Facemasks and SARS-CoV-2 case fatality rate

by

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Abstract

The importance of facemasks during COVID-19 pandemic has been a controversial topic, hampered in part by lack of empirical evidence. However, a large number of countries worldwide has already issued mask mandates. Here I show, that mask mandates in Kansas counties during the summer of 2020 actually increased case fatality rate significantly compared to Kansas counties without mask mandates, with a risk ratio of over 1.5 for death *with and by* SARS-CoV-2. After correcting for death *with* SARS-CoV-2, I find that the case fatality rate *by* SARS-CoV-2 is as low as 0.026% in Kansas counties without mask mandates, but 0.286% in Kansas counties with mask mandates, resulting in a highly significant risk ratio of over 11. Also, I find that face masks to not reduce but slightly increase infection rates.

Why this happens and the possible connection between long-term effects associated with SARS-CoV-2 and facemasks are explained in theory herein by the 'foegen effect', which describes the deep reinhalation of pure virions that were caught in the face masks as droplets.

These findings have immediate implications for the handling of SARS-CoV-2 worldwide.

Introduction

The SARS-CoV-2 pandemic has caused many countries in the world to issue mask mandates, even though there is no clear evidence that masks can actually reduce infection rate or case fatality rate. During summer 2020, 24 Kansas states and at least 8 cities had issued a mask mandate, the other 81 did not.

The study by Van Dyke et al.[1] tries to address that issue by analyzing data from Kansas states. However, groups were not aligned for comparison purposes (e. g. rural vs. urban), large cities with mask mandates were not factored in, and most importantly, case fatality rate (CFR) was not calculated at all. In addition, data until October is available now. Therefore, I used July 3rd (day of issuing of mask mandate) as starting date and October 15th as ending point as I had proof of mask mandates up to that point.

I analyzed infection rate and case fatality rate as described below. The analysis showed a highly significant increase in CFR, and that increase can only be attributed to death *by* SARS-COV-2, not death *by and with* SARS-CoV-2. (Since all other respiratory infections have basically disappeared [2], that increase can be attributed solely to death *by* SARS-CoV-2*).*

So in order to calculate the relative risk (RR), I had to distinguish between death *by* and death *with* SARS-COV-2.

However, I could not find the required data for every Kansas county, so I used German numbers to help account for that (Germany had a partial mask mandate in place, requiring masks in public transportation and indoors, but not in public areas in general).

Since end of June all hospitals in Germany had to test all new and existing patients for SARS-CoV-2. To make sure all hospitals had enough tests available I decided to start in August instead of June (or July). As Germany used weekly data, I chose weeks 32 to 42 (included) to almost exactly match the Kansas' data.

As mentioned, the German Robert-Koch-Institute (RKI) only collects data *with and by* SARS-CoV-2, so to calculate CFR (only) *by* SARS-CoV-2, I had to subtract the number of death that would have occurred *without* SARS-CoV-2. This is possible because SARS-CoV-2 is a completely new disease, so any death *by* SARS-CoV-2 has to exceed the number of deaths that would happen if this year were like another year without it (I use numbers for the year 2017, as the hospital stats we use go back to that year).

Since hospitalized persons have a much higher likelihood of dying, and all hospitalized persons were tested, I divided all infected into two groups, into hospitalized infected as one group and all not hospitalized infected as another group.

Because almost all patients with a positive test will be treated in internal medicine by pure logic, and all the most important risk factors[3] (chronic kidney disease, hypertension, diabetes, obesity) for a severe course will also be treated by internal medicine, I used numbers for internal medicine for calculation of CFR. This also includes people dying by a heart attack *with* SARS-COV-2, but it

does not include people dying with SARS-CoV-2 after a car crash in hospital. However, these cases should be extremely rare given the likelihood of having both a near death experience and being positive for SARS-CoV-2 (with only 0.2% of population infected during the chosen weeks) are extremely unlikely and thus negligible.

However, since correcting for a focused testing of elderly patients and patients with pre-existing conditions among non-hospitalized is impossible, the resulting CFR *by* SARS-CoV-2 will be overestimated.

To finally compare the result to Kansas, the CFR was still dependent on the distribution between groups (dying in hospital and dying outside of), which was directly correlated to the number of tests (since all hospitalized were tested, more tests would have only occurred outside of the hospital) so I corrected Kansas numbers for that.

Method

I collected the data listed under sources and analyzed it using LibreOffice Calc 4.1.

