SUPPLEMENTARY INFORMATION

1. List of keyword searches used in the categorization of medically certified causes of death

| Cause of death | Inclusions | Exclusions |
|-------------------------|---|--|
| Confirmed COVID-19 | CORONAVIRUS, CORONAVIRUS DISEASE 2019, 2019-NCOV, CORUNAVIRUS, CORONA VIRUS, NOVEL CORONAVIRUS, SARS CORONAVIRUS, SARS-COV-2, SARSCOV2, SARSCOV, CORONAVIRUS2, COVID, COVID-19, COVID-19 POSITIVE TEST | |
| Unconfirmed COVID-19 | SUSPECTED CORONAVIRUS DISEASE 2019, POSSIBLY CORONAVIRUS DISEASE 2019, POSSIBLE CORONAVIRUS DISEASE 2019, LIKELY CORONAVIRUS DISEASE 2019, NEGATIVE FOR SEVERE ACUTE RESPIRATORY SYNDROME CORONAVIRUS 2, COVID-19 NEGATIVE, CORONAVIRUS DISEASE 2019 NEGATIVE, SEVERE ACUTE RESPIRATORY SYNDROME CORONAVIRUS 2 NEGATIVE, N.E.C CORONAVIRUS | |
| Influenza | INFLUENZA, INFULENZA, INFLEUNZA, INFUENZA, FLU INFECTION, H1N1, HINI VIRAL, SWINEFLU, SWINE INF, HAEMOPHILUS INFLUENZAE AND INFLUENZA A | HAEMOPHILUS INFLUENZAE, HAEMOPHILUS INFLUENZAE, HEMOPHILUS INFLUENZAE, HEAMOPHILUS INFLUENZAE, HAEMOPHILUS INFLUENZA, HAEMOPHILUS INFLUENZA, HAEMOPHILUSINFLUENZAE, HAEMOPHILUSINFLUENZAE, HAEMOPHILUSINFLUENZAE, HAEMOPHILUSINFLUENZA, HAEMOPHILUS INFULENZAE, HAEMOPHILUS INFULENZAE, HAEMOPHILUS INFULENZA, HAEMOPHILUS INFULENZA, HAEMOPHILUSINFULENZAE, HAEMOPHILUSINFULENZAE, HAEMOPHILUSINFULENZA, HAEMOPHILUSINFULENZA, HEMOPHILIS INFLUENZA, HEMOPHILUS INFLUENZA, HEMOPHILUS INFLUENZA, HAEMOPHILUS INFLUENZAE, HEMOPHYLLIS INFLUENZA, H INFLUENZAE, PARA-INFLUENZAE, PARAINFLUENZA, PARA INFLUENZA, PARA-INFLUENZA, PARA INFULENZA, |
| Pneumonia | PNEUMONIA, PNEUEMONIA, PNEMONIA, PNEOMONIA, PENUMONIA, PNUEMONIA, PHEUMONIA, PNEUMONAL, PNEUMONA, PNEUMONIE, PNEUMONNIA, PNEUMONITIS, PNEUMONITITIS, LOWER RESPIRATORY TRACT INFECTION, SEVERE PNEUMONIA, REFRACTORY PNEUMONIA, NASOPHARYNGEAL ASPIRATE, PNEUMONIA WITH ASSOCIATED SEPSIS, COMMUNITY ACQUIRED LEFT LOWER LOBE PNEUMONIA, LEFT LOWER LOBE COMMUNITY ACQUIRED PNEUMONIA, BILATERAL STREPTOCOCCAL PNEUMONIA | ASPIRATION, ASPIRATE, ASPIRANION, ASPIRATION PNEUMONIA, HYPERSENSITIVITY PNEUMONITIS, RADIATION PNEUMONITIS, INTERSTITIAL PNEUMONITIS, LEFLUNOMIDE PNEUMONITIS, CHLORAMBUCIL PNEUMONITIS, BISULPHAN INDUCED PNEUMONITIS, ASPIRATION PNEUMONITIS, STREPTOCOCCUS PNEUMONIAE SEPSIS, CHEMICAL PNEUMONITIS, SEVERE PNEUMONIA (ASPIRATION), SEVERE PNEUMONIA ASPIRATION |
| Injuries | HEAD INJURY, FRACTURED NECK OF FEMUR, BLUNT HEAD TRAUMA, HEAD INJURIES, FRACTURED RIGHT NECK OF FEMUR, FRACTURED LEFT NECK OF FEMUR, ELECTROCUTION, INJURIES SUSTAINED, SUBDURAL HAEMATOMA, CHEST INJURIES, HEAD AND NECK INJURY, SUBDURAL HAEMORRHAGE, SUSTAINED IN A FALL, INJURY SUSTAINED, FOLLOWING A FALL, INJURIES RECEIVED, HEAD AND CHEST INJURIES, TRAUMATIC SUBDURAL HEMATOMA, ABDOMINAL INJURIES, ACQUIRED BRAIN INJURY, INCISED INJURIES, TRAUMATIC AMPUTATION, MULTIPLE RIB FRACTURES, BLUNT FORCE TRAUMA, IN A FALL, MULTITRAUMA, FRACTURE, OF A FALL, INCISED INJURY, PEDESTRIAN, DRIVER, PASSENGER, PEDAL CYCLIST, OCCUPANT, MOTORCYCLE, MOTOR VEHICLE, TRAUMATIC SUBARACHNOID HAEMORRHAGE, CRUSH INJURY | |

