

The demographic- and geographic impact of the first major wave of the COVID pandemic in Bulgaria

ANTONI RANGACHEV¹, MLADEN MLADENOV², AND GEORGI K. MARINOV³

¹*Department of Mathematics, University of Chicago, Chicago, IL 60637, USA*

²*XXXXXX*

³*Department of Genetics, Stanford University, Stanford, CA 94305, USA*

Abstract

Background The COVID-19 pandemic followed a unique trajectory in Eastern Europe compared to other heavily affected regions, with most countries there only experiencing a major surge of cases and deaths towards the end of 2020 after a relatively uneventful first half of the year. However, the consequences of that surge have not received as much attention as the situation in Western countries. Bulgaria, even though it has been one of the most heavily affected countries, has been one of those neglected cases.

Methods We use mortality and mobility data **TO BE FILLED WITH PROPER DETAILS**, **STRINGENCY INDEXES**, **Eurostat**, **Official BG sources** to examine the development and impact of the COVID-19 pandemic in Bulgaria.

Results We find an exceptionally high level of excess mortality in Bulgaria relative to other European countries in the second half of 2020. The excess mortality rate (EMR) for 2020 stands at 0.27% of the population, compared to officially registered COVID deaths amounting to 0.11% of it. **PYLLs**. This high excess mortality correlates with insufficient intensity of testing and with delayed imposition of “lockdown” measures. We also find major geographic and demographic disparities within the country, with considerably lower mortality observed in major cities relative to more remote areas, and a striking and largely unique to the country high mortality burden in the working age population, especially females. Analysis of the course of the epidemic revealed time spent at home to be the most predictive mobility measure of the eventual decline in cases and deaths. However, while mobility declined as a result of the imposition of quarantine, it already trended downwards before such measures were introduced, which resulted in a reduction of deaths independent of the effect of restrictions.

Conclusions Large, largely unaccounted for excess mortality is observed as a result of the COVID pandemic in Bulgaria. Early imposition of stringent mobility reducing measures was critical for avoiding an explosion of casualties due to COVID-19, and significant delays in introducing such restrictions caused massive loss of life. **MORE**.

Introduction

The SARS-CoV-2 virus and COVID, the disease it causes^{11–13}, have emerged as the most acute public health emergency in a century. The novel coronavirus spread rapidly before significant efforts at containment were implemented in much of the world, resulting in devastating early outbreaks in the United States and Western Europe starting late February and March of 2020.

Some combination of lockdown measures, imposed in response to surging infections, voluntary changes in behavior, and the onset of the summer season is thought to have caused the major decline in COVID cases in Europe in the summer of 2020. However, winter in the Southern hemisphere, during which large epidemics developed in South Africa and South America, together with well-documented

seasonality of common-cold coronaviruses¹⁰, strongly suggested that a major second wave was to be expected in Europe with the arrival of its winter⁹, which eventually indeed arrived.

During the early months of the pandemic, a dichotomy emerged between countries in Western and Eastern Europe (with the possible exception of Russia). Western Europe was heavily affected – by June 2020 official COVID mortality reached the 600 to 800 death per million (DPM) in countries such as the Spain, Italy, UK, Belgium, France, and Sweden, with excess mortality rates even higher^{4–8}. In contrast, most Eastern European countries registered relatively few deaths, possibly because of much earlier relative to the development of the outbreak implementation of social distancing measures.

This dichotomy has disappeared during the second wave

at the end of 2020, with both countries in Western and Eastern Europe officially registering a large number of COVID-related fatalities, as well as in some cases considerably larger excess mortality. However, the development of the pandemic in Eastern Europe has so far generally received much less attention than that in the West even though multiple countries in the region were heavily affected by it.

Here we analyze the development and impacts of the pandemic over the course in Bulgaria, across demographic groups and the regions of the country, as well as the influence of human mobility changes and government-imposed quarantine measure on the course of the pandemic. We use these analyses to identify correlate factors likely responsible for particularly high unaccounted for excess mortality in certain settings.

Methods

Data on excess mortality

Eurostat, NSI, etc.