I checked all states without mask mandates that had known cities with mask mandates for the percentage of the county population that was represented by that city (or cities). If the city's population was within +/-20% of half of the county's population (that is, between 30% and 70%), the county was left out. Therefore, I excluded Labette (Parsons) and Cowley (Winfield) counties.

If the city's population was over 70%, I counted the county as having mask mandate, which meant Lyon (Emporia), Ellis (Hays) and Riley (Manhattan) counties were switched to mask mandate.

If the city's population was under 30%, the county remained in its group (Miami county with Osawatomie and Paola, Marion county with Marion).

Then I checked the distribution of mask mandate and total population to keep mask and no-mask counties as well comparable as possible. The analysis showed that all counties with population over 100,000 had mask mandates, whereas from 67 counties with population below 10,000 only 8 had mask mandates. Using this information, I proposed a population of 100,000 as upper boundary and proposed 10,000 as lower boundary for inclusion into the calculation.

As there were also only five counties with a population between 50,000 and 100,000, and their population and number was leaning towards mask mandates, I decided to also calculate for the 10,000 to 50,000 range as the 100,000 split might be wrongfully chosen.

The crude death rate (CDR) represents age and pre-existing illness in the underlying population. Both affect natural resistance and thus infection probability and mortality by COVID-19, so both groups need to have almost the same CDR to be comparable. Comparison of raw CDR showed that it ranged from 575.8 to 2010.1 between Kansas' counties.

I the modified the CDR of each county for 2019 by reducing deaths from sources that would clearly not be COVID-19 related to prevent statistical anomalies when comparing CDR (accumulations of deaths from other causes that are not related to older age and pre-existing illness). These were pregnancy complications, birth defects, conditions of perinatal period (early infancy), sudden infant death syndrome, motor vehicle accidents, all other accidents and adverse effects, suicide, homicide, and other external causes.

This modified CDR (mCDR) of the counties was then population-weighted and summed up to calculate the mCDR of mask vs. no-mask counties. I then checked again, and counties below 10,000 had an almost 10 percent difference in mCDR (9.24%) between mask and no-mask, so I settled for the lower boundary of 10,000 proposed earlier.

For the 10,000-100,000 range, Population was 482,184 in no-mask vs. 475,935 in mask, while mCDR was almost the same (-0.29%).

For the 10,000-50,000 range, mCDR was slightly higher in mask (2.36%) which I still yielded not

acceptable. So I checked for 9,000 as lower boundary and mCDR was almost identical (-0.38%), Population was 372,026 in no-mask vs. 294,644 in mask.
Therefore, I finally settled for a small range of 9,000 to 50,000 and a large range of 10,000 to 100,000.

I calculated infection totals from July 3rd to October 15th. For death totals, I used data from July 17th to November 15th, as most people die 2 to 4 weeks after infection.
I calculated totals for infections and deaths among mask and no-mask counties, and using a fourfold table calculated infection and case fatality rates, chi^2 (α=0.05), RR and 95%CI (using formula [4]).

I then extracted the number of cases, number of death *by and with* SARS-CoV-2 and the number of hospitalized patients in Germany from week 32 to 42.
I used average (not median!) hospital time for SARS-CoV-2 patients to calculate the total number of days in hospital for the hospitalized patients. By dividing the result through the number of days of treatment until one person dies in internal medicine dies (Using data from 2017), I got the number of deaths *with* SARS-CoV-2 for the hospitalized group.
For the people tested but not hospitalized, I calculated how many people die outside of a hospital in Germany each year, and calculate how many of them die during four weeks (after testing positive). This is supported by the natural course of SARS-CoV-2 disease, also studies using 28-day-mortality and UK using 28-day mortality in their official statistics. Again, this may overestimate CFR slightly. Using these numbers, I got the number of deaths *with* SARS-CoV-2 for the not-hospitalized group.

I then calculate the number of death *by* SARS-CoV-2 by subtraction and calculate CFR *by* SARS-CoV-2 *with German mask mandate*.

To improve the comparability between Kansas and Germany, I recalculated Kansas data with

08/01/2020 as starting date. Additionally, I recalculated the number of death for Kansas groups as the average of death differences between 08/08 and 10/22, 08/15 and 10/29 as well as 08/22 and 11/05. This way, infections and deaths both span 11 weeks. I chose to focus on 14 days after testing after referring to [5].

To keep difference in mCDR between Germany and Kansas groups as low as possible, I chose the "lower range" group, so Germany and Kansas were only 2.85% (no mask) and 3.22% (no mask) apart in mCDR.

