Public Health 189 (2020) 101–103

Contents lists available at ScienceDirect

Public Health

journal homepage: www.elsevier.com/locate/puhe

Short Communication

Non–COVID-19 excess deaths by age and gender in the United States during the first three months of the COVID-19 pandemic

S.H. Jacobson [a,*], J.A. Jokela [b]

[a] Department of Computer Science, Carle Illinois School of Medicine, University of Illinois, Urbana, IL 61801, USA
[b] University of Illinois College of Medicine at Urbana, Urbana, IL, 61801, USA

ARTICLE INFO

Article history:
Received 15 August 2020
Received in revised form
5 October 2020
Accepted 7 October 2020
Available online 10 October 2020

Keywords:
Fatality risk
Statistics
COVID-19

ABSTRACT

Objectives: The first three months of the COVID-19 pandemic has disrupted healthcare systems, creating an environment by which deaths have occurred that are not directly due to COVID-19, but have occurred owing to the healthcare and societal environment resulting from COVID-19. The objective of this research is to quantify such excess deaths, partitioned by age group and gender.
Study design: This is a data analysis.
Methods: Excess deaths by age and gender are estimated using provisional death data available from the Centers for disease control and prevention (CDC) over the time period from March 1, 2020 through May 30, 2020. Previous year fatality and population data are used as the benchmark.
Results: Several of the eighteen age and gender cohorts experienced statistically significant excess deaths. The results also indicate that COVID-19 has been protective for one of the age and gender cohorts.
Conclusions: There have been more excess deaths in several age group and gender cohorts during the first three months of the pandemic, beyond direct deaths directly attributable to COVID-19. These non–COVID-19 excess deaths are most apparent in the 25- to 44-year age group for women and 15- to 54-year age group for men. Further research is needed to assess the cause of such excess deaths and introduce safeguards to reduce such deaths in the future.

Introduction

The COVID-19 pandemic has resulted in more than 7 million infections and more than 210,000 deaths in the US. In mid-March, state governments began to close their economies and encouraged citizens to stay home to suppress the spread of the virus. The purpose of such shelter-in-place orders was to better facilitate physical distancing to reduce community virus transmission, blunt the anticipated surge in demand of hospital intensive care unit beds and ventilators and gain time to provide sufficient personal protective equipment for healthcare workers. The preponderance of cases and deaths from mid-March 2020 through mid-June 2020 was in large, densely populated urban areas such as New York City, Chicago and Detroit. This surge mostly sidestepped rural communities during this period, creating an uneven impact of COVID-19 across the nation.

Given the speed at which COVID-19 spread in early March 2020 and the uncertainty of its virulence, the aggressive step of closing the US economy was prudent and widely accepted. Hsiang et al.[1] estimated that without such actions, 4.8 million additional confirmed cases would have occurred in the US alone through May 2020. Using a 5% case fatality rate, this would have translated into 240,000 additional deaths.

Through mid-June, data collected and disseminated by the CDC have demonstrated a clearer picture of which population cohorts are most vulnerable to COVID-19 (such as those older than 65 years and those with underlying health conditions). This has provided a road map for protecting at-risk people while progressing towards reopening communities and local economies. To limit the spread of the virus without shelter-in-place orders, in addition to testing and contact tracing, public health countermeasures of hand hygiene, physical distancing and face coverings provide the best available defences to limit virus transmission and protect the most vulnerable populations.

The CDC disseminates a weekly summary of provisional deaths from all causes and COVID-19 deaths, broken down by age and

* Corresponding author.
E-mail addresses: shj@illinois.edu (S.H. Jacobson), jokela@illinois.edu (J.A. Jokela).

https://doi.org/10.1016/j.puhe.2020.10.004
0033-3506/

Table 1
Average weekly death statistics (female).

Age cohort (years)	2020 total deaths	2020 COVID-19 deaths	2020 non–COVID-19 deaths	Hybrid 2019 deaths	Pooled standard deviation estimator	*P*-value
5–14	37.5	0.2	37.3	45.3	1.7	<0.001*
15–24	166.8	3.8	163.0	155.2	4.4	0.05
25–34	412.5	17.6	394.9	346.7	8.5	<0.001
35–44	673.2	42.4	630.8	561.1	8.8	<0.001
45–54	1345.5	122.0	1223.5	1200.7	22.2	0.16
55–64	3245.2	340.7	2904.5	2823.9	66.9	0.13
65–74	5420.4	662.0	4758.4	4586.1	109.0	0.07
75–84	7706.3	1005.9	6700.4	6506.7	199.0	0.17
85+	12,568.2	1688.5	10,879.7	10,436.8	425.5	0.16

gender.[2] The disruptive social and economic upheavals created by the COVID-19 pandemic have led to excess deaths that are either directly or indirectly attributable to COVID-19. The CDC reports estimates of such excess deaths.[3] This article uses CDC estimates for 2019 deaths as a baseline to estimate excess deaths specified by age and gender cohorts. This analysis provides an alternative perspective by which to estimate excess deaths and the health impact of COVID-19.

