**Family bereavement due to Covid-19 and its consequences for society: a new approach using formal demographic models and demographic microsimulation**

**Applicants**

Dr., **Diego Alburez-Gutierrez**, Postdoctoral Research Scientist, Max Planck Institute for Demographic Research (Lab of Digital and Computational Demography )

Prof. Dr., **Emilio Zagheni**, Director, Max Planck Institute for Demographic Research

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**In a Nutshell**

Much attention has been given to Covid-19 excess mortality rates, but little is known about how the pandemic will increase the exposure to the death of relatives (parents, grandparents, siblings, etc.) for people around the world. This project will produce the first dataset of excess bereavement attributable to the Covid-19 disease. It is the first attempt to quantify this phenomenon and its wide-ranging implications for society using a set of innovative methods from mathematical demography and computational social science.

**Project Description**

This project will combine existing and future data on Covid-19 excess mortality with pioneering methods from mathematical demography to estimate the global burden of Covid-19 bereavement. We are interested in quantifying the number of people who will suffer the death of a relative (parent, grandparent, great-grandparent, uncle, cousin, nephew, sibling, or child) because of the disease, a phenomenon we call ‘excess bereavement’. Timely and accurate information on how family bereavement affects the population by age and sex can help officials minimize the indirect public health consequences of the pandemic.

**Objectives**

1. Produce the first set of international estimates of family bereavement from Covid-19 using a novel methodology combined with existing data on Covid-19 excess mortality
2. Identify which demographic groups are at a highest risk of losing a relative to Covid-19 in different countries and how this varies by type of relative
3. Explore how family bereavement from Covid-19 will affect the mental health of grieving relatives and how this differs from bereavement from other causes of death

**Innovative aspects of the project**

Initiatives to understand the spread of the Covid-19 disease have focused on tracking excess mortality, number of cases, testing coverage, and government responses to the crisis. No attention has been given to the extent to which the pandemic will result in millions of individuals experiencing the death of a relative. This will be the first attempt to develop a new scientific approach to produce estimates of family bereavement attributable to Covid-19. Our interdisciplinary approach combines demographic methods, data science, and sociological theory to improve our understanding of the indirect effects of mortality crises. Our novel methodolgy can be used to estimate levels of bereavement in other mortality crises worldwide, such as natural disasters, famines, or wars (Alburez-Gutierrez 2019).

**Approach and methodology**

We seek to generalize a set of equations from mathematical demography known as the Goodman, Keyfitz, and Pullum Kinship Equations (Goodman 1974). This will allow us to estimate the potential increase in the probability of experiencing the death of a relative given a set of age-specific Covid-19 mortality rates. We will weight these estimates with data on the age and sex structure of the population to estimate the population-level magnitude of excess bereavement and the age distribution of the bereaved population (’excess' bereavement can be compared to a baseline counter-factual scenario using rates that exclude the excess mortality from Covid-19). We will initially focus on deriving mathematical expressions to model the effect of changes in mortality on the population-level prevalence of bereavement. Our method will be efficiently implemented in the R language for statistical programming. We will use demographic microsimulations to model the effect of the pandemic on complex kinship ties, such as cousins or in-laws by adapting a series of microsimulations developed for a previous project (Mason and Zagheni 2014). As a robustness check, we will compare estimates from the mathematical models and the microsimulations.

Our models will initially be calibrated using data from 13 countries for which monthly data on Covid-19 death rates is already available, and updated on a weekly basis, from the “Short-term Mortality Fluctuations” ([www.mortality.org](http://www.mortality.org)). We will extend our analysis to other countries once reliable data on Covid-19 excess mortality becomes available (the PI is involved in a project to collect Covid-19 excess deaths: <https://github.com/timriffe/covid_age>). The project will produce a range of estimates to reflect the uncertainty inherent in the Covid-19 mortality statistics that are required as input. However, we expect the accuracy of our models to improve as more quality data becomes available.

