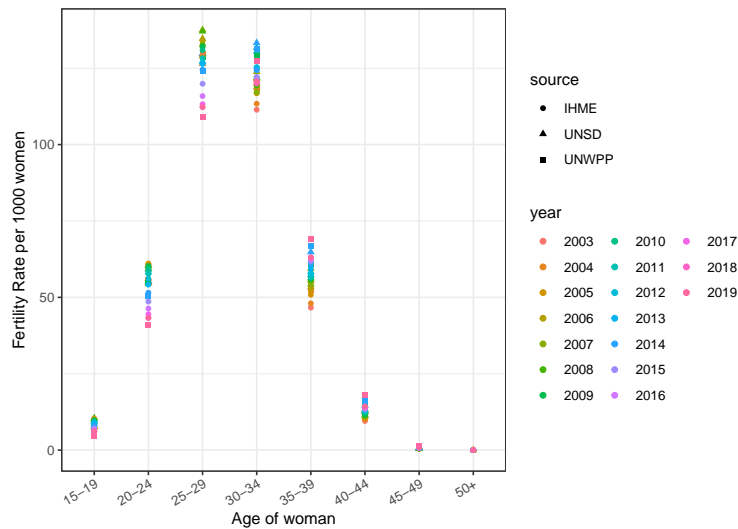


Figure 1: Comparison between the data source from IHME and UNSD for France.

For some countries it was not possible to find male fertility rates. For Argentina we assumed the same male and female fertility rate as Colombia because they are developmentally similar. For I.R. Iran we found no information that could be used to estimate male fertility so following similar patterns to countries such as India (which had the closest total fertility rate to I.R. Iran that we had data for), we shifted the female fertility trend by 5 years to reflect that fathers were on average slightly older than mothers. This is discussed more in the Section 4 below.

1.3 Numbers of orphans from loss of parents

We first calculated the average number of children under 18 each adult of different ages and sexes would have in 2020. This was done by summing the average number of children born to a man or women aged x over each of the past 17 years and multiplying each contribution by the child mortality of that year. We use UN estimates of number of deaths per age 5-year age group of child [13] divided by the corresponding population in that age group [14] unless otherwise stated. We then aggregated the average number of children from our parents of different ages and sexes in 5-year age bands, which we multiply by the corresponding age-sex-specific deaths to calculate the number of orphans from loss of either mother or father. If we calculate the fertility using the own-child method, we assume child mortality here is equal to 1 because we already have incorporated the impact of childhood mortality on our fertility estimates. We also assume that fertility rate for women aged 50 and over is negligible so set it to zero but use all the data available for men up to 80 years old.

We adjust the total numbers of orphans who lose a mother or a father to account for children who lose both a mother and a father. Since the age of parents may not be the same, we group the age of parents into the three categories we collate the death data into and assume both parents lie within the same band. To work out the number of double orphans in each age group, we multiply the total number of orphans who have lost mothers or fathers and multiply by a secondary attack rate (SAR) of 37% to infect the second parent [15] and the age-specific probability that the second parent dies (infection fatality ratio, IFR). We assume the age-specific IFRs from the midpoints of our groups where possible and assume age 67 for the highest age group since we assume the fertility rate for women over 50 is zero: 0.04% for lowest age group, 0.57% for middle age group and 1.39% for highest age group [6]. We note the age groups themselves vary slightly due to the disaggregation of the data available. We use the upper end of secondary attack rates and infection mortality ratios to avoid over-counting total orphans. This approach may marginally overestimate double orphans. However our estimates of double orphans are solely due to both parents dying in the pandemic, rather than single orphans who became double orphans, so are likely an underestimate. Due to the lack of globally consistent data on orphanhood, estimates of pre-existing single orphans are not available, so we are unable to estimate double orphans who were previously single orphans and the second parent died in the pandemic.

This analysis assumes that the past fertility of those dying of COVID-19 is the same as the past fertility of everyone else of the same age. Since we are presenting minimum estimates, we investigated the impact of poverty and co-morbidities on female and male fertility using DHS data to see adults with COVID-19 were expected to have fewer children than average, which would invalidate this assumption. We included data from Colombia, India, Kenya, Malawi, Nigeria, Peru, South Africa and Zimbabwe in this analysis because they are included in both our study and DHS data. We used a mixed effects model to estimate the effect sizes of age, poverty indicator, and BMI on number of children born to women and the effect sizes of age, poverty indicator, BMI and smoking on number of children born to men. We included a country specific random effect for both models to enable country specific variation in overall fertility rates and a smoking random effects term for males to enable the effect of smoking on fertility to vary by country. We could not include smoking for women as too few respondents answered that question in our data set and we used the negative of the DHS indicator as our poverty indicator.

1.4 Numbers of children losing care from grandparents

We consider two metrics to describe the loss of care to children from their co-residing grandparents dying:

1. children who lost skip generation grandparent primary caregivers (custodial grandparents) between 60 and 84 years old.
2. children who lost grandparent or in some cases other co-residing kin (such as aunts or uncles) serving as primary and secondary caregivers between 60 and 84 years old.

These numbers come from household composition data, which excludes grandparents living in care facilities. To calculate the number of children in the first category, we multiply the number of adults aged 60-84 inclusive who died of each sex by the sex specific “percentage of older persons in households that consist of grandparents and their grandchildren, but none of the parents of the grandchildren” [16]. This assumes

that the percentage of custodial caregivers is constant between 60-84. We use the number of adults aged 61-85 in Zimbabwe due to the reported age categorisation. We truncate our deaths at 85 since we are seeking a conservative estimate and a large proportion of deaths over 84 in Europe and the USA were in carehomes, which are excluded from the household composition data [17]. Where data was not in 5 year age brackets, we weighted the deaths by the age-sex-specific population and the IFR including sero-reversion from Brazeau et al. [6]. For the second category we estimate the sex specific “percentage of older persons living in households with at least one member under age 18 years (aged 0-17)” by taking the mean of the sex specific “percentage of older persons living in households with at least one member under age 20 years (aged 0-19)” and “percentage of older persons living in households with at least one member under age 15 years (aged 0-14)” [16]. We then multiply this by the sex disaggregated deaths between 60 and 85 and 0.89 to reflect that 89% or more of persons over 60 who are living with children, only live with extended family members [18].

We again adjust these numbers to avoid over-counting. First we account for the proportion of children who have lost two grandparents from skip generation households. We estimate the number of children who lost two grandparents to be the total number of children who lost a grandmother or a grandfather by the SAR and the IFR of a 70-year-old (2.17% [6]), which equals to 0.8%. Second, we account for the number of orphans in households with a grandparent family member who have lost one or both parents and one or both primary grandparent caregivers. Initially we work out the percentage of grandparents who live in households with both parents a children. We assume this is equal to the percentage who cohabit with their grandparents minus the proportion in custodial grandparent households. Then we account for children who have also lost a mother, father or both parents. Given a child loses their grandparent, there is a probability of IFR*SAR they will have also lost their mother, IFR*SAR they will have also lost their father and IFR*IFR*SAR*SAR they will have also lost both. We again assume the SAR is 37% and choose the IFR to be 1.39%, which is the IFR for 60-69 year olds (the maximum age of mothers in our study). This gives us a probability of 1.03%, which is an upper estimate for the number of children who should be removed from the number of children in households with grandparent family members to avoid over-counting when combining with the number of orphans and double orphans.

1.5 Global extrapolation of pandemic associated orphans

To extrapolate beyond the 21 countries in our study, we relied on the high correlation between total fertility rate (TFR) and the ratio of orphans to deaths (Pearson $r^2 = 0.93$) and fit a logistic model (spanning 0 to 1) scaled by a parameter gamma so it spans 0 to gamma using least squares to estimate the two logistic parameters (alpha and beta) and gamma, see equation 1.

$$\frac{\gamma e^{\alpha+\beta*\text{TFR}}}{1 + e^{\alpha+\beta*\text{TFR}}} \quad (1)$$

We found COVID-19 deaths from each country from Johns Hopkins University [5] and TFRs from the UN World Prospects data [12]. We considered uncertainty from the TFR in our global estimates by assuming our TFR was normally distributed with the medium fertility variant estimate for 2020-2025 as our mean and estimating the standard deviation from the low and high variants given. We then calculated the global numbers of orphans by sampling the TFR for each country 1000 times and using our previously fitted logistic model. Our central estimates include our country specific estimates from our study, but our 95% credible intervals (CIs) are based solely on the samples. A limitation of this approach is that it does not take into account other sources of uncertainty (infection fatality ratio estimates and COVID-19 / excess deaths) and it weights each country’s observation equally. While our model will sometimes overestimate and sometimes underestimate, we expect these errors to largely cancel out when we aggregate to an overall estimate for the world.

We also completed a leave-one-out sensitivity analysis to show how our central estimates of total number of orphans from loss of care from primary caregivers and primary and/or secondary caregivers varied if we fit to our data leaving out one country each time from the fit and include a sensitivity analysis where we use IHME TFRs [11].

2 Assessment of potential confounding by socioeconomic status and co-morbidities

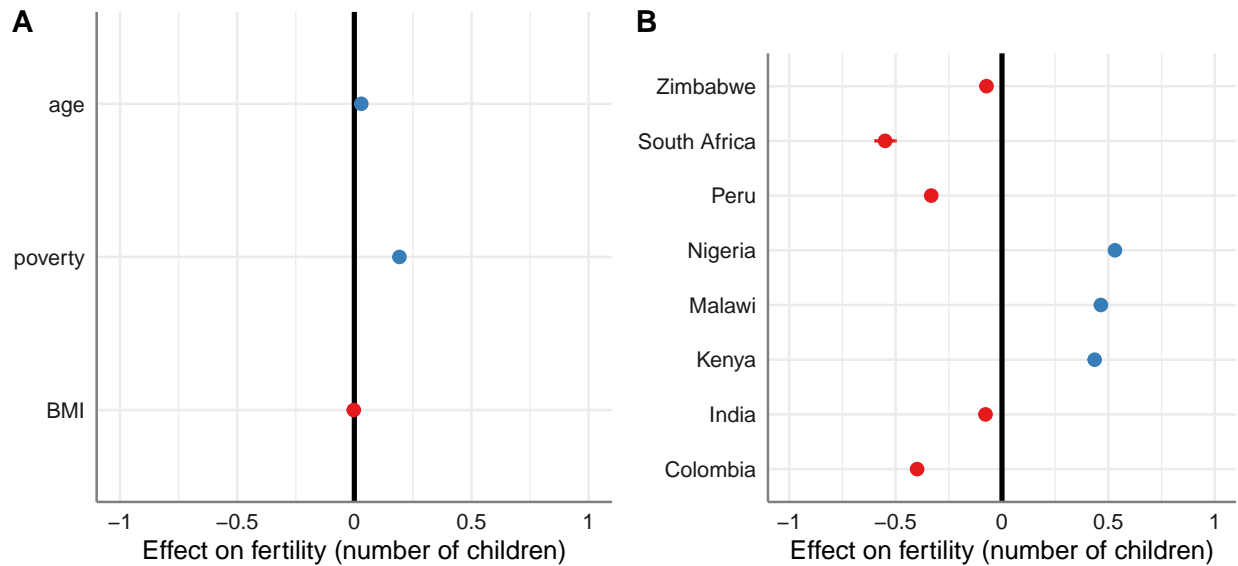


Figure 2: Fixed effect sizes of age, poverty, and BMI on number of children born to women from DHS surveys in Colombia, India, Kenya, Malawi, Nigeria, Peru, South Africa and Zimbabwe (Figure A). Country random effects are included, as shown here by the country-specific intercept term in the model, to allow for country specific variation in overall fertility rates (Figure B).

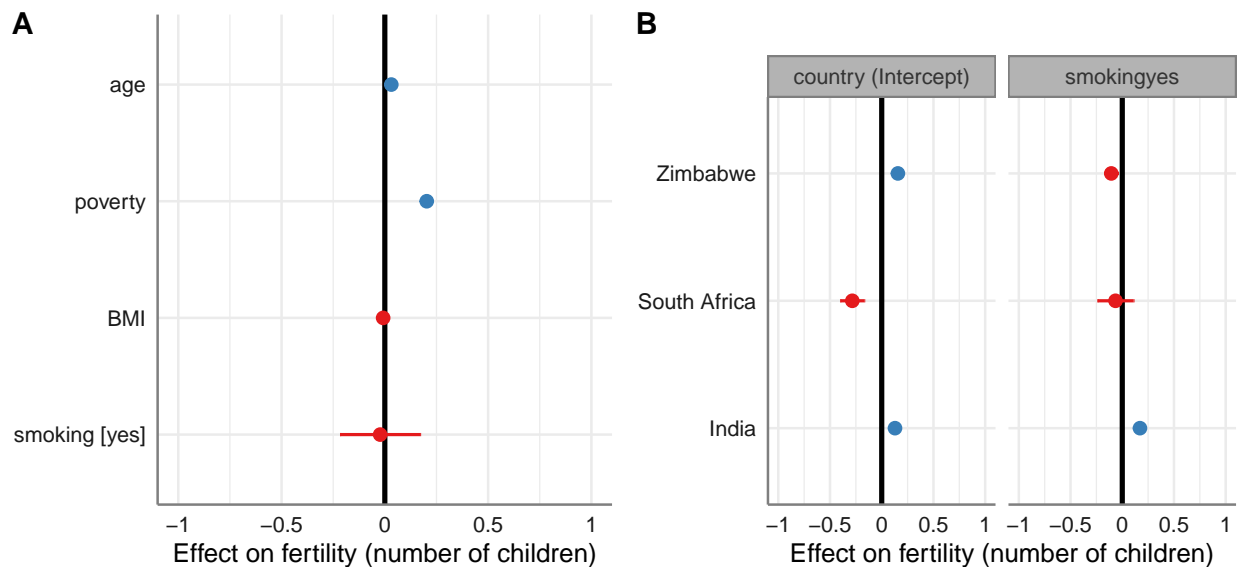


Figure 3: Fixed effect sizes of age, poverty indicator, BMI and smoking on number of children born to men from DHS surveys in India, South Africa and Zimbabwe (Figure A). Random effects sizes of country specific intercept to allow for country specific variation in overall fertility rates and smoking to enable the effect size of smoking to vary between countries (Figure B).

Figures 2 and 3 show the fixed and random effect sizes of our coefficients in our linear model for mothers and fathers respectively. We have 713,109 observations in our mothers model and 91,671 in our fathers model. We note there are many more mothers than fathers because more mothers are identified in our studies than men and fewer countries asked men wealth and co-morbidity questions than women. We found that after adjusting for age, the relationship between poverty and increased fertility was strong and that obesity (BMI) did not influence female or male fertility in this sample. We also found that smoking – a risk factor which increases both chronic disease such as diabetes and heart disease, as well as COVID-19 risk – was associated with increased fertility in men in India and was insignificant in the other countries. We could not address this in women because very few women reported that they smoked. This suggests a net effect of underestimation of orphanhood in our study.

This underestimation is in agreement with literature. Millett et al. [19] find that poverty-associated factors were associated with significantly higher numbers of COVID cases and deaths than comorbidities, which suggests that it is likely any net variations in fertility rates associated with these factors would be towards underestimation of our global minimum estimates for orphanhood. In addition, a recent study from New York [20] found that given access to a health care system in a densely populated city with a racially diverse population, once minority groups with higher comorbidities have accessed the health care system, COVID-19 mortality rates are similar among minority and majority populations. Thus, with access to health care, outcomes from SARS-Cov-2 infection while adjusting for comorbidities is similar among populations that are observed to have unequal mortality in the overall community. Despite these findings based on poverty, we note our analyses do not quantify - or controls for - the entire effect of socioeconomic status, the residual component of which could be masking health-related effects.

3 Country-specific results

We present here the country-specific data for the 21 countries and our data are also available on Tableau¹. Table 1 shows a summary of the data available for each location. All code necessary to recreate our analysis can be found on GitHub².

3.1 Argentina

For Argentina, we collated the age- and sex-stratified COVID-19-attributed death rates per 100,000 [21] until 20 April 2021. We then adjusted our deaths up to 30 April using the total number of deaths from Johns Hopkins University [5]. We could not find male fertility rates for Argentina, so we used male and female fertility rates calculated for Colombia (see below) since they are similar in terms of family and household composition [22]. This is a limitation of our method.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 2. These are broken down by age in Figure 4. We also estimated the number of children who have lost care from grandparents dying in Table 3 and adjusted for double counting in Table 4.

Age of parent	Sex of parent	COVID-19 deaths	# Orphans
20-39	Female	528	719
	Male	794	923
40-59	Female	2992	1885
	Male	5900	7189
60+	Female	23316	58
	Male	30253	2233
Total	Female	26836	2662
	Male	36947	10345

Table 2: The number of orphans and COVID-19 deaths for Argentina up to 30 April 2021 from male and female parents of different ages.

¹<https://tabsoft.co/3xjQ09e>

²https://github.com/ImperialCollegeLondon/covid19_orphans

Country	Excess deaths	Age-specific	Sex-specific	COVID-19 deaths	Age-specific	Sex-specific	Calculate composite	Adjust orphans	Female fertility source	Male fertility source
Argentina	N	N	N	Y	Y	Y	N	N	Colombia	Colombia
Brazil	N	N	N	Y	Y	Y	N	Y	PNAD	PNAD
Colombia	N	N	N	Y	Y	Y	N	Y	DHS	DHS
England & Wales	Y	Y	Y	Y	Y	Y	Y	N	ONS	ONS
France	Y	Y	Y	Y	Y	Y	Y	N	UNWPP	UNSD
Germany	N	N	N	Y	Y	Y	N	N	UNWPP	UNSD
India	N	N	N	Y	Y	Y	N	Y	DHS	DHS
I.R. Iran	N	Y	Y	Y	Y	Y	N	Y	UNWPP	-
Italy	Y	Y	Y	Y	Y	Y	Y	N	UNWPP	UNSD
Kenya	N	N	N	Y	Y	Y	N	N	DHS	DHS
Malawi	N	N	N	Y	Y	Y	N	N	DHS	DHS
Mexico	N	N	N	Y	Y	Y	N	N	UNWPP	UNSD
Nigeria	N	N	N	Y	Y	Y	N	Y	DHS	DHS
Peru	N	N	N	Y	Y	Y	N	N	DHS	DHS
Philippines	N	N	N	Y	Y	Y	N	Y	UNWPP	UNSD
Poland	N	N	N	Y	Y	Y	N	N	UNWPP	UNSD
Russian Federation	Y	N	Y	Y	N	N	N	N	UNWPP	UNSD
South Africa	N	N	N	Y	Y	Y	N	N	UNWPP	UNSD
Spain	Y	Y	Y	Y	Y	Y	Y	Y	DHS	DHS
USA	Y	Y	Y	Y	Y	Y	Y	N	UNWPP	UNSD
Zimbabwe	N	N	N	Y	Y	Y	N	N	UNWPP	DHS

Table 1: Summary of data sources available

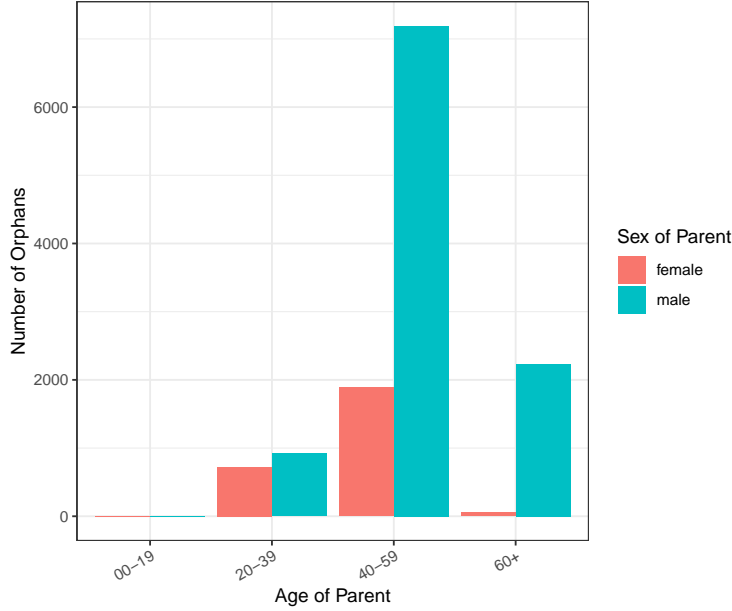


Figure 4: The estimated number of orphans who lost mothers or fathers from different age groups in Argentina up to 30 April 2021.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	14926	3.6	537	18.2	2411
60-84	Male	23237	2.5	581	19.6	4043

Table 3: The estimated number of children who have lost care from male or female grandparents in Argentina up to 30 April 2021 from two categories: custodial households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
2658	10341	4	533	577	4	14117	1898	3474	15	19504

Table 4: The estimated number of children who have lost care in Argentina up to 30 April 2021.

3.2 Brazil

For Brazil, we collated the age- and sex-stratified COVID-19-attributed deaths [23] until 30 April 2021 (data published on 10 May 2021) and adjusted them up to the number from Johns Hopkins University [5] for the same date. We derived the fertility rates from the 2015 National Household Sample Survey (PNAD) surveys [24], using the own-child method [10]. However, there was only line information for mothers so we could only find out line numbers of fathers if they were sons of a male head of household. This meant we were missing line numbers for approximately 50% of fathers instead of the usual approximation of 10% in the other DHS studies. We also did not have any information about proportions of fathers who had died

so used the mothers died ratio of 98.8% to remove a proportion of dead fathers. We checked our method against IHME estimates to see if we got a good estimate for female fertility if 50% of data was missing about mothers ages and found our results were consistent, see Figure 5. The fertility rates by five-age groups and sex are shown in Figure 6 and the average number of children under 18 years of age born to parents of different ages in 2020 is shown in Figure 7.

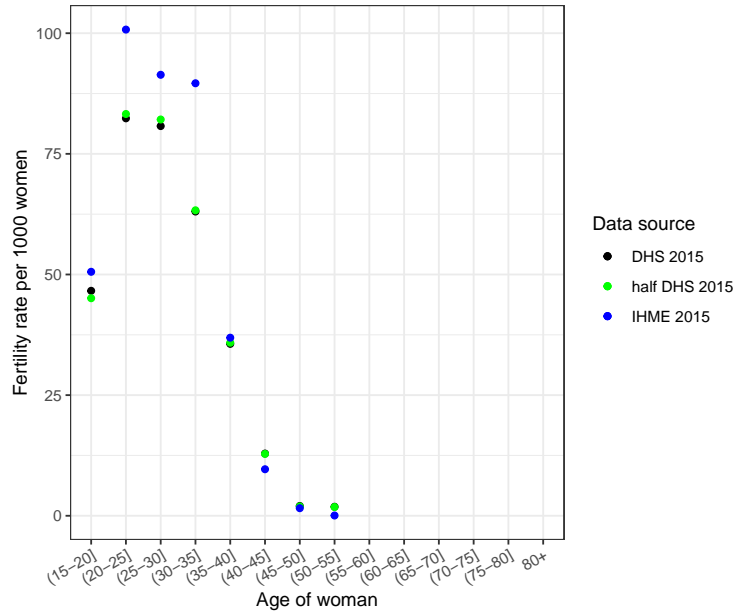


Figure 5: Comparison of female fertility rates by age between full DHS survey data, DHS data with half the ages of mothers missing and IHME.

