Report

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Abstract

COVID-19 is a global pandemic with mortality rates comparable to those of other major diseases, calling for a need for effective prevention and treatment strategies. We used the dataset collected by Center for Disease Control (CDC) to study COVID-19, and several factors in this dataset such as states, age groups, or co-existing conditions were analyzed. To analyze this dataset, a time series plot was created for purposes of temporal and condition group differences and a spatial mapping of COVID-19 deaths over states was created. Given the non-linear temporal and spatial trends discovered in the initial analysis of the dataset, a generalized linear model was used to model the COVID-19 deaths from the factors in the dataset.

Background

COVID-19, caused by the novel coronavirus SARS-CoV-2, has caused a global pandemic with significant morbidity and mortality. Understanding the factors contributing to COVID-19 deaths is crucial for developing effective prevention and treatment strategies.

Several factors have been identified as being associated with an increased risk of COVID-19 death. These include older age, male gender, certain underlying health such as obesity, hypertension, and diabetes, as well as certain racial and ethnic groups.

Other factors that may contribute to COVID-19 deaths include inadequate access to healthcare, lack of timely diagnosis and treatment, and inadequate infection control measures in healthcare settings. The effectiveness of public health interventions, such as mask-wearing and social distancing, may also play a role in the risk of COVID-19 death.

Additionally, the severity of the COVID-19 pandemic may vary based on the specific strain of SARS-CoV-2 and the presence of comorbidities and other health conditions. The impact of COVID-19 on individuals and populations may also be influenced by social determinants of health, such as poverty, overcrowding, and limited access to healthcare.

Overall, a combination of individual and societal factors contribute to the risk of COVID-19 death. Further research is needed to better understand these factors and develop effective strategies to reduce morbidity and mortality associated with COVID-19. In this study, we used data from the Center for Disease Control (CDC) to explore a few of the aforementioned factors contributing to COVID-19 death.

Data

The data were collected by the Center for Disease Control (CDC), and included a number of demographic variables. The full list of variables is included in the data dictionary included in the GitHub repository. The particular variables of interest are the Number of COVID-19 Deaths within the specified groups, as well as the Co-Existing Conditions within the patients. Other variables of interest are the State wherein the deaths occurred, the time (in months since Dec 2019) that the deaths occurred, and the Age Group of the individuals with COVID-19. The primary exposure of interest is considered to be the other conditions exhibited by the patients, with the other being considered primarily as variables that need to be controlled for, as they are additionally associated with the outcome variable.

In regards to the primary outcome of interest, we additionally noted the significant amount of missing data. This was due to NCHS guidelines, which required death counts under 10 to be replaced with missing values, as values that were too low could be considered as identifying information. These values were imputed from a uniform distribution, which drew from integer values between 1 and 9, as these were the only possible values that would have been replaced with missing values.

Exploratory Analyses

Temporal and Condition Group Differences

Given the particular interest in the differences in COVID-19 Mortality among the differing conditions, an exploratory analysis was conducted into the relationship between the COVID-19 Death counts and the coexisting conditions that were present in the patients. In order to visualize this relationship, a time series plot was created for the number of COVID-19 Deaths that occurred in each condition group across 35 months (January 2020 - November 2022). These values were aggregated over the Age Groups and the State in which the deaths occurred, as this exploratory analysis is primarily concerned with the differences among the condition groups. This time series plot can be found in the appendix (Figure 1).

The time series plot shows a clear difference between the condition groups, with two groupings of co-existing conditions having significantly higher counts of COVID-19 Deaths than the others. Particularly, co-existing conditions that fall into the categories "Respiratory Diseases" and "Circulatory Diseases" have significantly more COVID-19 deaths than any other category. This suggests that these different groupings of conditions have an impact on an individual's likelihood of dying to COVID-19.

In addition, we can see a very clear temporal trend in the count of COVID-19 Deaths, corresponding to different waves of the COVID-19 pandemic, as well as different strains of the SARS-CoV-2 virus. Notably, we can see that the temporal trend is not linear, i.e. there are spikes at varying points in time, corresponding to a variety of events during the pandemic, including new strains of the virus and vaccine rollouts. This non-linearity in the temporal trend may suggest that using a linear spline - or some other non-linear model for time - may be beneficial in our model.

