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Estimates from 31 countries show the significant impact of COVID-19 excess mortality on the incidence of family bereavement

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Excess mortality associated with the COVID-19 pandemic has led many to experience the loss of family members, with significant negative outcomes. We quantify the extent to which these population-wide rates of kin loss represent a departure from levels expected in the absence of COVID-19 excess mortality and consider which demographic groups are most likely to be affected. Results for biological kin in 31 countries indicate dramatic increases in excess kin loss associated with excess mortality and follow a generational pattern consistent with COVID-19 mortality risk by age. During periods of high excess mortality, the number of younger individuals losing a grandparent increased by up to 845 per 100,000, or 1.2 times expected levels (for individuals aged 30 to 44 y in the United Kingdom in April 2020), while the number of older individuals losing a sibling increased by up to 511 per 100,000 or 1.15 times (for individuals aged 65 y and over in Poland in November 2020). Our monthly multicountry estimates of excess kin loss complement existing point estimates of the number of individuals bereaved by COVID-19 mortality [Verdery et al., *Proc. Natl. Acad. Sci. U.S.A.* 117, 17695–17701 (2020); Kidman et al., *JAMA Pediatr.* 175, 745–746 (2021); Hillis et al., *Lancet* 398, 391–402 (2021)] and highlight the role of heterogeneous excess mortality in shaping country experiences.

COVID-19 | excess mortality | bereavement

As excess mortality associated with the COVID-19 pandemic is better estimated and understood (1, 2), less is known about how this is reflected in kin loss by survivors of the pandemic. The scale of pandemic-associated bereavement is significant. Each US COVID-19 death leaves nine close kin bereaved (3), including 0.078 children aged 0 to 17 y experiencing parental bereavement (4), and the pandemic has resulted in over 1 million new orphans under age 18 y globally as of May 2021 (5). This will have important population health and welfare implications given the known negative consequences of kin loss, including declines in physical and mental health and the loss of social and economic support (6–8). What remains to be better understood, however, is how these increases in population-wide bereavement shape individual-level risks of losing relatives—by how much does the incidence of kin loss increase in periods of high excess mortality, and which demographic groups are likely to be affected? Answering this question is key for better understanding the lived experience of pandemic excess mortality for those who survive it.

In this study, we complement estimates of numbers of bereaved individuals associated with COVID-19 mortality by extending a set of existing demographic microsimulations (9) to consider how pandemic-associated excess mortality affected the number of individuals experiencing losses in their close family networks, across 31 countries, each month between March 2020 and June 2021. Our estimates, which demonstrate a generational pattern of kin loss, show consistent increases across countries in the numbers of younger individuals losing a grandparent, and of older individuals losing a sibling. Moreover, our results highlight the role of heterogeneity in excess mortality and population and kinship structure in shaping levels of family bereavement.

Results

To estimate our outcome measure, termed "excess bereavement," we consider individuals who survive to at least July 2021. Some of these individuals experienced the loss of a certain type of biological relative between March 2020 and June 2021, but would not have in the absence of COVID-19 mortality. Our approach focuses on the average additional losses associated with a COVID-19 excess mortality scenario over those associated with a scenario in which only seasonally adjusted mortality in line with previous years had

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occurred (a counterfactual baseline scenario). We divide the number who lost kin in each month by the total population of survivors (irrespective of their kin availability) and use it to calculate the absolute difference in the number of individuals who experience loss per 100,000 in a given month and age group ($EB_{x,t}$) across the two scenarios. In the case of lower mortality than expected, $EB_{x,t}$ may be negative. This measure, which is comparable across different countries and types of kin, is expressed in Eq. **1**, where N is the number of individuals of either sex in age group x (as of February 2020) who survive to July 2021, with subscripts b, for bereaved, denoting the number who lose kin in a particular month t between March 2020 and June 2021, and 0 denoting the counterfactual case,

$$EB_{x,t} = \left(\frac{N_{b,x,t}}{N_x} - \frac{N_{b,x,t,0}}{N_{x,0}}\right) \times 100{,}000. \qquad [1]$$

In Fig. 1, we plot values of $EB_{x,t}$ for a set of countries with varied mortality experiences associated with COVID-19. As expected, the concentration of COVID-19 excess mortality among older individuals is reflected in accompanying increases in numbers of younger individuals aged 15 to 44 y losing a grandparent, and in numbers of older individuals aged 65 y and above losing a sibling. We report results aggregated across sexes, as values of $EB_{x,t}$ do not differ significantly by sex. Country-specific trends in COVID-19 mortality, such as mortality "waves," are mirrored in trends in excess bereavement. Notable in Fig. 1 are short periods of negative excess bereavement following spikes in excess mortality. This suggests that these spikes may have reflected an acceleration of kin mortality, with deaths occurring sooner than otherwise expected.

