Fundamentals of Computing and Data Display
Term paper template

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Contents

Introduction

COVID-19 represents the first global pandemic of the 21st century. But despite being a global pandemic it did not affect every area equally. Not only were countries in the Global South hit very hard but certain areas of more developed countries also were hit harder than the rest of their country. Within the USA the areas hit hardest are those with higher minority populations and especially with higher Black populations (Gravlee 2020; Kim and Bostwick 2020; Khazanchi, Evans, and Marcelin 2020). This paper looks at the effect of COVID-19 on Prince George's County. Prince George's County was chosen for a few reasons. Firstly it is the most populated county in the country with a majority Black population. Secondly while not having the highest median household income of counties it does rank in the top 100 median household incomes. This should help control for the effect of income and healthcare. For a control county, Montgomery County was chosen. Montgomery County not only has a much smaller proportion of Black people but it is also geographically close to Prince George's County, with the two sharing a border. Having a county in the same state should help control for the effects of State-level governments on COVID-19.

The time period looked at for this paper is October 1st, 2020 through December 31st, 2021. This period was chosen as it represents the pandemic having existed for some months but before vaccinations were being administered. Not having to control for vaccine rollouts allows for simpler comparisons cross-county. In addition it was around this time period that COVID-19 was seen to be affecting areas with high minority populations much more than lower minority areas.

Data

The CensusAPI package provides a way to access the Census's API within R. For the purposes of this analysis Census data is used in a supplementary fashion. Population, age and household income were gathered for each county to see how different they were. Beyond that the White, Black and Latino population numbers were gathered. All of these values were put into an R object for statistical manipulation.

The COVIDcast package from the Delphi group at Carnegie Mellon University contains data from 19 sources referred to as signals within the package. Each of these signals represent different sources like the COVID-19 Trends and Impact Facebook survey, the CDC, and others. Within those signals there are many variables represented. For data from the Facebook survey, the smoothed weighted version of a variable was always chosen so as to allow for cross-county comparisons more easily.

I wanted to look at proportions of people with COVID-19, both from PCR test results and also estimates from the Facebook survey. Beyond that I wanted to see the differences in the data for variables that showed potential exposure and also feelings during the pandemic. For the first of those variables I wanted to look at estimated use of public transit. The thought here is that being in tight confined spaces, especially in the first year of the pandemic, would increase your risk of catching COVID-19. How often people felt anxious was looked at from the Facebook survey. This measure was chosen to see if there's a difference in feelings of anxiety between the two counties. Use of masks was looked at as another variable to see potential exposure. Alongside that we also looked at percentage of individuals that had to either work or go to school outside their home. Lastly from the Facebook survey we looked at how many people were worried about their finances. The thought behind all of these is that Prince George's County should, as the county with the higher proportion of Black people and the lower median income, be the county where more people have to go out to work instead of working from home. With that they should use public transit more, be more anxious, and potentially more worried about finances. Masking should be similar between the two counties pre-vaccines but there is a possibility it will be more prevalent in Prince George's County if that county feels like it's being hit harder by COVID-19.

For more quantitative data I also looked at hospitalization rates and death rates. Hospitalization rates used data from electronic medical records and claims data about new admissions to the hospital for individuals with COVID-19. Death rates were taken from the Johns Hopkins University COVID-19 data, both cumulative and adjusted rates were gathered.

The COVIDcast data was accessed using their API and the COVIDcast R package. With the package you select a data source, a signal within that data source, a time period, and a geographic location. For all of my variables I looked at both Prince George's and Montgomery counties. In addition I looked at the time period of October 1st to December 31st.

```
cs_key <- "1448b92acdfc46410a020ee82b98af8fad7de580"
census_pg <- getCensus(name = "acs/acs5",
                  vintage = 2020,
                  vars = c("NAME", "B01001_001E", "B06002_001E", "B19013_001E", "B19301_001E","B02001_
                  region = "county:033",
                regionin = "state:24",
                  key = cs_key)
census_pg <-
  census_pg %>%
  rename(pop = B01001_001E, age = B06002_001E, hh_income = B19013_001E, income = B19301_001E, White = B0
knitr::kable(head(census_pg), caption = "Census data for Prince George's County")
```

Table 1: Census data for Prince George's County

state	county	NAME	pop	age	hh_income	income	White	Black	Latino
24	033	Prince George's County, Maryland	910551	37.5	86994	38502	146540	565972	171094

```
census_moco <- getCensus(name = "acs/acs5",
                  vintage = 2020,
                  vars = c("NAME", "B01001_001E", "B06002_001E", "B19013_001E", "B19301_001E","B02001_
```

```
                   region = "county:031",
                   regionin = "state:24",
                   key = cs_key)
census_moco <-
  census_moco %>%
  rename(pop = B01001_001E, age = B06002_001E, hh_income = B19013_001E, income = B19301_001E, White = B(
knitr::kable(head(census_moco), caption = "Census data for Montgomery County")
```

Table 2: Census data for Montgomery County

state	county	NAME	pop	age	hh_income	income	White	Black	Latino
24	031	Montgomery County, Maryland	1047661	39.4	111812	55643	536767	193450	204620

```
# A code chunk that exemplifies the data gathering process
#code to find the FIPS codes for our counties of interest
pg_fips <- name_to_fips("Prince George's")
moco_fips <- name_to_fips("Montgomery", state = "MD")
#code to find the proportion of positive PCR tests for a county within a certain time period
pg_pcr_pos <- covidcast_signal(data_source = "covid-act-now", signal = "pcr_specimen_positivity_rate",
                       start_day = "2020-10-01", end_day = "2020-12-31",
                       geo_type = "county", geo_value = pg_fips)
```

```
## Fetched day 2020-10-01 to 2020-12-31: num_entries = 92
```

```
moco_pcr_pos <- covidcast_signal(data_source = "covid-act-now", signal = "pcr_specimen_positivity_rate"
                       start_day = "2020-10-01", end_day = "2020-12-31",
                       geo_type = "county", geo_value = moco_fips)
```

```
## Fetched day 2020-10-01 to 2020-12-31: num_entries = 92
```

Results

This section presents the main results.

Data exploration

The results section may have a data exploration part, but in general the structure here depends on the specific project.