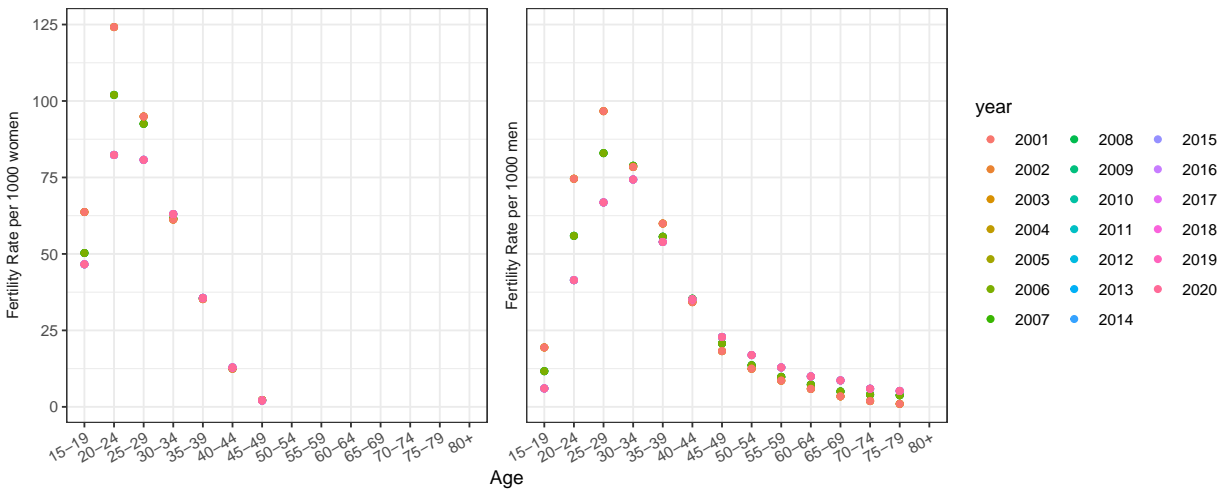


Figure 6: Fertility rates for parents by age and sex in Brazil.

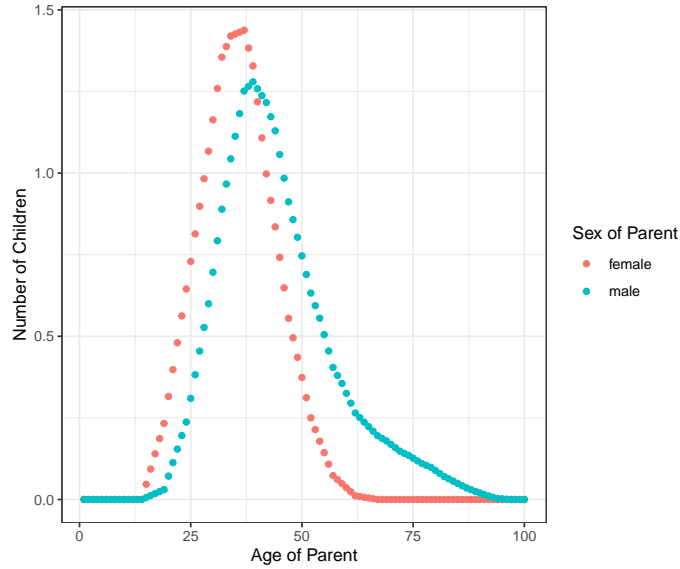


Figure 7: Average number of children born to women or men of different ages between 2003 and 2020 in Brazil.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 5. These are broken down by age in Figure 8. We also estimated the number of children who have lost care from grandparents dying in Table 6 and adjusted for double counting in Table 7.

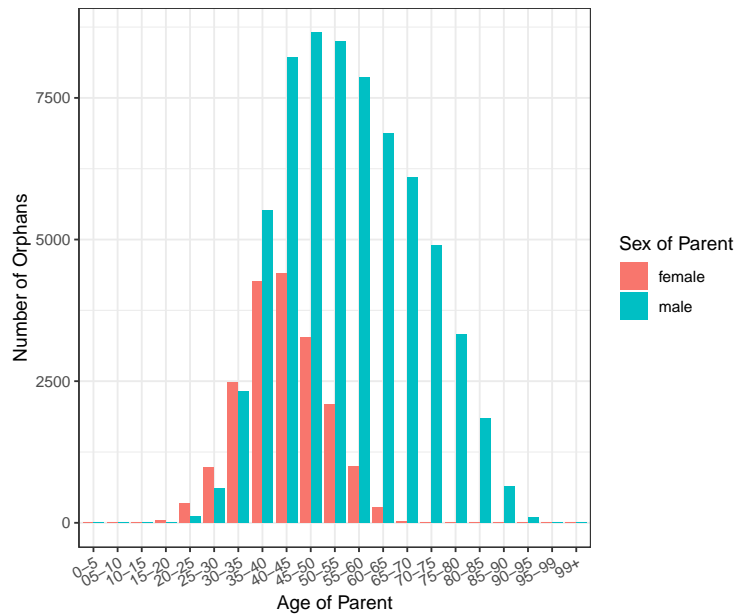


Figure 8: The estimated number of orphans who lost mothers or fathers from different age groups in Brazil.

Age of parent	Sex of parent	COVID-19 deaths	# Orphans
15-49	Female	17107	15802
	Male	25836	25437
50-64	Female	35559	3363
	Male	56956	23233
65+	Female	118905	27
	Male	147943	16905
Total	Female	171571	19192
	Male	230735	65575

Table 5: The number of orphans and COVID-19 deaths for Brazil up to 30 April 2021 from male and female parents of different ages.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	102687	6.3	6469	25.2	23031
60-84	Male	143937	4.5	6477	26.3	33691

Table 6: The estimated number of children who have lost care from male or female grandparents in Brazil up to 30 April 2021 from two categories: custodial households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
19182	65565	10	6417	6425	52	97651	16958	27501	137	142247

Table 7: The estimated number of children who have lost care in Brazil up to 30 April 2021.

Under-reporting is a known issue in Brazil. One study estimated the total excess deaths between March and May 2020 was 33.5% higher than the number of deaths accumulated by COVID-19 as of May 31 [25]. Therefore, we multiplied our orphans calculated from COVID-19 deaths by 1.335 to reflect this multiplier on our deaths, see Table 8.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
25608	87529	13	8567	8577	69	130363	22639	36714	183	189899

Table 8: The estimated number of children who have lost care in Brazil up to 30 April 2021 including under-reporting.

3.3 Colombia

For Colombia, we only found COVID-19 deaths [26] age-sex disaggregated until 19 November 2020. We then adjusted our deaths up to 30 April 2021 using the total number of deaths from Johns Hopkins University [5].

We derived the fertility rates from DHS surveys [8] in 2005, 2010 and 2015, using the own-child method [10]. The fertility rates by five-age groups and sex are shown in Figure 9 and the average number of children under 18 years of age born to parents of different ages in 2020 is shown in Figure 10.

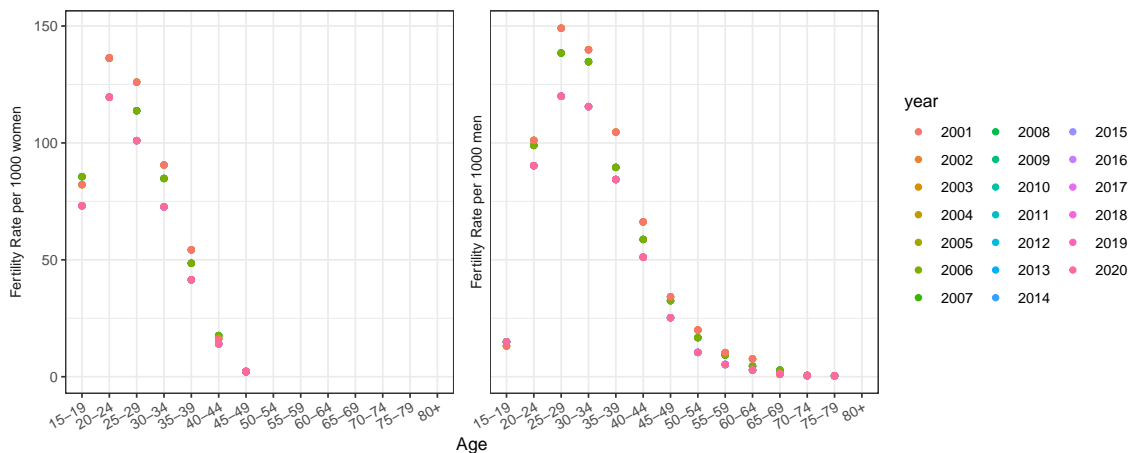


Figure 9: Fertility rates for parents by age and sex in Colombia.

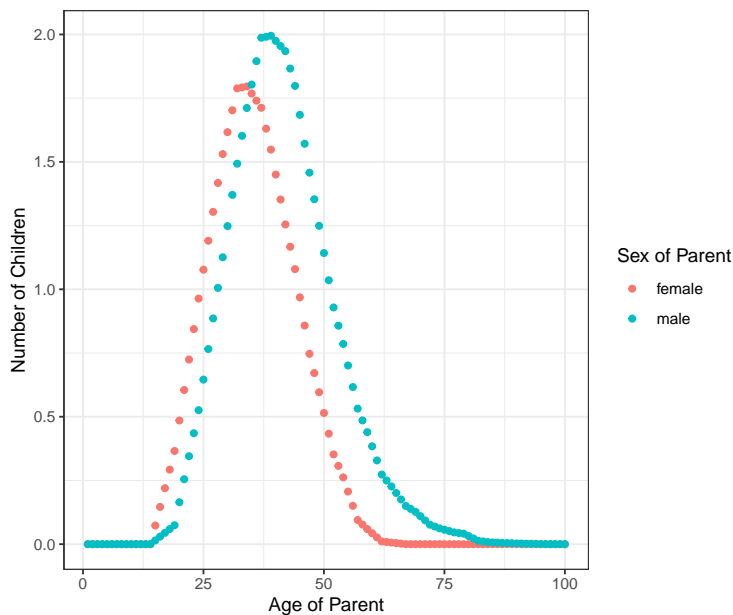


Figure 10: Average number of children born to women or men of different ages between 2003 and 2020 in Colombia.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 9. These are broken down by age in Figure 11. We also estimated the number of children who have lost care from grandparents dying in Table 10. We adjusted for double counting in Table 11.

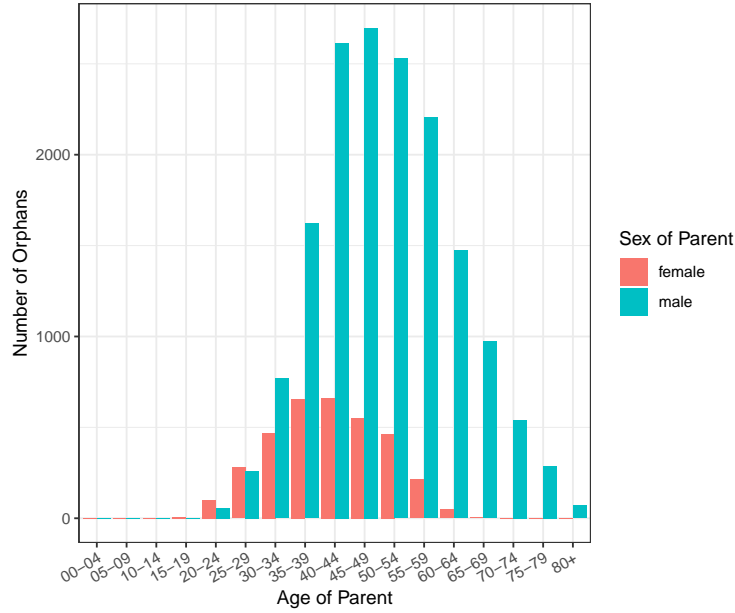


Figure 11: The estimated number of orphans who lost mothers or fathers from different age groups in Colombia.

Age of parent	Sex of parent	COVID-19 deaths	# Orphans
15-44	Female	1571	2171
	Male	3232	5320
45-64	Female	6374	1278
	Male	13516	8904
65+	Female	18412	4
	Male	30479	1868
Total	Female	26357	3453
	Male	47227	16092

Table 9: The number of orphans and COVID-19 deaths for Colombia up to 30 April 2021 from male and female parents of different ages.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	15535	6.0	932	34.6	4777
60-84	Male	28252	4.7	1328	33.3	8373

Table 10: The estimated number of children who have lost care from male or female grandparents in Colombia up to 30 April 2021 from two categories: custodial households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
3450	16089	3	925	1321	7	21795	3875	7086	31	32787

Table 11: The estimated number of children who have lost care in Colombia up to 30 April 2021.

We again scaled our orphans by the ratio of excess deaths to COVID-19 deaths according to a presentation by Gobierno de Colombia [27] to account for under-reporting. Between weeks 10 and 44 there were 48569 excess deaths compared to 31796 COVID-19 deaths from Johns Hopkins University (data taken up to 1 November 2020). This gave us a multiplication factor of 1.53, see Table 12 for our estimates including under-reporting.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
5270	24576	5	1413	2018	11	33293	5919	10824	47	50083

Table 12: The estimated number of children who have lost care in Colombia up to 30 April 2021 including under-reporting.

3.4 England and Wales

For England and Wales, we found COVID-19 death registrations [28] between week 13 2020 and week 17 2021, where COVID-19 had been mentioned on the death certificate, and computed the excess deaths using the difference between the total deaths in 2020 or 2021 and the average deaths in 2015 - 2019 on the week level [28]. We extracted the male age-specific fertility rates [29], the annual live births from women between 2003 to 2018 [29] and the age-specific female population [30] from the Office of National Statistics (ONS). Figure 12 shows the age-specific fertility rates for male and female, where we used the number of live births and female population to estimate female fertility rates.

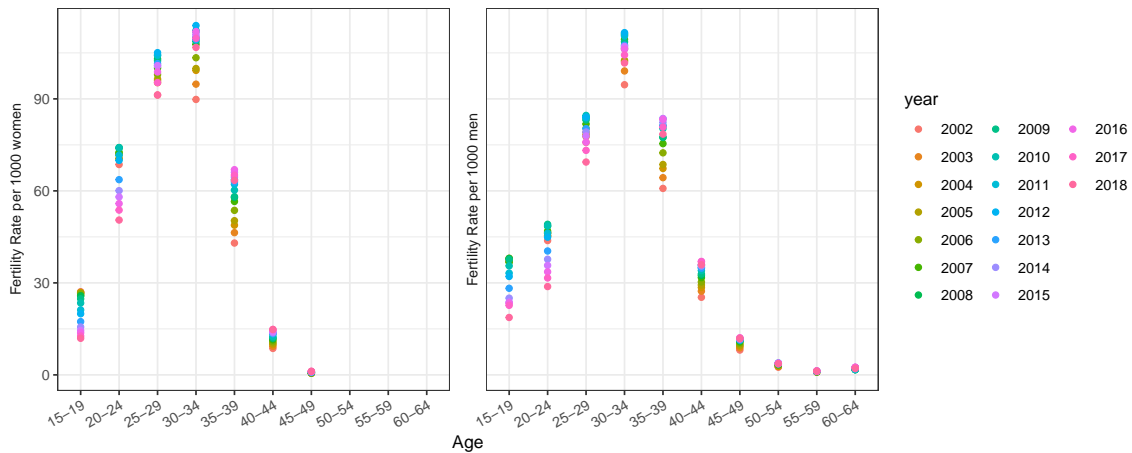


Figure 12: Fertility rates for parents by age and sex in England & Wales.

We weighted these fertility rates by the time-varying infant[31] and child[32] mortality rates again from

ONS. Figure 13 shows how the average number of offspring per man and woman varies between different ages in England and Wales.

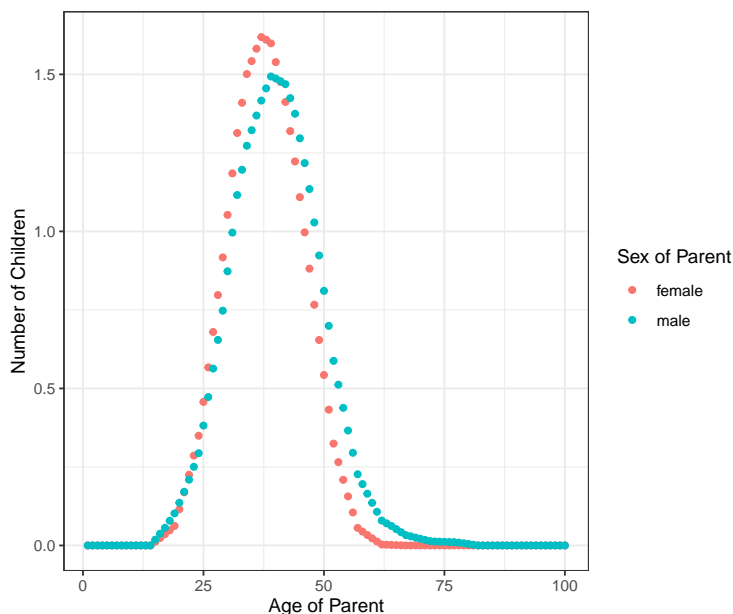


Figure 13: Average number of children born to women or men of different ages between 2003 and 2020 in England and Wales.

The estimated number of orphans in England and Wales who lost mothers or fathers during 2020 by different age groups is presented in Table 13 and further disaggregated in Figure 14. We also estimated the number of children who have lost care from grandparents dying in Table 14. We note the percentage of custodial grandparent household and households with at least one older person and a child under 18 were taken from a survey in 1991, but could not find more recent data. We adjust for double counting in Table 15.

Age of parent	Sex of parent	Excess deaths	COVID-19 deaths	Composite deaths	# Orphans
15-44	Female	961	626	1018	1388
	Male	1402	925	1529	1980
45-64	Female	5510	5094	5645	970
	Male	11357	9052	11357	3702
65+	Female	41174	57340	57874	1
	Male	57155	64833	65396	456
Total	Female	47645	63060	64537	2359
	Male	69914	74810	78282	6138

Table 13: The number of orphans and COVID-19 deaths for England and Wales up to and including week 17 2021 from male and female parents of different ages.

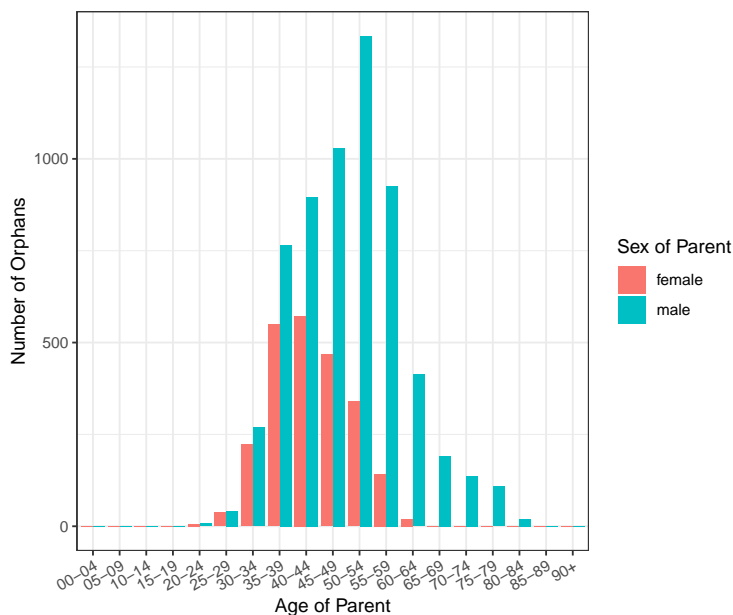


Figure 14: The estimated number of orphans who lost mothers or fathers from different age groups in England and Wales.

Age of parent	Sex of parent	Composite deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	28902	0.6	173	2.35	604
60-84	Male	43896	0.5	219	3.4	1328

Table 14: The estimated number of children who have lost care from male or female grandparents in England and Wales from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
2357	6136	2	172	218	1	8886	442	1118	4	10450

Table 15: The estimated number of children who have lost care in England and Wales.

3.5 France

For France, we extracted the COVID-19 hospital deaths by age and sex [33] until 30 April 2021. We therefore used the age-sex-ratios from the hospital data to disaggregate the Johns Hopkins University data for France [5], which included community based deaths. We estimated the age- and sex-specific excess deaths as the difference between the weekly deaths in 2020/2021 and the mean of the past five-year deaths in the corresponding weeks between week 10 2020 and week 17 2021 [34]. We use the yearly female fertility rates from UN WPP [12] and compute the male fertility rates via the annual live births from UNSD [7] and the population from [14]. The child mortality rates are extracted from [13].

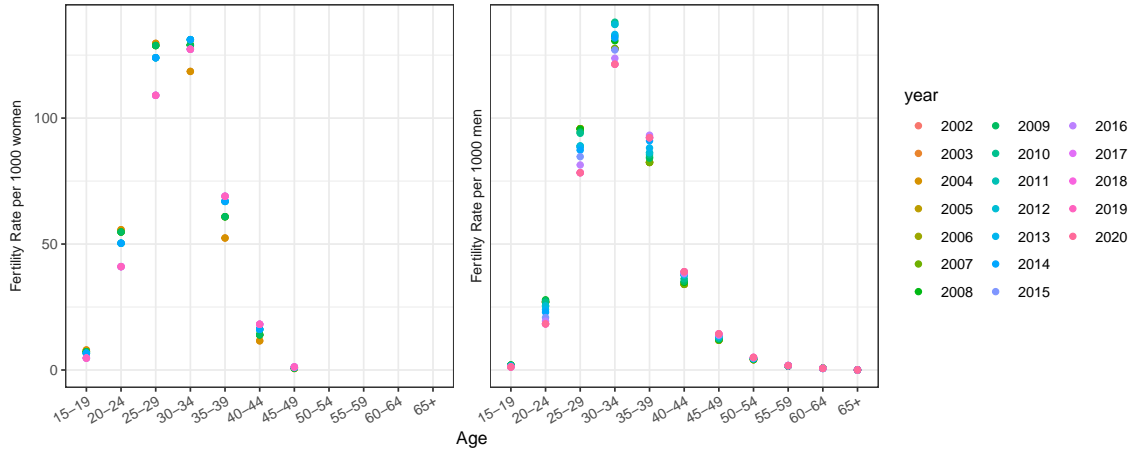


Figure 15: Fertility rates for parents by age and sex in France.

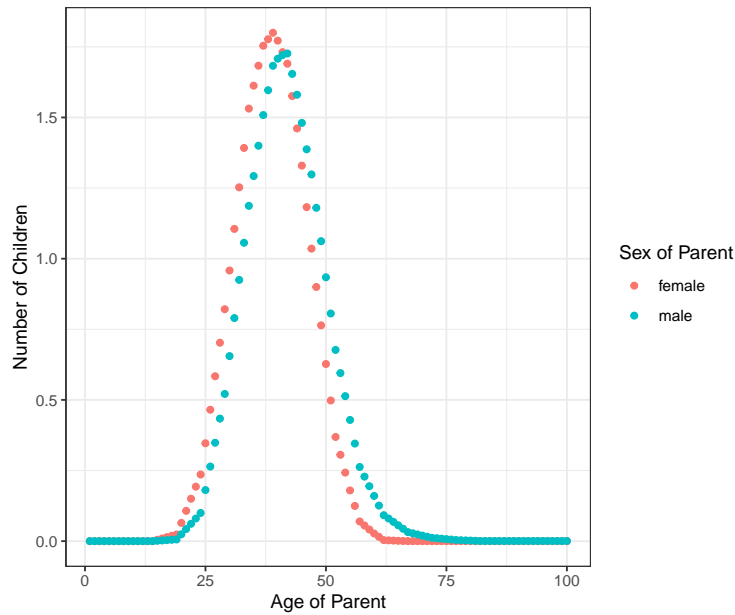


Figure 16: Average number of children born to women or men of different ages between 2003 and 2020 in France.

The estimated number of orphans in England and Wales who lost mothers or fathers during 2020/2021 by different age groups is presented in Table 16 and further disaggregated in Figure 17. We use the custodial grandparent proportions for England and Wales since we could not find any values for France [35] and adjust for double counting in Table 18. This is a limitation of our method.

Age of parent	Sex of parent	Excess deaths	COVID-19 deaths	Composite deaths	# Orphans
20-49	Female	-530	574	574	739
	Male	-960	819	819	1099
50-69	Female	1251	4710	4710	330
	Male	388	10030	10030	1716
70+	Female	39548	38868	51924	0
	Male	45685	49656	56838	181
Total	Female	40269	44152	57208	1069
	Male	45113	60505	67687	2996

Table 16: The number of orphans and deaths for France up to 30 April 2021 from male and female parents of different ages.