Spatial Analyses

In addition to the temporal effects, an exploratory analysis was conducted into the spatial effects, namely how nearby states were related to each other. This was of particular interest due to the nature of infectious disease spread, and we considered it likely that nearby areas (in this case, States) would be correlated. As such, the COVID-19 deaths by each state, aggregated over all other explanatory variables, was plotted over time. In addition, the response variable was considered as a rate (COVID-19 Deaths per 100000) rather than a count for this exploratory analysis, in order to avoid the more populous states (New York, California, etc.) from dominating the visualization. A few of the months (April 2020 - October 2022, increments of 6 months) are given in the appendix (Figure 2).

Regression Modeling

Given the exploratory analyses, a few things were clear - first, there is indeed an association between the primary exposure variable, Condition Group, and the count of COVID-19 deaths experienced. Furthermore, there are indeed both spatial and temporal trends exhibited in the count of COVID-19 deaths, both of which will need to be accounted for in our regression modeling. Given the notable non-linearity in the temporal trend, a linear spline with knots at 4, 9, 13, 18, 21, 23, and 25 months was used in order to capture this non-linearity. The spatial trend was done simply by considering the State as a categorical factor in the linear regression model. This does not capture the entire spatial trend, i.e. the correlation exhibited between nearby states, but including a full spatial model while also including the other effects proved to be beyond the scope of this project.

Thus, we have identified our linear regression model as using COVID-19 Deaths as the sole response variable, with time, Condition Group, Age Group, and State being considered as predictor variables. Additionally, there is the consideration of a link function. In this case, the natural choice is that of a Poisson link function, or a log link, for the COVID-19 Deaths, as the deaths due to COVID-19 is a count variable. The model was adjusted to use this log link, as opposed to no link function (i.e. a Normally distributed outcome variable), in order to more accurately predict the outcome. The issue with assuming a Poisson distribution, however, is overdispersion - since a Poisson distribution is defined by the property $E(Y) = Var(Y) = \mu$, then if the variance of the outcome does not have equal mean and variance, then the outcome cannot be assumed to be Poisson distributed. This model was tested for overdispersion, and it was indeed found that the outcome variable could not be assumed to be Poisson ($p < 0.0001$). To correct this, a Negative Binomial link was instead assumed, which is similarly useful for outcomes that are count variables without the issue of overdispersion.

A few other modeling approaches were considered, namely GEE and GLMM, but were ultimately not moved forward with. Thus, our final model is a Generalized Linear Model with a linear spline for time at the aforementioned knots, as well as a Negative Binomial distribution for the outcome with a log link function.

After fitting our final model, there are a number of things that we wish to note. Firstly, we note that the parameter estimate for the linear spline of time changes quite a bit between each knot, suggesting that there is indeed a large difference in the slope between these given time points - indeed, we knew this to be the case from the exploratory analyses. Furthermore, using Alzheimer's Disease as the reference group, we did confirm our suspicion from the exploratory analysis that Respiratory Diseases were associated with the greatest increase in risk of COVID-19 death ($\beta = 1.7996$), which corresponds to a multiplicative increase of 6.047 in the count of COVID-19 Deaths when compared to the group with Alzheimer's disease, holding all other factors constant. Interestingly, Diabetes was the group with the second largest increase in COVID-19 Death count ($\beta = 1.6435$), which corresponds to a multiplicative increase of 5.173 in COVID-19 Death count over the group with Alzheimer's disease, holding all else constant. This is surprising because Diabetes was well beneath both Respiratory Diseases and Circulatory diseases in our exploratory analysis. A table including all of the effect sizes for the Condition Groups is included in the Appendix (Table 1).