Shown below is a table of the first six results from one of each of the four different data sources used from the COVIDcast package. The tables have been trimmed for ease of reading to include only the data source, the signal from within the source, the county FIPS code (geo_value), date (time_value), value being measured, and sample size. The values from covid-act-now are represented as proportions. Data from fb-survey and hospital-admissions is shown as a percentage. Lastly the data from jhu-csse is represented as individuals.

```
# What happens here depends on the specific project
#Data of PCR Positive Test Proportion
vis_pg_pcr_pos <- pg_pcr_pos %>% select(data_source ,signal, geo_value, time_value,value, sample_size)
knitr::kable(head(vis_pg_pcr_pos),caption = "Proportion of PCR Positive Tests for Prince George's County
```

Table 3: Proportion of PCR Positive Tests for Prince George's County

data_source	signal	geo_value	time_value	value	sample_size
covid-act-now	pcr_specimen_positivity_rate	24033	2020-10-01	0.0770	3680.14
covid-act-now	pcr_specimen_positivity_rate	24033	2020-10-02	0.0799	3544.00
covid-act-now	pcr_specimen_positivity_rate	24033	2020-10-03	0.0820	3261.14
covid-act-now	pcr_specimen_positivity_rate	24033	2020-10-04	0.0786	3302.29
covid-act-now	pcr_specimen_positivity_rate	24033	2020-10-05	0.0747	3366.71
covid-act-now	pcr_specimen_positivity_rate	24033	2020-10-06	0.0734	3317.29

```
vis_moco_pcr_pos <- moco_pcr_pos %>% select(data_source ,signal, geo_value, time_value,value, sample_si
knitr::kable(head(vis_moco_pcr_pos),caption = "Proportion of PCR Positive Tests for Montgomery County")
```

Table 4: Proportion of PCR Positive Tests for Montgomery County

data_source	signal	geo_value	time_value	value	sample_size
covid-act-now	pcr_specimen_positivity_rate	24031	2020-10-01	0.0421	4384.57
covid-act-now	pcr_specimen_positivity_rate	24031	2020-10-02	0.0438	4410.57
covid-act-now	pcr_specimen_positivity_rate	24031	2020-10-03	0.0440	4179.43
covid-act-now	pcr_specimen_positivity_rate	24031	2020-10-04	0.0409	4241.71
covid-act-now	pcr_specimen_positivity_rate	24031	2020-10-05	0.0377	4334.29
covid-act-now	pcr_specimen_positivity_rate	24031	2020-10-06	0.0373	4498.71

```
#Estimated percentage of people who masked most of the time in the past 5 days
vis_pg_fb_mask <- pg_fb_mask %>% select(data_source ,signal, geo_value, time_value,value, sample_size)
knitr::kable(head(vis_pg_fb_mask),caption = "Estimated percentage of people who masked most of the time
```

Table 5: Estimated percentage of people who masked most of the time in the past 5 days for Prince George's County

data_source	signal	geo_value	time_value	value	sample_size
fb-survey	smoothed_wwearing_mask	24033	2020-10-01	96.59740	341.6956
fb-survey	smoothed_wwearing_mask	24033	2020-10-02	97.15269	338.1204
fb-survey	smoothed_wwearing_mask	24033	2020-10-03	95.52754	335.9149
fb-survey	smoothed_wwearing_mask	24033	2020-10-04	95.63788	336.7555
fb-survey	smoothed_wwearing_mask	24033	2020-10-05	95.69659	363.0860
fb-survey	smoothed_wwearing_mask	24033	2020-10-06	94.38246	370.5629

```
vis_moco_fb_mask <- moco_fb_mask %>% select(data_source ,signal, geo_value, time_value,value, sample_si
knitr::kable(head(vis_moco_fb_mask),caption = "Estimated percentage of people who masked most of the tim
```

Table 6: Estimated percentage of people who masked most of the time in the past 5 days for Montgomery County

data_source	signal	geo_value	time_value	value	sample_size
fb-survey	smoothed_wwearing_mask	24031	2020-10-01	94.81161	510.8723

data_source	signal	geo_value	time_value	value	sample_size
fb-survey	smoothed_wwearing_mask	24031	2020-10-02	95.49223	538.9780
fb-survey	smoothed_wwearing_mask	24031	2020-10-03	95.76241	556.1614
fb-survey	smoothed_wwearing_mask	24031	2020-10-04	96.08837	557.0509
fb-survey	smoothed_wwearing_mask	24031	2020-10-05	96.29473	593.7574
fb-survey	smoothed_wwearing_mask	24031	2020-10-06	96.34647	612.4790

```
#Estimated percentage of new hospital admissions with COVID-associated diagnoses, based on claims data
vis_pg_hhs_hospital <- pg_hhs_hospital %>% select(data_source ,signal, geo_value, time_value,value, samp
knitr::kable(head(vis_pg_hhs_hospital),caption = "Estimated percentage of new hospital admissions with C
```

Table 7: Estimated percentage of new hospital admissions with
COVID-associated diagnoses for Prince George's County

data_source	signal	geo_value	time_value	value	sample_size
hospital-admissions	smoothed_covid19_from_claims	24033	2020-10-01	4.980869	NA
hospital-admissions	smoothed_covid19_from_claims	24033	2020-10-02	5.328849	NA
hospital-admissions	smoothed_covid19_from_claims	24033	2020-10-03	5.701405	NA
hospital-admissions	smoothed_covid19_from_claims	24033	2020-10-04	5.827876	NA
hospital-admissions	smoothed_covid19_from_claims	24033	2020-10-05	5.878814	NA
hospital-admissions	smoothed_covid19_from_claims	24033	2020-10-06	5.760586	NA

```
vis_moco_hhs_hospital <- moco_hhs_hospital %>% select(data_source ,signal, geo_value, time_value,value,
knitr::kable(head(vis_moco_hhs_hospital),caption = "Estimated percentage of new hospital admissions with
```

Table 8: Estimated percentage of new hospital admissions with
COVID-associated diagnoses for Montgomery County

data_source	signal	geo_value	time_value	value	sample_size
hospital-admissions	smoothed_covid19_from_claims	24031	2020-10-01	4.081688	NA
hospital-admissions	smoothed_covid19_from_claims	24031	2020-10-02	4.357004	NA
hospital-admissions	smoothed_covid19_from_claims	24031	2020-10-03	4.675541	NA
hospital-admissions	smoothed_covid19_from_claims	24031	2020-10-04	5.113851	NA
hospital-admissions	smoothed_covid19_from_claims	24031	2020-10-05	5.646182	NA
hospital-admissions	smoothed_covid19_from_claims	24031	2020-10-06	6.104618	NA

```
#looking at "Cumulative number of confirmed deaths due to COVID-19" from the JHU data
vis_pg_jhu_deaths <- pg_jhu_deaths %>% select(data_source ,signal, geo_value, time_value,value, sample_s
knitr::kable(head(vis_pg_jhu_deaths),caption = "Cumulative number of confirmed deaths due to COVID-19 fo
```

Table 9: Cumulative number of confirmed deaths due to COVID-19
for Prince George's County

data_source	signal	geo_value	time_value	value	sample_size
jhu-csse	deaths_cumulative_num	24033	2020-10-01	828	NA
jhu-csse	deaths_cumulative_num	24033	2020-10-02	827	NA
jhu-csse	deaths_cumulative_num	24033	2020-10-03	828	NA

data_source	signal	geo_value	time_value	value	sample_size
jhu-csse	deaths_cumulative_num	24033	2020-10-04	830	NA
jhu-csse	deaths_cumulative_num	24033	2020-10-05	830	NA
jhu-csse	deaths_cumulative_num	24033	2020-10-06	831	NA

```
vis_moco_jhu_deaths <- moco_jhu_deaths %>% select(data_source ,signal, geo_value, time_value,value, samp
knitr::kable(head(vis_moco_jhu_deaths),caption = "Cumulative number of confirmed deaths due to COVID-19
```