Differences in overall testing numbers was still a factor to consider. By focusing testing on elderly and hospitalized, and testing less people overall than in Germany, CFR in Kansas is higher. To correct for this, I calculated the weekly testing per 100,000 people in Germany and Kansas during the chosen period and multiplied the number of infected for each group (Kansas counties mask/no mask) by the resulting factor. Since the additional infected cannot possibly be hospitalized (given all severely ill are already brought to hospital or at least tested), I added the additional expected deaths among the added infected within four weeks using the German number to the number of deaths *with and by* SARS-CoV-2 (since mCDR was almost the same).

I then reduced the number of death *with and by* SARS-CoV-2 by the number of death only *with* SARS-CoV-2, the latter using again the German numbers as both testing numbers and mCDR were already aligned. This way I calculated CFR for death *by* SARS-CoV-2 *without mask mandate*, *with German mask mandate* and *with Kansas mask mandate*.

Finally, using a fourfold table, I calculated case fatality rates for the German and Kansas mask mandates compared to Kansas no mask mandate, also calculating chi^2 ($\alpha=0.05$), RR and 95%CI.

Results

For the 9,000-50,000 range, infection rate was higher in mask-mandated counties than in no-mask-

mandated counties ($Chi^2<0.001$, RR=1.08 [95%CI 1.05-1.11]).

For the 10,000-100,000 range, it was the same ($Chi^2<0.001$, RR=1.13 [95%CI 1.11-1.15]).

For both ranges, case fatality rate was significantly higher counties with mask mandates, with a significant relative risk for masked countries. For smaller range ($Chi^2=0.006$) RR was 1.52 [95%CI 1.21-1.85]). For larger range ($Chi^2=0.003$) RR was 1.49 [95%CI 1.2-1.76]).

During weeks 32 to 42, RKI reported 159,953 cases, 7,893 hospitalizations and **949 deaths** for a CFR ***with and by*** **SARS-CoV-2 at 0.59%**.

Hospital data for 2017 showed 43,962,058 days of treatment in internal medicine as well as 292,793 deaths, resulting in one dead every 150 days of treatment.

An average SARS-CoV-2 hospitalization time of 14 days resulted in 110,502 hospitalization days.

Dividing this by 150 results in **737 deaths** among hospitalized patients.

In the year of 2017, Germany had 82,500,000 people of which 505,000 died not inside of a hospital.

So 0.61% is the likelihood of dying outside of a hospital during one year. Multiplying this number by (28/365) and by 152,060 (non-hospitalized) results in **71 deaths** among non-hospitalized patients.

So the number of patients that died *by* SARS-CoV-2 is 141.

This results in a **CFR *by* SARS-CoV-2 *with german mask mandate* of 0.088%**.

Data from Kansas resulted in a CFR *with and by* SARS-CoV-2 of 0.85% for non-mask-mandated countries and of 1.28% for mask-mandated countries.

Since Kansas hat 912.66 Tests per 100.000 per week and Germany had 1,507.92 Tests per week, number of cases was increased by 1.65 for each Kansas group.

Using the above probability for dying outside of a hospital in Germany of 0.61%, total deaths increased from 57.67 to 59.76 in no-mask group and from 74.33 to 76.12 in mask group.

This led to CFR *with and by* SARS-CoV-2 of 0.531% in no-mask group and 0.791% in mask group. By reducing this number by the percentage of death *with* SARS-CoV-2 in Germany of 0.505%, the **final CFR *by* SARS-CoV-2 *without mask mandate* is 0.026%**, and the final CFR *by* SARS-CoV-2 *with Kansas mask mandate* is 0.286%.

So, RR for the German mask mandate is 3.4 [95%CI 1.08-4.04, p=0.027], RR for the Kansas mask mandate is 11.03 [95%CI 3.53-15.99, p<0.001].

Discussion

A) Infection rate

Although there is a significant increase in infection rate in counties with mask mandates compared to counties without, the RR remains relatively low. Looking at CI, it about 1.11.

Therefore, this analysis indicates that masks do not help prevent the spreading of SARS-CoV-2, but instead even increase it slightly by around 10%.

Comparing the week before 07/03/2020 showed 17% (large range) and 6.5 % (small range) more infections in mask-mandated counties, which might be the cause for this slight increase.

As the dark number is not known, I compared cumulative cases as of 07/03/2020: In the large range, 6,370 infections in no-mask vs. 1,467 in mask. In the small range, 5,125 cases in no-mask vs. 1,079 in mask. This indicates that non-mask states could have had more infectious individuals and a higher dark number of 07/03/2020.