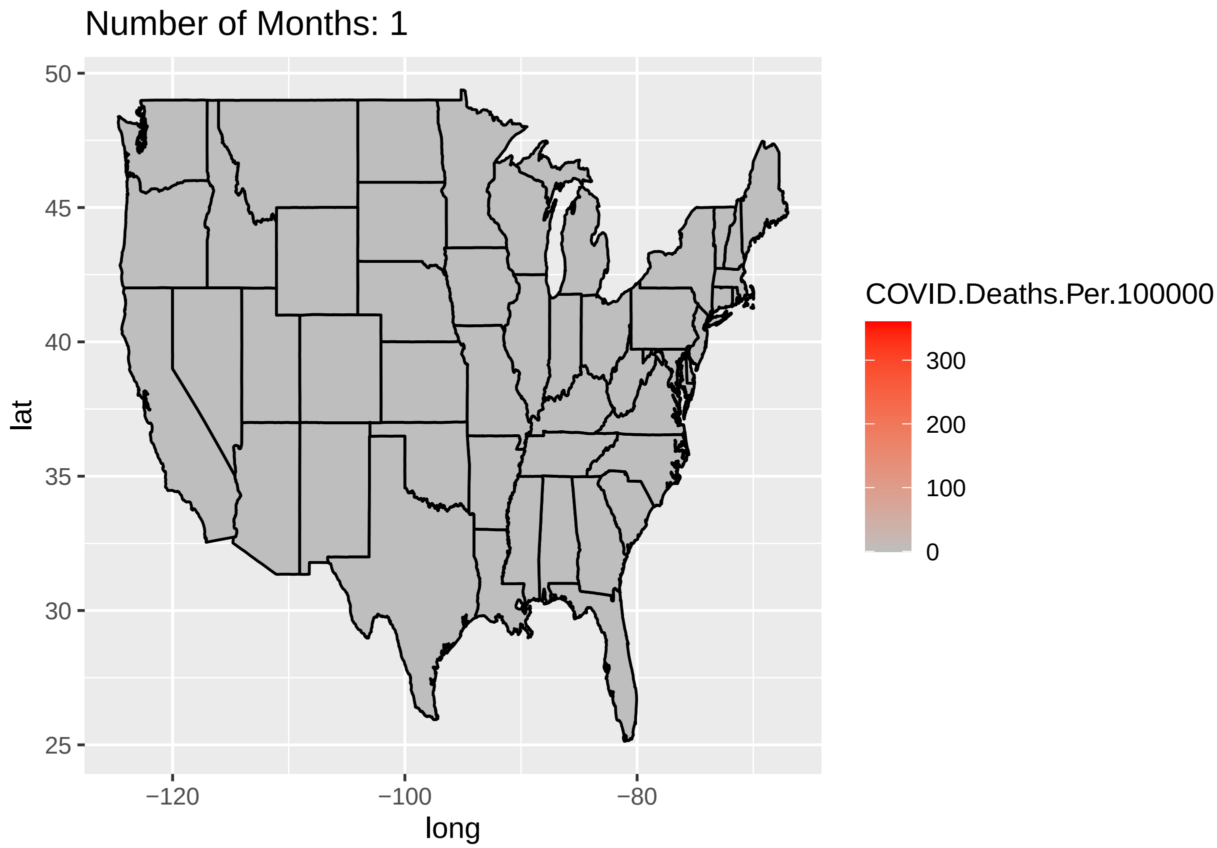
As for the other covariates of interest, the results were largely unsurprising. States with large population sizes (New York, California, etc.) were largely associated with an increased number of COVID-19 Deaths. This is primarily because the state population is so large, and as such we of course expect the raw counts of COVID-19 Deaths to be larger for these states. Ideally, rates would have been worked with instead (i.e. COVID-19 Deaths per 100000) in order to address this issue. However, while it is trivial to get population sizes by State, it is much more difficult to get group sizes for the other categories considered, and as such creating such a rate variable proved too difficult.

The Age Group variable was similarly unsurprising - lower age ranges were associated with lower expected counts of COVID-19 Deaths. Given the age group 0-24 as a reference, the count of COVID-19 Deaths increased with each age group, up to a an increase in the log expected death count of $\beta = 3.510$ at Age 85+, which corresponds to a multiplicative increase in COVID-19 Deaths of 33.448 in the Age Group 85+ when compared to that of the Ages 24 and under.