Mobility data

XXX

P-score calculation

XXX

Potential Years of Life Lost (PYLL) estimates

XXX

Results

Mortality during the COVID pandemic in Bulgaria

We analyzed overall excess mortality patterns in Bulgaria for the year 2020 and compared it to data for other European Union (EU) countries for the same period. We focus on excess mortality rather than officially registered COVID deaths because limited testing and varying standard for official reporting of COVID deaths can result in large disparities between public figures for COVID-related mortality and the actual burden the disease has imposed on the population⁸. While some of the excess deaths are caused by the collapse of healthcare services during peak moments of COVID waves, when a particularly large discrepancy between official COVID deaths and excess deaths is observed, this is likely mostly due to underreporting of COVID deaths due to insufficient testing and other irregularities.

a couple sentences about data

In total, we estimate that 18,715 lives have been lost in Bulgaria in 2020 in excess of the baseline from previous years. This amounts to an EMR rate of 2,673 death per million (DPM), or $\sim 0.27\%$, for the year and ranks the country as the most highly affected within the EU (Figure

1A; according to P-scores Spain, Poland and Belgium rank higher). COVID mortality is in most countries higher in males and in females², and this is also what is observed in Bulgaria and most other EU countries (Figure 1B-C). For females, a EMR of 2178 DPM is observed (P-score of 18.79), compared to an EMR of 3198 DPM for males (P-score 23.99) across all ages. These estimates are in agreement with other recent analyses of excess mortality^{1,3}

We next examine the impact of the pandemic in terms of PYLLs.

DETAILS – I DON'T HAVE THE NUMBERS FOR THIS

Demographic-specific mortality patterns in Bulgaria

Next, we examine mortality in Bulgaria within the working age population. Due to the well-documented age-related skew of COVID fatalities, we focused on two subgroups of working age individuals – those in the 30-39 and those in the 40-64 age ranges.

We find no elevated mortality in females in the 30-39 age group, while in contrast mortality is elevated in males of the same age bracket, with P-scores of -0.39 and 9.37 , respectively (Figure 3A-C).

In contrast, we find highly elevated excess mortality in both males and females in the 40-64 age group, in which Bulgaria ranks highest in the EU (Figure 3D-F), with P-scores of 21.97 and 19.45 for males and females, respectively. The difference between males and females is remarkable, as, unlike the typical situation, in this group in Bulgaria excess mortality is lower for males than for females. A similar reversal of the usual sex-specific mortality pattern is only also observed in Spain and Estonia within the EU. We discuss the possible explanation for these observations in the subsequent section.

MORE

Regional disparities in COVID pandemic-related mortality in Bulgaria

TO BE WRITTEN – ANTONI

Figure 4

The trajectory of the pandemic in Bulgaria and the effectiveness of implemented pandemic control measures

– cases, testing, lockdown measures, to be written

Figure 5

testing is negatively correlated with mortality?