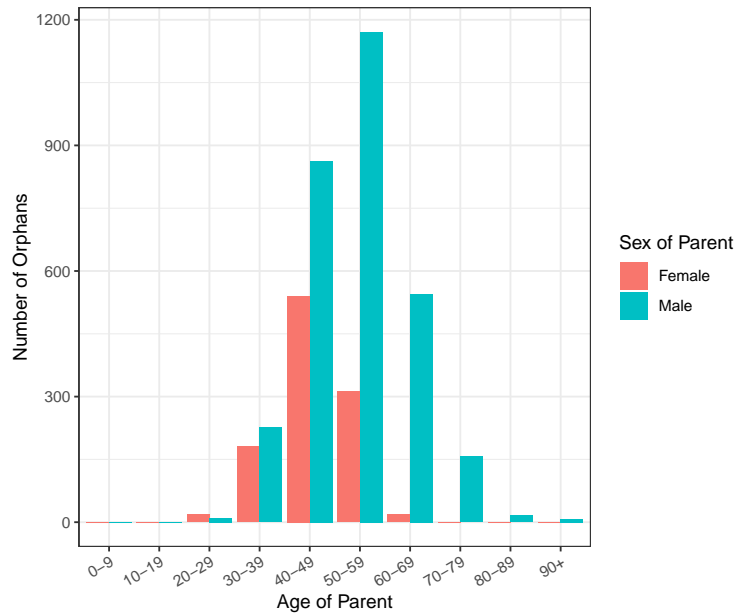


Figure 17: The estimated number of orphans who lost mothers or fathers from different age groups in France

Age of parent	Sex of parent	Composite deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	20332	0.6	122	1.75	317
60-84	Male	37189	0.5	186	3.45	1142

Table 17: The estimated number of children who have lost care from male or female grandparents in France up to 30 April 2021 from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
1068	2995	1	121	185	1	4371	204	965	2	5542

Table 18: The estimated number of children who have lost care in France up to 30 April 2021.

3.6 Germany

For Germany, the COVID-19 tested deaths by age and sex were extracted from [36] until 27 April 2021. We then adjusted our deaths up to 30 April using the total number of deaths from Johns Hopkins University [5]. We used the yearly female fertility rates from UNWPP [12] and computed the male fertility rates via the annual live births from UNSD [7] and the population from [14]. The fertility rates by five-age groups and sex are shown in Figure 18 and the average number of children under 18 years of age born to parents of different ages in 2020 is shown in Figure 19.

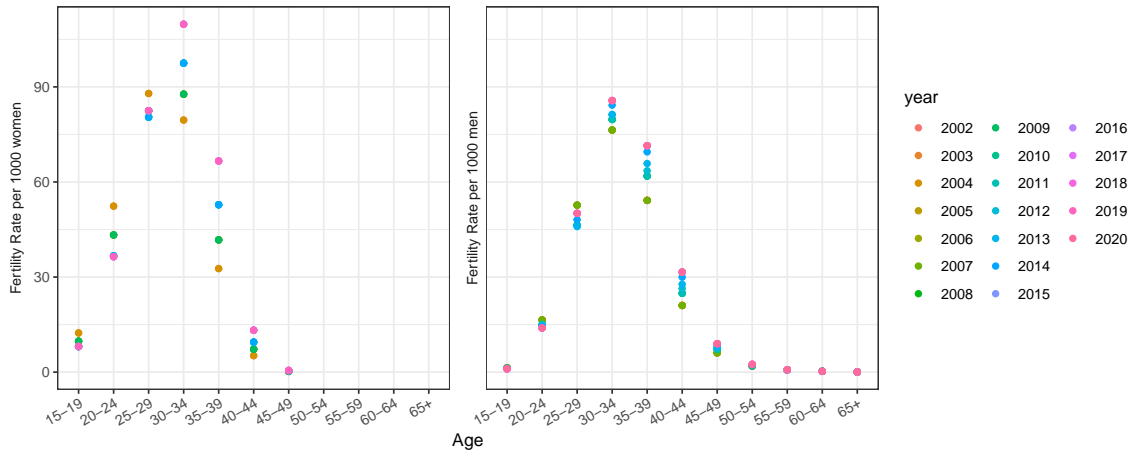


Figure 18: Fertility rates for parents by age and sex in Germany.

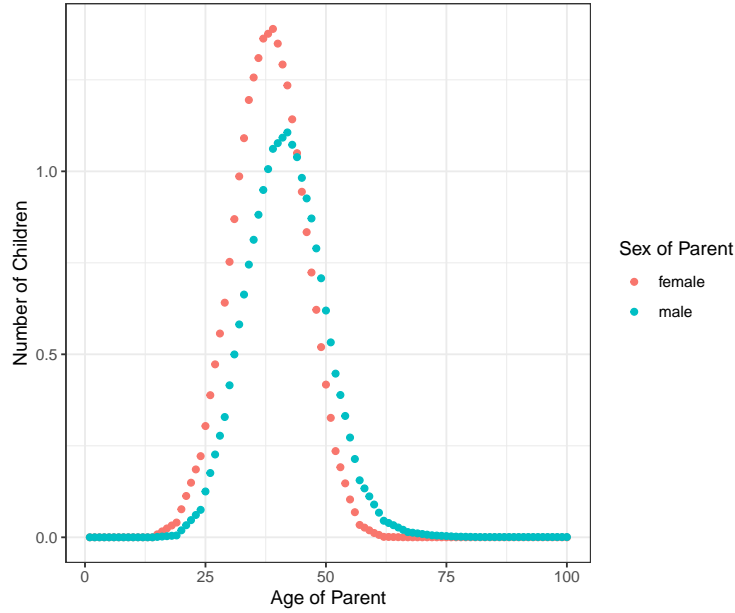


Figure 19: Average number of children born to women and men of different ages between 2003 and 2020 in Germany.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 19. These are broken down by age in Figure 20. We also estimated the number of children who have lost care from grandparents dying in Table 20. We adjusted for double counting in Table 21.

Age	Sex	COVID-19 deaths	Orphans
20-49	Female	263	251
	Male	514	437
50-69	Female	2818	118
	Male	6510	720
70+	Female	36813	0
	Male	36162	64
Total	Female	39894	369
	Male	43186	1221

Table 19: The number of orphans and COVID-19 deaths for Germany up to 30 April 2021 from male and female parents of different ages.

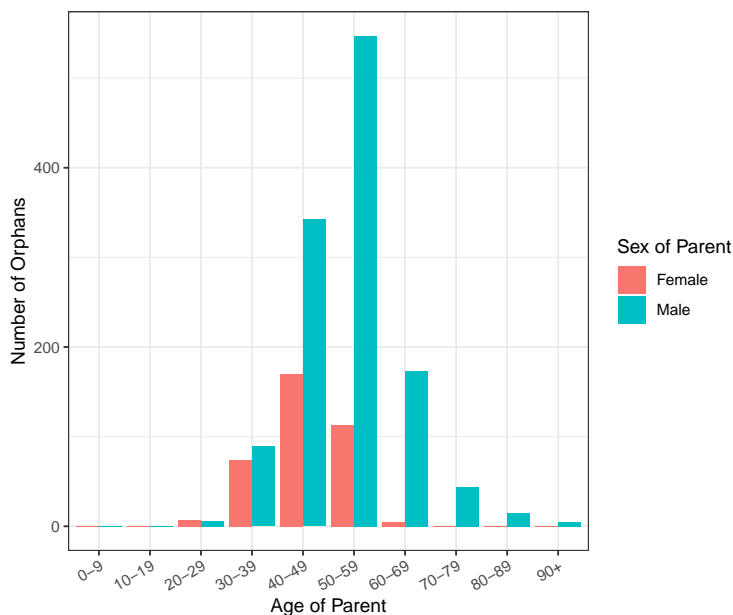


Figure 20: The estimated number of orphans who lost mothers or fathers from different age groups in Germany up to 30 April 2021.

The percentage of skip-generation and co-residing households are not available for Germany so we assume the values are the same as for England and Wales [35]. This is a limitation of our method.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	18231	0.6	109	2.35	381
60-84	Male	26738	0.5	134	3.4	809

Table 20: The estimated number of children who have lost care from male or female grandparents in Germany up to 30 April 2021 from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
369	1221	0	108	133	1	1832	279	681	2	2794

Table 21: The estimated number of children who have lost care in Germany up to 30 April 2021.

3.7 India

For India we used the age and sex ratios from Joe et al. [37] up to 20 May 2020 to weight the COVID-19 deaths up to 30 April 2021 from the COVID-19 India Dashboard [38]. We derived the fertility rates from DHS surveys [8] in 2006 and 2015 using the own-child method [10]. The fertility rates by five-age groups and sex are shown in Figure 21 and the average number of children under 18 years of age born to parents of different ages in 2020 is shown in Figure 22.

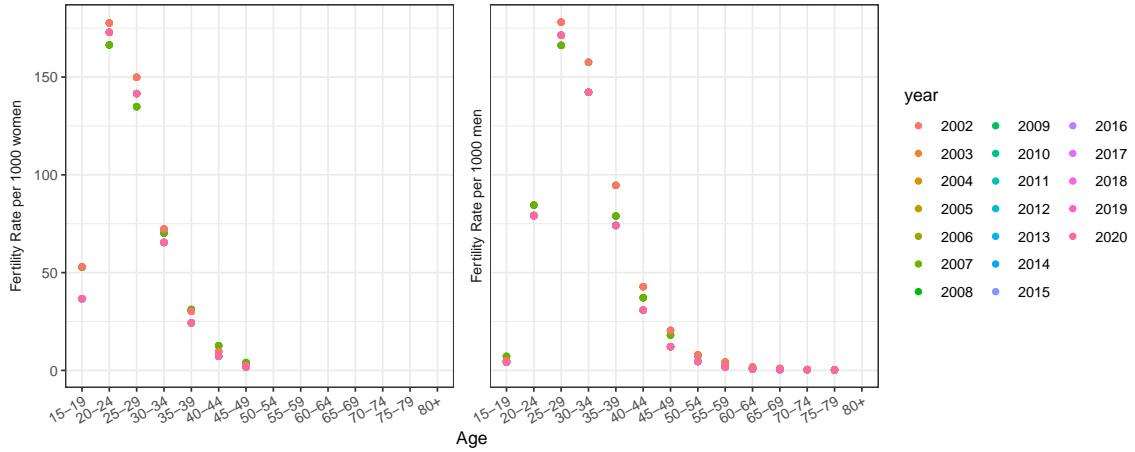


Figure 21: Fertility rates for parents by age and sex in India.

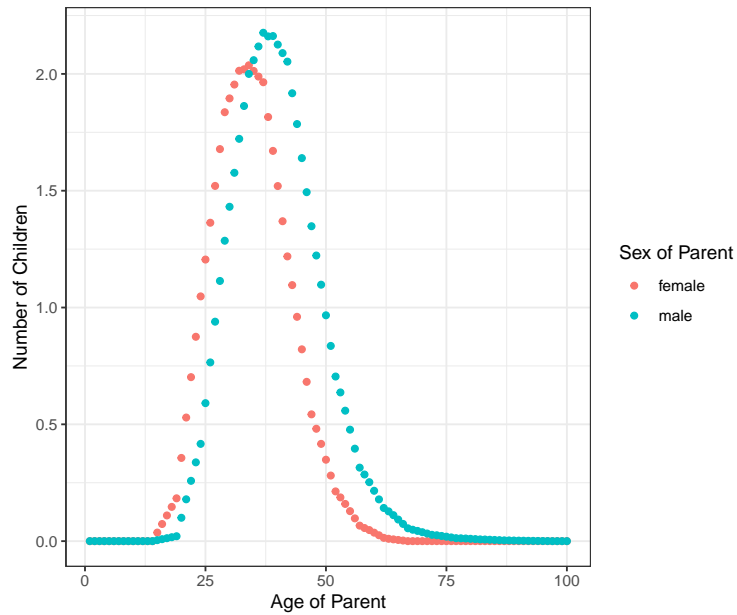


Figure 22: Average number of children born to women or men from different ages in between 2003 and 2020 in India.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 22. These are broken down by age in Figure 23. We also estimated the number of children who have lost care from grandparents dying in Table 23. We adjusted for double counting in Table 24.

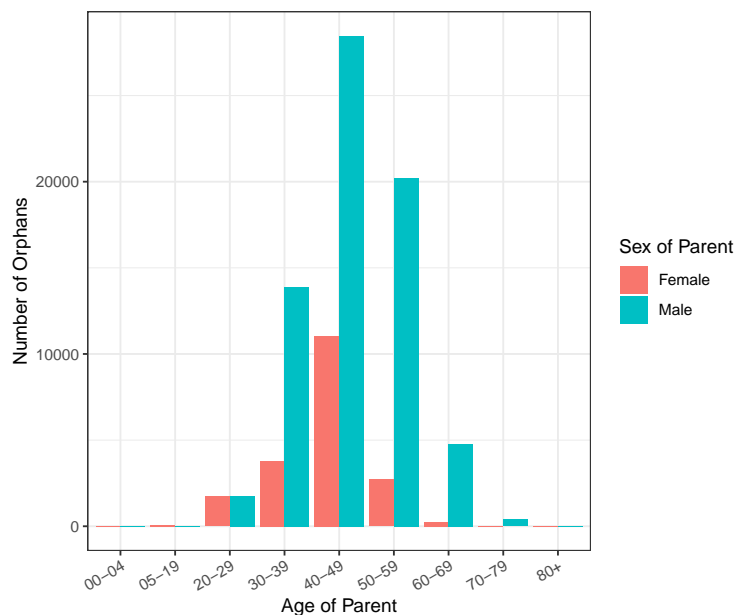


Figure 23: The estimated number of orphans who lost mothers or fathers from different age groups in India up to 30 April 2021.

Age of parent	Sex of parent	COVID-19 deaths	# Orphans
20-49	Female	15649	16574
	Male	27120	44115
50-69	Female	41078	2968
	Male	81092	24998
70+	Female	18778	0
	Male	23914	411
Total	Female	75505	19542
	Male	132126	69524

Table 22: The number of orphans and COVID-19 deaths for India up to 30 April 2021 from male and female parents of different ages.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	39740	2.2	874	60.2	21292
60-84	Male	64753	2.1	1360	57.8	33339

Table 23: The estimated number of children who have lost care from male or female grandparents in India up to 30 April 2021 from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
19533	69515	9	867	1353	7	91284	20139	31634	163	143220

Table 24: The estimated number of children who have lost care in India up to 30 April 2021.

Incomplete death registration is a known problem in India. Kumar et al. [39] estimated that in 2015 76.6% of deaths were registered. We therefore multiplied our orphans by 1.31 to account for under-reporting, see Table 25.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
25500	90751	12	1132	1766	9	119170	26291	41298	213	186972

Table 25: The estimated number of children who have lost care in India up to 30 April accounting for under-reporting.

In light of the precipitous rise in COVID-19-associated mortality in India from February to April 2021, we present estimates of COVID-19-associated death to illustrate the impact of such a crisis on increases in orphanhood and loss of care from primary and secondary grandparents in Table 26.

Up to month	Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
	Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
Feb	18924	67339	8	841	1311	7	88430	19509	30645	158	138742
Mar	19615	69813	9	872	1359	7	91675	20226	31769	163	143833
Apr	25500	90751	12	1132	1766	9	119170	26291	41298	213	186972

Table 26: The estimated cumulative number of children who have lost care in India accounting for under-reporting between February and April 2021.

3.8 Islamic Republic of Iran

For I.R. Iran, COVID-19 deaths were collected from hospital patients admitted between 19 February and 15 April 2020 to calculate age- and sex- specific ratios of cases [40]. We then adjusted our deaths up to 30 April 2021 using the total number of deaths from Johns Hopkins University [5]. We used female fertility rates from UNWPP [12], which we adjusted according to child mortality rates [13]. Since we could not find any male fertility rates, we shifted the female fertility trend by 5 years to reflect that fathers were on average slightly older than mothers. This followed a similar pattern to countries such as India, which had the closest total fertility rate to I.R. Iran that we had data for. The fertility rates by five-age groups and sex are shown in Figure 24 and the average number of children under 18 years of age born to parents of different ages in 2020 is shown in Figure 25.

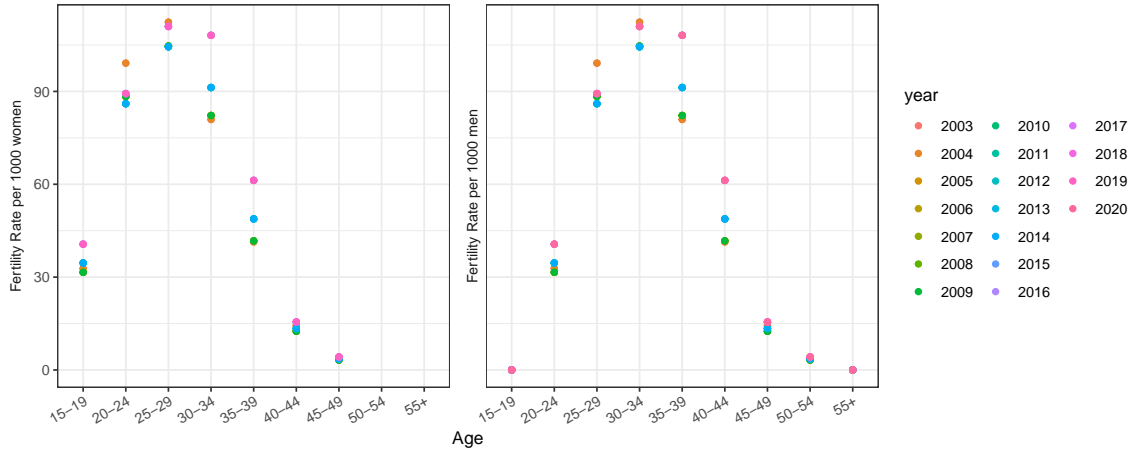


Figure 24: Fertility rates for parents by age and sex in I.R. Iran.

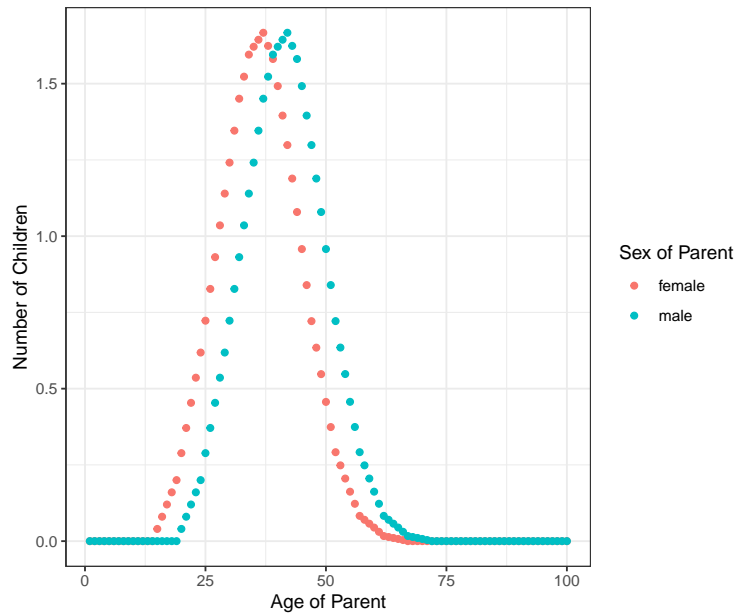


Figure 25: Average number of children born to women or men from different ages in between 2003 and 2020 in I.R. Iran.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 27. These are broken down by age in Figure 26. We also estimated the number of children who have lost care from grandparents dying in Table 28. We adjusted for double counting in Table 29.

Age of parent	Sex of parent	COVID-19 deaths	# Orphans
20-49	Female	2261	2778
	Male	5245	6765
50-69	Female	11306	1092
	Male	26224	6890
70+	Female	8050	0
	Male	18671	12
Total	Female	21617	3870
	Male	50140	13667

Table 27: The number of orphans and COVID-19 deaths for I.R. Iran up to 30 April 2021 from male and female parents of different ages.

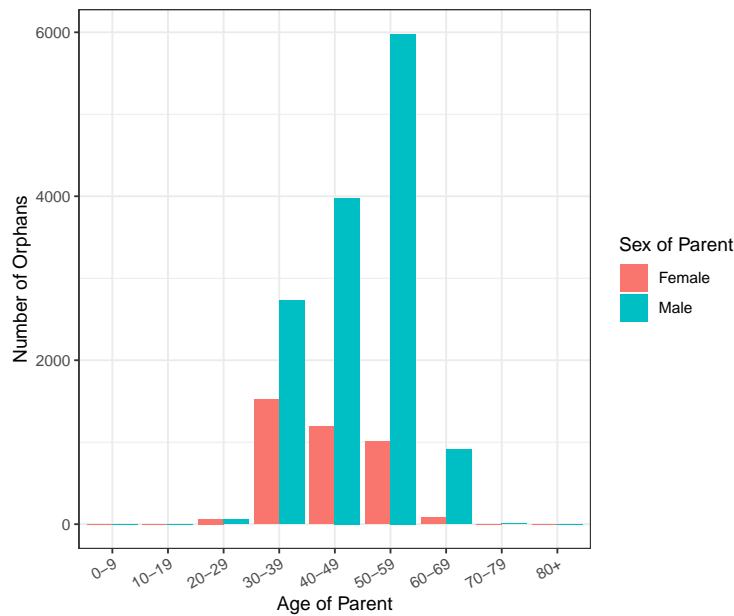


Figure 26: The estimated number of orphans who lost mothers or fathers from different age groups in I.R. Iran.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	12675	0.8	101	13.8	1557
60-84	Male	29434	0.5	147	17.0	4453

Table 28: The estimated number of children who have lost care from male or female grandparents in I.R. Iran from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
3867	13664	3	100	146	1	17781	1440	4266	12	23499

Table 29: The estimated number of children who have lost care in I.R. Iran up to 30 April 2021.

Again, there were large discrepancies between COVID-19 attributed deaths and excess deaths in I.R. Iran so we adjusted our orphans using data from Ghafari et al. [41]. In this study, they showed the COVID-19 deaths and excess deaths for three time points. We chose them mean of the ratio between the excess deaths and COVID-19 deaths (2.31) to multiply our orphans by, see Table 30.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
8916	31503	7	231	337	2	40996	3320	9836	28	54180

Table 30: The estimated number of children who have lost care in I.R. Iran adjusted by under-reporting up to 30 April 2020.

3.9 Italy

We extracted the COVID-19 tested deaths by age and sex [33] until 28 April 2021 and updated to 30 April 2021 the same date using Johns Hopkins University data [5]. We estimated the age-and sex-specific excess deaths as the difference between the weekly deaths in 2020/2021 and the mean of the past five-year deaths in the corresponding weeks between weeks 10 2020 and 17 2021 [34]. We use the yearly female fertility rates from UNWPP [12] and compute the male fertility rates via the annual live births from UNSD [7] and the population from [14]. The fertility rates by five-age groups and sex are shown in Figure 27 and the average number of children under 18 years of age born to parents of different ages in 2020 is shown in Figure 28.

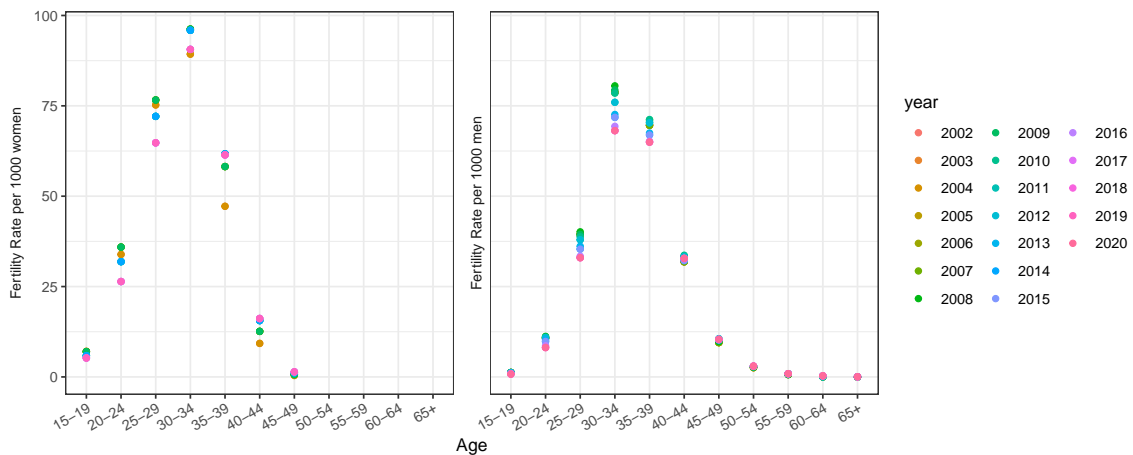


Figure 27: Fertility rates for parents by age and sex in Italy.