Table 10: Cumulative number of confirmed deaths due to COVID-19 for Montgomery County

data_source	signal	geo_value	time_value	value	sample_size
jhu-csse	deaths_cumulative_num	24031	2020-10-01	850	NA
jhu-csse	deaths_cumulative_num	24031	2020-10-02	851	NA
jhu-csse	deaths_cumulative_num	24031	2020-10-03	849	NA
jhu-csse	deaths_cumulative_num	24031	2020-10-04	849	NA
jhu-csse	deaths_cumulative_num	24031	2020-10-05	850	NA
jhu-csse	deaths_cumulative_num	24031	2020-10-06	850	NA

The Census ACS 2020 data provides data on racial makeup of each of our counties. For this study we looked at White, Black and Latino. A chi-squared test was performed for each pair or proportions to test equality. All three were statistically significantly not equal but the Latino difference was much less extreme. The proportions there were approximately 18.8% for Prince George's County and 19.5% for Montgomery County. On the other hand the proportion of Prince George's County that is Black is approximately 62.2% and for Montgomery County it is only 18.5%. Such a difference could very well be an explanation for why COVID-19 impacts Prince George's County differently than Montgomery County.

```
# What happens here depends on the specific project
#Chi-squared test to determine if the difference between the proportions of the Black population in Pri
sig <- prop.test(x = c(census_pg$Black, census_moco$Black), n = c(census_pg$pop, census_moco$pop))
sig
```

```
##
##  2-sample test for equality of proportions with continuity correction
##
## data:  c(census_pg$Black, census_moco$Black) out of c(census_pg$pop, census_moco$pop)
## X-squared = 391709, df = 1, p-value < 2.2e-16
## alternative hypothesis: two.sided
## 95 percent confidence interval:
##  0.4356777 0.4381652
## sample estimates:
##    prop 1    prop 2
## 0.6215709 0.1846494
```

```
sig2 <- prop.test(x = c(census_pg$Latino, census_moco$Latino), n = c(census_pg$pop, census_moco$pop))
sig2
```

```
##
##  2-sample test for equality of proportions with continuity correction
```

```
## 
## data:  c(census_pg$Latino, census_moco$Latino) out of c(census_pg$pop, census_moco$pop)
## X-squared = 172.45, df = 1, p-value < 2.2e-16
## alternative hypothesis: two.sided
## 95 percent confidence interval:
##  -0.008515242 -0.006304075
## sample estimates:
##    prop 1    prop 2
## 0.1879016 0.1953113
```

```r
sig3 <- prop.test(x = c(census_pg$White, census_moco$White), n = c(census_pg$pop, census_moco$pop))
sig3
```

```
## 
##  2-sample test for equality of proportions with continuity correction
## 
## data:  c(census_pg$White, census_moco$White) out of c(census_pg$pop, census_moco$pop)
## X-squared = 264803, df = 1, p-value < 2.2e-16
## alternative hypothesis: two.sided
## 95 percent confidence interval:
##  -0.3526324 -0.3501925
## sample estimates:
##    prop 1    prop 2
## 0.1609355 0.5123480
```

Analysis

For all of the gathered variables I looked at the rate of them over time compared between the two counties. The Facebook survey data as a whole tends to look more erratic than the other data sources. This is most likely a result of how the survey was conducted and the estimation process used for the data.

First we have the positive proportion of PCR tests for both Prince George's County and Montgomery County. At all times the Prince George's line is higher than the Montgomery line. In addition, two of the times we see a spike in the Montgomery line, mid-October and mid-November, we see a correlating larger spike in the Prince George's line. There is a spike in early December for Montgomery that is not reciprocated by Prince George's but this could be a result of the very large spike for Prince George's in late November leading to under-testing in early to mid December. Throughout the time period we see Prince George's having a higher proporiton of positive PCR tests, which should correlate with a higher rate of COVID-19.

```r
#Graph of PCR positive proportion over time for Prince George's County vs Montgomery County
pos_pg <- pg_pcr_pos %>%
  group_by(time_value, value)
pos_moco <- moco_pcr_pos %>%
  group_by(time_value, value)
pos <- ggplot()+geom_line(data=pos_pg, aes(time_value,value), color="blue") +
  geom_line(data=pos_moco, aes(time_value,value), color="black") + labs(title= "PCR Positive Test Propor
pos
```

## PCR Positive Test Proportion Over Time
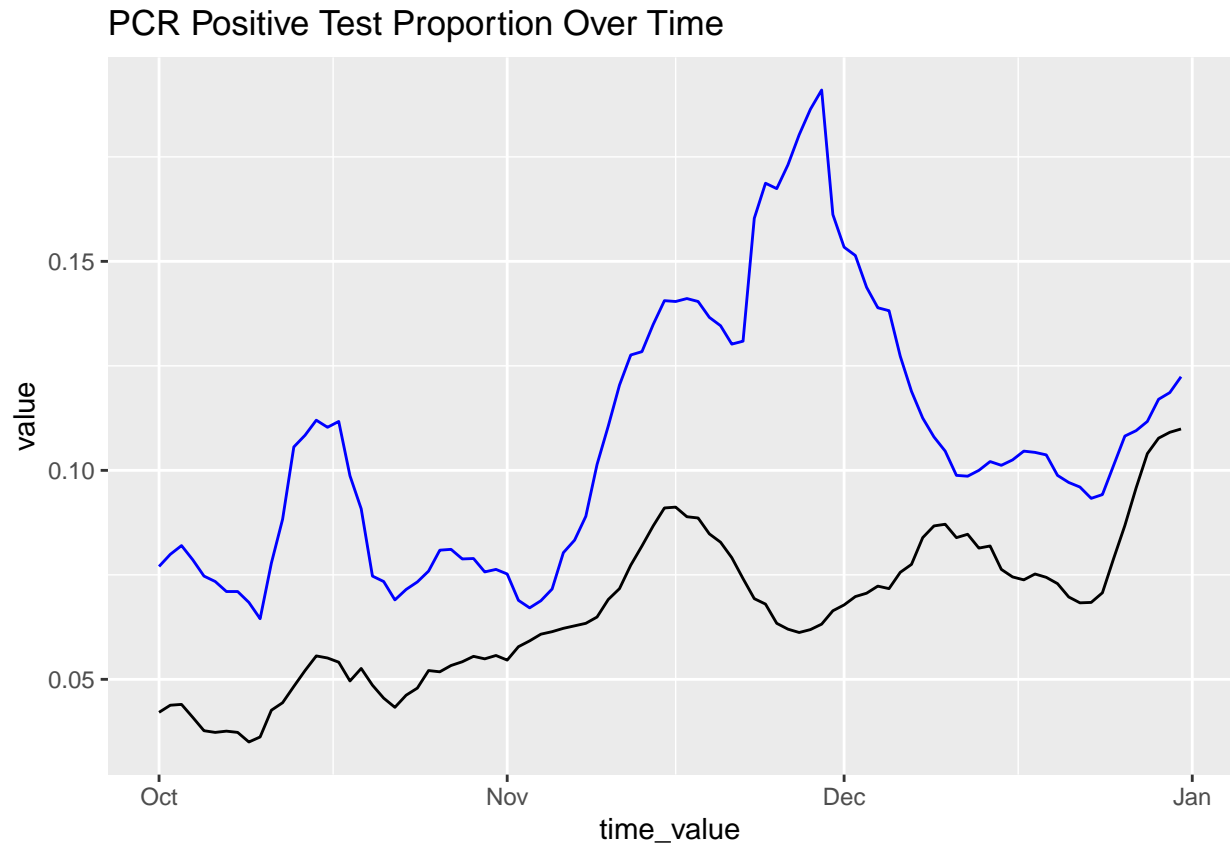
In comparison with the PCR proportion, the estimated proportion of people with COVID-like illnesses from the Facebook survey shows the two counties closer together for large section of the three month period. We do still see areas where Prince George's county is higher, early to mid October and both early and mid December, but outside of those the lines are much closer to each other.

```
fb_pg <- pg_fb_pos %>%
  group_by(time_value, value)
fb_moco <- moco_fb_pos %>%
  group_by(time_value, value)
pos_fb <- ggplot()+geom_line(data=fb_pg, aes(time_value,value), color="blue") +
  geom_line(data=fb_moco, aes(time_value,value), color="black") + labs(title= "Estimated Proportion of
pos_fb
```