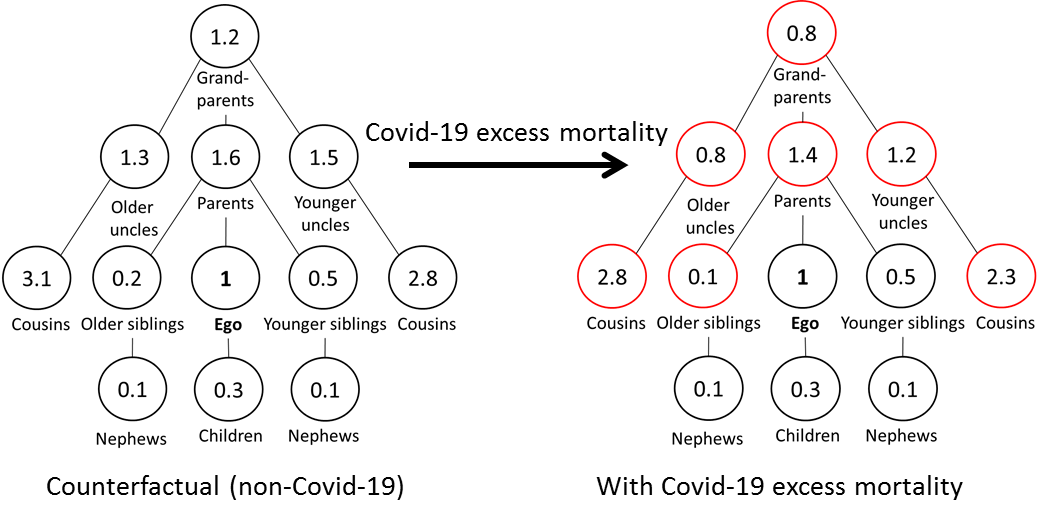


Fig 1. Expected number of living relatives for a man aged 45 (‘Ego’) in a hypothetical population without Covid-19 mortality (left, counterfactual scenario) and with Covid-19 mortality (right, observed values). The sum of the difference between the values in each diagram is the bereavement attributable to Covid-19. In our example, this is .4+.5+.2+.3+.3+.1+.5 = 2.3 ‘extra’ deaths that Ego would not have experienced in the absence of the pandemic. Later on, we obtain population-level estimates of bereavement by including weights in our estimation to represent the real size and structure of the population.

**Work plan**

Stage 1. Methodological Development

1. Derive a methodology to estimate excess bereavement, implement them in the R language, and wrap-up functions in an open-source package
2. Estimate excess bereavement for an initial set of 13 countries using data from the “Short-term Mortality Fluctuations” database
3. Conduct extensive sensibility and robustness checks to validate the results, including hundreds of counterfactuals using demographic microsimulations

Stage 2. Empirical Estimation

1. Extend estimates to other countries as more quality data becomes available
2. Write academic papers to discuss the methodology and substantive results
3. Create digital dashboard for sharing results with the public

**Expected Main Results and Achievements**

1. The first dataset of excess bereavement from Covid-19 by age and sex of the grieving population (in thousands or millions of bereaved individuals by country)
2. A flexible methodology to estimate excess bereavement caused by Covid-19 that can be used to analyze any past or future crisis for which mortality rates are known
3. A set of academic publications in high-impact journals describing the methodology and the main results of the project
4. A online platform for scientists and policy makers to explore and download the data (see this interactive app developed by the Principal Investigator for a previous project: https://research-app.shinyapps.io/child\_death\_paa/)

**Relevance of the topic for society in light of the Corona Pandemic**

Death and bereavement have come to the forefront of public debate as the world grapples with the global pandemic of Covid-19. The infectious disease has already caused the death of hundreds of thousands of mainly elderly people. Each death is meaningful in itself, but it also represents the loss of a parent, grandparent, great-grandparent, aunt, uncle, cousin, or child. Studies in sociology and public health have consistently shown the negative and long-term consequences of bereavement on mental, physical, and emotional health (Umberson et al. 2017). An increased exposure to mortality poses a major societal challenge in the median and long term (Raker, Zacher, and Lowe 2020). Bereavement also matters because relatives are crucial providers of social and financial support, the loss of which affects the individuals left behind (Hendrickson 2009). However, there are currently no international estimates of the number of people who will lose a relative to the Covid-19 disease, in spite of the recognized importance of the problem (Verdery and Smith-Greenaway 2020).

Information on the expected number of bereaved relatives can help policy makers develop appropriate plans for supporting the grieving relatives. Data on the age gradient of bereavement is essential for targeting these programs more effectively. Orphaned children may need a different type of support than widowers or elderly parents who lose a middle-aged child. We expect levels of bereavement to vary by geographic region, reflecting population structure and the spread of the disease. For many people living in the Global North this will be their first close encounter with death, as historically low mortality rates have implied a reduction in the exposure to mortality at all ages in high-income countries (Alburez-Gutierrez, Kolk, and Zagheni 2019). For people in the Global South, it will add to an already high burden of bereavement (Smith-Greenaway and Trinitapoli 2020).

**Relevance of the topic for Science**

Our project will operationalize, for the first time, a set of demographic equations that can be used to estimate the expected number of surviving kin and the number of kin expected to die in the context of dramatic changes in mortality rates. We will make use of the rapid advances in computational power and parallel processing to perform complex estimations, previously thought unfeasible (Goodman 1974).

Substantially, the question of kin survival sits at the very center of demographic theory used for studying human populations. Historical demographers draw liberally on assumptions about kin availability and individual's exposure to the death of relatives to explain human behavior, especially in the context of rapid societal change such as epidemics, but these assumptions are often untested given data scarcity. This project will produce reliable quantitative estimates about the exposure to mortality in the context of a current pandemic. Our novel methodology can be used to understand the prevalence of bereavement in past and future global mortality crises.

**Details on collaboration**

Diego Alburez-Gutierrez, the principal investigator, will lead the project and contribute to the methodological and empirical work, as well as to the write-up of the final papers. Emilio Zagheni will provide methodological supervision and assistance for project management. Ivan Williams (Universidad de Buenos Aires, Argentina), who has ample experience in actuarial and mathematical demography, will lead the formal methodological development. A second research assistant will be hired to conduct the empirical analysis and help produce an open-source implementation of our new method in the R language.

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