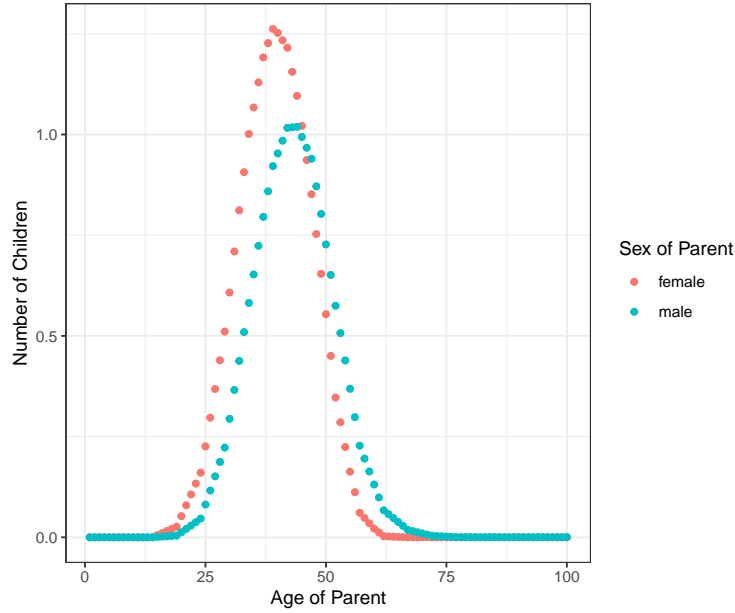


Figure 28: Average number of children born to women or men from different ages in between 2003 and 2020 in Italy.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 31. These are broken down by age in Figure 29. We also estimated the number of children who have lost care from grandparents dying in Table 32. We adjusted for double counting in Table 33.

Age of parent	Sex of parent	Excess deaths	COVID-19 deaths	Composite deaths	# Orphans
20-49	Female	-542	412	412	399
	Male	-797	900	900	781
50-69	Female	1815	4372	4372	273
	Male	6921	11669	11669	1676
70+	Female	49603	47900	57093	0
	Male	53713	55529	60162	73
Total	Female	50876	52684	61877	672
	Male	59837	68098	72731	2530

Table 31: The number of orphans and COVID-19 deaths for Italy up to 30 April 2021 from male and female parents of different ages.

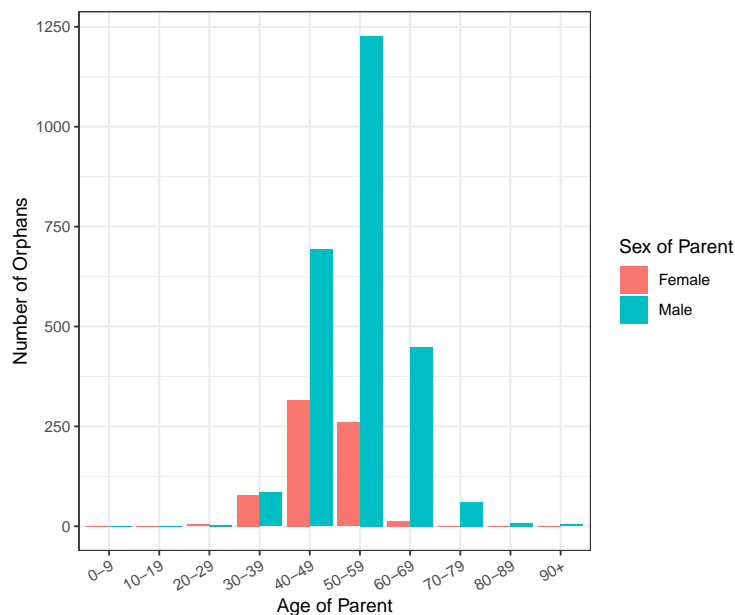


Figure 29: The estimated number of orphans who lost mothers and fathers from different age groups in Italy up to 30 April 2021.

Age of parent	Sex of parent	Composite deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	23980	0.8	192	3.8	811
60-84	Male	43880	0.4	176	4.5	1757

Table 32: The estimated number of children who have lost care from male or female grandparents in Italy up to 30 April 2021 from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
671	2529	1	191	175	1	3568	629	1580	5	5782

Table 33: The estimated number of children who have lost care in Italy up to 30 April 2021.

3.10 Kenya

We collected COVID-19 deaths [42] up to 27 July 2020 and again updated to 30 April from Johns Hopkins University [5] using the country-specific age and sex rates. The fertility rates were derived from two DHS surveys [8] in 2003 and 2014 using the own-child method [10]. The 2008 survey did not have several necessary variables filled in. The fertility rates by five-age groups and sex are shown in Figure 30 and the average number of children under 18 years of age born to parents of different ages in 2020 is shown in Figure 31.

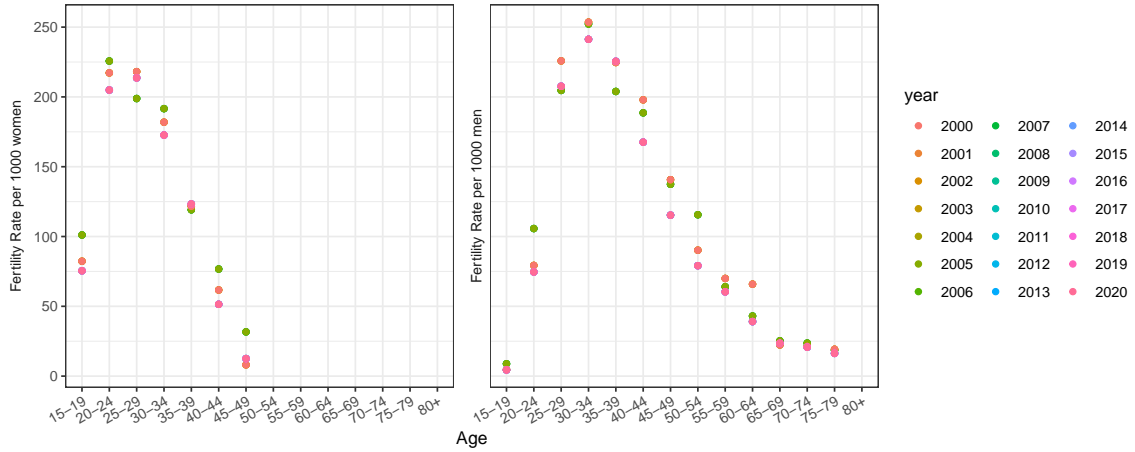


Figure 30: Fertility rates for parents by age and sex in Kenya.

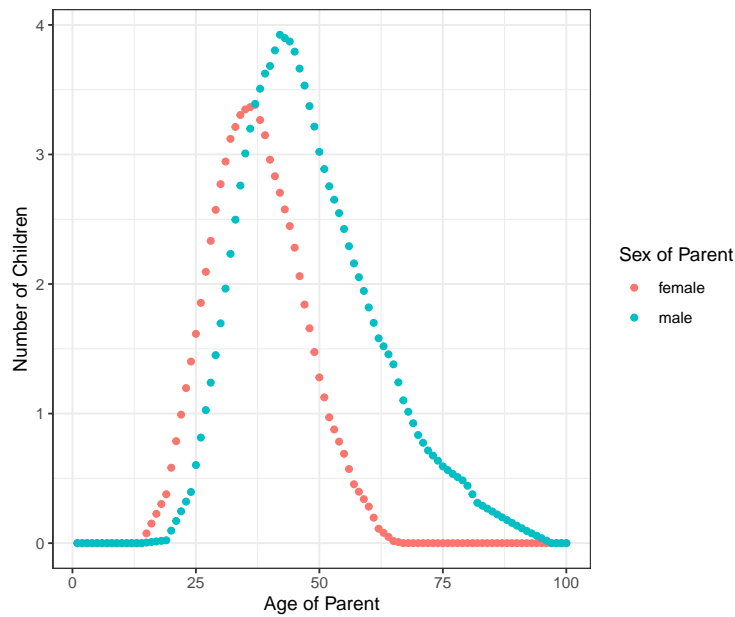


Figure 31: Average number of children born to women and men of different ages between 2003 and 2020 in Kenya.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 34. These are broken down by age in Figure 32. We also estimated the number of children who have lost care from grandparents dying in Table 35 and adjust for double counting in Table 36.

Age	Sex	COVID19 deaths	Orphans
20-49	Female	230	604
	Male	650	2017
50-59	Female	172	129
	Male	421	1041
60+	Female	258	5
	Male	908	516
Total	Female	660	738
	Male	1979	3574

Table 34: The number of orphans and COVID-19 deaths for Kenya up to 30 April 2021 from male and female parents of different ages.

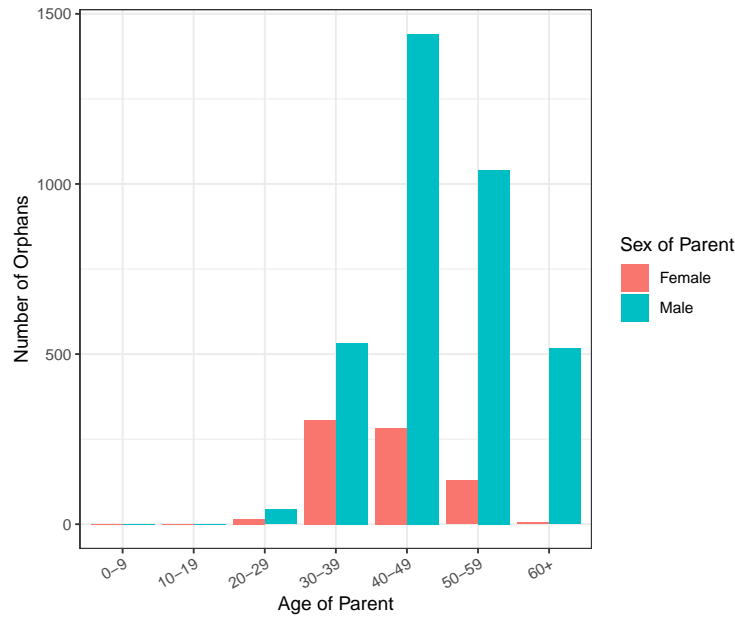


Figure 32: The estimated number of orphans who lost mothers or fathers from different age groups in Kenya.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	229	27.0	62	56.95	116
60-84	Male	839	15.0	126	56.90	425

Table 35: The estimated number of children who have lost care from male or female grandparents in Kenya from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
738	3574	0	62	126	0	4500	60	309	0	4869

Table 36: The estimated number of children who have lost care in Kenya.

3.11 Malawi

We collected COVID-19 deaths [43] up to 27 December 2021 and again updated to 30 April from Johns Hopkins University [5] using the country-specific age and sex rates. The fertility rates were derived from three DHS surveys [8] in 2004, 2010 and 2015 using the own-child method [10]. The fertility rates by five-age groups and sex are shown in Figure 33 and the average number of children under 18 years of age born to parents of different ages in 2020 is shown in Figure 34.

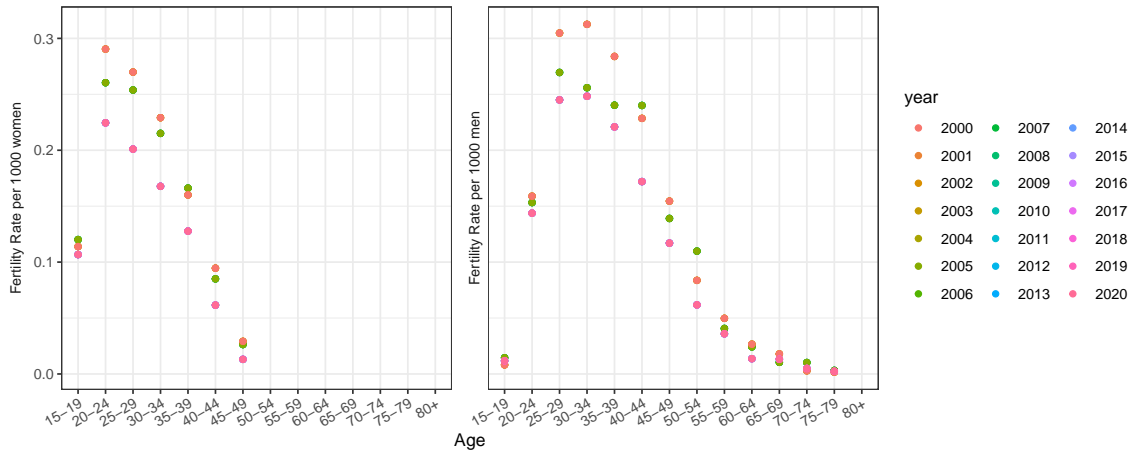


Figure 33: Fertility rates for parents by age and sex in Malawi.

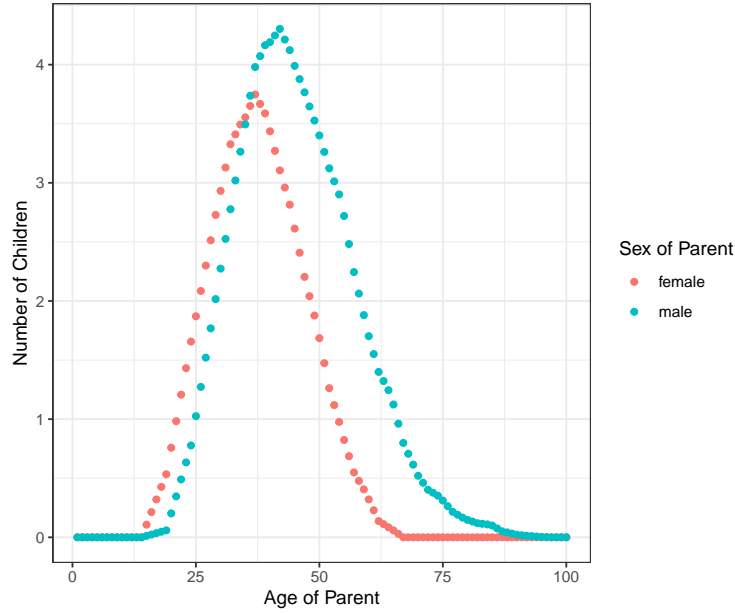


Figure 34: Average number of children born to women and men of different ages between 2003 and 2020 in Malawi.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 37. These are broken down by age in Figure 35. We also estimated the number of children who have lost care from grandparents dying in Table 38 and adjust for double counting in Table 39.

Age	Sex	COVID19 deaths	Orphans
20-49	Female	116	323
	Male	268	971
50-69	Female	116	48
	Male	433	868
70+	Female	37	0
	Male	171	23
Total	Female	269	371
	Male	872	1862

Table 37: The number of orphans and COVID-19 deaths for Malawi up to 30 April 2021 from male and female parents of different ages.

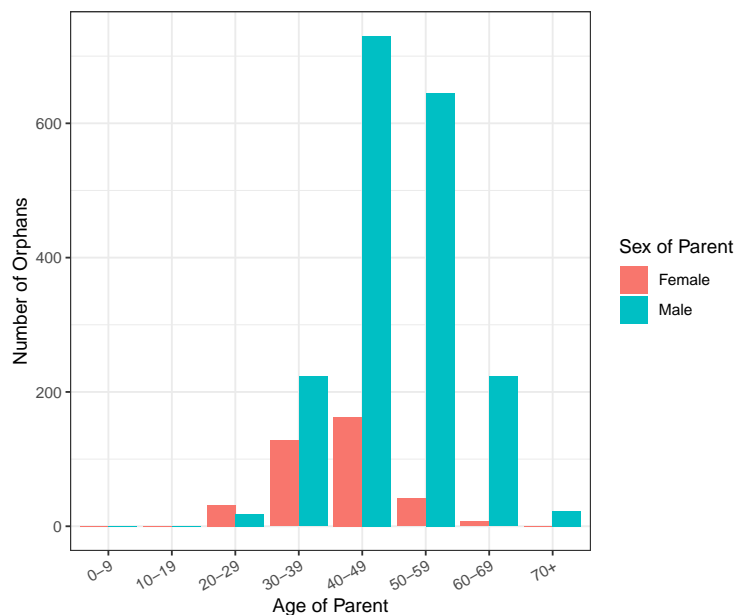


Figure 35: The estimated number of orphans who lost mothers or fathers from different age groups in Malawi.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	104	39.4	41	72.4	67
60-84	Male	347	26.7	93	70.8	218

Table 38: The estimated number of children who have lost care from male or female grandparents in Malawi from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
371	1862	0	41	93	0	2367	30	135	0	2532

Table 39: The estimated number of children who have lost care in Malawi.

3.12 Mexico

COVID-19 deaths per 100,000 in Mexico is collected from [44] up to 20 April 2021 and again updated to 30 April 2021 from Johns Hopkins University [5] using the country-specific age and sex ratios. We used the yearly female fertility rates from UNWPP [12] and computed the male fertility rates via the annual live births [7], population [14] and child mortality [13] from UNSD.

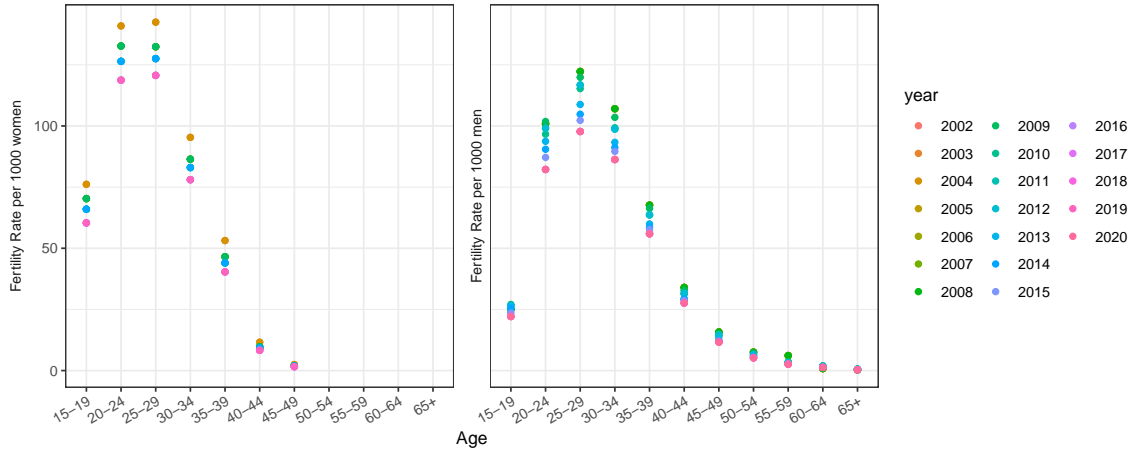


Figure 36: Fertility rates for parents by age and sex in Mexico.

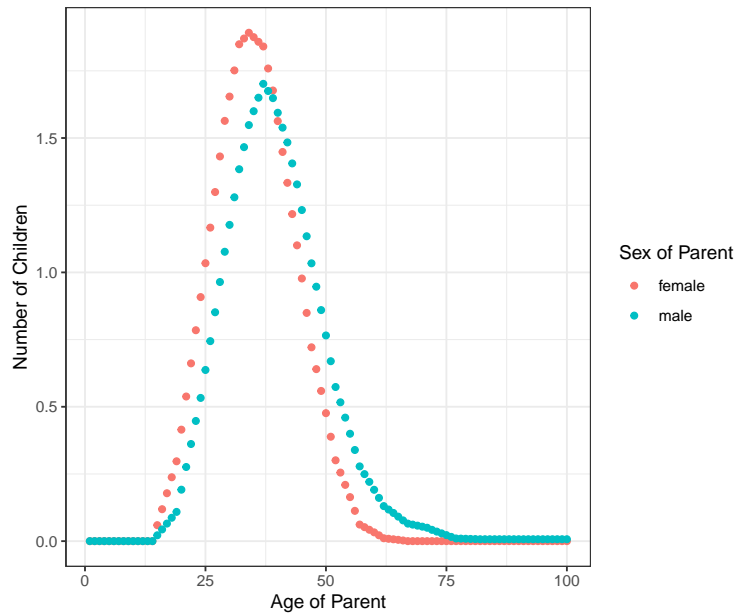


Figure 37: Average number of children born to women and men of different ages between 2003 and 2020 in Mexico.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 40. These are broken down by age in Figure 38. We also estimated the number of children who have lost care from grandparents dying in Table 41 and adjust for double counting in Table 42.

Age	Sex	COVID19 deaths	Orphans
15-44	Female	6084	8940
	Male	12966	18282
45-64	Female	32169	6587
	Male	56973	25003
65+	Female	43079	18
	Male	65316	2353
Total	Female	81332	15545
	Male	135255	45638

Table 40: The number of orphans and COVID-19 deaths for Mexico up to 30 April 2021 from male and female parents of different ages.

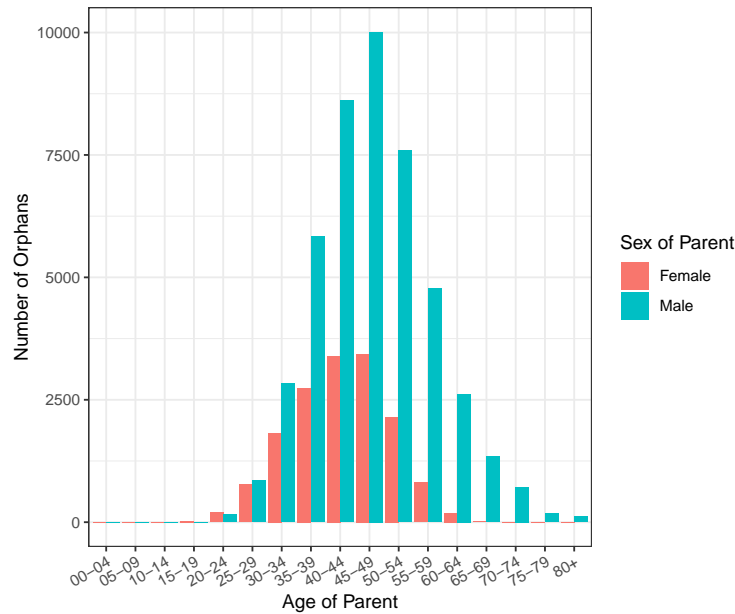


Figure 38: The estimated number of orphans who lost mothers and fathers from different age groups in Mexico up to 30 April 2021.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	47272	4.4	2080	31.0	13021
60-84	Male	73676	3.4	2505	31.3	20524

Table 41: The estimated number of children who have lost care from male or female grandparents in Mexico up to 30 April 2021 from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
15530	45623	15	2063	2488	17	65736	10966	18017	89	94808

Table 42: The estimated number of children who have lost care in Mexico up to 30 April 2021.

Mexico recorded 254625 excess deaths until November, which corresponded to 118598 confirmed COVID-19 deaths in the country [45, 46]. We therefore multiplied our deaths by 2.14 to better estimate the number of orphans, see Table 43.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
33342	97951	32	4429	5342	36	141132	23544	38682	191	203549

Table 43: The estimated number of children who have lost care in Mexico including under-reporting.