Estimated Proportion of People with COVID–like Illnesses
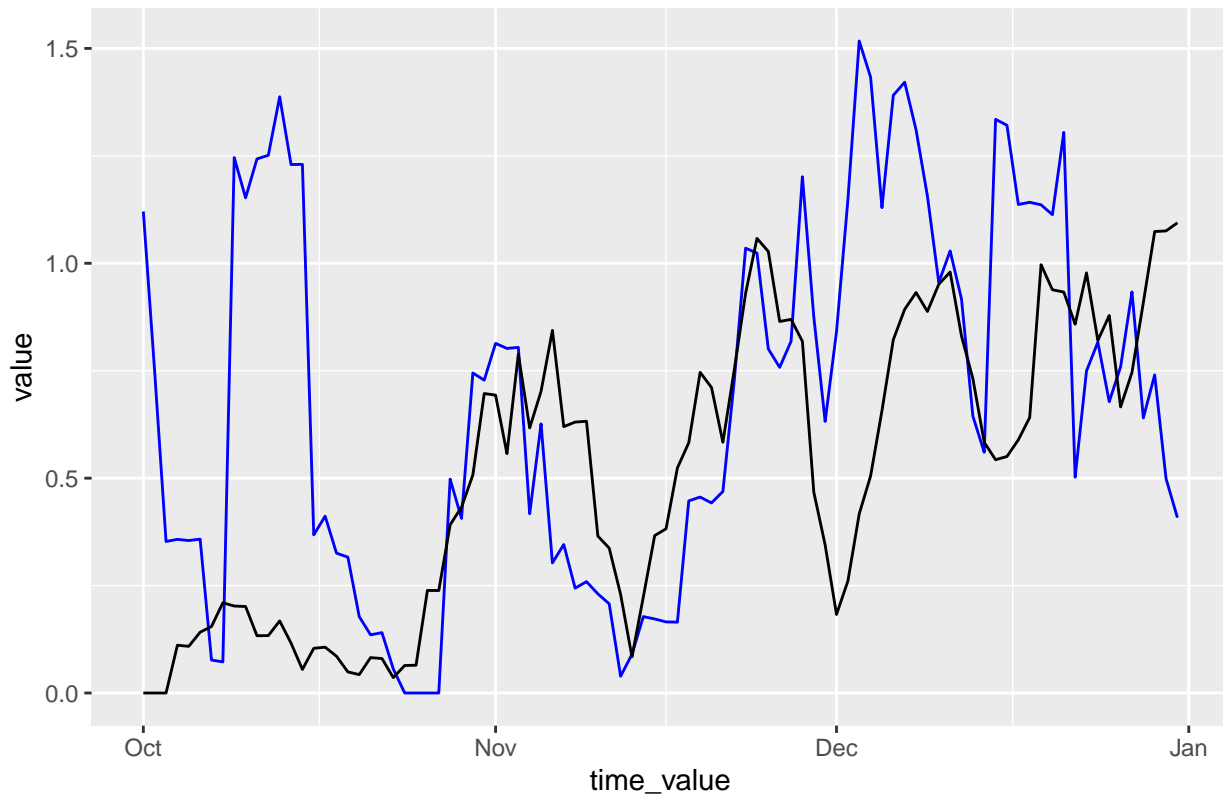
With percentage of people who used public transit in the past day we see a graph where neither county is consistently on top. At times residents in Prince George's county look to ride public transit more and at other times residents in Montgomery county look to ride it more. As such this does not appear to be a good metric to judge the effects of COVID-19 by.

```
bus_pg <- pg_fb_bus %>%
  group_by(time_value, value)
bus_moco <- moco_fb_bus %>%
  group_by(time_value, value)
bus <- ggplot()+geom_line(data=bus_pg, aes(time_value,value), color="blue") +
  geom_line(data=bus_moco, aes(time_value,value), color="black") + labs(title= "Percentage of Respondent
bus
```

Percentage of Respondents Who Used Public Transit in the Past 24 Hours
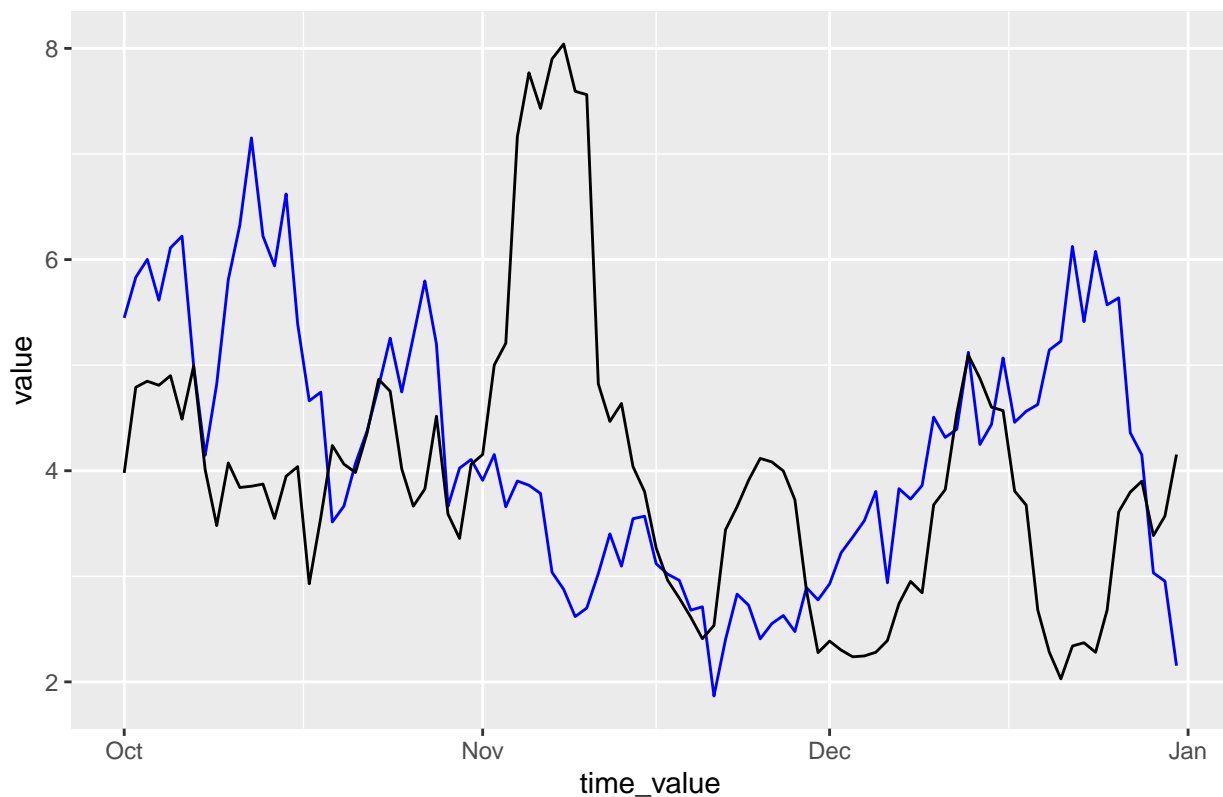
The variable looking at the percentage of respondents who felt anxious over the past 5 days differs from my hypothesis. I had assumed that we would see higher feelings of anxiety for those in Prince George's county due to lower median household income and the effects of systemic racism (Gravlee 2020). Instead we see residents of Montgomery county showcasing higher feelings of anxiety relatively consistently.

```
anxious_pg <- pg_fb_anxious %>%
  group_by(time_value, value)
anxious_moco <- moco_fb_anxious %>%
  group_by(time_value, value)
anxious <- ggplot()+geom_line(data=anxious_pg, aes(time_value,value), color="blue") +
  geom_line(data=anxious_moco, aes(time_value,value), color="black") + labs(title= "Estimated Percentage
anxious
```