| Cause of death | Inclusions | Exclusions |
|-------------------------|--|--|
| Cardiovascular diseases | MYOCARDIAL, PERICARDIAL, RHEUMATIC, RHUEMATIC, MITRAL AORTIC, TRICUSPID, VALVE, VALVULAR, INTRAVASCULAR, HEART, CONGESTIVE, CORONARY, CARDIAC, CARDIO, DRESSLER'S SYNDROME, ANGINA, RUPTURE OF CHORDA TENDINEAE, RUPTURE OF PAPILLARY MUSCLE, ATHEROSCLEROTIC, ATHEROSCLEROSIS, ANEURYSM OF HEART, CORONARY ARTERY ANEURYSM, CARDIOMYOPATHY, PULMONARY EMBOLISM, PULMONARY EMBOLUS, PULMONARY EMBOLISM, PULMONARY EMBOLUS, PULMONARY HYPERTENSION, MYOCARDITIS, PERICARDITIS, ENDOCARDITIS, AORTITIS, CARDIOMEGALY, HAEMOPERICARDIUM, OESOPHAGEAL VARICES, VARICEAL BLEEDING, UPPER GASTROINTESTINAL BLEED, ATRIOVENTRICULAR BLOCK, INTRAVENTRICULAR BLOCK, CONDUCTION DISORDER, ATRIAL, VENTRICULAR, PREMATURE DEPOLARISATION, SICK SINUS SYNDROME, PULSELESS ELECTRICAL ACTIVITY ARREST, BRADYCARDIA, TACHYCARDIA, CEREBROVASCULAR, CEREBRO VASCULAR ACCIDENT, INTRACRANIAL HAEMORRHAGE, INTRACEREBRAL HAEMORRHAGE, SUBARACHNOID HAEMORRHAGE, SUBDURAL HAEMORRHAGE, EXTRADURAL HAEMORRHAGE, EXTRADURAL HAEMORRHAGE, FRONTOPARIETAL HAEMORRHAGE, TEMPORAL INTRAPARENCHYMAL HAEMORRHAGE, TEMPORAL INTRAPARENCHYMAL HAEMORRHAGE, CEREBRAL, CEREBELLAR, BASILAR, STROKE, TRANSIENT ISCHAEMIC ATTACK, BRAIN STEM INFARCT, BASAL GANGLIA INFARCTION, HYPERTENSIVE ENCEPHALOPATHY, VASCULAR LEUCOENCEPHALOPATHY, MOYAMOYA DISEASE, NONPYOGENIC THROMBOSIS OF INTRACRANIAL VENOUS SYSTEM, ANEURYSM, DISSECTION, HIGH BLOOD PRESSURE, HYPOTENSION, HYPERTENSION, ARTERIOVENOUS FISTULA, ARTERITIS, ARTERIAL, ARTERIOLE, PERIPHERAL VASCULAR DISEASE, THROMBOANGITIS OBLITERANS, RAYNA | |
| Respiratory diseases | BRONCHITIS, BRONCHIECTASIS, EMPHYSEMA, CHRONIC OBSTRUCTIVE, CHRONIC LUNG DISEASE, CHRONIC OBSTRUCTIVE PULMONARY DISEASE, CHRONIC OBSTRUCTION PULMONARY DISEASE, EXACERBATION OF AIRWAYS DISEASE, COPD, COAD, OBSTRUCTIVE LUNG, CHRONIC AIRWAYS, AIRWAYS DISEASE, AIRWAY DISEASE, ASTHMA, STATUS ASTHMATICUS, RESPIRATORY, PNEUMONIA, PNEUMONIA, PNEMONIA, PNEOMONIA, PNEAMONIA, PNEUMONIA, PNEUMONIA, PNEUMONIA, PNEUMONIA, PNEUMONIA, INFLUENZA, INFLEUNZA, NFUENZA, FLU INFECTION, H1N1, HINI VIRAL, SWINEFLU, SWINEINFLU, SWINE FLU, SWINE INF, SMOKE INHALATION, PULMONARY FIBROSIS, CHEST INFECTION, CHEST SEPSIS, PNEUMOSEPSIS, PLEURAL EFFUSION, SHORTNESS OF BREATH, LOWER RESPIRATORY TRACT INFECTION, LOWER RESPIRATORY TRACT INFECTION, LOWER RESPIRATORY TRCAT INFECTION, INTERSTITIAL LUNG DISEASE, HYALINE MEMBRANE DISEASE, MACLEOD'S SYNDROME | |
| Cancer | METASTATIC, METASTASES, METASTASIS, MALIGNANT, MALIGNANCY, NEOPLASM, CANCER, CARCINOMA, TUMOUR, TUMOR, LEUKEMIA, LEUKAEMIA, LYMPHONA, HODGKIN, SECONDARIES, BLASTOMA, SARCOMA, GRANUCOMA | COMA, GLAUCOMA, STOMA, MYXOMA, HEMATOMA, HAEMATOMA, ATHEROMA, ASPERGILLOMA |