3.13 Nigeria

The COVID-19 deaths in Nigeria was collected from the Nigeria Centre for Disease Control [47] up to 30 April 2021 and again updated to the same date from Johns Hopkins University [5] using the country-specific age and sex ratios. We derived the fertility rates from DHS surveys [8] from 2003, 2008, 2013 and 2018, using the own-child method [10]. The fertility rates by five-age groups and sex are shown in Figure 39 and the average number of children under 18 years of age born to parents of different ages in 2020 is shown in Figure 40.

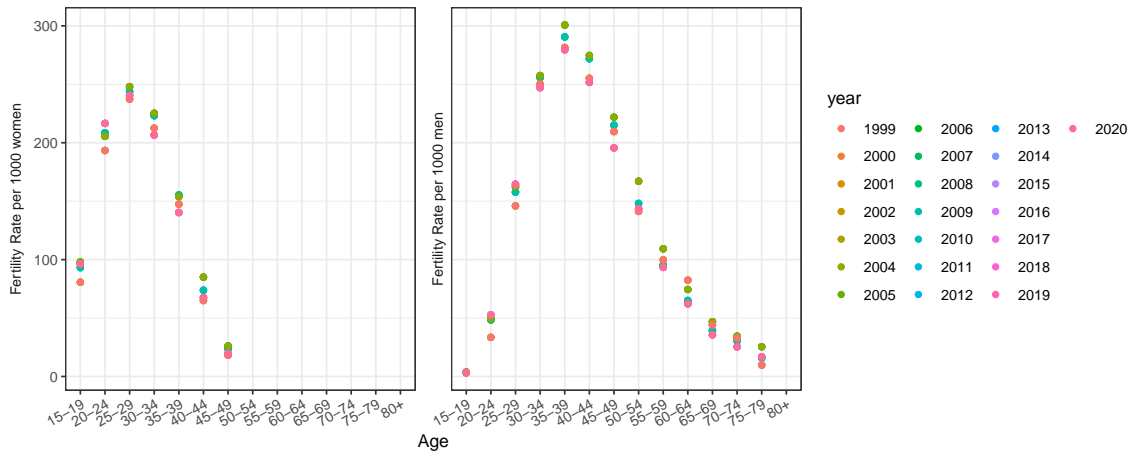


Figure 39: Fertility rates for parents by age and sex in Nigeria.

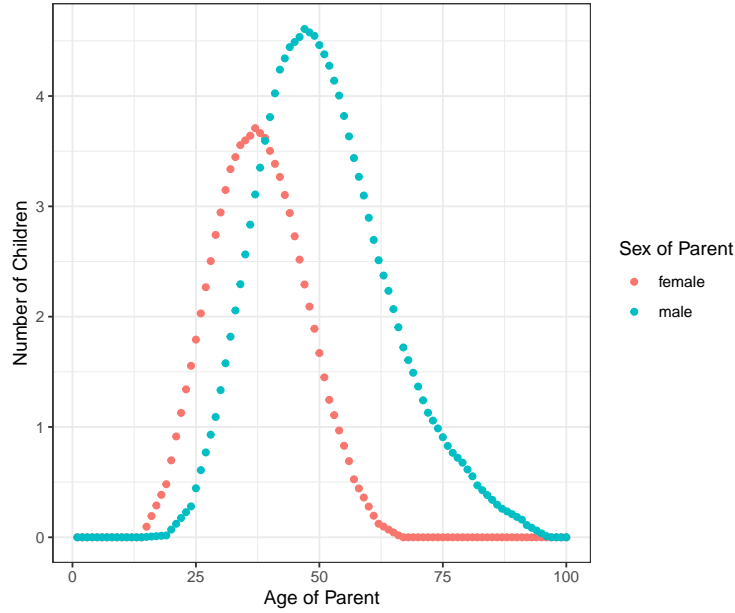


Figure 40: Average number of children born to women and men from different age bands between 2003 and 2020 in Nigeria.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 44. These are broken down by age in Figure 41. We also estimated the number of children who have lost care from grandparents dying in Table 45 and adjust for double counting in Table 46.

Age	Sex	COVID19 deaths	Orphans
20-49	Female	147	413
	Male	205	611
50-69	Female	276	143
	Male	794	2331
70+	Female	161	0
	Male	445	355
Total	Female	584	556
	Male	1444	3297

Table 44: The number of orphans and COVID-19 deaths for Nigeria up to 30 April 2021 from male and female parents of different ages.

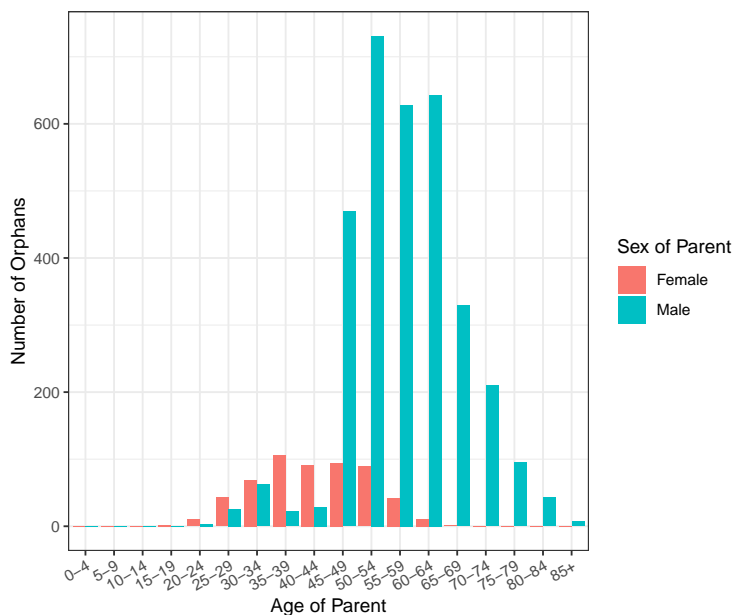


Figure 41: The estimated number of orphans who lost mothers and fathers from different age groups in Nigeria up to 30 April 2021.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	263	14.2	37	61.0	143
60-84	Male	831	6.9	57	65.9	487

Table 45: The estimated number of children who have lost care from male or female grandparents in Nigeria up to 30 April 2021 from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
556	3297	0	37	57	0	3947	108	431	1	4487

Table 46: The estimated number of children who have lost care in Nigeria up to 30 April 2021.

3.14 Peru

The COVID-19 deaths in Peru was collected from Sala Situacional COVID-19 Peru [48] until 13 May 2021 and adjusted to 30 April 2021 from Johns Hopkins University [5] using the country-specific age and sex ratios. The fertility rates are derived from six DHS surveys [8] in 2004, 2007, 2009, 2010, 2011 and 2012, using the own-child method [10]. The fertility rates by five-age groups and sex are shown in Figure 42 and the average number of children under 18 years of age born to parents of different ages in 2020 is shown in Figure 43.

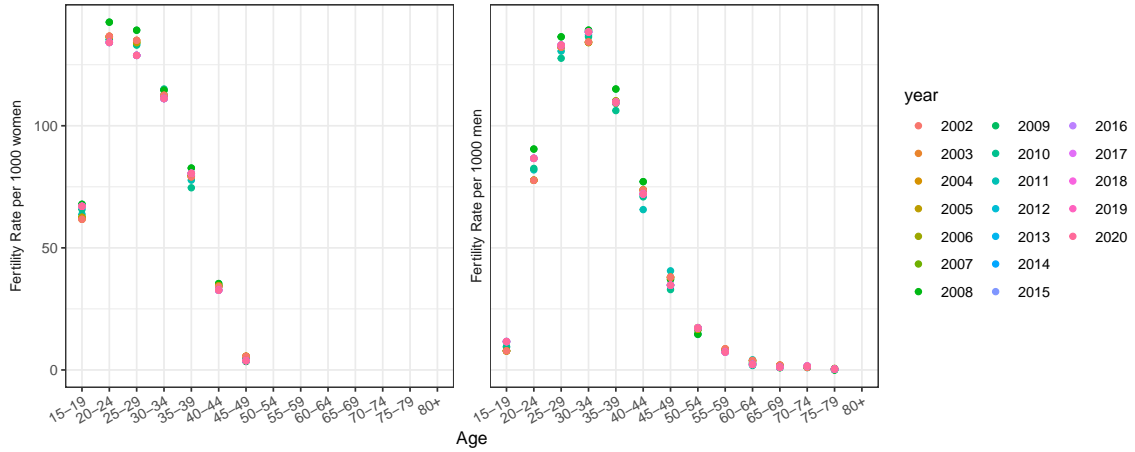


Figure 42: Fertility rates for parents by age and sex in Peru.

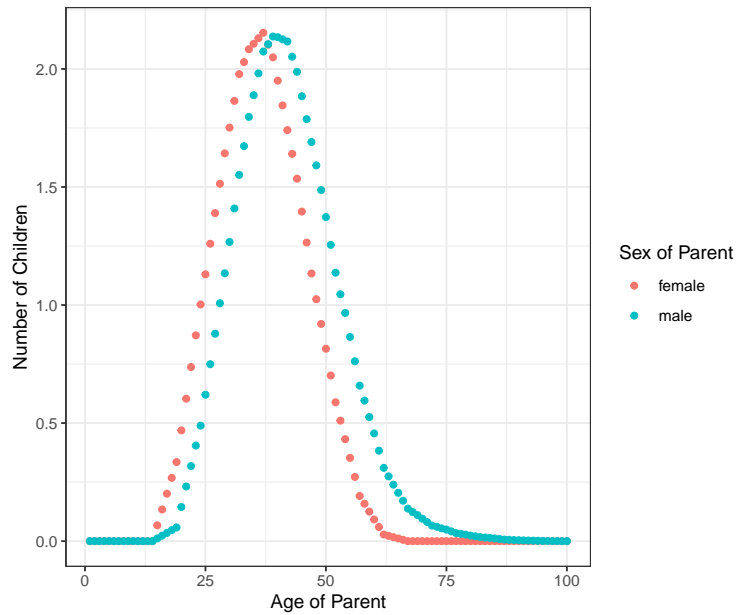


Figure 43: Average number of children born to women and men of different ages between 2003 and 2020 in Peru.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 47. These are broken down by age in Figure 44. We also estimated the number of children who have lost care from grandparents dying in Table 48 and adjusted for double counting in Table 49.

Age	Sex	COVID19 deaths	Orphans
20-49	Female	2456	3844
	Male	5494	9673
50-69	Female	8744	1472
	Male	18426	9585
70+	Female	9535	0
	Male	16416	595
Total	Female	20735	5316
	Male	40336	19853

Table 47: The number of orphans and COVID-19 deaths for Peru up to 30 April 2021 from male and female parents of different ages.

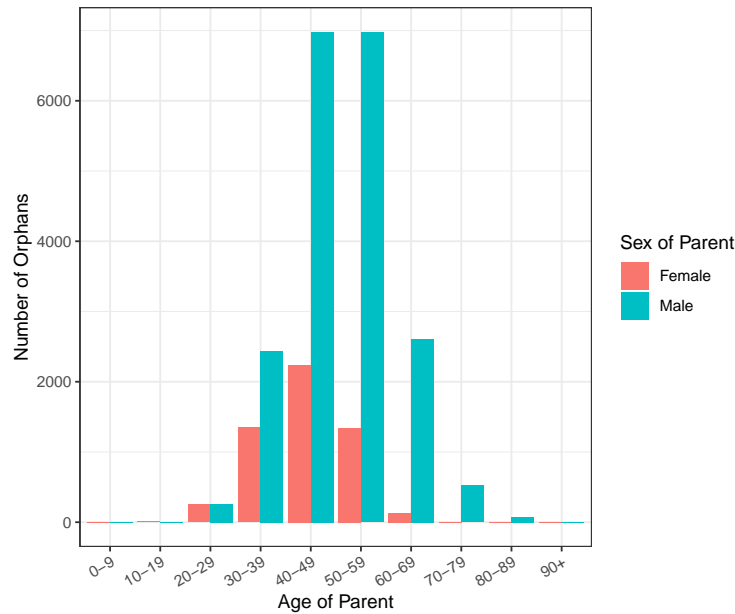


Figure 44: The estimated number of orphans who lost mothers and fathers from different age groups in Peru up to 30 April 2021.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	12440	5.5	684	34.7	3836
60-84	Male	23815	4.3	1024	37.8	8023

Table 48: The estimated number of children who have lost care from male or female grandparents in Peru up to 30 April 2021 from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
5312	19849	4	679	1019	5	26868	3168	7012	26	37074

Table 49: The estimated number of children who have lost care in Peru up to 30 April 2021.

Peru recorded 36322 excess deaths until 30 June, which corresponded to 9860 confirmed COVID-19 deaths in the country [49]. We therefore multiplied our deaths by 3.68 to better estimate the number of orphans, see Table 50.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
19568	73119	15	2501	3754	18	98975	11670	25831	96	136572

Table 50: The adjusted estimated number of children who have lost care in Peru up to 30 April 2021.

3.15 Philippines

The age-sex-specific COVID-19 deaths in the Philippines were collected from the Philippines Ministry of Health [50] until 30 April 2021. We use the yearly female fertility rates from IHME [11] and compute the male fertility rates via the annual live births from UNSD [7] and the population from [14]. The fertility rates by five-age groups and sex are shown in Figure 45 and the average number of children under 18 years of age born to parents of different ages in 2020 is shown in Figure 46.

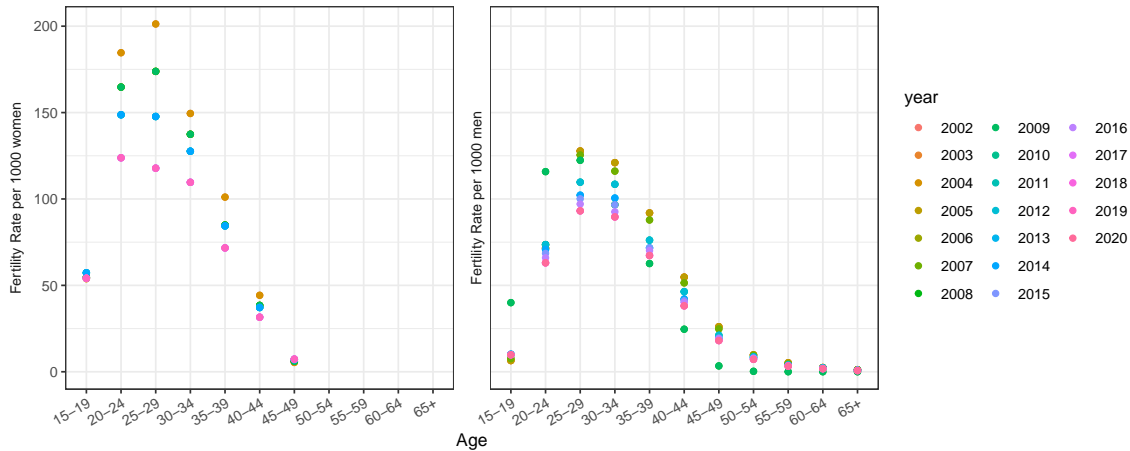


Figure 45: Fertility rates for parents by age and sex in the Philippines.

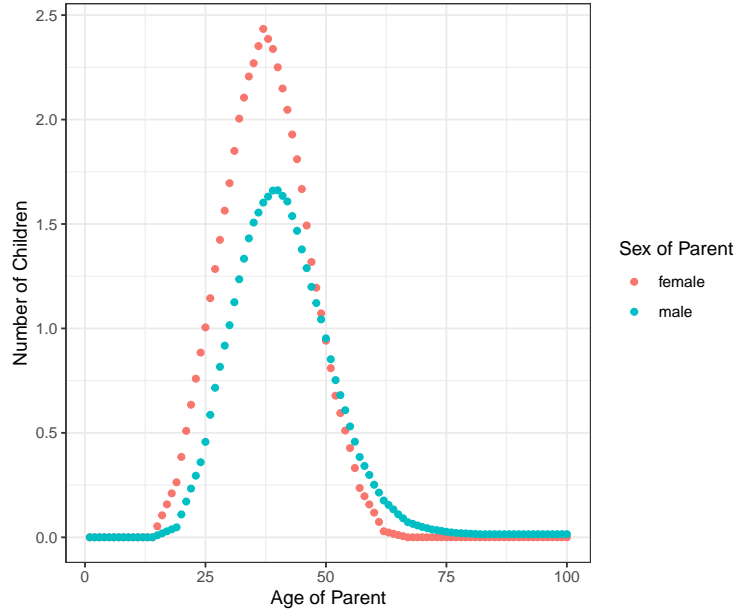


Figure 46: Average number of children born to women and men of different ages between 2003 and 2020 in the Philippines.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 51. These are broken down by age in Figure 47. We also estimated the number of children who have lost care from grandparents dying in Table 52 and adjusted for double counting in Table 53.

Age	Sex	COVID 19 deaths	Orphans
15-44	Female	790	1412
	Male	1236	1554
45-64	Female	2465	1068
	Male	4282	2248
65+	Female	3935	3
	Male	5025	219
Total	Female	7190	2483
	Male	10543	4021

Table 51: The number of orphans and COVID-19 deaths for the Philippines up to 30 April 2021 from male and female parents of different ages.

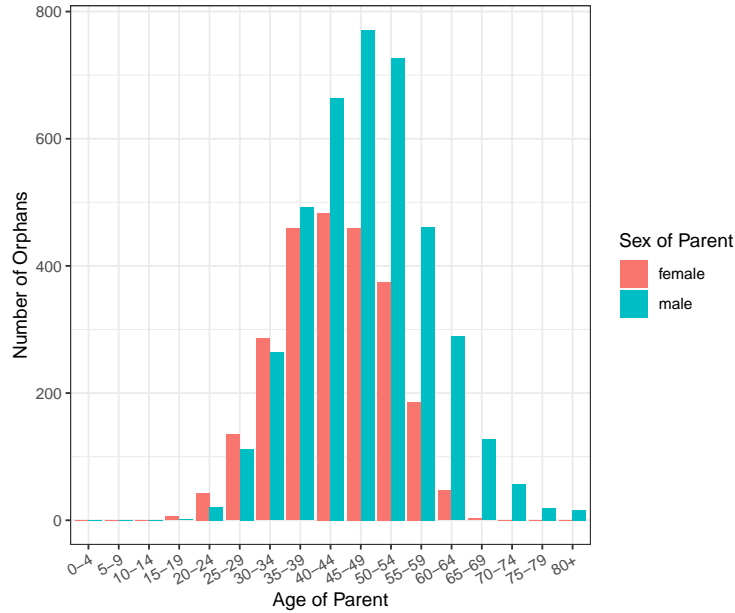


Figure 47: The estimated number of orphans who lost mothers and fathers from different age groups in the Philippines up to 30 April 2021.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	3840	9.1	349	47.6	1627
60-84	Male	5127	7.4	379	49.1	2240

Table 52: The estimated number of children who have lost care from male or female grandparents in the Philippines up to 30 April 2021 from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
2481	4019	2	346	376	3	7227	1292	1873	10	10402

Table 53: The estimated number of children who have lost care in the Philippines up to 30 April 2021.

3.16 Poland

The COVID-19 deaths in Poland is collected until 9 October 2020 [51] and adjusted up to 30 April 2021 using the total number of deaths from [5] using the country-specific age and sex ratios. We use the yearly female fertility rates from UNWPP [12] and compute the male fertility rates via the annual live births from UNSD [7] and the population from [14].

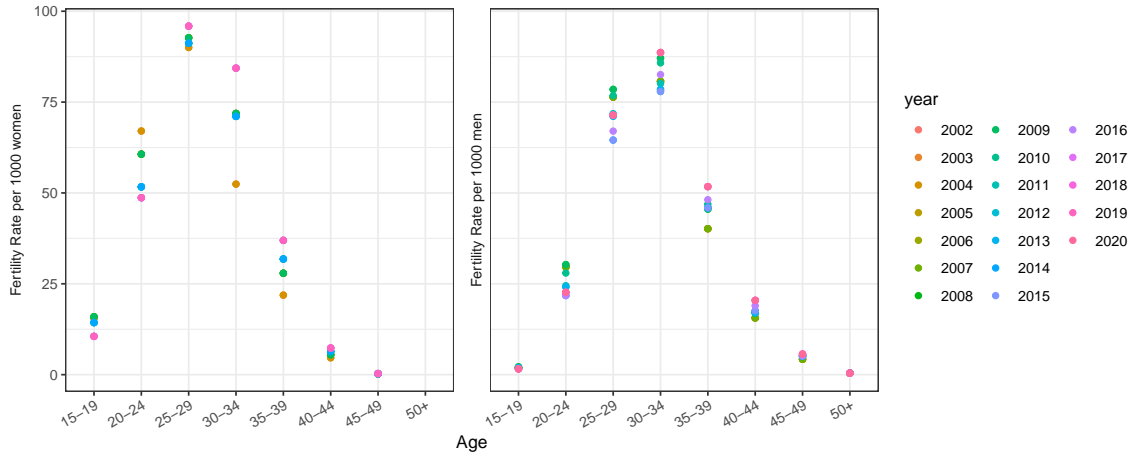


Figure 48: Fertility rates for parents by age and sex in Poland.

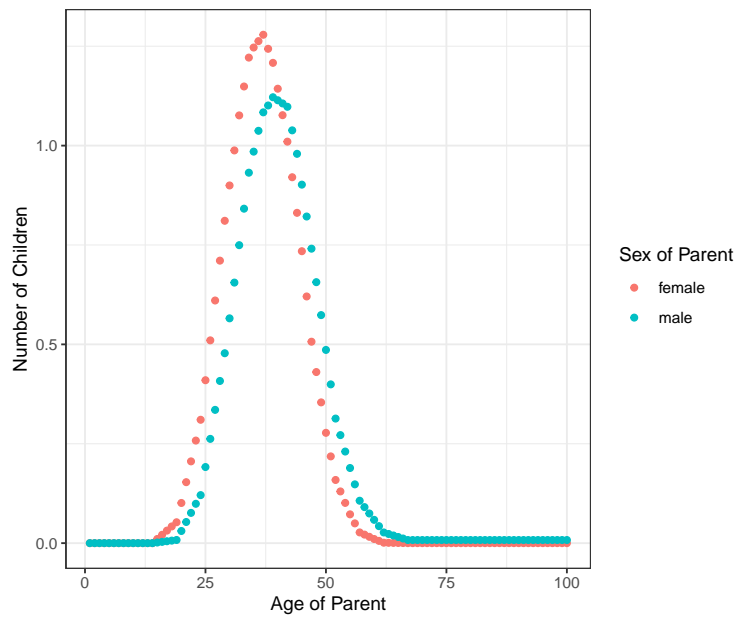


Figure 49: Average number of children born to women and men of different ages between 2003 and 2020 in Poland.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 54. These are broken down by age in Figure 50. We also estimated the number of children who have lost care from grandparents dying in Table 55 and adjust for double counting in Table 56.

Age of parent	Sex of parent	COVID-19 deaths	# Orphans
20-49	Female	855	781
	Male	1364	1217
50-69	Female	5248	161
	Male	11420	808
70+	Female	24019	0
	Male	24550	192
Total	Female	30122	942
	Male	37334	2217

Table 54: The number of orphans and COVID-19 deaths for Poland up to 30 April 2021 from male and female parents of different ages.