Estimated Percentage of Respondents Who Felt Anxious Over the Past 5 Days
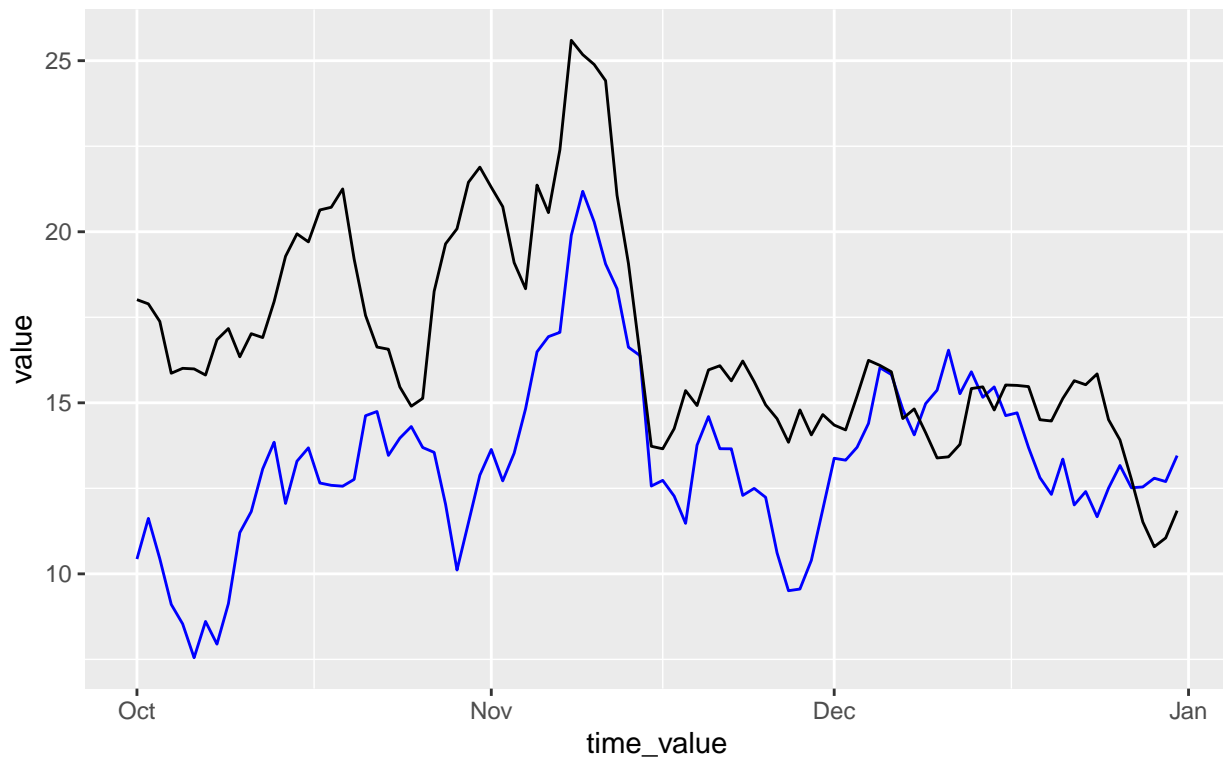
Across both counties we see high masking percentages. At various points both counties are masking more than the other but throughout the time period both are masking at an estimated 91% or better.

```
mask_pg <- pg_fb_mask %>%
  group_by(time_value, value)
mask_moco <- moco_fb_mask %>%
  group_by(time_value, value)
mask <- ggplot()+geom_line(data=mask_pg, aes(time_value,value), color="blue") +
  geom_line(data=mask_moco, aes(time_value,value), color="black") + labs(title= "Estimated Percentage o
mask
```