XXX

Discussion

XXX

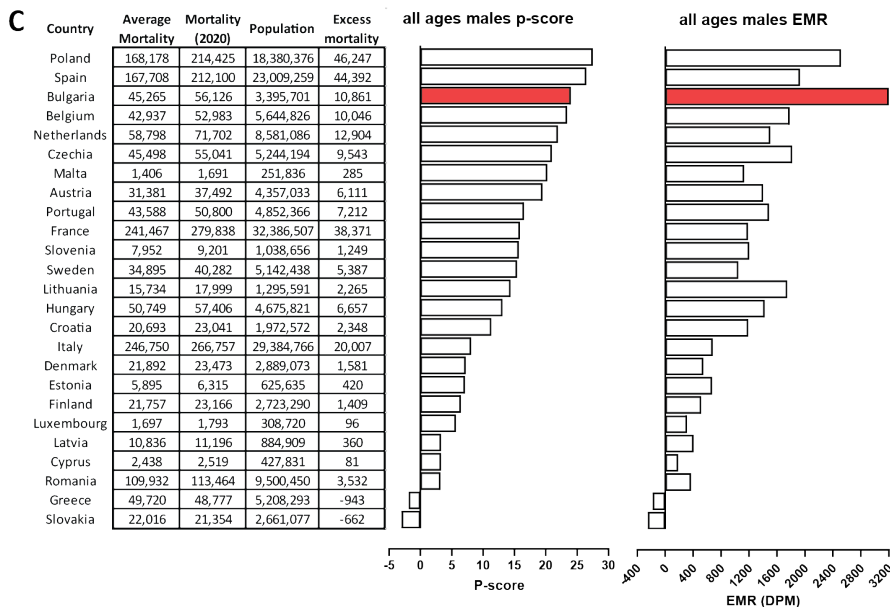
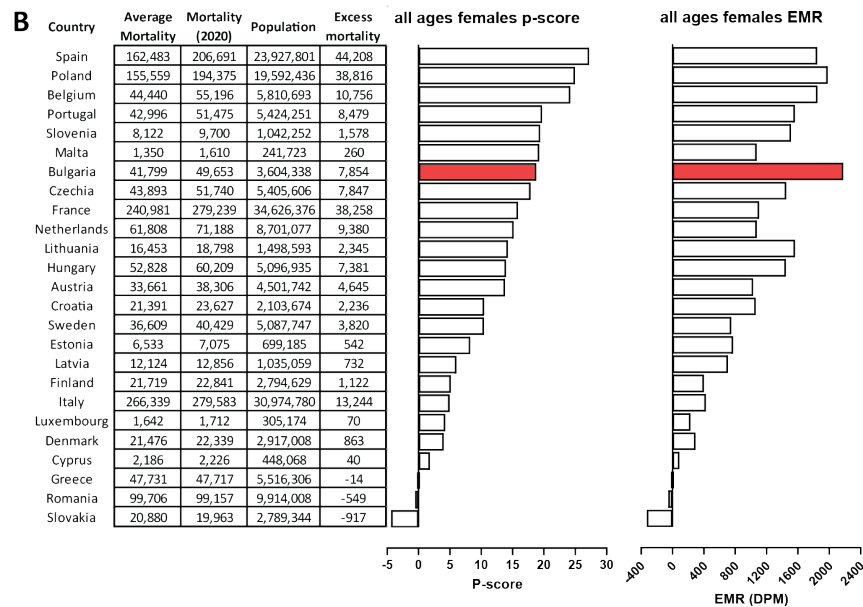
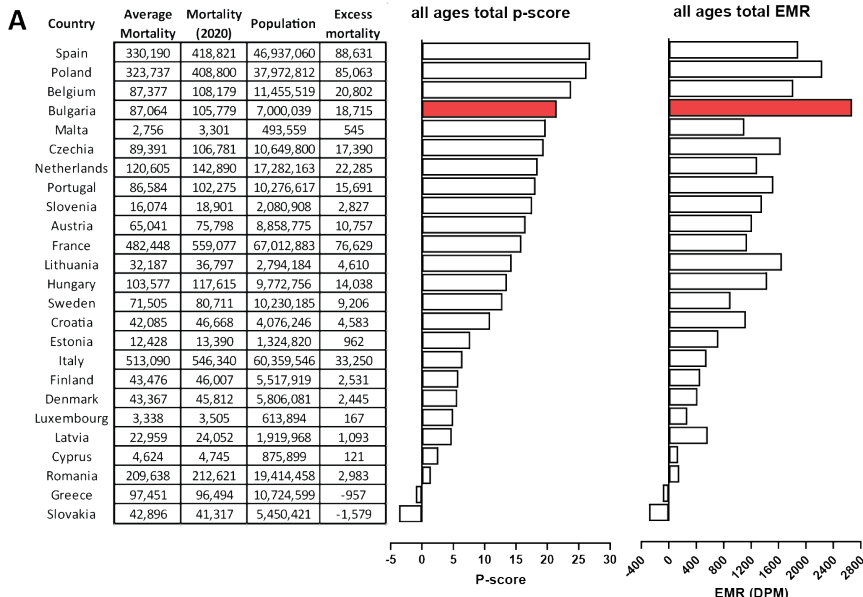


Figure 1: Excess mortality in Bulgaria and other EU countries in 2020. (A) Overall P-scores and excess mortality (in death per million; DPM) for all ages in Bulgaria (highlighted in red) and other EU countries; (B) P-scores and excess mortality for females of all ages; (C) P-scores and excess mortality for males of all ages.