2. Categorization of COVID-19 restrictions

A stringency index, categorized into five levels, was developed based on key restrictions implemented by the state government. Categorization of restrictions is described in detail elsewhere. For the present paper, five levels of restrictions were used. Note that in all periods there were restrictions on international travel.

- Level 1: Restrictions on large indoor and outdoor gatherings, including funerals, weddings and worship.
- Level 2: No indoor gatherings; small outdoor gatherings permitted (varied).
- Level 3: 4 reasons to leave home (grocery shopping, work if an essential worker, provision of receipt of health care, exercise).
- Level 4: 4 reasons to leave home + masks, and, later, a 21:00 curfew.
- State of Disaster declared; 4 reasons to leave home + a 20:00 curfew; travel not permitted beyond Level 5: a 5-km radius; masks required in indoor and outdoor areas.

3. R script for estimating excess mortality

Data are structured as shown below. The same format is used for each cause and each age group

```
head(df)
# week week_start_date year cause
                                                          ERP
                                                                 wMR
                                           count
# <dbl> <date>
                            <dbl> <chr> <int>
                                                       <dbl> <dbl>
                    1 2015-01-04
       1 2016-01-03
                          2016 all cause 684 6173172 11.1
       1 2017-01-01 2017 all_cause 752 6321606 11.9
1 2017-12-31 2018 all_cause 760 6462019 11.8
1 2018-12-30 2019 all_cause 708 6596880 10.7
1 2019-12-29 2020 all_cause 709 6729626. 10.5
# 3
# 4
# 5
# predict deaths
head(df)
all cause <- df %>%
  mutate(sin_of_week_num = sin(2*week*pi/52.18)),
         cos_of_week_num = cos(2*week*pi/52.18),
         week_num=as.numeric(week_start date))
mod <- MASS::rlm(wMR~week num + sin of week num + cos of week num,
                  data=subset(all_cause, year<2020), psi=MASS::psi.bisquare)</pre>
all_cause_emr <- cbind(all_cause,
                        predict(mod, all cause, interval = "prediction"))
# to plot the predicted and observed rates
all cause emr %>%
 rename(Predicted="fit", Observed="wMR") %>%
  pivot longer(cols=c("Predicted", "Observed"),
               values_to = "rate", names_to = "rate_type") %>%
 arrange(week_start_date) %>%
  filter(year==2020) %>%
  ggplot(aes(x = week)) +
  geom ribbon(aes(ymin=lwr, ymax=upr, fill="95%PI"), alpha=0.15) +
  geom_line(aes(y = rate, lty=rate_type)) +
  geom_vline(xintercept = 0, colour="#201547") +
  geom_hline(yintercept = 8, colour="#201547") +
  scale_x_continuous(limits = c(0,53.5),
                     breaks = seq(1,53,4),
                      expand = c(0,0) +
  scale_y_continuous(limits=c(8,16),
                      breaks = seq(8,16,2),
                      labels = seq(8,16,2),
```

```
expand = c(0,0) +
labs(y="Estimated mortality rate per 100,000",
 x="Week", lty="Rate (year)", fill="") +
theme_minimal() +
theme(legend.position = c(0.19, 0.85),
      legend.direction = "vertical", legend.box = "horizontal") +
guides(linetype = guide_legend(order = 1), fill = guide_legend(order = 2))
```

References

1. Victorian Department of Health COVID-19 writing group. Population-based analysis of the epidemiological features of COVID-19 epidemics in Victoria, Australia, January 2020-March 2021, and their suppression through comprehensive control strategies. Lancet Reg Health West Pac. $2021; 17: 100297.\ doi: 10.1016/j.lanwpc. 2021. 100297\ pmid: 34723232$