Estimated Percentage of Respondents Who Masked for Most of the Past 5 Days
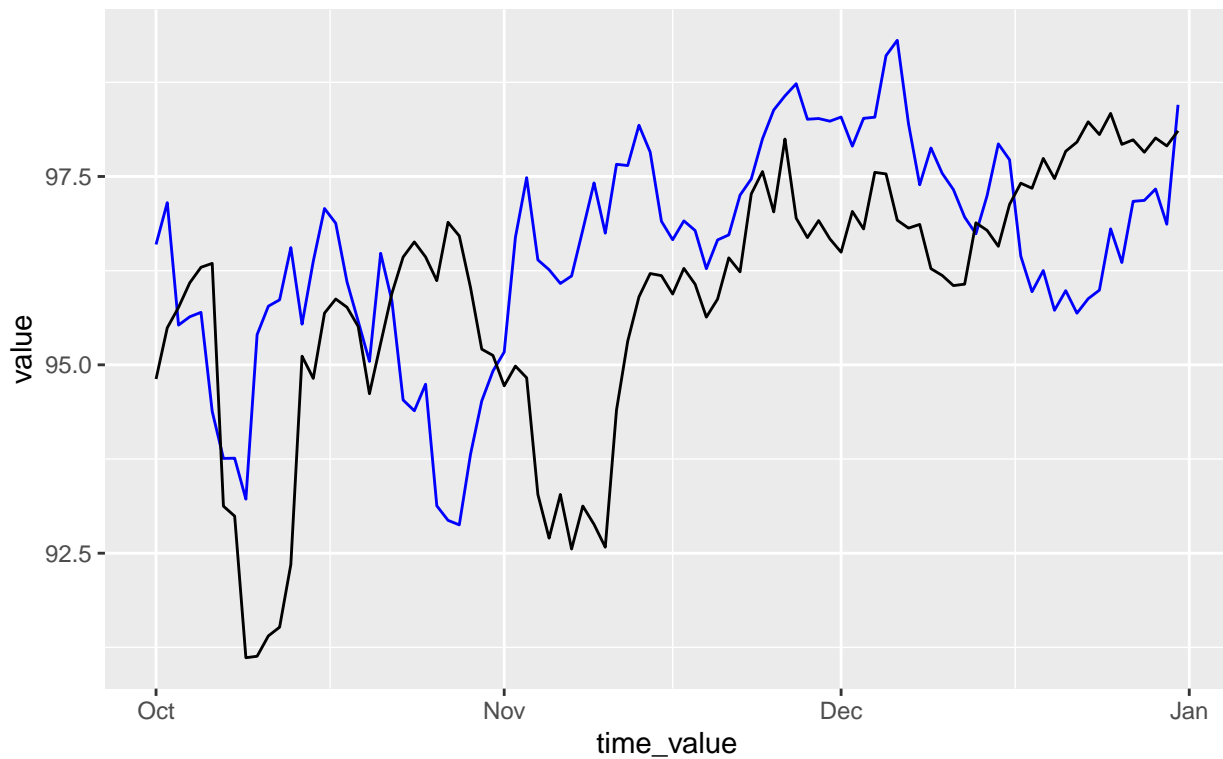
Over time both counties have a smaller percentage of residents working or going to school outside their home. But within that trend Prince George's county residents were outside their home for work or school more than Montgomery especially within the period of mid-November to mid-December.

```
out_pg <- pg_fb_out %>%
  group_by(time_value, value)
out_moco <- moco_fb_out %>%
  group_by(time_value, value)
out <- ggplot()+geom_line(data=out_pg, aes(time_value,value), color="blue") +
  geom_line(data=out_moco, aes(time_value,value), color="black") + labs(title= "Est. Percentage of Resp
out
```

Est. Percentage of Respondents Who Worked or Went to School Outside their Home
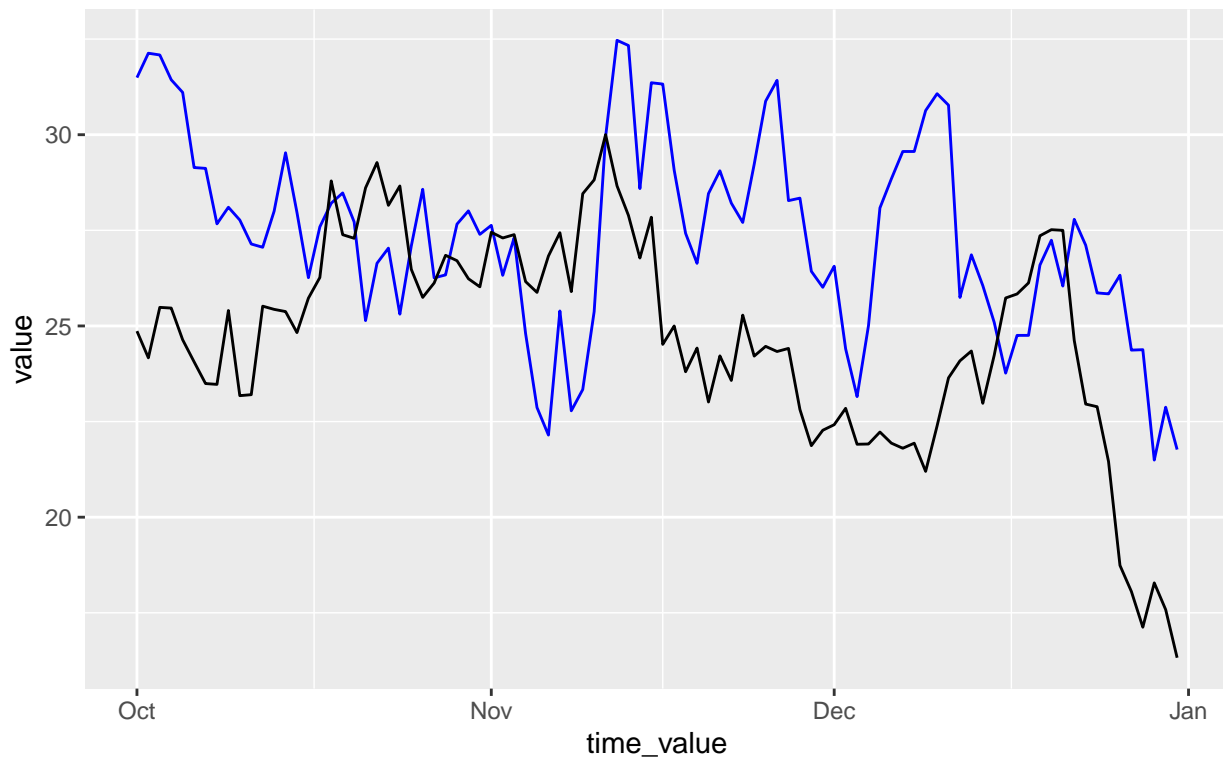
Residents of Prince George's county were more worried about their finances than those in Montgomery county. The spikes seem to correlate to the spikes shown in PCR positive tests as well for Prince George's county.

```
money_pg <- pg_fb_money %>%
  group_by(time_value, value)
money_moco <- moco_fb_money %>%
  group_by(time_value, value)
money <- ggplot()+geom_line(data=money_pg, aes(time_value,value), color="blue") +
  geom_line(data=money_moco, aes(time_value,value), color="black") + labs(title= "Est. Percentage of Res
money
```