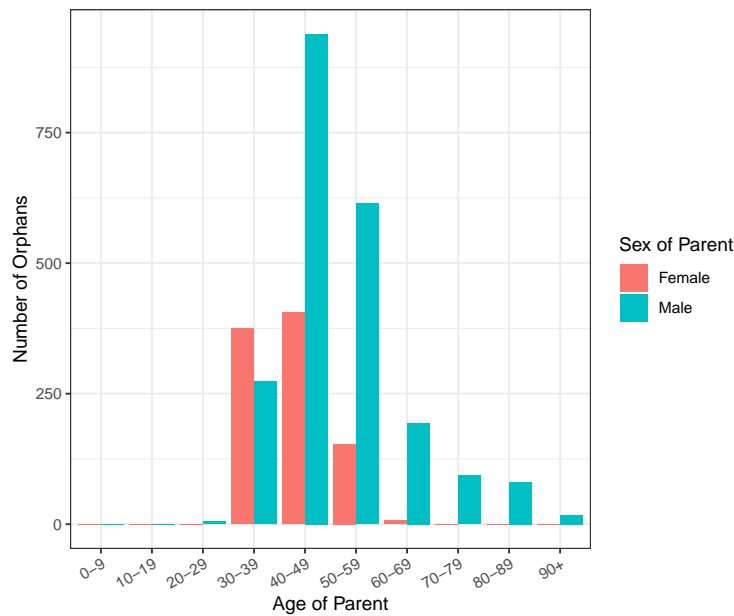


Figure 50: The estimated number of orphans who lost mothers and fathers from different age groups in Poland up to 30 April 2021.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	17121	2.9	497	14.4	2194
60-84	Male	26163	1.7	445	13.8	3225

Table 55: The estimated number of children who have lost care from male or female grandparents in Poland up to 30 April 2021 from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
942	2217	0	493	441	4	4097	1720	2786	14	8617

Table 56: The estimated number of children who have lost care in Poland up to 30 April 2021.

3.17 Russian Federation

For the Russian Federation we only found data on all deaths between March 2020 and February 2021 [52] so we calculated excess deaths by subtracting the mean monthly death between 2015 and 2019. We scaled these by the all cause age-sex specific mortality. We used the number of excess deaths from February to approximate the number of excess deaths in March and April. We used the yearly female fertility rates from UNWPP [12] and compute the male fertility rates via the annual live births from UNSD [7] and the population from [14]. The fertility rates by five-year age groups and sex are shown in Figure 51 and the average number of children under 18 years of age born to parents of different ages in 2020 is shown in Figure 52.

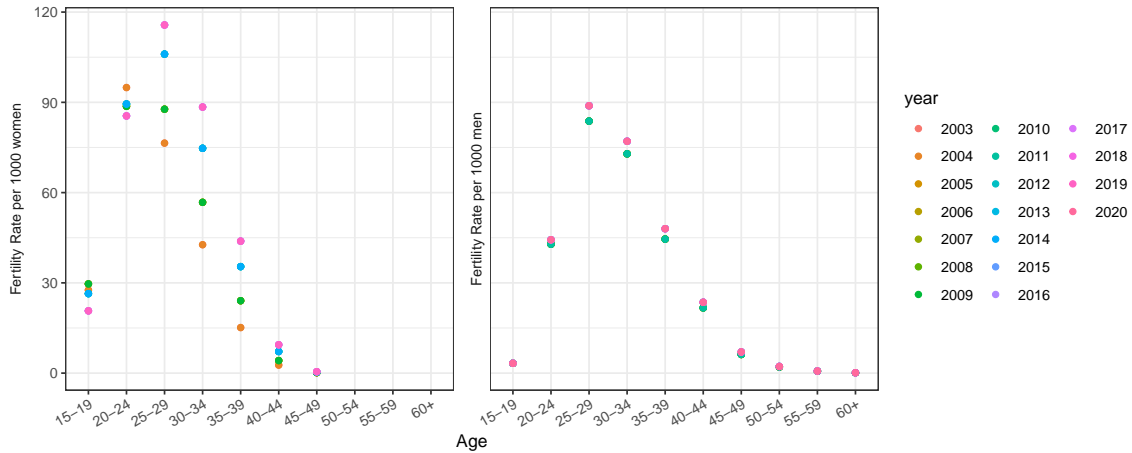


Figure 51: Fertility rates for parents by age and sex in the Russian Federation.

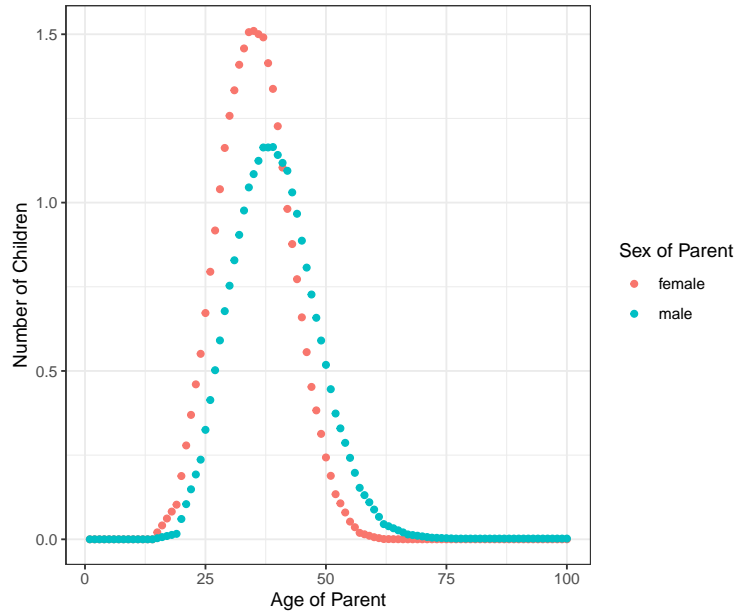


Figure 52: Average number of children born to women and men of different ages between 2003 and 2020 in the Russian Federation.

Table 57 shows the number of orphans from a mother or father dying. This is further disaggregated in Figure 53. We also estimated the number of children who have lost care from grandparents dying in Table 58 and accounted for double counting orphans in Table 59.

Age	Sex	Excess deaths	Orphans
15-44	Female	5064	5654
	Male	5659	5247
45-64	Female	37341	2544
	Male	41726	8034
65+	Female	144092	2
	Male	161014	818
Total	Female	186497	8200
	Male	208399	14099

Table 57: The number of orphans and excess deaths for the Russian Federation from March 2020 to April 2021 from male and female parents of different ages.

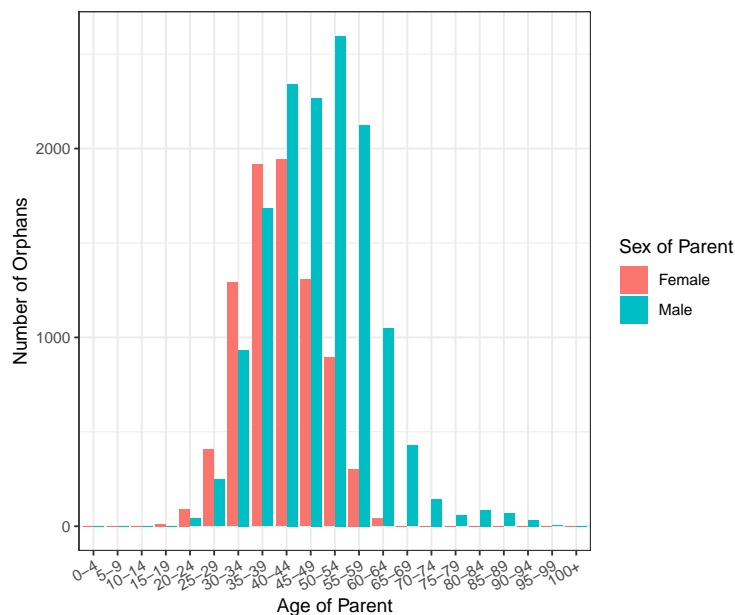


Figure 53: The estimated number of orphans who lost mothers and fathers from different age groups in the Russian Federation using excess death data up to March 2021.

Age	Sex	Excess deaths	Custodial grandparent households		Households with grandparent family member	
			Percentage	Number of children	Percentage	Number children
60-84	Female	118297	3.4	4022	15.4	16161
60-84	Male	132190	2.6	3437	15.0	17647

Table 58: The estimated number of children who have lost care from male or female grandparents in the Russian Federation up to April 2021 from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
8194	14093	6	3994	3409	28	29724	12352	14338	100	56514

Table 59: The estimated number of children who have lost care in the Russian Federation up to April 2021.

3.18 South Africa

The COVID-19 deaths in South Africa was collected from the National Institute for Communicable Diseases [53] from hospitals until 30 April 2021 and scaled to the Johns Hopkins University numbers for the same date [5]. When the sex disaggregation was not provided, we used the sex ratio for the data provided (52% female, 48% male). The fertility rates were derived from DHS program [8], using the own-child method [10]. The fertility rates by five-age groups and sex are shown in Figure 54. This results in the estimated number of children per adult of different ages in Figure 55.

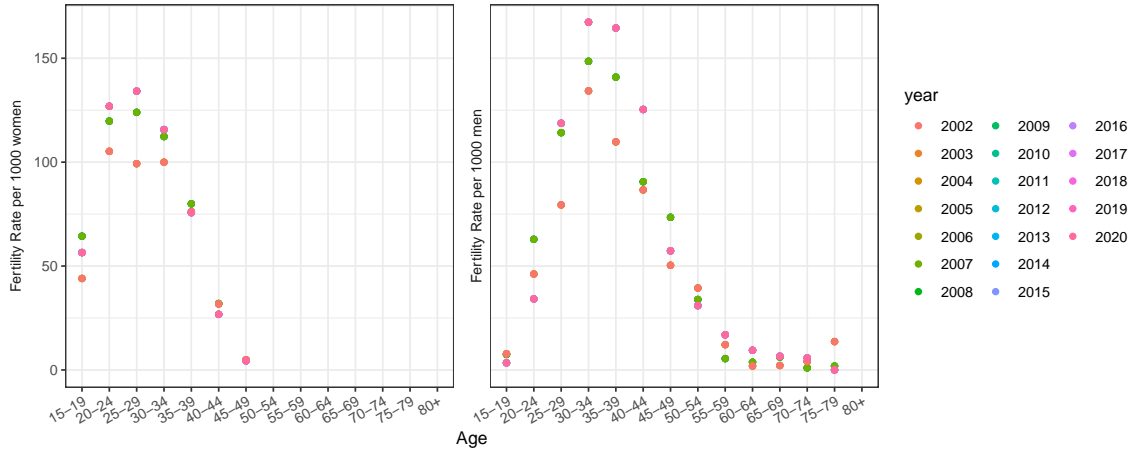


Figure 54: Fertility rates for parents by age and sex in South Africa.

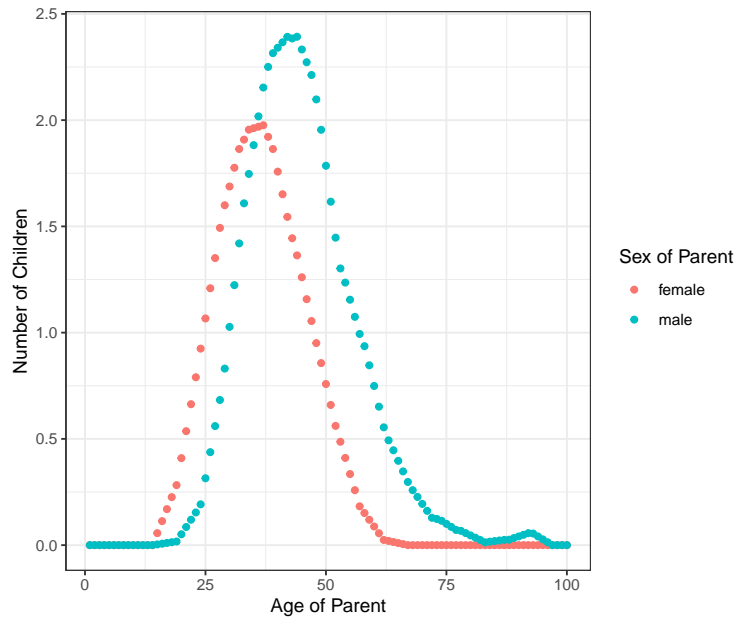


Figure 55: Average number of children born to women/men of different ages between 2003 and 2020 in South Africa.

Table 60 shows the number of orphans from a mother or father dying. This is further disaggregated in Figure 56. We also estimated the number of children who have lost care from grandparents dying in Table 61 and accounted for double counting of orphans in Table 62.

Age	Sex	COVID-19 deaths	Orphans
20-49	Female	4967	7257
	Male	4716	9241
50-69	Female	13611	2451
	Male	13252	10371
70+	Female	9480	0
	Male	7994	666
Total	Female	28058	9708
	Male	25962	20278

Table 60: The number of orphans and COVID-19 deaths for South Africa up to 30 April 2021 from male and female parents of different ages.

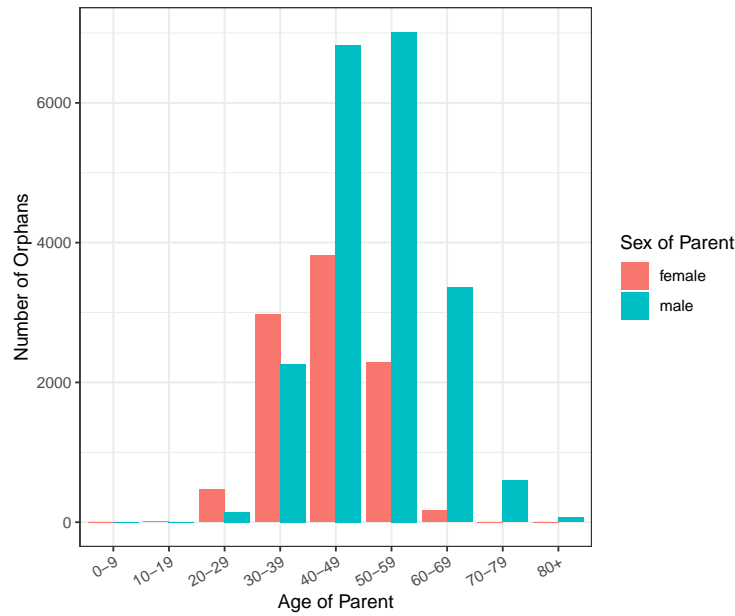


Figure 56: The estimated number of orphans who lost mothers or fathers from different age groups in South Africa using COVID-19 death data

Age	Sex	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			Percentage	Number of children	Percentage	Number children
60-84	Female	15628	19.4	3032	53.4	7427
60-84	Male	14621	9.7	1418	43.2	5615

Table 61: The estimated number of children who have lost care from male or female grandparents in South Africa from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
9702	20272	6	3021	1407	11	34419	4646	4273	35	43373

Table 62: The estimated number of children who have lost care in South Africa.

There was also a noticeable difference between cumulative excess deaths between 6 May 2020 and 5 January 2021 in South Africa [54]. We therefore adjusted our orphans by $(83918/30524 = 2.75)$, the ratio of excess deaths and COVID-19 reported deaths within that time frame, see Table 63.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
26673	55733	16	8305	3868	30	94625	12773	11748	96	119242

Table 63: The adjusted estimated number of children who have lost care in South Africa.

3.19 Spain

For Spain, we extracted COVID-19 attributed deaths by age and sex [55] up to 30 April 2021 and adjusted according to these ratios to match the total in Johns Hopkins University [5], which included some deaths of unknown sex and age. We estimated the age- and sex-specific excess deaths as the difference between the weekly deaths in 2020/2021 and the mean of the past five-year (2015-2019) deaths in the corresponding weeks [34]. The estimated excess deaths by age and sex are as of week 17 2021. We used the yearly female fertility rates from UNWPP [12] and computed the male fertility rates via the annual live births [7] and the population [14] from UNSD. The child mortality also came from UNSD [13].

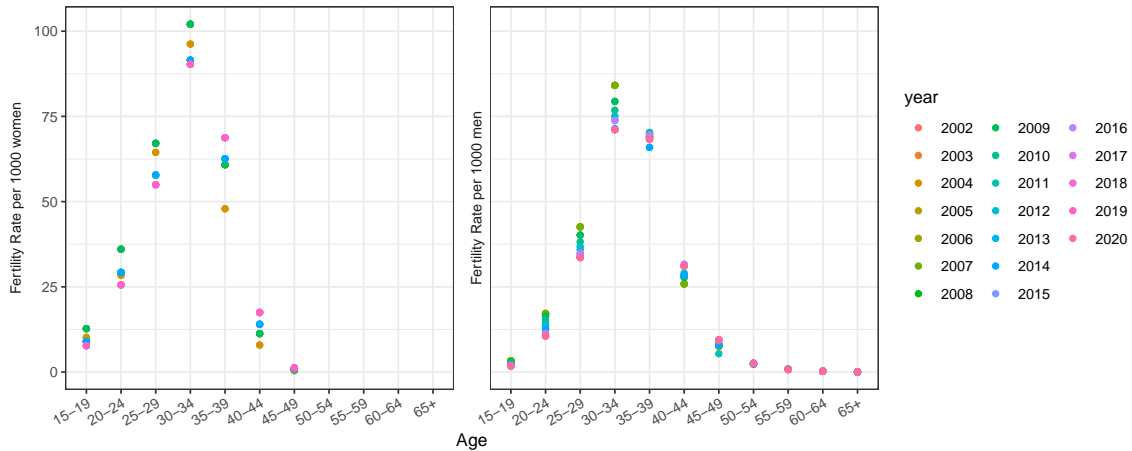


Figure 57: Fertility rates for parents by age and sex in Spain.

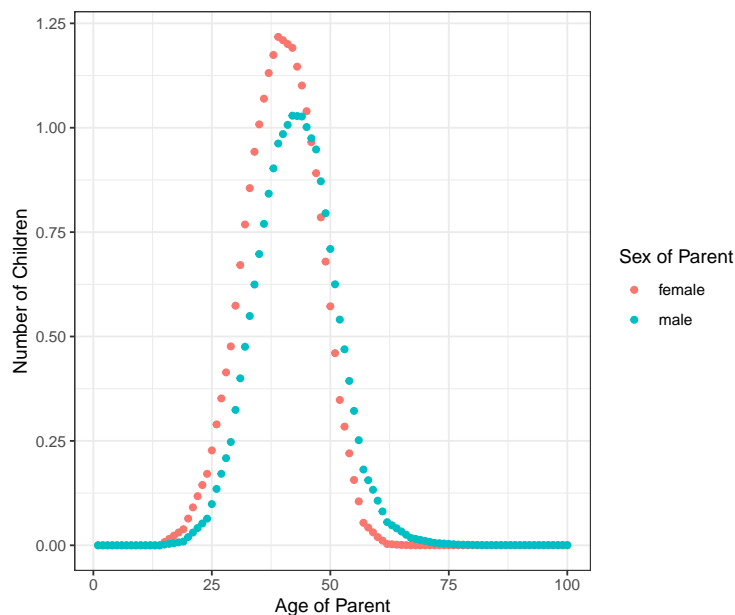


Figure 58: Average number of children born to women/men of different ages in the last 18 years in Spain.

Table 64 shows the number of orphans from a mother or father dying. This is further disaggregated in Figure 59. We also estimated the number of children who have lost care from grandparents dying in Table 65 and account for over-counting in Table 66.

Age	Sex	Excess deaths	COVID-19 deaths	Composite deaths	Orphans
20-49	Female	63	393	393	363
	Male	-178	686	686	579
50-69	Female	4751	2910	4751	255
	Male	8245	7250	8749	1029
70+	Female	38720	31715	38720	0
	Male	43929	35226	43929	84
Total	Female	43534	35018	43864	618
	Male	51996	43162	53364	1692

Table 64: The number of orphans and COVID-19 deaths for Spain up to 30 April 2021 from male and female parents of different ages.

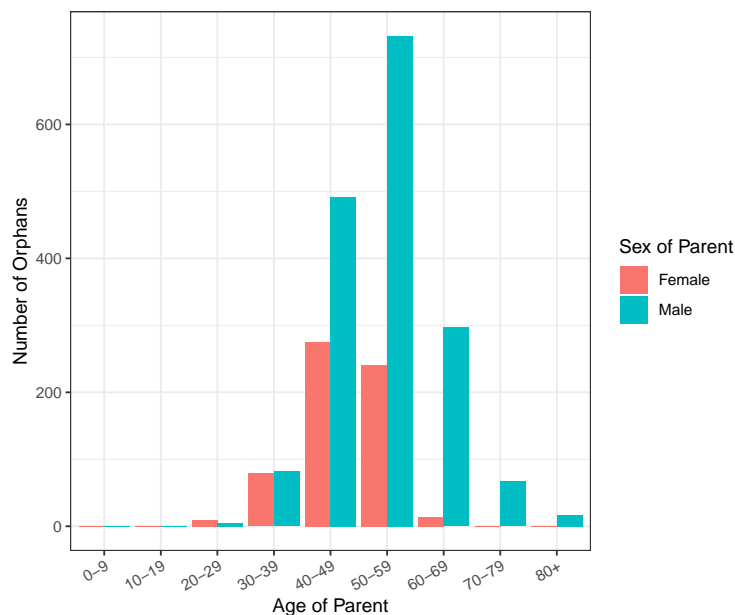


Figure 59: The estimated number of orphans who lost mothers or fathers from different age groups in Spain.

Age of parent	Sex of parent	Composite deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	19315	0.9	174	7.9	1358
60-84	Male	31177	0.6	187	8.35	2317

Table 65: The estimated number of children who have lost care from male or female grandparents in Spain from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
617	1691	1	173	186	1	2669	1181	2119	10	5979

Table 66: The estimated number of children who have lost care in Spain.

3.20 United States of America

For the USA we collated the age- and sex-stratified COVID-19-attributed deaths [56] until 28 April 2021, and adjusted our deaths up to 30 April using the total number of deaths from Johns Hopkins University [5]. The excess deaths are estimated by the difference between the weekly age- and sex-specific total deaths in 2020/2021 and the average weekly total deaths from 2015 to 2019 disaggregated by sex and age [57]. We use the yearly female fertility rates from UNWPP [12] and computed the male fertility rates via the annual live births from UNSD [7] and the population [14] from UNSD. The child mortality also came from UNSD [13].

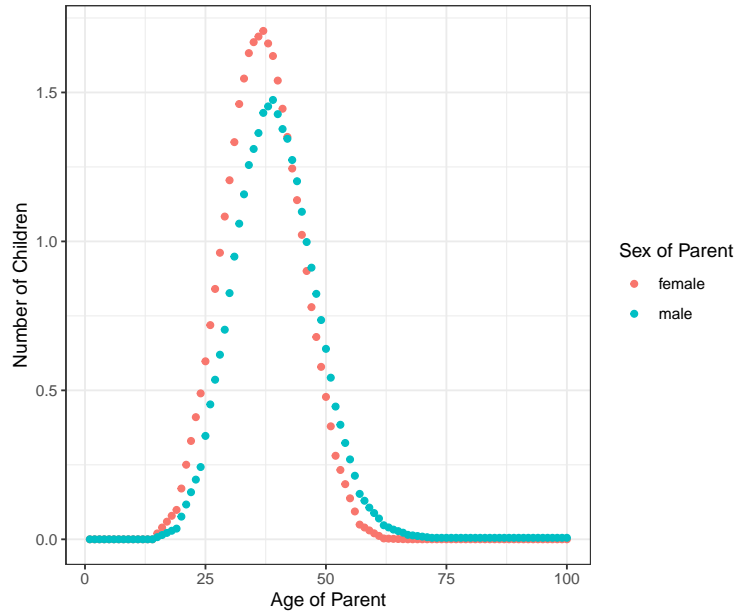


Figure 61: Average number of children born to women and men of different age groups between 2003 and 2020 in the USA.

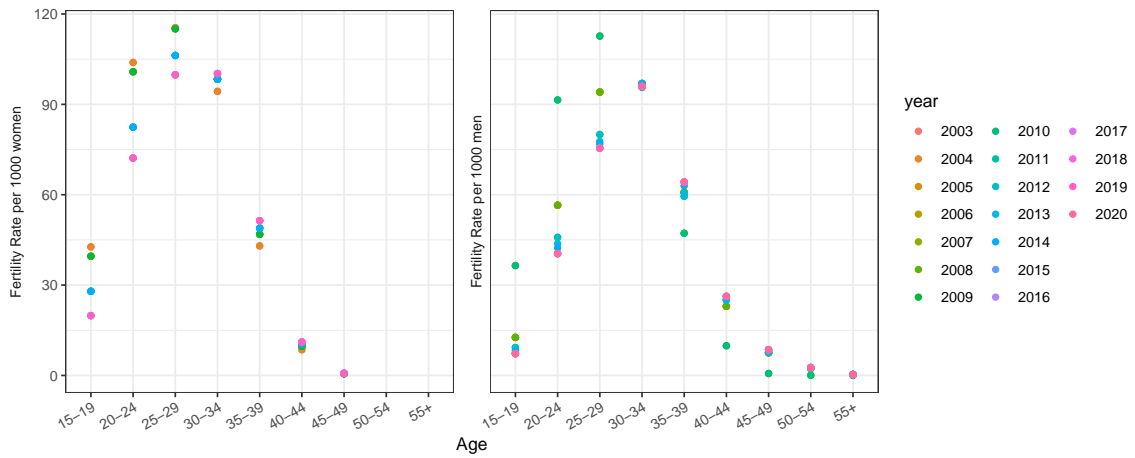


Figure 60: Fertility rates for parents by age and sex in the United States of America.