PLACEHOLDER

Figure 2: PYLLs . (A)

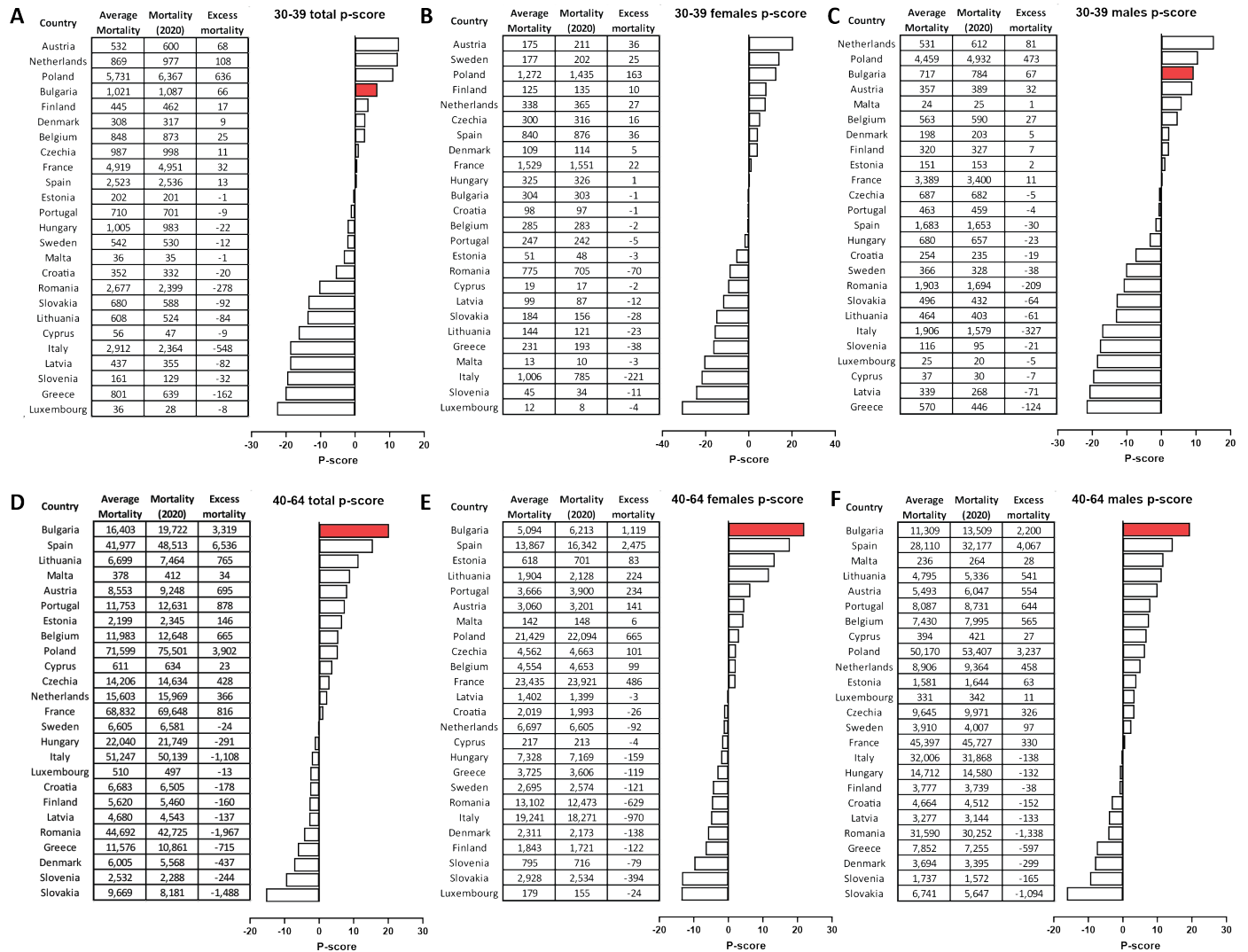


Figure 3: Excess mortality in working age populations in Bulgaria and other EU countries in 2020. (A) P-scores for the overall population in ages 30-39; (B) P-scores for females in ages 30-39; (C) P-scores for males in ages 30-39; (D) P-scores for the overall population in ages 40-64; (E) P-scores for females in ages 40-64; (F) P-scores for males in ages 40-64.