Est. Percentage of Respondents Who are Worried about their Finaces Next Month
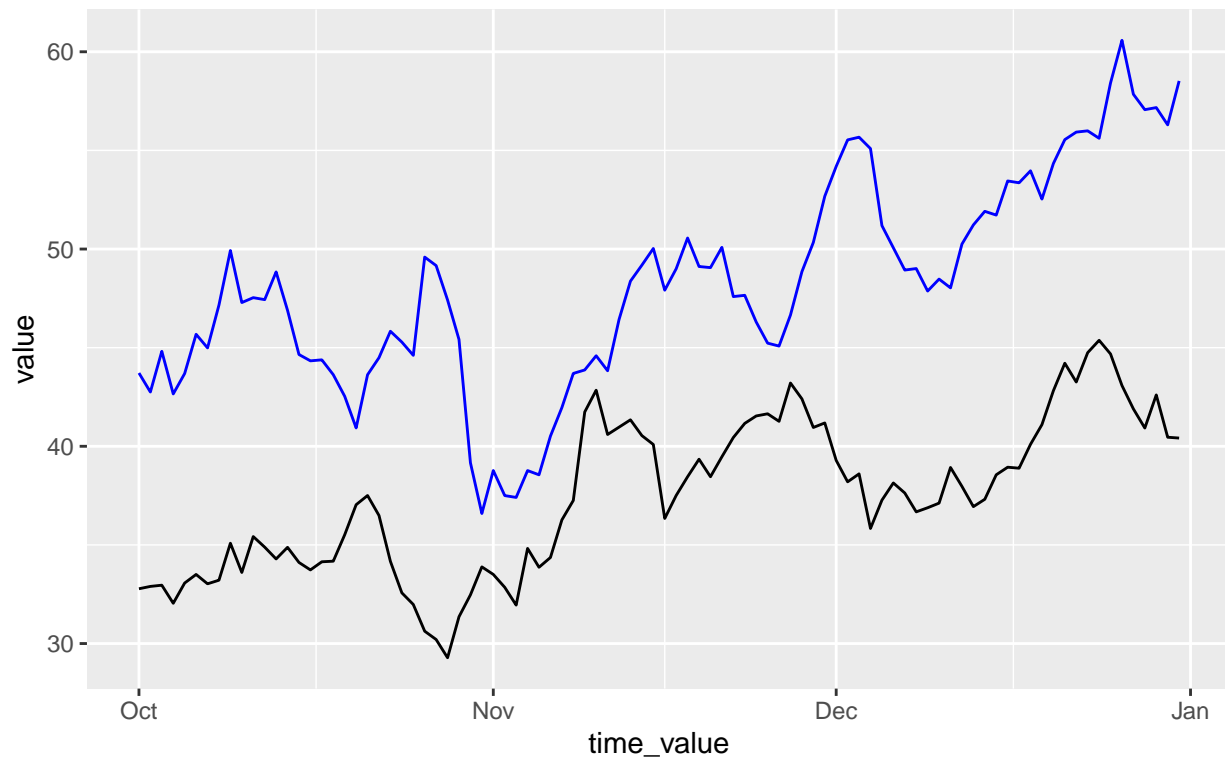
Both counties experience an increase in new hospital admissions over the time period, starting at approximately 5% at the start and between 11% to 16% towards the end. Within the time period we can see two major spikes for Prince George's county, in late-October and mid-December, with only the later spike being represented in Montgomery county as well.

```
hospitals_pg <- pg_hhs_hospital %>%
  group_by(time_value, value)
hospitals_moco <- moco_hhs_hospital %>%
  group_by(time_value, value)
hospitals <- ggplot()+geom_line(data=hospitals_pg, aes(time_value,value), color="blue") +
  geom_line(data=hospitals_moco, aes(time_value,value), color="black") + labs(title= "Est. Percentage o
hospitals
```

Est. Percentage of New Hospital Admissions with COVID−Associated Diagnoses
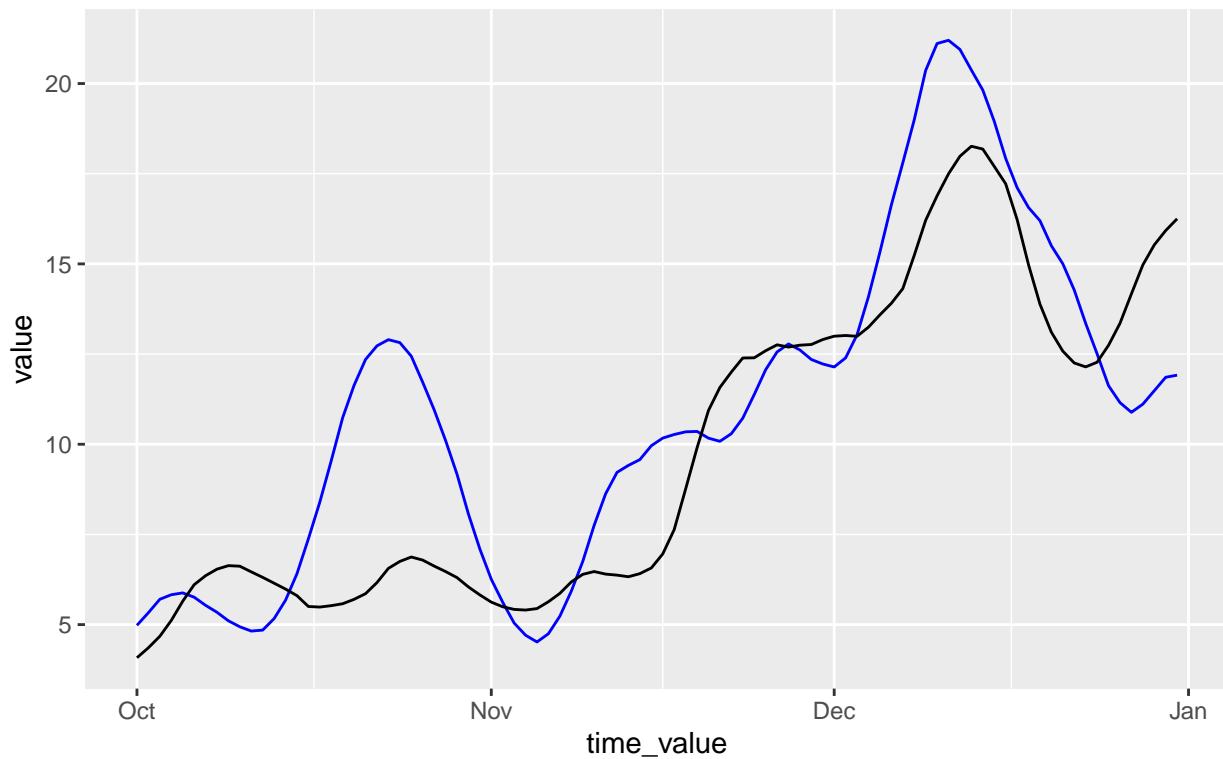
For cumulative death rates, both counties follow roughly the same slope trajectory with Montgomery county having a consistently higher cumulative death toll throughout the time period.

```
deaths_pg <- pg_jhu_deaths %>%
  group_by(time_value, value)
deaths_moco <- moco_jhu_deaths %>%
  group_by(time_value, value)
deaths <- ggplot()+geom_line(data=deaths_pg, aes(time_value,value), color="blue") +
  geom_line(data=deaths_moco, aes(time_value,value), color="black") + labs(title= "Cumulative number of
deaths
```