Table 67 shows the number of orphans from a mother or father dying. This is further disaggregated in Figure 62. We also estimated the number of children who have lost care from grandparents dying in Table 68 and account for over-counting in Table 69.

Age	Sex	Excess deaths	COVID-19 deaths	Composite deaths	Orphans
15-44	Female	17567	5316	17567	22758
	Male	46796	9538	46796	48851
45-64	Female	38368	35329	41178	6469
	Male	90610	64127	90610	24211
65+	Female	260259	219412	275780	12
	Male	337312	242336	337312	2600
Total	Female	316194	260057	334525	29239
	Male	474718	316001	474718	75662

Table 67: The number of orphans and deaths for the USA up to 30 April 2021 from male and female parents of different ages.

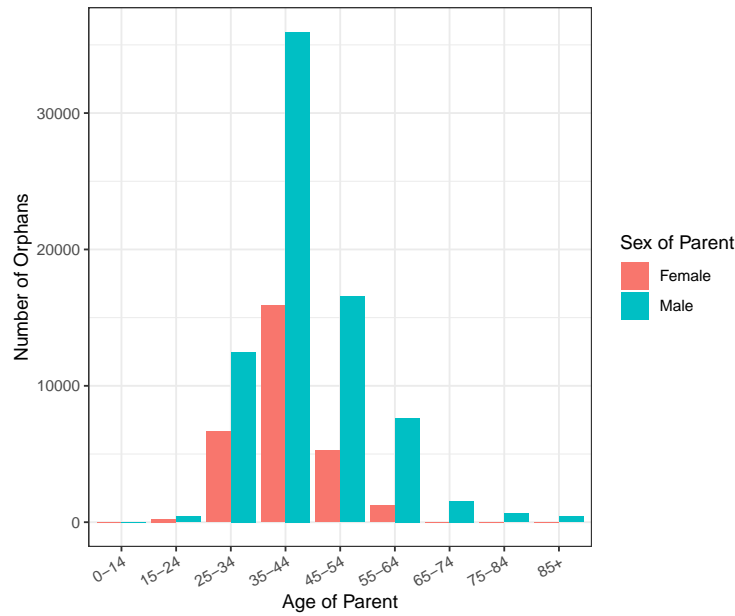


Figure 62: The estimated number of orphans who lost mothers or fathers from different age groups in the USA.

Age of parent	Sex of parent	Composite deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
60-84	Female	191178	2.2	4206	7.45	12676
60-84	Male	290769	1.6	4652	7.15	18503

Table 68: The estimated number of children who have lost care from male or female grandparents in the USA from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
29222	75645	17	4172	4618	34	113708	8770	14143	71	136692

Table 69: The estimated number of children who have lost care in the USA up to 30 April 2021.

3.21 Zimbabwe

We collected COVID-19 deaths [58] up to 14 December 2020 and again updated to 30 April 2021 from Johns Hopkins University [5] using the country-specific age and sex rates. The fertility rates were derived from three DHS surveys [8] in 2005, 2010 and 2015 using the own-child method [10]. The fertility rates by five-age groups and sex are shown in Figure 63 and the average number of children under 18 years of age born to parents of different ages in 2020 is shown in Figure 64.

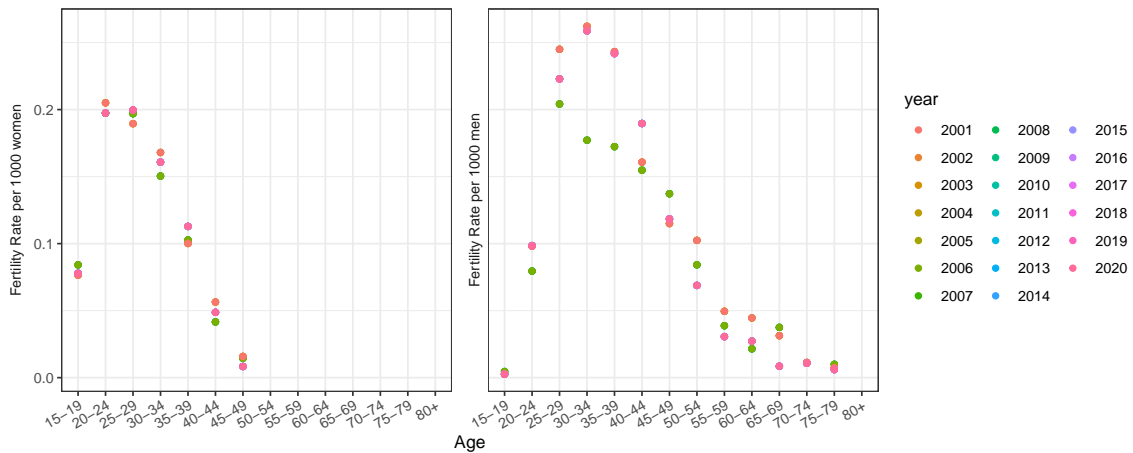


Figure 63: Fertility rates for parents by age and sex in Zimbabwe.

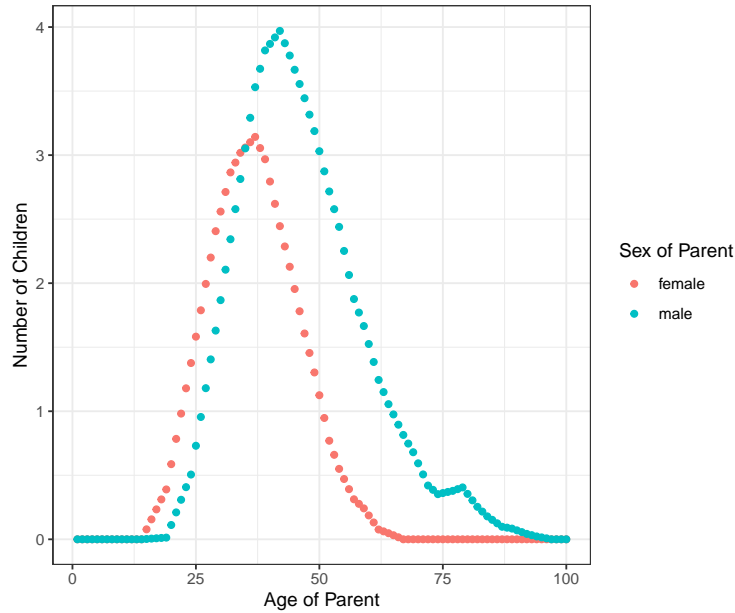


Figure 64: Average number of children born to women and men of different ages between 2003 and 2020 in Zimbabwe.

Using these data, we estimated the number of orphans who lost mothers or fathers separately in Table 70. These are broken down by age in Figure 65. We also estimated the number of children who have lost care from grandparents dying in Table 71 and adjust for double counting in Table 72.

Age	Sex	COVID19 deaths	Orphans
21-50	Female	296	689
	Male	440	1285
51-70	Female	159	57
	Male	327	563
71+	Female	118	0
	Male	196	73
Total	Female	573	746
	Male	963	1921

Table 70: The number of orphans and COVID-19 deaths for Zimbabwe up to 30 April 2021 from male and female parents of different ages.

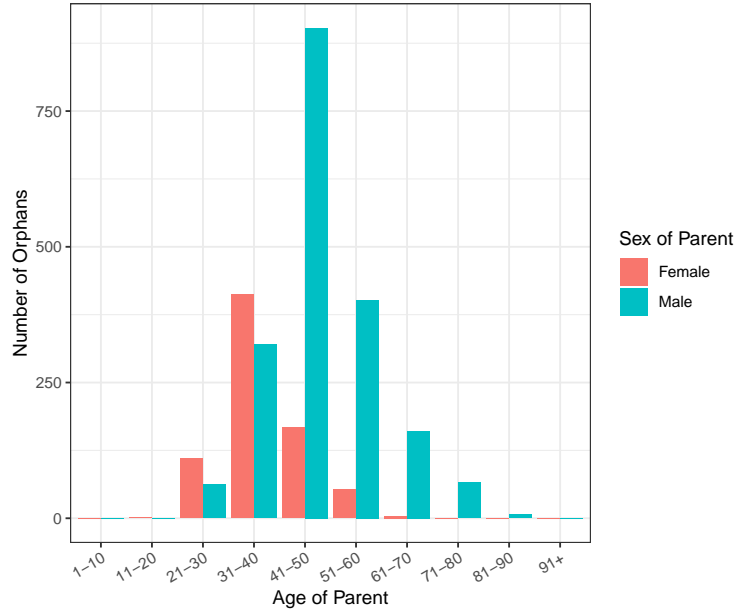


Figure 65: The estimated number of orphans who lost mothers or fathers from different age groups in Zimbabwe.

Age of parent	Sex of parent	COVID-19 deaths	Custodial grandparent households		Households with grandparent family member	
			% households	# children	% households	# children
61-85	Female	165	33.5	55	71.9	105
61-85	Male	338	22.4	76	67.6	204

Table 71: The estimated number of children who have lost care from male or female grandparents in Zimbabwe from two categories: custodial grandparent households and the households with at least one older person and a child under 18.

Parents			Custodial grandparent households			Lost primary caregiver	Households with grandparent family member			Lost primary & secondary caregiver
Female	Male	Both	Female	Male	Both		Only Female	Only Male	Only both	
746	1921	0	55	76	0	2798	55	134	0	2987

Table 72: The estimated number of children who have lost care in Zimbabwe.

4 Global extrapolation

We fit our logistic model to all countries in our study excluding I.R. Iran because we did not have male fertility data. As seen in Figure 66, we get a very good fit between our model and data for orphanhood, primary caregiver loss (orphanhood and the loss of a custodial grandparent caregiver) and primary and/or secondary caregivers. Our estimate for I.R. Iran is only slightly different from the fitted estimate, which further validates our choice of male fertility estimates.

Using the fits in Figure 66A, C, and E we estimated a minimum number of children orphaned due to the COVID-19 pandemic to be 1.04 million [95% CIs 0.80 - 1.09 million], children orphaned or losing primary

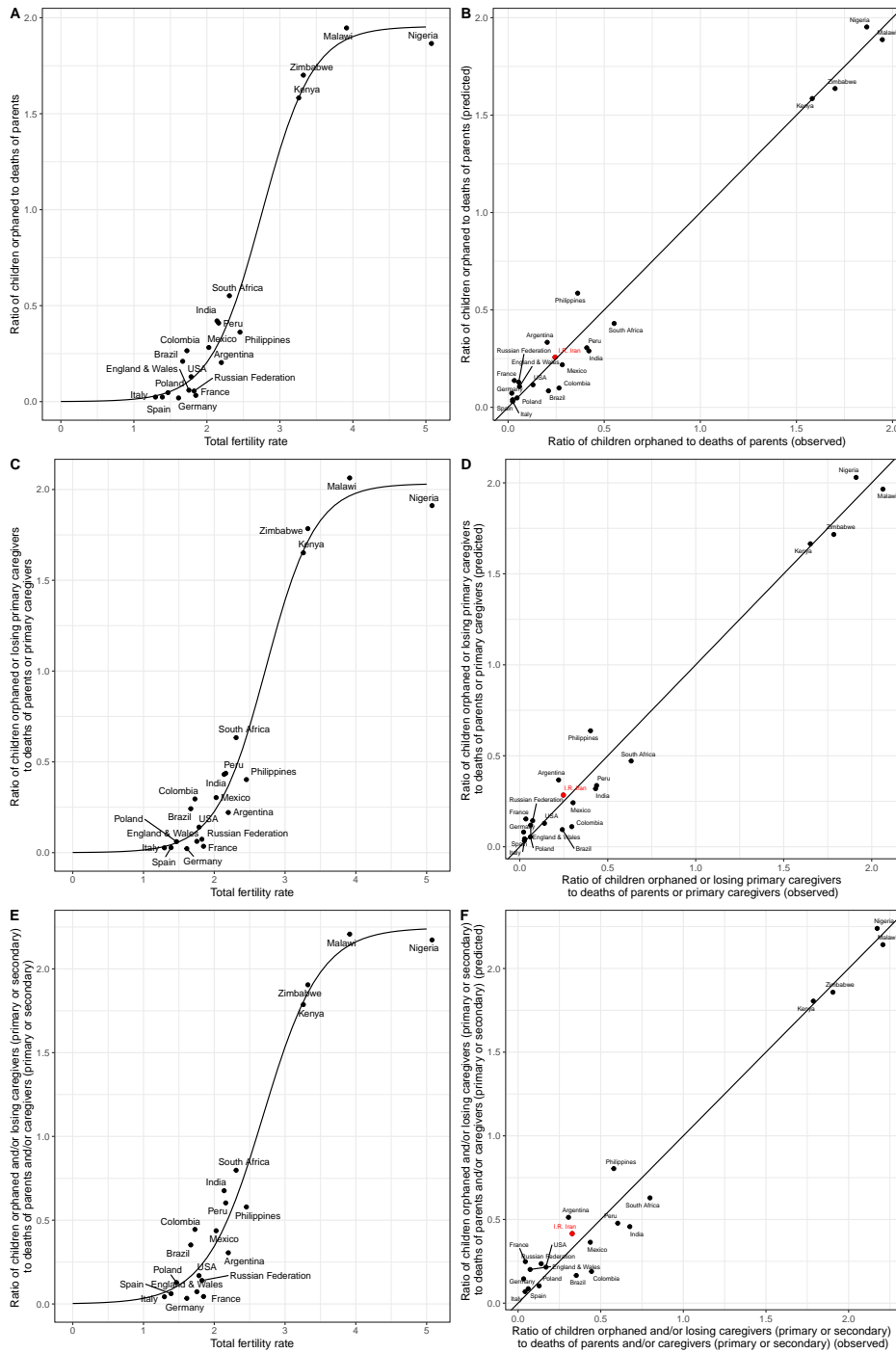


Figure 66: Logistic fit for total fertility rate (TFR) against ratio of orphans to deaths for our study countries. Panel A shows the TFR against our observed ratio of children orphaned to death of parent and panel B shows our observed ratio against our predicted ratio. Panel C shows the TFR against our observed ratio of children orphaned or losing primary caregivers (custodial grandparents) to death of caregivers and panel D shows our observed ratio against our predicted ratio. Panel E shows the TRF against the ratio of children orphaned and/or losing caregivers (primary or secondary) to deaths of parents and/or caregivers (primary or secondary) and panel F shows our observed ratio against our predicted ratio. I.R. Iran is shown in red because we do not include it in our fits but have included it in our study.

caregivers (custodial grandparents grandparents) due to the COVID-19 pandemic to be 1.13 million [95% CIs 0.88 - 1.19 million] and children orphaned and/or losing primary or secondary caregivers to be 1.56 million [95% CIs 1.29 - 1.69]. Country-specific estimates, grouped by WHO regions, are given in Table 73. Here our uncertainty represents uncertainty around our minimum estimates, rather than attempting to account for all sources of error. When we updated our data through March 2021 to April 2021, a rapid escalation in the number of children facing death of caregivers became apparent, see Section 4.4. Our totals through March 2021 are: minimum number of children orphaned due to the COVID-19 pandemic of 0.89 million [95% CIs 0.70 - 0.95 million], children orphaned or losing primary caregivers (custodial grandparents grandparents) due to the COVID-19 pandemic of 0.97 million [95% CIs 0.76 - 1.04 million] and children orphaned and/or losing primary or secondary caregivers of 1.34 million [95% CIs 1.13 - 1.47]. This means that during April 2021, 149,000 children suffered orphanhood. This equates to 0.057 children per second (149,000/2,592,000) or 1 every 17 seconds. 161,000 children suffered the loss of a primary caregiver dying. This equates to 0.062 children per second (161,000/2,592,000) or 1 every 16 seconds. 220,000 children suffered the loss of a primary and/or secondary caregiver dying. This equates to 0.085 children per second (220,000/2,592,000) or 1 every 12 seconds.

Table 73: Minimum estimates of orphanhood, primary caregivers (orphanhood and loss of care from a primary co-habiting grandparent) and primary and/or secondary grandparents at the country level. We display our study estimates for the 21 countries in our study and model estimates with 95% CIs for the other countries. We only show countries included by Johns Hopkins University on April 30 2021.

Country	Estimates of Orphanhood	Estimates of primary caregiver loss	Estimates of primary and/or secondary caregiver loss
Africa			
Algeria	3400 [2200 - 4400]	3600 [2400 - 4700]	4100 [3000 - 5100]
Angola	1200 [1100 - 1200]	1200 [1200 - 1300]	1300 [1300 - 1400]
Benin	190 [100 - 200]	200 [100 - 300]	220 [200 - 300]
Botswana	640 [400 - 900]	680 [400 - 1000]	800 [500 - 1100]
Burkina Faso	310 [300 - 400]	320 [300 - 400]	350 [300 - 400]
Burundi	**	**	**
Cabo Verde	65 [0 - 200]	71 [0 - 200]	100 [0 - 200]
Cameroon	2100 [2100 - 2200]	2200 [2100 - 2300]	2400 [2400 - 2500]
Central African Republic	170 [100 - 200]	180 [100 - 200]	190 [100 - 200]
Chad	330 [300 - 400]	350 [300 - 400]	380 [300 - 400]
Comoros	280 [200 - 300]	290 [200 - 300]	310 [300 - 400]
Congo	280 [200 - 300]	290 [200 - 300]	320 [300 - 400]
Cote d'Ivoire	550 [500 - 600]	580 [500 - 600]	630 [600 - 700]
Democratic Republic of the Congo	1500 [1400 - 1500]	1600 [1500 - 1600]	1700 [1700 - 1800]
Equatorial Guinea	220 [200 - 300]	220 [200 - 300]	240 [200 - 300]
Eritrea	**	**	21 [0 - 100]
Eswatini	710 [400 - 1000]	750 [500 - 1000]	860 [600 - 1100]
Ethiopia	6900 [6500 - 7100]	7200 [6800 - 7400]	7800 [7400 - 8100]
Gabon	260 [200 - 300]	270 [200 - 300]	290 [200 - 300]
Gambia (Republic of The)	340 [300 - 400]	350 [300 - 400]	390 [300 - 400]
Ghana	1400 [1300 - 1500]	1500 [1300 - 1600]	1600 [1500 - 1700]
Guinea	280 [200 - 300]	290 [200 - 300]	320 [300 - 400]
Guinea Bissau	130 [100 - 200]	130 [100 - 200]	150 [100 - 200]
Kenya*	4312	4500	4869
Lesotho	400 [200 - 500]	430 [300 - 600]	470 [300 - 600]
Liberia	160 [100 - 200]	170 [100 - 200]	180 [100 - 200]
Madagascar	1200 [1100 - 1300]	1300 [1200 - 1300]	1400 [1300 - 1500]
Malawi*	2233	2367	2532

Mali	950 [900 - 1000]	980 [900 - 1000]	1100 [1000 - 1100]
Mauritania	880 [800 - 900]	920 [900 - 1000]	1000 [900 - 1100]
Mauritius	**	**	**
Mozambique	1600 [1500 - 1600]	1600 [1600 - 1700]	1800 [1700 - 1900]
Namibia	970 [700 - 1100]	1000 [800 - 1200]	1100 [900 - 1300]
Niger	370 [300 - 400]	390 [300 - 400]	430 [400 - 500]
Nigeria*	3853	3947	4487
Rwanda	620 [500 - 700]	640 [600 - 700]	700 [600 - 800]
Sao Tome and Principe	67 [0 - 100]	70 [0 - 100]	76 [0 - 100]
Senegal	2100 [2100 - 2200]	2200 [2200 - 2300]	2400 [2400 - 2500]
Seychelles	**	**	**
Sierra Leone	150 [100 - 200]	150 [100 - 200]	170 [100 - 200]
South Africa*	82422	94625	119242
South Sudan	220 [200 - 300]	230 [200 - 300]	250 [200 - 300]
Togo	230 [200 - 300]	240 [200 - 300]	270 [200 - 300]
Uganda	660 [600 - 700]	690 [600 - 700]	760 [700 - 800]
United Republic of Tanzania	41 [0 - 100]	42 [0 - 100]	47 [0 - 100]
Zambia	2400 [2300 - 2500]	2500 [2400 - 2600]	2800 [2700 - 2800]
Zimbabwe*	2667	2798	2987
Americas			
Antigua and Barbuda	**	**	**
Argentina*	13003	14117	19504
Bahamas	**	21 [0 - 100]	36 [0 - 100]
Barbados	**	**	**
Belize	110 [0 - 200]	120 [0 - 300]	160 [100 - 300]
Bolivia (Plurinational State of)	9600 [5800 - 14200]	10000 [6300 - 15200]	13000 [8400 - 17100]
Brazil*	113150	130363	189899
Canada	1200 [600 - 2600]	1400 [600 - 2800]	2600 [1400 - 4800]
Chile	1800 [800 - 3500]	2100 [900 - 3900]	3700 [2000 - 6400]
Colombia*	29851	33293	50083
Costa Rica	280 [100 - 600]	320 [100 - 700]	550 [300 - 1000]
Cuba	42 [0 - 100]	47 [0 - 100]	85 [0 - 200]
Dominican Republic	1300 [600 - 2200]	1400 [700 - 2400]	1900 [1100 - 3000]
Ecuador	8300 [4700 - 13600]	9000 [5200 - 14700]	12000 [7700 - 17900]
El Salvador	390 [200 - 800]	430 [200 - 800]	670 [300 - 1200]
Grenada	**	**	**
Guatemala	6600 [4200 - 9000]	7100 [4600 - 9600]	8300 [5800 - 10700]
Guyana	140 [0 - 300]	160 [0 - 300]	210 [100 - 400]
Haiti	250 [100 - 400]	260 [100 - 400]	300 [200 - 400]
Honduras	2300 [1200 - 4000]	2600 [1400 - 4400]	3400 [2000 - 5200]
Jamaica	130 [0 - 300]	140 [0 - 300]	220 [100 - 400]
Mexico*	131325	141132	203549
Nicaragua	73 [0 - 200]	80 [0 - 200]	110 [0 - 200]
Panama	3000 [1600 - 5000]	3300 [1800 - 5400]	4300 [2600 - 6500]
Paraguay	2900 [1500 - 4700]	3100 [1700 - 5000]	4200 [2500 - 6100]
Peru*	92702	98975	136572
Saint Lucia	**	**	**
Saint Vincent and the Grenadines	**	**	**
Suriname	89 [0 - 200]	98 [0 - 200]	130 [0 - 200]
Trinidad and Tobago	**	**	28 [0 - 100]
Uruguay	440 [200 - 900]	490 [200 - 1000]	770 [400 - 1300]