Conclusion

Appendix

```
## Read in the data
d.625 <- read.csv("C:/Users/s-edw/Downloads/Conditions_Contributing_to_COVID-19_Deaths__by_State_and_Age
d.625 <- d.625[d.625$Group == "By Month", ]
d.625 <- d.625[d.625$State != "United States", ]
d.625$totMonth <- (d.625$Year - 2020) * 12 + d.625$Month

###### POPULATION DATA FOR MAPPING RATES ######################################
## Get population data for each state
d.pop <- read.csv("Population Data.csv")
d.pop <- d.pop[, -c(2,3)]
d.pop <- mutate(d.pop, across('Population.Estimate..July.1..2021..POP_2021.', str_replace, ',', ''))
d.pop <- mutate(d.pop, across('Population.Estimate..July.1..2021..POP_2021.', str_replace, ',', ''))
# Necessary to do twice or else it will only remove one comma, and the following command will not be ab
d.pop[, 2] <- as.numeric(d.pop[, 2])

## Manipulate columns to merge neatly with ggplot state data
colnames(d.pop) <- c("region", "Population")
d.pop$region <- tolower(d.pop$region)

###### Mapping - Spatial analysis #############################################
## Mapping data
states <- map_data("state")
d.625.mapping <- d.625[d.625$Age.Group == "All Ages", -c(1:6, 10, 13, 14)]
d.625.mapping <- aggregate(COVID.19.Deaths ~ totMonth + State, data = d.625.mapping, FUN = sum)

## Aggregate New York and New York City
d.625.mapping$State[d.625.mapping$State == "New York City"] = "New York"
d.625.mapping <- aggregate(COVID.19.Deaths ~ State + totMonth, data = d.625.mapping, FUN = sum)

## Merge Datasets (population and states data)
d.625.mapping$region <- tolower(d.625.mapping$State)

d.625.mapping <- merge(d.625.mapping, states, by = "region")
d.625.mapping <- merge(d.625.mapping, d.pop, by = "region")

## Create the COVID Deaths Per 100000 variable for plotting
d.625.mapping$COVID.Deaths.Per.100000 <- d.625.mapping$COVID.19.Deaths / (d.625.mapping$Population / 10

## Print all maps for each time point - 2 second delay between maps
for (i in 1:35) {
  print(ggplot(d.625.mapping[d.625.mapping$totMonth == i, ], aes(x = long, y = lat, group = group)) + g
  Sys.sleep(2)
}
```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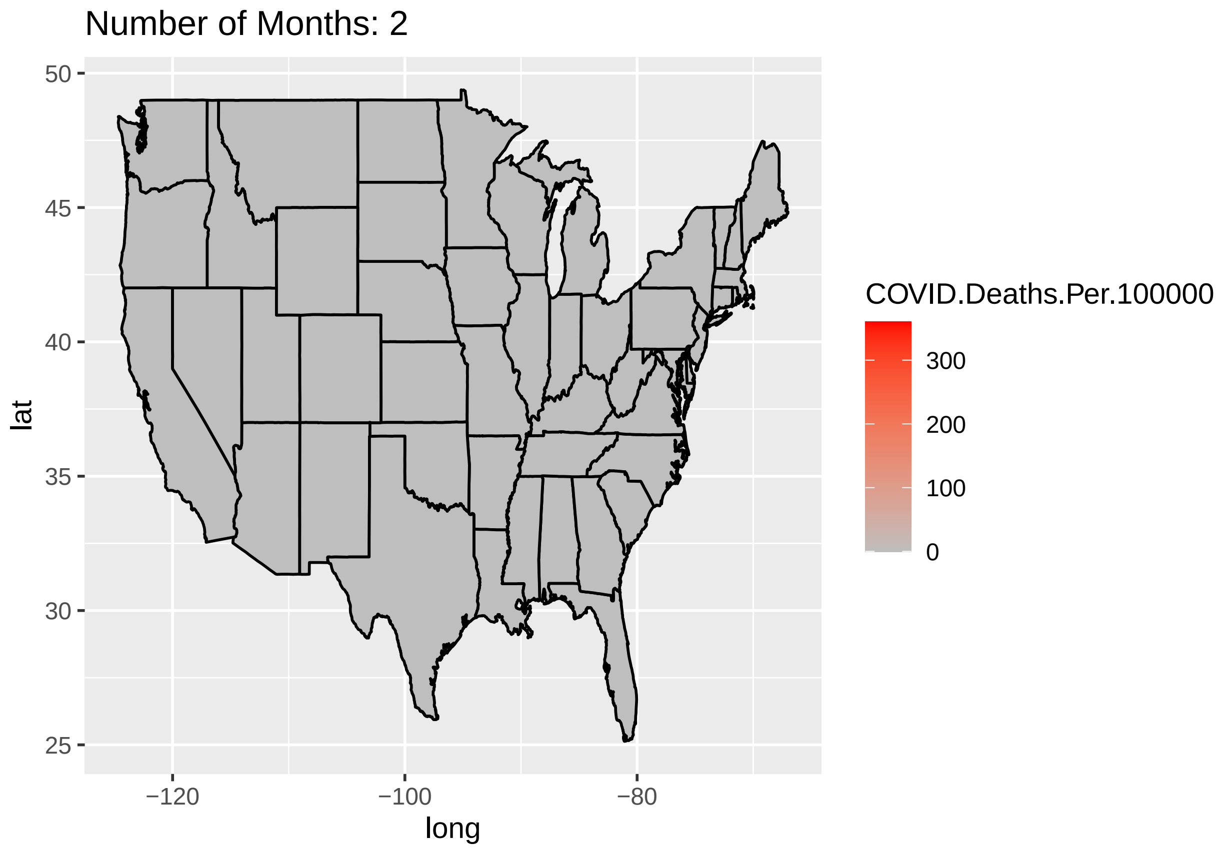