However, the effect of facemasks on infection rate remains very small.

B) Case fatality rate *by* SARS-CoV-2

The CFR for SARS-CoV-2 is incredibly low at 0.026%. It is so low, that although there are over ten thousand infected in the mask Kansas groups (after correcting for undertesting), the number of death in no-mask is so small (~3) that each 95%CI remains very large.

The CFR calculated here is still not easily to compare to a normal year of influenza, because in Germany, nightclubs and mass gathering events like big concerts were forbidden. This caused SARS-CoV-2 to be less prevalent in younger, healthier and far more socially active groups. During the German “Lockdown” in April, data showed this trend even more: The “Lockdown” mostly reduced the number of social contacts younger people had, so the number of elder patients infected by SARS-CoV-2 kept rising relative to their share of total population until they were even overrepresented [6]. Of course, this has directly increased CFR. I used a population of 83,200,000 and a herd immunity after reaching 70% to calculate the total number of death in Germany *by* SARS-CoV-2 *without mask mandates*, which would be 15,142 deaths - which is less than deaths caused by Influenza for most of the last years. [7]

C) Effect of mask mandates

The mask mandates have increased the risk of dying by 3.4 in Germany and by ~11 in Kansas counties with mask mandates.

The explanation for this is probably that virions that are breezed or coughed out in droplets are stopped in the facemask tissue, and after (quick [8]) evaporation of the droplets, pure virions are reinhaled from a very short distance when breathing in. For further reference, I refer to this as the 'foegen effect' as I could not find this effect described earlier.

By the 'foegen effect' the virions are not only spreading to other areas (like the olfactory nerve, causing loss of smell) but also (because of their smaller size) deeper into the respiratory tract [also 8]. They bypass the bronchia and are inhaled deep into the alveoli, where they cause a pneumonia instead of a bronchitis, which would rather be typical for a virus infection. They also bypass the wall of multilayer squamous epithelium that they cannot pass in vitro [9] and most likely also cannot pass in vivo. So the only propable way to enter the blood vessels for the virions is through the alveoli.

The 'foegen effect' also increases overall viral load, because virus reproduction in vivo is exponential compared to the linear [10] droplet reduction caused by the mask, so the number of exhaled or coughed out virions quickly exceeds those of non-mask patients. This explains why masks do not reduce infection rate but rather slightly increase it.

The 'foegen effect' is also supported by studies [11,12] comparing (ventilation) masks to alternatives for acute respiratory distress syndrome (ARDS), where the direct obstruction of the exhalatory pathway is the only difference in treatment.

The existence of the 'foegen effect' is also supported by the observation that a lot of medical personal in Italy was dying during the "first wave" [13] – they were working many hours, despite being ill, and with facemasks. They probably were using "better" masks than just a chirurgical face mask (FFP2, FFP3) – however, masks with a higher droplet filtering effect probably cause an even stronger 'foegen effect'.

Another very important point to consider is that the long term effects that have been described in association with COVID-19 may all be a direct cause of the 'foegen effect': With the virus entering alveoli and blood, and not being restricted to the upper respiratory tract and bronchi (as explained above), it can cause damage by initiating (auto)immune reaction in most organs.

Concerning the proposed consequences of the 'foegen effect' – they question nonetheless whether the entire COVID-19 pandemic was caused by over-treatment or rather illness-worsening treatment of a rather bland virus.

However, since ethical principles prevent clinical studies to prove the 'foegen effect' in vivo, and wearing a mask is unblindable, further proving the 'foegen effect' may be impossible, especially considering that [11] was stopped because results for the mask group were so much worse.

However, as the CFR *by* SARS-CoV-2 is calmingly low, it clearly indicates that we should return to living our normal lives before COVID-19.

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Figure 7

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Data Sources

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→ Counties and Cities with Mask mandates (October 15th): https://www.khi.org/policy/article/20-25

→ Population of Cities: http://en.wikipedia.org/ (entry for each city).

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→ crude death rate by Counties 2019, Number of Death by County 2019 for pregnancy complications, birth defects, conditions of perinatal period (early infancy), sudden infant death syndrome (SIDS), motor vehicle accidents, all other accidents and adverse effects, suicide, homicide, and other external causes : http://kic.kdheks.gov/death_new.php

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Declaration of conflicts of interest:

The author and his family live in a country with mask mandates (Germany). As a general practitioner, the author has to wear masks at work. No financial conflicts of interests are declared.