Notes

Competing Interests

Funding

XXXX probably none XXXX

The authors declare no competing interests.

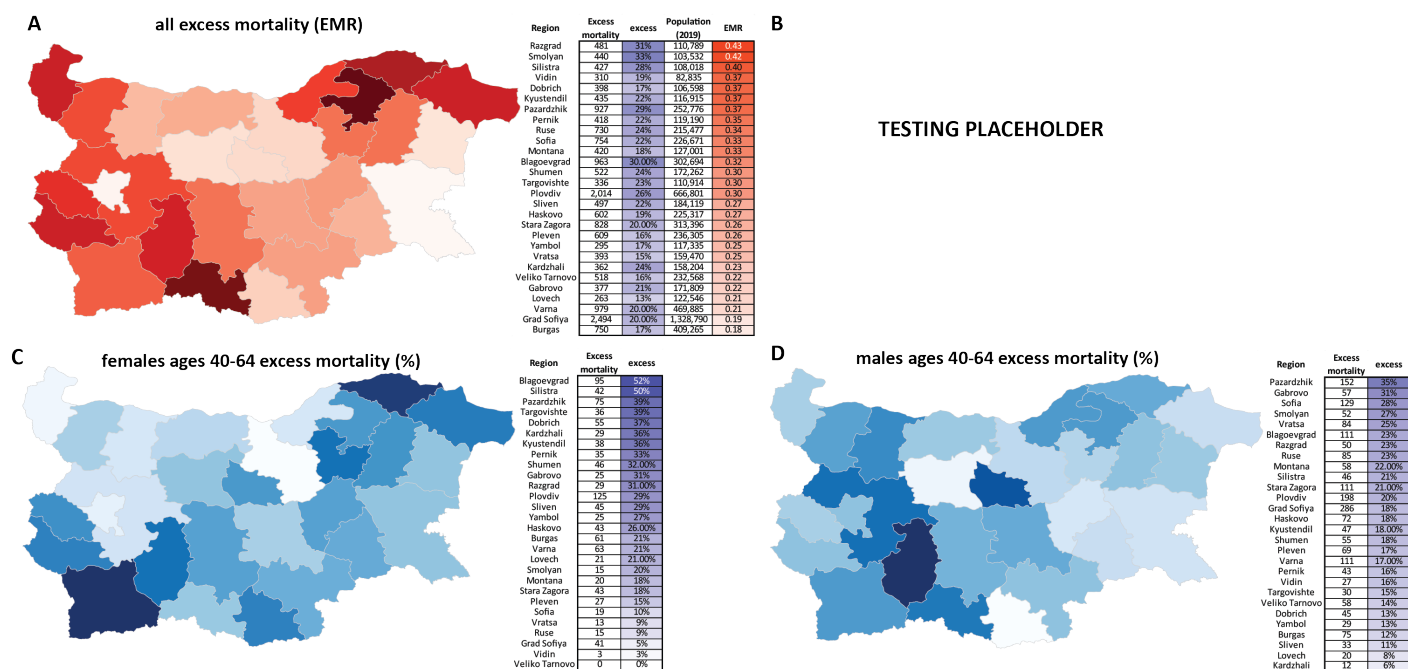


Figure 4: Regional disparities in the handling of the pandemic in Bulgaria . (A) Overall excess mortality in Bulgarian regions; (B) COVID testing in Bulgarian regions; (C) Excess mortality in working age (40-64) females in Bulgarian regions; (D) Excess mortality in working age (40-64) males in Bulgarian regions.