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long
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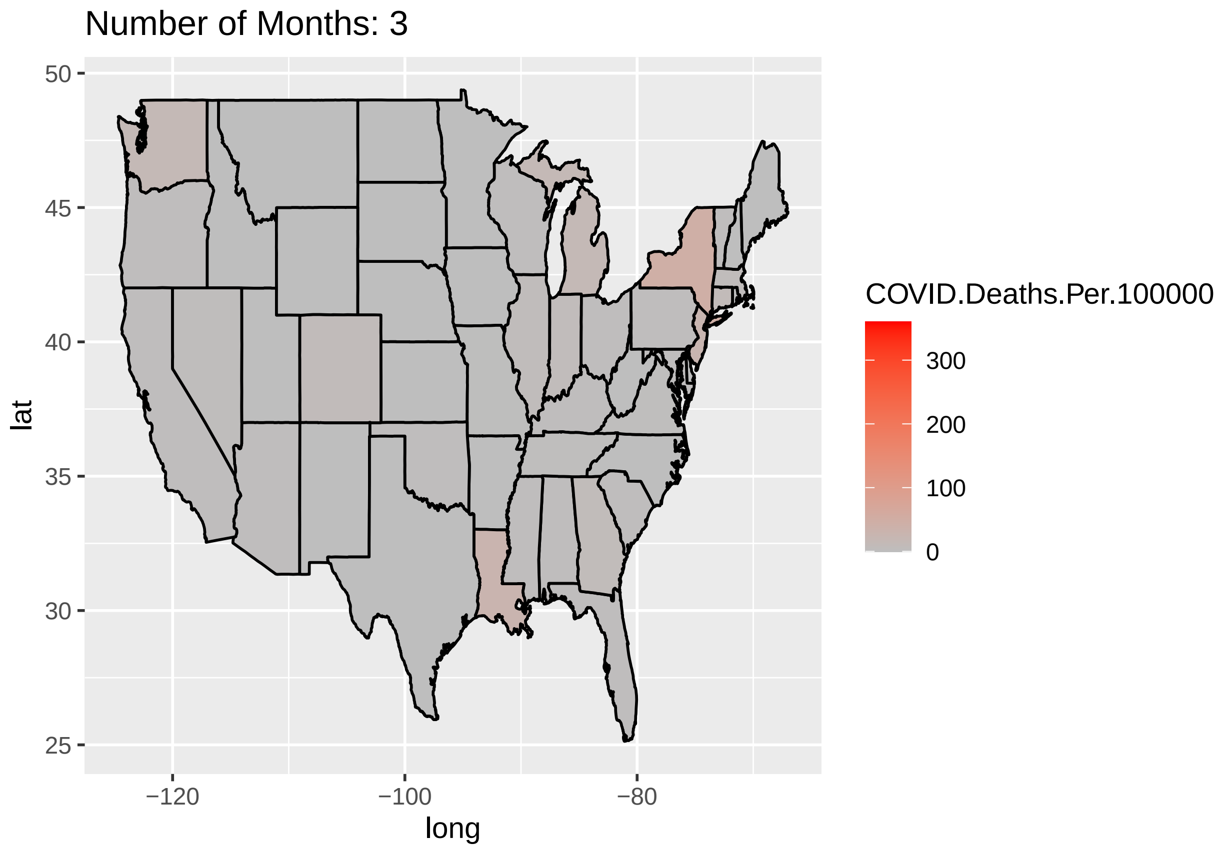
100
0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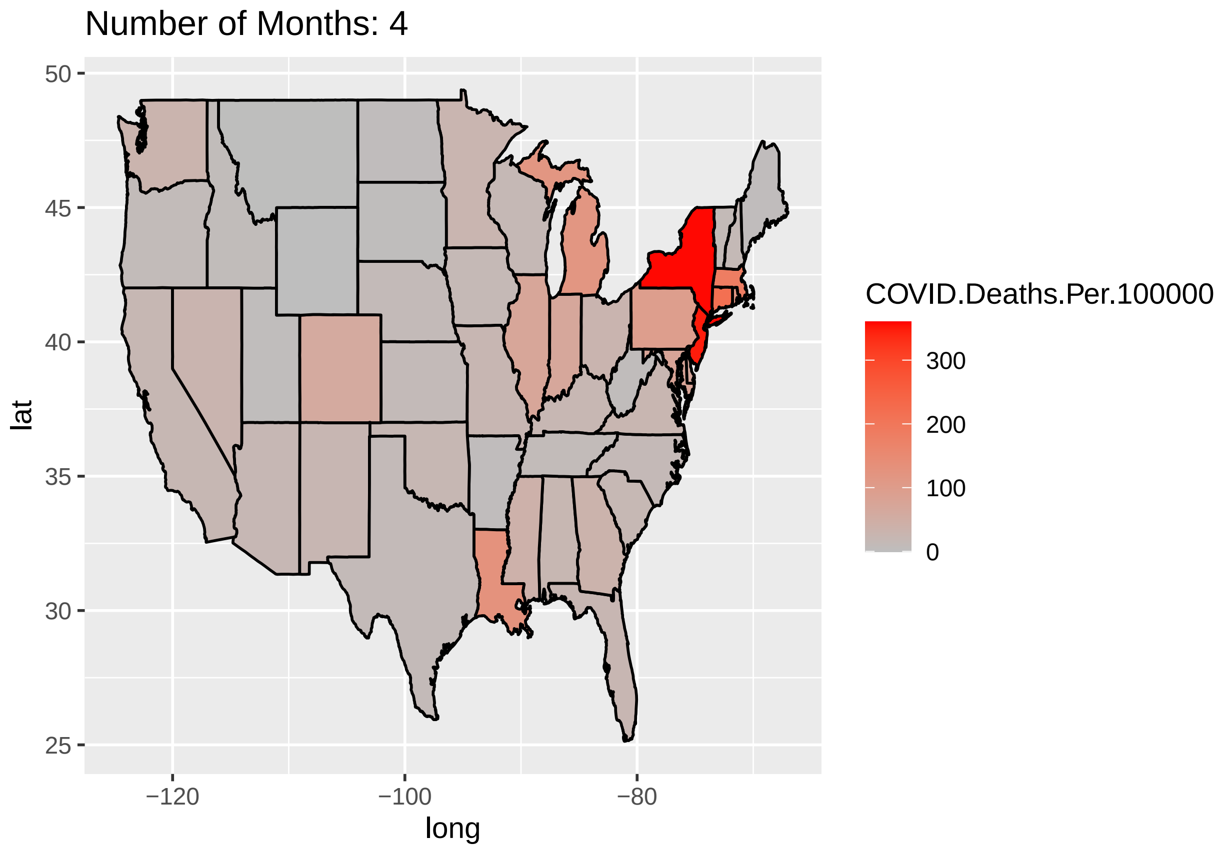