USA*	104884	113708	136692
Venezuela (Bolivarian Republic of)	690 [300 - 1200]	760 [300 - 1300]	1100 [600 - 1700]
Eastern Mediterranean			
Afghanistan	4900 [4700 - 5100]	5100 [4900 - 5300]	5600 [5300 - 5800]
Bahrain	99 [0 - 200]	110 [0 - 300]	180 [0 - 400]
Djibouti	96 [0 - 200]	100 [0 - 200]	130 [0 - 200]
Egypt	20000 [15500 - 22500]	21000 [16500 - 23500]	22000 [18500 - 25500]
I.R. Iran*	40426	40996	54180
Iraq	27000 [23600 - 28400]	28000 [24900 - 29600]	30000 [27000 - 32100]
Jordan	6500 [3900 - 9400]	7000 [4300 - 10100]	8500 [5700 - 11500]
Kuwait	350 [100 - 700]	380 [200 - 800]	570 [300 - 1000]
Lebanon	1600 [800 - 2800]	1700 [900 - 3000]	2600 [1500 - 4100]
Libya	820 [400 - 1400]	910 [400 - 1600]	1300 [700 - 2000]
Morocco	3800 [2000 - 6400]	4100 [2300 - 6900]	5600 [3400 - 8400]
Oman	1500 [900 - 2300]	1700 [1000 - 2400]	2000 [1300 - 2700]
Pakistan	28000 [22800 - 31300]	30000 [24200 - 32700]	32000 [26800 - 35400]
Qatar	52 [0 - 200]	58 [0 - 200]	97 [0 - 200]
Saudi Arabia	2200 [1100 - 3900]	2400 [1200 - 4200]	3400 [2000 - 5400]
Somalia	1400 [1300 - 1400]	1400 [1400 - 1500]	1600 [1500 - 1700]
Sudan	4500 [4400 - 4600]	4700 [4600 - 4800]	5100 [5000 - 5200]
Syrian Arab Republic	1300 [700 - 1900]	1400 [800 - 2000]	1700 [1100 - 2300]
Tunisia	2800 [1400 - 5000]	3100 [1600 - 5400]	4500 [2600 - 7200]
United Arab Emirates	56 [0 - 200]	63 [0 - 200]	130 [0 - 300]
Yemen	2100 [1800 - 2300]	2200 [1900 - 2400]	2400 [2100 - 2600]
Europe			
Albania	140 [0 - 300]	160 [0 - 400]	300 [100 - 600]
Andorra	**	**	**
Armenia	440 [200 - 900]	490 [200 - 1000]	830 [400 - 1500]
Austria	660 [300 - 1400]	740 [300 - 1500]	1300 [700 - 2400]
Azerbaijan	900 [400 - 1700]	1000 [500 - 1900]	1500 [800 - 2600]
Belarus	260 [100 - 500]	290 [100 - 600]	490 [200 - 900]
Belgium	2400 [1200 - 4600]	2700 [1300 - 5000]	4600 [2600 - 7800]
Bosnia and Herzegovina	210 [100 - 500]	230 [100 - 500]	490 [200 - 900]
Bulgaria	1200 [500 - 2400]	1300 [600 - 2600]	2400 [1300 - 4200]
Croatia	290 [100 - 600]	320 [100 - 700]	640 [300 - 1200]
Cyprus	**	**	21 [0 - 100]
Czech Republic	2600 [1200 - 5000]	2900 [1400 - 5500]	5000 [2700 - 8600]
Denmark	280 [100 - 600]	310 [100 - 600]	520 [200 - 900]
England & Wales*	8495	8886	10450
Estonia	89 [0 - 200]	100 [0 - 200]	180 [0 - 400]
Finland	39 [0 - 100]	43 [0 - 100]	84 [0 - 200]
France*	4064	4371	5542
Georgia	870 [400 - 1600]	970 [500 - 1800]	1500 [800 - 2400]
Germany*	1590	1832	2794
Greece	280 [100 - 600]	320 [100 - 700]	660 [300 - 1200]
Hungary	1600 [800 - 3300]	1800 [900 - 3700]	3400 [1800 - 6100]
Iceland	**	**	**
Ireland	570 [200 - 1100]	630 [300 - 1200]	1100 [500 - 1800]
Israel	7800 [5700 - 9700]	8300 [6200 - 10200]	9200 [7200 - 11100]

Italy*	3201	3568	5782
Kazakhstan	2700 [1600 - 3800]	2900 [1800 - 4000]	3400 [2300 - 4500]
Kosovo	91 [0 - 200]	100 [0 - 300]	200 [100 - 400]
Kyrgyzstan	1800 [1100 - 2300]	1900 [1200 - 2400]	2100 [1500 - 2700]
Latvia	220 [100 - 500]	240 [100 - 500]	410 [200 - 800]
Liechtenstein	**	**	**
Lithuania	360 [100 - 700]	400 [200 - 800]	700 [300 - 1200]
Luxembourg	33 [0 - 100]	37 [0 - 100]	73 [0 - 200]
Malta	22 [0 - 100]	25 [0 - 100]	47 [0 - 100]
Monaco	**	**	**
Montenegro	150 [0 - 400]	170 [0 - 400]	290 [100 - 600]
Netherlands	1500 [800 - 2800]	1700 [900 - 3200]	3000 [1700 - 5000]
North Macedonia	230 [100 - 500]	260 [100 - 600]	500 [200 - 900]
Norway	70 [0 - 200]	78 [0 - 200]	130 [0 - 300]
Occupied Palestinian Territory	4000 [2800 - 4900]	4200 [3000 - 5200]	4700 [3500 - 5600]
Poland*	3159	4097	8617
Portugal	590 [200 - 1200]	660 [300 - 1300]	1300 [700 - 2300]
Republic of Moldova	180 [0 - 400]	200 [100 - 500]	420 [200 - 800]
Romania	2200 [1100 - 4500]	2500 [1200 - 5000]	4400 [2500 - 7900]
Russian Federation	22293	29724	56514
San Marino	**	**	**
Scotland & Northern Ireland	1100 [500 - 2000]	1200 [600 - 2200]	2000 [1100 - 3400]
Serbia	270 [100 - 600]	300 [100 - 600]	590 [300 - 1100]
Slovakia	720 [300 - 1500]	800 [400 - 1600]	1500 [800 - 2700]
Slovenia	330 [100 - 700]	370 [100 - 700]	660 [300 - 1200]
Spain*	2309	2669	5979
Sweden	1900 [900 - 3800]	2100 [1000 - 4200]	3500 [1900 - 6100]
Switzerland	660 [300 - 1300]	740 [300 - 1500]	1400 [700 - 2400]
Tajikistan	150 [100 - 200]	160 [100 - 200]	170 [100 - 200]
Turkey	8100 [4100 - 14000]	8900 [4600 - 15400]	14000 [7900 - 21400]
Ukraine	2000 [1000 - 4300]	2300 [1100 - 4700]	4400 [2400 - 8200]
Uzbekistan	280 [100 - 500]	310 [100 - 600]	410 [200 - 700]
South-East Asia			
Bangladesh	1900 [1000 - 3800]	2200 [1100 - 4200]	3400 [1900 - 5900]
Bhutan	**	**	**
India*	116263	119170	186972
Indonesia	16000 [9000 - 26700]	18000 [9900 - 29100]	24000 [15200 - 36600]
Maldives	**	**	**
Myanmar	790 [400 - 1500]	870 [400 - 1600]	1300 [700 - 2100]
Nepal	390 [200 - 800]	440 [200 - 900]	730 [400 - 1300]
Sri Lanka	190 [100 - 400]	210 [100 - 400]	300 [100 - 500]
Thailand	**	**	21 [0 - 100]
Timor-Leste	**	**	**
Western Pacific			
Australia	110 [0 - 300]	120 [0 - 300]	200 [100 - 400]
Brunei Darussalam	**	**	**
Cambodia	48 [0 - 100]	53 [0 - 100]	68 [0 - 100]
China	450 [200 - 900]	500 [200 - 1000]	870 [400 - 1500]
Fiji	**	**	**
Japan	370 [100 - 800]	420 [200 - 900]	830 [400 - 1600]
Malaysia	250 [100 - 500]	280 [100 - 600]	440 [200 - 800]
Mongolia	110 [0 - 200]	120 [0 - 200]	140 [0 - 200]

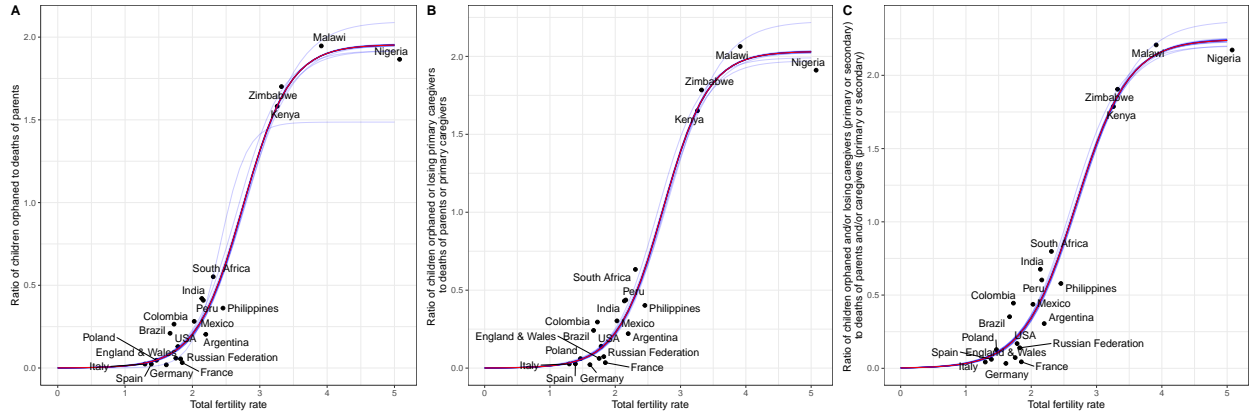


Figure 67: Logistic fit for total fertility rate (TFR) against ratio of orphans to deaths for our leave-one-out analysis. The blue lines show the fits when one country is left out of the fit and the red line shows the fit to all the data. Panel A shows the analysis for the loss of parents, whereas panel B shows the analysis for the loss of primary caregivers and panel C shows the analysis for the loss of both primary and/or secondary caregivers.

New Zealand	**	**	**
Papua New Guinea	180 [100 - 200]	190 [100 - 300]	200 [100 - 300]
Philippines*	6502	7227	10402
Republic of Korea	29 [0 - 100]	33 [0 - 100]	74 [0 - 200]
Singapore	**	**	**
Vanuatu	**	**	**
Viet Nam	**	**	**

* Uncertainty not reported for countries included in study set. ** Not reported due to small numbers.

4.1 Leave one out sensitivity analysis

The central estimates for our leave-one-out analysis for loss of parents only ranges between 1.03 million (when USA is missing) and 1.06 million (when the Philippines is missing), see Figure 67A for the fits obtained. The central estimates for our leave-one-out analysis for primary caregivers gives us a range of estimates between 1.12 million (when South Africa is missing) and 1.15 million (when the Philippines is missing), see Figure 67B for the fits. The central estimates for our leave-one-out analysis for primary and/or secondary caregivers gives us a range of estimates between 1.55 million (when India is missing) and 1.58 million (when the Philippines is missing), see Figure 67C for the fits. This suggests that our outcome is not very dependent on having any one of our countries in the study.

We also investigated the impact of leaving out Argentina, France and Germany where we also made assumptions about the data. This gave us estimates of number of children orphaned due to the COVID-19 pandemic to be 1.09 million [95% CIs 0.91 - 1.20 million], children orphaned or losing primary caregivers (custodial grandparents grandparents) to be 1.18 million [95% CIs 1.00 - 1.32 million] and children orphaned and/or losing primary or secondary caregivers to be 1.64 million [95% CIs 1.48 - 1.89]. Given the high similarity in results between the full model, and this reduced model, it is unlikely that our use of imputed parameters meaningfully biased our extrapolations. In keeping with our aim to present global minimum estimates, we report the full model in the paper.

4.2 Sensitivity to IHME TFR

When we used TFR from IHME instead of the UN World Prospects data, we found our estimates of number of children orphaned due to the COVID-19 pandemic to be 1.01 million [95% CIs 0.79 - 1.03 million], children

orphaned or losing primary caregivers (custodial grandparents) to be 1.10 million [95% CIs 0.88 - 1.14 million] and children orphaned and/or losing primary or secondary caregivers to be 1.53 million [95% CIs 1.32 - 1.62]. This suggests our estimates are robust to differing fertility estimates. We present estimates using UN world Prospects TFR in the paper because they are likely to remain stable over the next several years, allowing us to update the analyses; and use estimates having more information about the upper and lower bounds on fertility.

4.3 Temporal trends

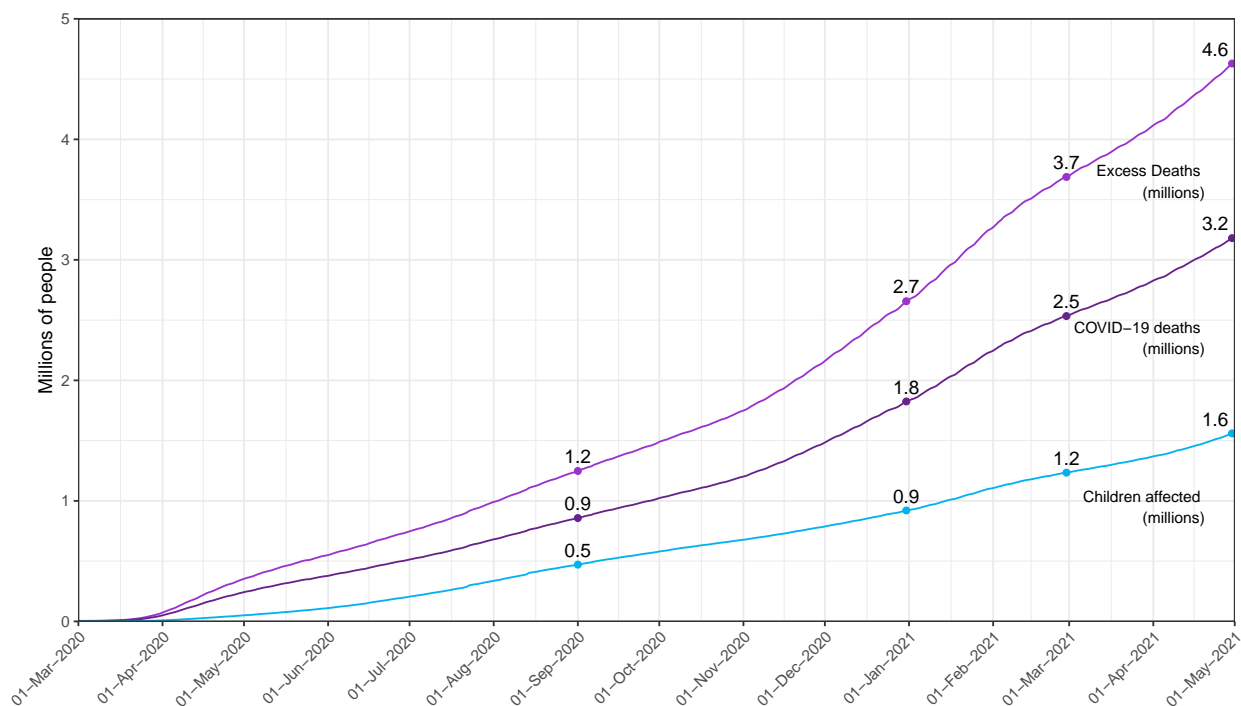


Figure 68: Excess deaths, COVID-19 and orphanhood &/or caregiver loss trends from March 2020 through April 2021. COVID-19 death time series comes from John Hopkins University death data on 15 May 2021 and excess deaths are based on a adjustment factor from the total number of deaths used in our study and the number reported by Johns Hopkins University on the same day.

4.4 Country specific ratios

Table 74: Country specific ratios of children affected by COVID-19-associated orphanhood and loss of caregivers, to COVID-19-associated deaths, calculated during the extrapolation.

Country	Ratio of children orphaned to COVID-19-associated deaths	Ratio of children orphaned or losing primary caregivers to COVID-19-associated deaths	Ratio of children orphaned or losing caregivers (primary or secondary) to COVID-19-associated deaths
Afghanistan	1.87	1.95	2.13
Albania	0.06	0.07	0.12

Algeria	1.03	1.10	1.26
Andorra	0.04	0.04	0.09
Angola	1.95	2.03	2.24
Antigua and Barbuda	0.18	0.20	0.31
Argentina	0.20	0.22	0.31
Armenia	0.11	0.12	0.20
Australia	0.12	0.13	0.22
Austria	0.06	0.07	0.13
Azerbaijan	0.20	0.22	0.34
Bahamas	0.09	0.11	0.18
Bahrain	0.15	0.17	0.27
Bangladesh	0.17	0.19	0.30
Barbados	0.08	0.09	0.16
Belarus	0.10	0.11	0.19
Belgium	0.10	0.11	0.19
Belize	0.33	0.36	0.51
Benin	1.94	2.02	2.22
Bhutan	0.14	0.16	0.26
Bolivia (Plurinational State of)	0.74	0.80	0.97
Bosnia and Herzegovina	0.02	0.03	0.06
Botswana	0.89	0.96	1.12
Brazil	0.21	0.24	0.35
Brunei Darussalam	0.11	0.12	0.20
Bulgaria	0.07	0.08	0.15
Burkina Faso	1.95	2.03	2.23
Burundi	1.95	2.03	2.24
Cabo Verde	0.30	0.33	0.47
Cambodia	0.52	0.56	0.73
Cameroon	1.93	2.01	2.20
Canada	0.05	0.06	0.11
Central African Republic	1.94	2.01	2.21
Chad	1.95	2.03	2.24
Chile	0.07	0.08	0.14
China	0.09	0.10	0.18
Colombia	0.27	0.30	0.44
Comoros	1.89	1.97	2.15
Congo	1.92	2.00	2.19
Costa Rica	0.09	0.10	0.17
Cote d'Ivoire	1.94	2.02	2.21
Croatia	0.04	0.05	0.09
Cuba	0.06	0.07	0.13
Cyprus	0.03	0.03	0.07
Czech Republic	0.09	0.10	0.17
Democratic Republic of the Congo	1.95	2.03	2.24
Denmark	0.11	0.12	0.21
Djibouti	0.67	0.73	0.89
Dominica	0.26	0.29	0.42
Dominican Republic	0.36	0.40	0.55
Ecuador	0.44	0.49	0.64
Egypt	1.46	1.54	1.68
El Salvador	0.18	0.20	0.31
England & Wales	0.06	0.06	0.07

Equatorial Guinea	1.92	2.00	2.19
Eritrea	1.85	1.93	2.10
Estonia	0.08	0.09	0.15
Eswatini	1.05	1.12	1.28
Ethiopia	1.87	1.95	2.12
Fiji	0.84	0.91	1.07
Finland	0.04	0.05	0.09
France	0.03	0.03	0.04
Gabon	1.84	1.92	2.08
Gambia (Republic of The)	1.95	2.03	2.24
Georgia	0.21	0.23	0.36
Germany	0.02	0.02	0.03
Ghana	1.82	1.89	2.05
Greece	0.03	0.03	0.06
Grenada	0.19	0.21	0.33
Guatemala	0.87	0.94	1.10
Guinea	1.94	2.01	2.21
Guinea Bissau	1.92	2.00	2.19
Guyana	0.49	0.54	0.70
Haiti	0.97	1.04	1.20
Honduras	0.44	0.48	0.64
Hungary	0.06	0.07	0.12
I.R. Iran	0.24	0.25	0.33
Iceland	0.10	0.11	0.19
India	0.42	0.43	0.68
Indonesia	0.35	0.39	0.53
Iraq	1.72	1.80	1.95
Ireland	0.12	0.13	0.22
Israel	1.22	1.30	1.45
Italy	0.02	0.03	0.04
Jamaica	0.16	0.18	0.29
Japan	0.04	0.04	0.08
Jordan	0.74	0.80	0.96
Kazakhstan	0.80	0.86	1.03
Kenya	1.58	1.65	1.79
Kosovo	0.04	0.05	0.09
Kuwait	0.22	0.24	0.37
Kyrgyzstan	1.09	1.17	1.32
Lao People's Democratic Republic	0.61	0.67	0.83
Latvia	0.10	0.11	0.19
Lebanon	0.21	0.24	0.36
Lesotho	1.27	1.35	1.49
Liberia	1.91	1.98	2.17
Libya	0.27	0.30	0.44
Liechtenstein	0.06	0.07	0.13
Lithuania	0.09	0.10	0.18
Luxembourg	0.04	0.05	0.09
Madagascar	1.88	1.95	2.13
Malawi	1.95	2.06	2.21
Malaysia	0.17	0.19	0.29
Maldives	0.11	0.13	0.21
Mali	1.95	2.03	2.24

Malta	0.05	0.06	0.11
Marshall Islands	1.15	1.22	1.37
Mauritania	1.93	2.01	2.21
Mauritius	0.03	0.04	0.08
Mexico	0.28	0.30	0.44
Micronesia (Federated States of)	1.15	1.22	1.37
Monaco	0.14	0.15	0.25
Mongolia	0.95	1.02	1.18
Montenegro	0.10	0.11	0.20
Morocco	0.42	0.46	0.62
Mozambique	1.94	2.02	2.22
Myanmar	0.25	0.27	0.40
Namibia	1.50	1.58	1.72
Nepal	0.12	0.13	0.22
Netherlands	0.09	0.10	0.17
New Zealand	0.14	0.15	0.25
Nicaragua	0.40	0.44	0.60
Niger	1.96	2.03	2.25
Nigeria	1.87	1.91	2.17
North Macedonia	0.05	0.05	0.10
Norway	0.09	0.10	0.18
Occupied Palestinian Territory	1.22	1.30	1.45
Oman	0.76	0.82	0.99
Pakistan	1.57	1.65	1.79
Panama	0.49	0.53	0.70
Papua New Guinea	1.68	1.76	1.90
Paraguay	0.45	0.49	0.65
Peru	0.41	0.44	0.60
Philippines	0.36	0.40	0.58
Poland	0.05	0.06	0.13
Portugal	0.03	0.04	0.08
Qatar	0.11	0.13	0.21
Republic of Korea	0.02	0.02	0.04
Republic of Moldova	0.03	0.04	0.07
Romania	0.08	0.09	0.16
Russian Federation	0.06	0.07	0.14
Rwanda	1.84	1.92	2.09
Saint Kitts and Nevis	0.18	0.20	0.31
Saint Lucia	0.04	0.04	0.08
Saint Vincent and the Grenadines	0.12	0.14	0.23
Samoa	1.83	1.91	2.07
San Marino	0.03	0.03	0.07
Sao Tome and Principe	1.91	1.99	2.18
Saudi Arabia	0.32	0.35	0.49
Scotland & Northern Ireland	0.11	0.12	0.20
Senegal	1.93	2.01	2.21
Serbia	0.04	0.05	0.09
Seychelles	0.46	0.50	0.66
Sierra Leone	1.88	1.95	2.13
Singapore	0.03	0.03	0.06

Slovakia	0.06	0.07	0.13
Slovenia	0.08	0.09	0.15
Solomon Islands	1.92	2.00	2.19
Somalia	1.95	2.03	2.24
South Africa	0.55	0.63	0.80
South Sudan	1.94	2.01	2.21
Spain	0.02	0.03	0.06
Sri Lanka	0.28	0.31	0.45
Sudan	1.92	2.00	2.19
Suriname	0.44	0.48	0.64
Sweden	0.14	0.15	0.25
Switzerland	0.06	0.07	0.13
Syrian Arab Republic	0.83	0.89	1.06
Tajikistan	1.69	1.77	1.92
Thailand	0.05	0.05	0.10
Timor-Leste	1.80	1.88	2.03
Togo	1.91	1.99	2.17
Trinidad and Tobago	0.09	0.10	0.17
Tunisia	0.26	0.29	0.42
Turkey	0.20	0.22	0.34
Uganda	1.94	2.02	2.22
Ukraine	0.04	0.05	0.10
United Arab Emirates	0.04	0.04	0.08
United Republic of Tanzania	1.95	2.02	2.23
Uruguay	0.17	0.19	0.29
USA	0.13	0.14	0.17
Uzbekistan	0.43	0.47	0.63
Vanuatu	1.81	1.88	2.04
Venezuela (Bolivarian Republic of)	0.32	0.35	0.50
Viet Nam	0.21	0.24	0.36
Yemen	1.71	1.79	1.93
Zambia	1.94	2.01	2.21
Zimbabwe	1.70	1.78	1.90

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