References

- Aburto JM, Schöley J, Zhang L, Kashnitsky I, Rahal C, Missov TI, Mills MC, Dowd JB, Kashyap R. 2021. Recent Gains in Life Expectancy Reversed by the COVID-19 Pandemic. *medRxiv* 2021.03.02.21252772
- Bhopal SS, Bhopal R. 2020. Sex differential in COVID-19 mortality varies markedly by age. *Lancet* **396**(10250):532–533.
- Pifarré I Arolas H, Acosta E, López-Casasnovas G, Lo A, Nicodemo C, Riffe T, Myrskyl M. 2021. Years of life lost to COVID-19 in 81 countries. *Sci Rep* **11**(1):3504.
- Morfeld P, Timmermann B, GroßJV, DeMatteis S, Campagna M, Lewis P, Cocco P, Erren TC. 2020. COVID-19: Spatial resolution of excess mortality in Germany and Italy. *J Infect* **S0163-4453**(20)30678–2
- Fouillet A, Pontais I, Caserio-Schnemann C. 2020. Excess all-cause mortality during the first wave of the COVID-19 epidemic in France, March to May 2020. *Euro Surveill* **25**(34):2001485.
- Kontopantelis E, Mamas MA, Deanfield J, Asaria M, Doran T. 2020. Excess mortality in England and Wales during the first wave of the COVID-19 pandemic. *J Epidemiol Community Health* jech-2020-214764
- Bustos Sierra N, Bossuyt N, Braeye T, Leroy M, Moyersoen I, Peeters I, Scohy A, Van der Heyden J, Van Oyen H, Renard F. 2020. All-cause mortality supports the COVID-19 mortality in Belgium and comparison with major fatal events of the last century. *Arch Public Health* **78**(1):117.
- Karlinsky A, Kobak D. 2021. The World Mortality Dataset: Tracking excess mortality across countries during the COVID-19 pandemic *medRxiv* 2021.01.27.21250604
- Smit AJ, Fitchett JM, Engelbrecht FA, Scholes RJ, Dzhivhuho G, Sweijd NA. 2020. Winter Is Coming: A Southern Hemisphere Perspective of the Environmental Drivers of SARS-CoV-2 and the Potential Seasonality of COVID-19. *Int J Environ Res Public Health* **17**(16):5634.
- Li Y, Wang X, Nair H. 2020. Global Seasonality of Human Seasonal Coronaviruses: A Clue for Postpandemic Circulating Season of Severe Acute Respiratory Syndrome Coronavirus 2? *J Infect Dis* **222**(7):1090–1097.
- Huang C, Wang Y, Li X, Ren L, Zhao J, Hu Y, Zhang L, Fan G, Xu J, Gu X, Cheng Z, Yu T, Xia J, Wei Y, Wu W, Xie X, Yin W, Li H, Liu M, Xiao Y, Gao H, Guo L, Xie J, Wang G, Jiang R, Gao Z, Jin Q, Wang J, Cao B. 2020. Clinical features of patients infected with 2019 novel coronavirus in Wuhan, China. *Lancet* **395**(10223):497–506.
- Wang C, Horby PW, Hayden FG, Gao GF. 2020. A novel coronavirus outbreak of global health concern. *Lancet* **395**(10223):470–473.
- Zhou P, Yang XL, Wang XG, Hu B, Zhang L, Zhang W, Si HR, Zhu Y, Li B, Huang CL, Chen HD, Chen J, Luo Y, Guo H, Jiang RD, Liu MQ, Chen Y, Shen XR, Wang X, Zheng XS, Zhao K, Chen QJ,

A

CASES PER WEEK

B

OFFICIAL DEATHS
AND EXCESS MORTALITY PER WEEK

C

TESTING PER WEEK
(STACKED BAR CHART WITH PCR AND AgT)

D

LOCKDOWN TIMING
vs MOBILITY CHANGES

Figure 5: Development of the COVID pandemic in Bulgaria over 2020 and the effectiveness of measures implemented in order to control it. (A) Officially registered COVID cases. Note that rapid antigen tests were only included in statistics starting at **XXXX** (B) Officially registered weekly COVID deaths and overall weekly excess mortality over the course of 2020. (C) Number of tests conducted and test positivity percentage (D) Social mobility changes and the timing of imposition of restrictions.

Deng F, Liu LL, Yan B, Zhan FX, Wang YY, Xiao GF, Shi ZL. 2020. A pneumonia outbreak associated

with a new coronavirus of probable bat origin. *Nature* **579**(7798):270–273.