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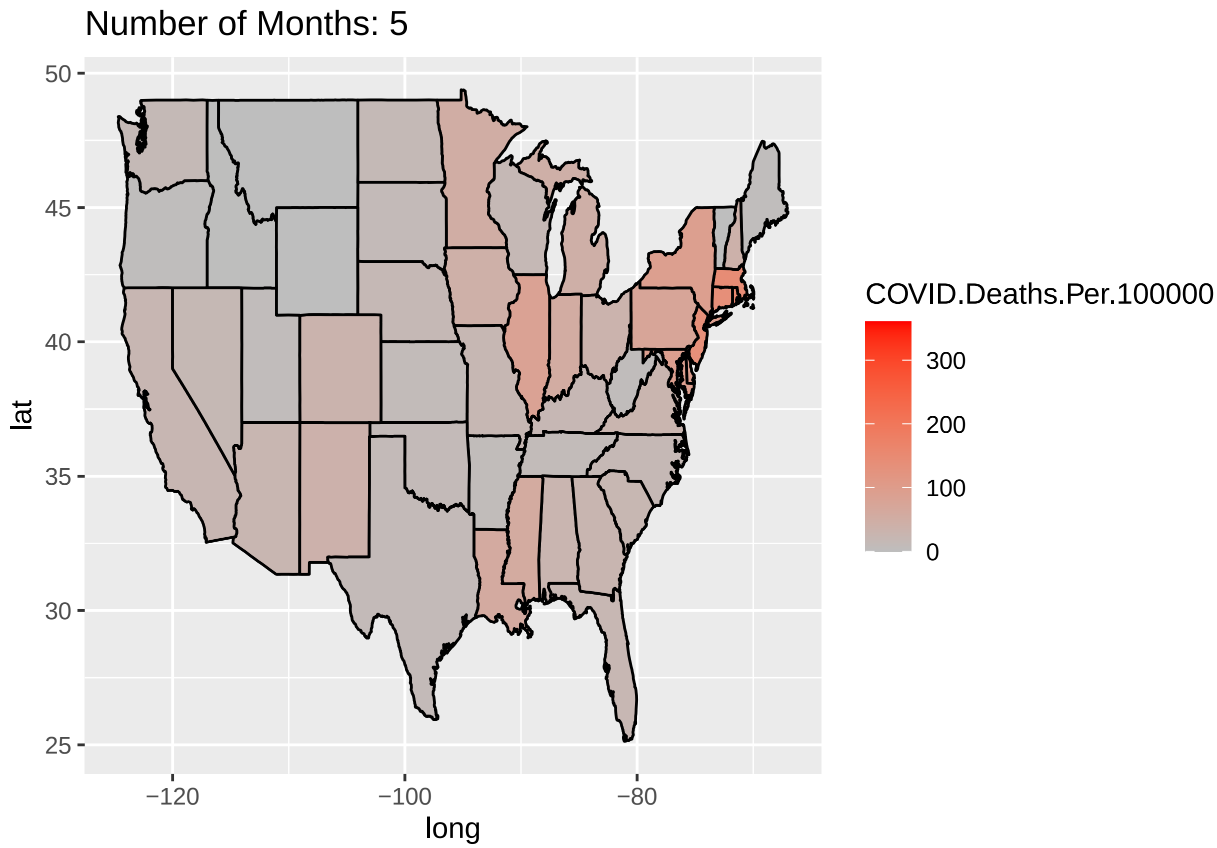
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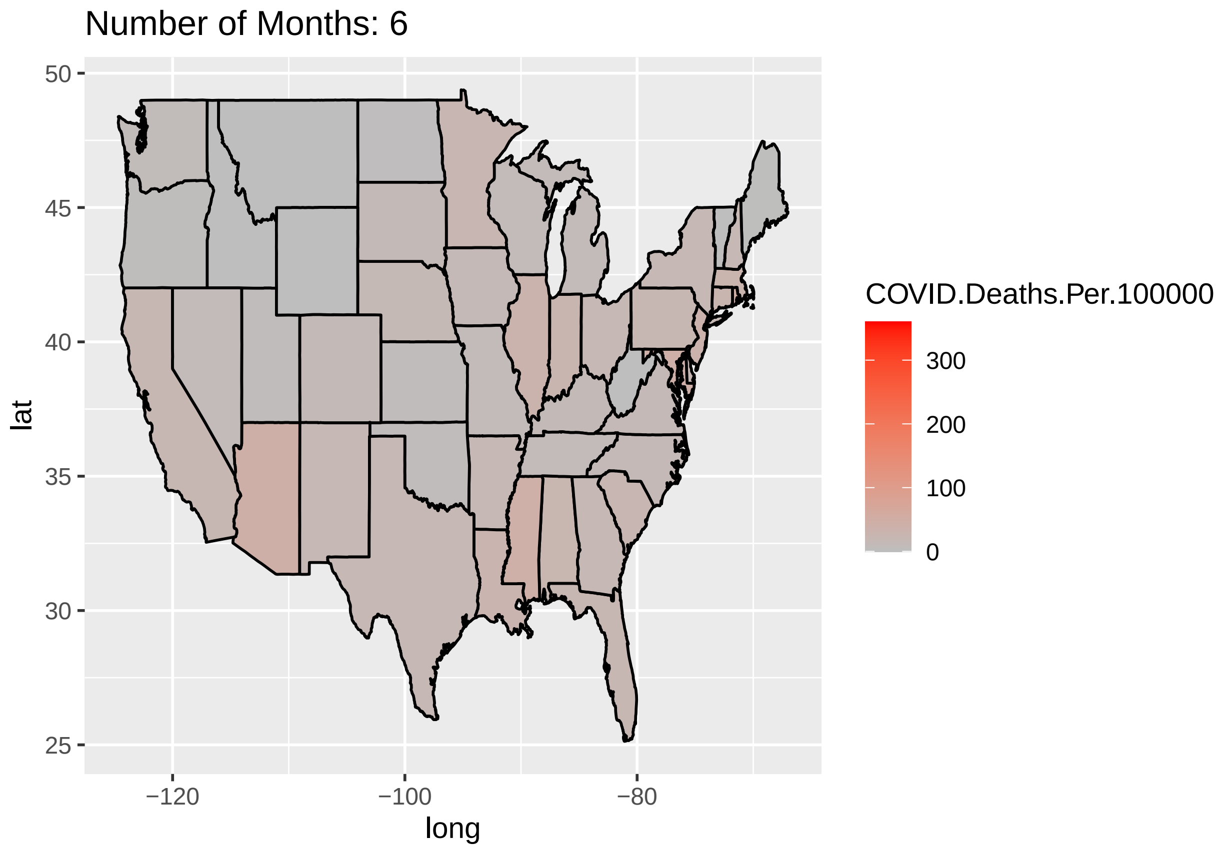