Comparing Sweden, which saw high excess mortality early in the pandemic, and Norway, which saw lower mortality than might have been expected, reveals the role of excess mortality in shaping experiences of countries with otherwise very similar age–sex and kinship structures. Sweden saw significant increases in kin loss during the period, while Norway saw very low or negative changes in the number of individuals experiencing bereavement. The similarity in counterfactual rates of loss across not only Sweden and Norway but all countries considered in Fig. 1 further indicates the importance of excess mortality even when considering countries with more varied demographic structures.

Kin loss would have been high for some groups even in the absence of COVID-19 mortality. For example, 711 (SEM of 19 across 100 paired simulations) per 100,000 UK individuals aged 30 to 44 y would have experienced the loss of a grandparent in March 2020 under a baseline scenario. However, very high excess mortality associated with the pandemic resulted in kin loss more than double the baseline levels. For example, by April 2020, over 845 (SEM 31) per 100,000 more individuals in this same group lost a grandparent, 1.2 times higher than the expected baseline of 703 (SEM 21) per 100,000. A comparably large increase in bereavement for older individuals was also observed, with 511 (SEM 15) per 100,000 or 1.15 times more individuals in Poland aged 65+ y losing a sibling in November 2020 than the expected 443 (SEM 8) per 100,000. The scale of loss associated with the pandemic is brought out even more clearly in Fig. 2, which multiplies $EB_{x,t}$ values from Fig. 1 by country populations in 2020 to highlight the large total number of individuals as of July 2021 who may have lost relatives as a result of COVID-19 excess mortality.

Discussion

With estimates showing, in some cases, a doubling of kin loss risks over expected levels, our results help put into context the staggering toll of excess mortality and bereavement associated with COVID-19 and highlight which groups are most likely to be affected. They also highlight the importance of excess mortality in shaping country experiences: The countries in our sample would have had similar population-adjusted projections of kin loss in the absence of COVID-19, but they diverged considerably based on COVID-19 excess mortality.

This similarity of counterfactual kin loss reflects other similarities between countries in our sample, which are high-income countries for which excess mortality data are readily available. We might see different impacts of similar levels of excess mortality

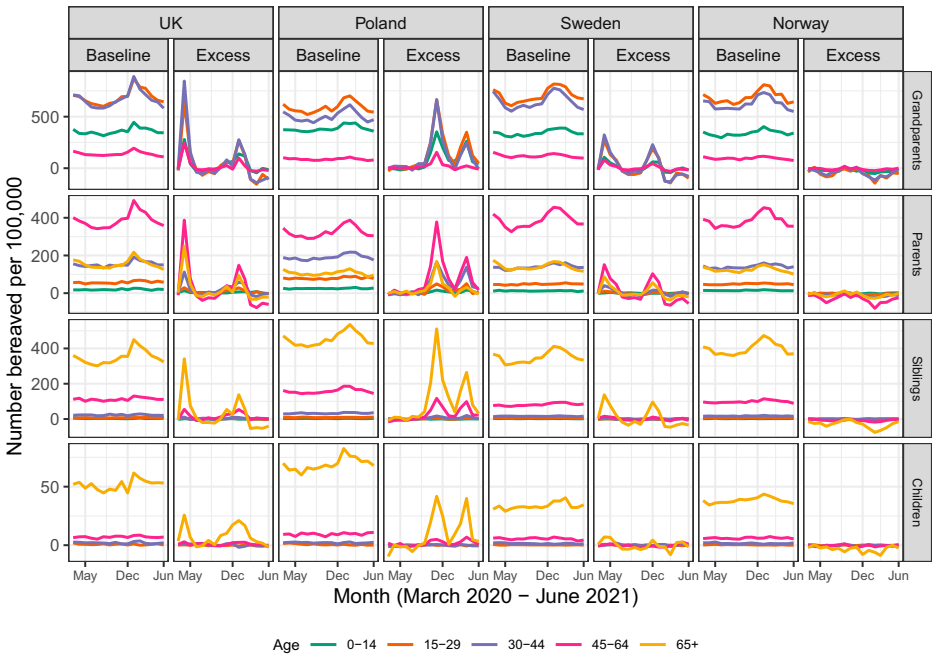

Fig. 1. Estimates of monthly excess bereavement ($EB_{x,t}$) and counterfactual bereavement, in multiple countries, by age of the bereaved individual and type of biological kin. Note the different scales on the *y* axis across panels. Results are shown where more than 1% of the group had a living relative of the type considered in February 2020.