Cumulative number of confirmed deaths due to COVID−19
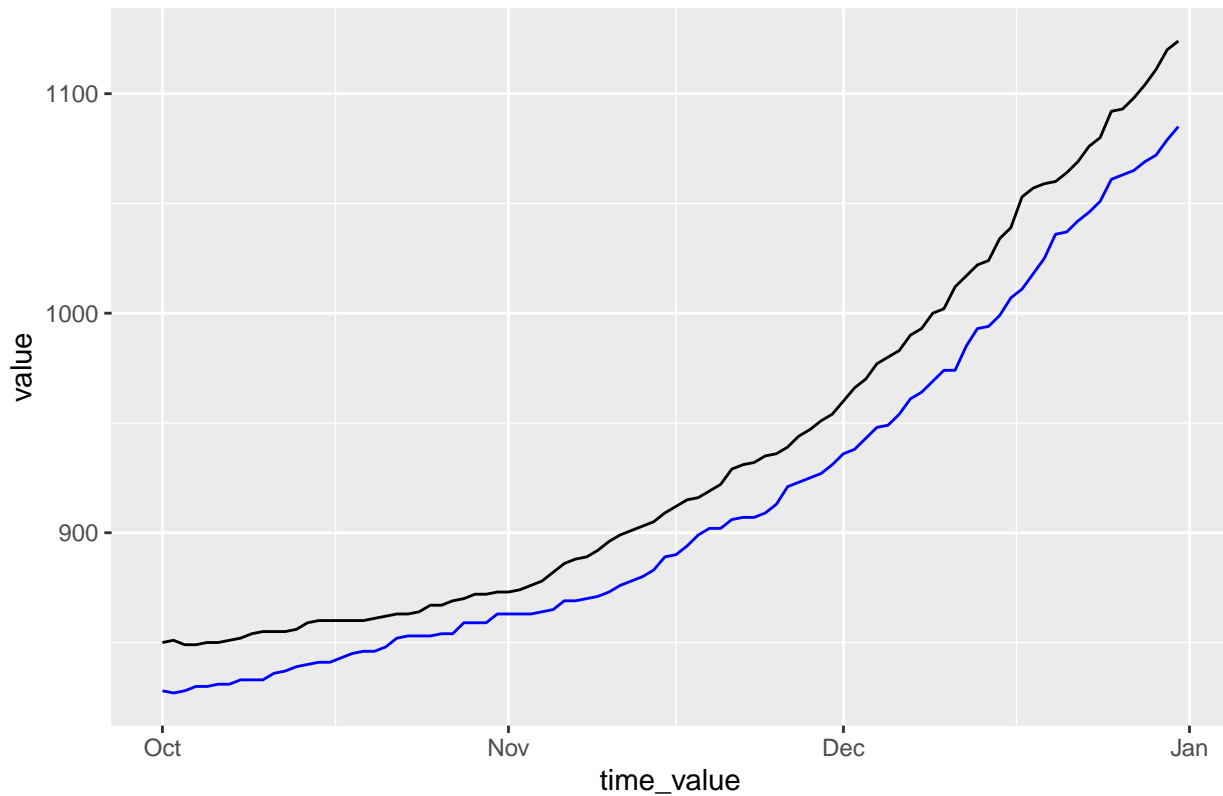
When adjusted to per 100,000 people we see that Prince George's county has the higher death rate throughout the time period.

```
prop_pg <- pg_jhu_prop %>%
  group_by(time_value, value)
prop_moco <- moco_jhu_prop %>%
  group_by(time_value, value)
prop <- ggplot()+geom_line(data=prop_pg, aes(time_value,value), color="blue") +
  geom_line(data=prop_moco, aes(time_value,value), color="black") + labs(title= "Cumulative number of co
prop
```

Cumulative number of confirmed deaths due to COVID−19, per 100,000 population
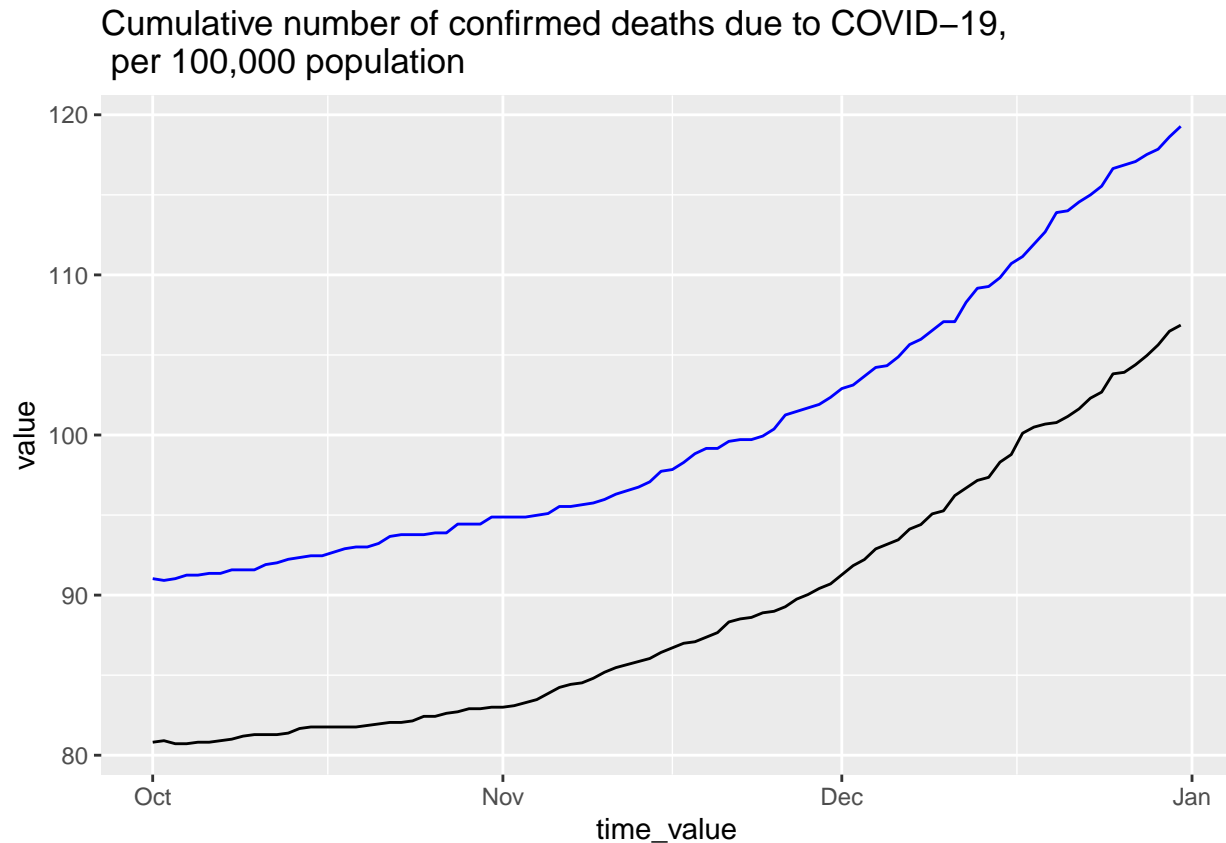
Discussion

For the time period of October 1st, 2020 through December 31st, 2020 we see the residents of Prince George's county being impacted more by COVID-19 then those in Montgomery county. Positive test rates, hospitalization and adjusted death rates were all higher for those in Prince George's county. One possible explanation is that Prince George's county has a higher proportion of Black residents.

A limitation of this paper is that the data used from the Facebook survey does not provide exactly what is needed in order to make anything stronger than inferences. While the residents in Prince George's county were more worried about finances consistently than those in Montgomery, for every other metric looked at the differences were either much smaller or varied between which county had a higher percentage.

References

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Kim, Sage J., and Wendy Bostwick. 2020. "Social Vulnerability and Racial Inequality in COVID-19 Deaths in Chicago." *Health Education & Behavior* 47 (4).