Methods

Provisional death data reported by the CDC from March 1, 2020 through May 30, 2020, are used to estimate the mean and standard error of the number of weekly deaths, both from all causes and those attributed to COVID-19 across 18 cohorts, broken down by age and gender (male and female).[2] Label the data from this 13-week period as '2020 weekly deaths'.

Point and standard error estimates for the expected number of deaths per week for each age and gender cohort are computed based on CDC data for 2018 death rates[4] and 2019 United States Census Bureau population estimates,[5] labelled 'hybrid 2019 weekly deaths'. This represents the most recent age-based mortality and population data available, hence can serve as a benchmark for assessing 2020 excess deaths. The standard errors were estimated using the 2018 monthly deaths for each age and gender,[4] the most recent death data available from the CDC.

For each age and gender cohort, a one-sided Student t-test was used to test the null hypothesis that the expected 2020 non–COVID-19 weekly deaths are equal to the expected hybrid 2019 weekly deaths, compared with the alternative hypothesis that it is greater. The 2020 non–COVID-19 weekly death estimates are computed by subtracting 2020 COVID-19 weekly deaths from all 2020 weekly deaths. A pooled standard error estimator for the Student t-test was computed by taking the square root of the sum of the standard error squared for the 2020 non–COVID-19 weekly deaths plus the standard error squared for the 2018 weekly deaths (rescaled used the 2018 monthly deaths).

Results

Table 1 shows estimates for the expected 2020 weekly female deaths, 2020 COVID-19 weekly female deaths, 2020 non–COVID-19 female deaths, 2019 hybrid weekly female deaths, pooled standard error estimator for weekly female deaths and *P*-values for the Student t-test statistic. The data in Table 2 are depicted in a similar manner for males.

The *P*-values create a hierarchy for evaluating excess deaths. An age cohort is labelled 'statistically significant' if the *P*-value is lower than 0.001, indicating strong evidence that the expected 2020 non–COVID-19 weekly deaths are larger than the expected hybrid 2019 weekly deaths. A cohort is labelled 'statistically inconclusive' if the *P*-value is between 0.001 and 0.05, indicating marginal evidence that the expected 2020 non–COVID-19 weekly deaths are more than the expected hybrid 2019 weekly deaths. A cohort is labelled 'statistically insignificant' if the *P*-value is higher than 0.05, indicating weak evidence that the expected 2020 non–COVID-19 weekly deaths are more than the expected hybrid 2019 weekly deaths.

For 17 of the 18 age and gender cohorts, the 2020 non–COVID-19 average weekly deaths are more than the hybrid 2019 average weekly deaths. The one exception is the 5- to 14-year age group for females, which indicates that the 2020 non–COVID-19 average weekly deaths are fewer; hence, COVID-19 was protective for these young girls (P-value < 0.001 labelled with a '*' in Table 1).

For women, two age cohorts (25–34 and 35–44 years) show a statistically significant (P-value < 0.001) increase in expected 2020 non–COVID-19 weekly deaths compared with the hybrid 2019 weekly deaths. For men, four age cohorts (15–24, 25–34, 35–44 and 45–54 years) show a statistically significant increase in expected 2020 non–COVID-19 weekly deaths. Alternatively, for males aged 5–14, 75–84 and ≥85 years and for females aged 15–24,

Table 2
Average weekly death statistics (male).