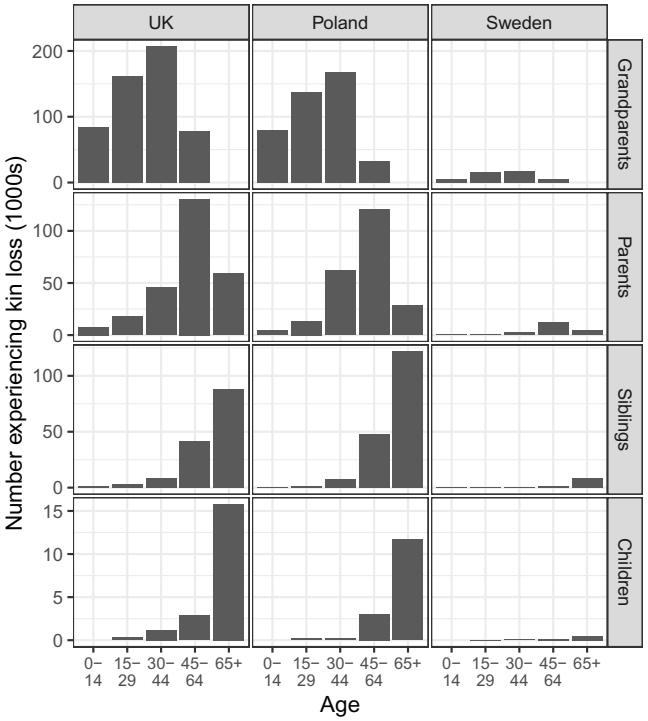

Fig. 2. Number of additional survivors (in thousands) who lost a given relative type. The figure multiplies EB_x values from Fig. 1 by 2020 population estimates from the 2019 Revision of the United Nations World Population Prospects to find the total number of surviving individuals bereaved as a result of COVID-19 excess mortality, as of July 2021; EB_x values are bounded at zero to reflect deaths associated with the pandemic. Note the different scales across panels. Results are shown where more than 1% of the group had a living relative of the type considered in February 2020.

for younger populations with more-varied kinship structures, such as in countries in the Global South. Excess bereavement is not simply a rescaled value of excess mortality. It results from complex interactions between fertility and survival functions over time. Further work is needed to understand how excess mortality and demographic structure shape country-level excess bereavement.

We present a lower-bound estimate, as the pandemic continues to take its toll. Furthermore, the quantities we estimate are averages at the country level; levels of excess bereavement are likely to be considerably higher in hard-hit subnational populations, and among individuals with larger or high-risk families. Our estimates do not account for within-country heterogeneity or clustering of excess mortality within groups or families. However, as with other large-scale public health crises, COVID-19 excess mortality tends to be clustered within population subgroups (10). This means that those who experience the death of a member of their extended family are more likely to face additional loss in their kin network. Future work to assess the extent of clustering of bereavement would be important to inform policies supporting vulnerable individuals.

Our study underlines recent calls for more support to be given to individuals bereaved from COVID-19 (3, 5), whether from their communities or governments. This is particularly urgent if, as recent evidence suggests, grief from COVID-19–associated bereavement is especially detrimental for survivors (11). Our results also identify groups who may lose significant members of their support network as a result of pandemic mortality, such as older individuals who lose a sibling. These losses will reverberate in kin networks for generations to come. More research is needed on the impacts of excess bereavement on survivors, not just in the context of COVID-19, but for mortality crises, past and present, around the world.

Materials and Methods

Our analysis uses SOCSIM, a stochastic microsimulation platform that generates population-level genealogies using vital demographic rates as input (3, 12, 13). Our simulations use, as input, vital rates for the 1950–2035 period from the 2019 Revision of the United Nations World Population Prospects (medium scenario). To identify the effects of COVID-19 mortality on kinship structures, we run 200 microsimulations for each country, half representing a COVID-19 mortality case and the other half representing a counterfactual scenario without excess mortality, with adjustments made using the Human Mortality Database's Short-term Mortality Fluctuations dataset (2).

Some caveats should be noted. We assume zero international migration, and do not include marriage rates; the latter means we consider only biological kin (see *SI Appendix* for more details). We also assume demographic stability before 1950 in our simulations: This is a necessary assumption, since reliable historical demographic data are not available for all countries studied. In *SI Appendix*, we apply formal demographic methods to historical Swedish data and show that the pre-1950 demographic stability assumption is unlikely to significantly affect the number of expected kin after 2015 for the types of kin considered in this paper.

As an additional robustness check, we compared our estimates of COVID-19–associated parental bereavement experienced by children to those in other published estimates (4, 5), and found similarities in magnitude, despite differences in the age groups considered and methods employed.

Data Availability. Dataset and replication files have been deposited in Open Science Framework (https://osf.io/jn2h9/?view_only=ce87de3c2310424da30bb3a520c4f0ce) (14).

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