Age cohort (years)	2020 total deaths	2020 COVID-19 deaths	2020 non–COVID-19 deaths	Hybrid 2019 deaths	Pooled standard deviation estimator	*P*-value
5–14	60.5	0.9	59.5	59.0	2.6	0.41
15–24	477.1	7.4	469.7	418.3	11.7	<0.001
25–34	964.6	40.1	924.5	789.2	23.7	<0.001
35–44	1317.7	106.1	1211.6	995.2	24.4	<0.001
45–54	2335.2	288.3	2046.9	1902.5	35.8	<0.001
55–64	5303.5	672.3	4631.2	4405.7	84.8	0.01
65–74	7626.4	1095.3	6531.1	6206.0	148.9	0.02
75–84	8399.4	1220.5	7178.9	6912.6	205.0	0.11
85+	7827.3	1084.8	6742.5	6610.4	253.3	0.31

45–54, 55–64, 65–74, 75–84 and ≥85 years, the expected 2020 weekly death increases may be explained by COVID-19 because increases in non–COVID-19 deaths were statistically insignificant (*P*-value > 0.05).

Discussion

The data do not explain why there is a statistically significant increase in expected 2020 non–COVID-19 weekly deaths compared with the expected hybrid 2019 weekly deaths. Czeisler et al.[6] discuss delays or avoidance of non–COVID-19 medical care during the pandemic, which could contribute to excess deaths beyond those attributed to COVID-19.

For all but one age and gender cohort, there were more 2020 average weekly deaths than the hybrid 2019 average weekly deaths. One possible explanation for this is that 2019 weekly deaths are not uniformly distributed across the year, which is highly likely. Another explanation is that because the 2020 population has a higher is larger than 2019, there may be more deaths, although this increase is likely to be negligible compared with the actual number of deaths. To overcome these limitations, we used a *P*-value cut-off of 0.001 (rather than 0.05) to assess statistical significance and a cut-off of 0.05 to assess statistical insignificance, whereas all other values in between were classified as statistically inconclusive.

The CDC provides weekly updates of provisional death reports,[2] which continue to be adjusted for the time period from March 1, 2020, through May 30, 2020, as new data become available. Therefore, the values reported in Table 1 will continue to change, albeit slightly as at from the time of the analysis. Because only new deaths are added, this will tend to result in *P*-values getting marginally lower.

The key takeaway from this analysis is that excess deaths across multiple age and gender cohorts occurred beyond what has been attributed to COVID-19. These excess deaths indicate that people across many age and gender cohorts have died unexpectedly. Over the ensuing months, possible explanations for such excess deaths may become more apparent.

Author statements

Acknowledgements

The authors wish to thank two anonymous reviewers for their comments on an earlier version of the article, resulting in a significantly improved manuscript.

Ethical approval

No ethical approval was required for this study. The analysis uses only publicly available data reported in the literature.

Funding

No funding was required for this study. The analysis uses only publicly available data reported in the literature.

Competing interests

The authors declare no conflicts of interest.

Author contributions

Both authors contributed to the ideas that led to the article. S.H.J. contributed to the statistical analysis, the literature review and the manuscript preparation. J.A.J. contributed to the concept and provided background on infectious diseases and public health. S.H.J. wrote the first draft of the article. J.A.J. provided extensive feedback and comments. Both authors read and approved the final version of the manuscript.

References

1. Hsiang S, Allen D, Annan-Phan S, Bell K, Bolliger I, Chong T, et al. The effect of large-scale anti-contagion policies on the COVID-19 pandemic. *Nature* 2020 Aug;**584**(7820):262–7. https://doi.org/10.1038/s41586-020-2404-8.
2. CDC. *Provisional COVID-19 deaths counts by Sex, Age, and week*. Available at, ********data.cdc.gov/NCHS/Provisional-COVID-19-Death-Counts-by-Sex-Age-and-W/vsak-wrfu, 2020. [Accessed 30 September 2020].
3. CDC. *Excess deaths associated with COVID-19*. September 30, 2020. Available at, ***********.cdc.gov/nchs/nvss/vsrr/covid19/excess_deaths.htm; 2020.
4. CDC, 2020. *National Center for Health Statistics. Underlying cause of death 1999-2018 on CDC WONDER online database, released in 2020. Data are from the multiple cause of death files, 1999-2018, as compiled from data provided by the 57 vital statistics jurisdictions through the vital Statistics cooperative program*. Available at, *******wonder.cdc.gov/ucd-icd10.html. [Accessed 30 September 2020].
5. US Census Bureau. *20th century Statistics*. 1999. Available at, https://www.census.gov/prod/99pubs/99statab/sec31.pdf. [Accessed 10 June 2020].
6. Czeisler ME, Marynak K, Clarke KE, et al. Delay or avoidance of medical care because of COVID-19 – related concerns – United States. *MMWR Morbidity Mortality Weekly Report* 2020;**69**:1250–7. June 2020.