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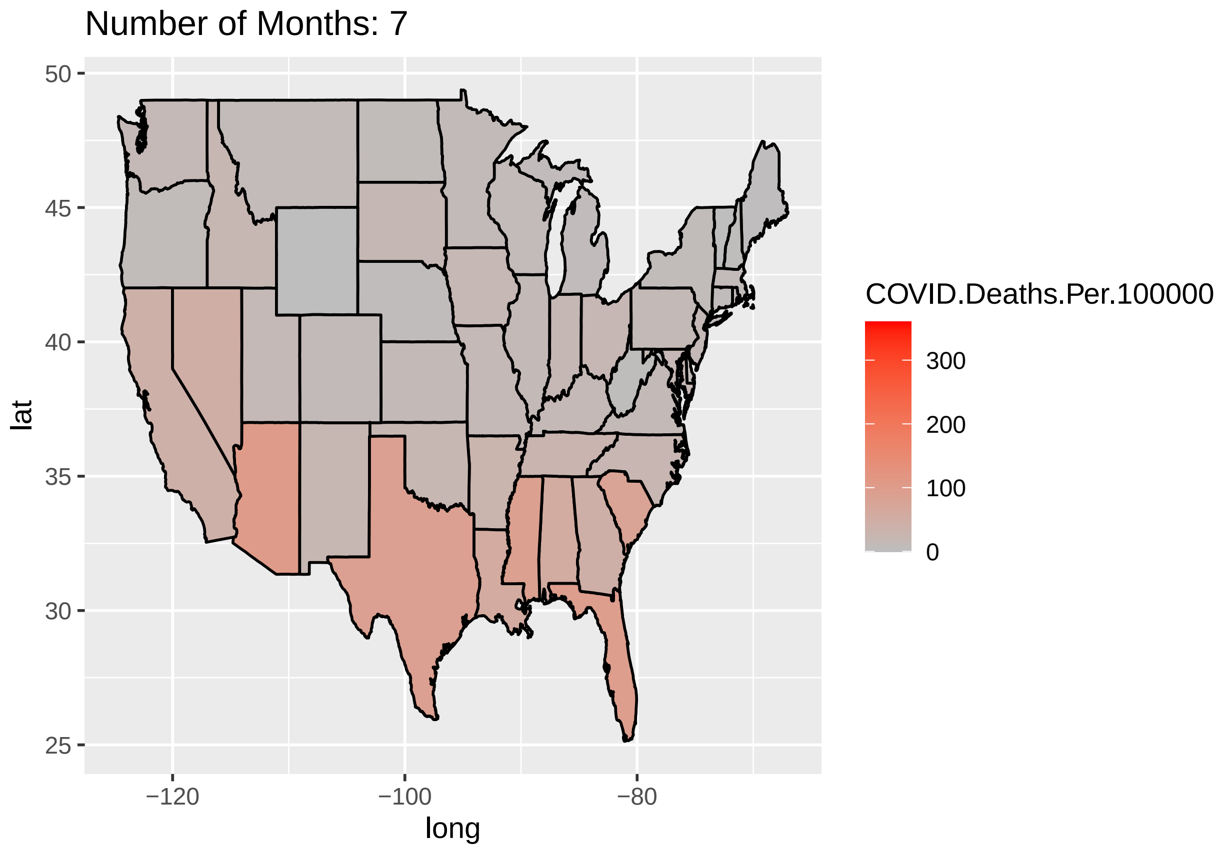
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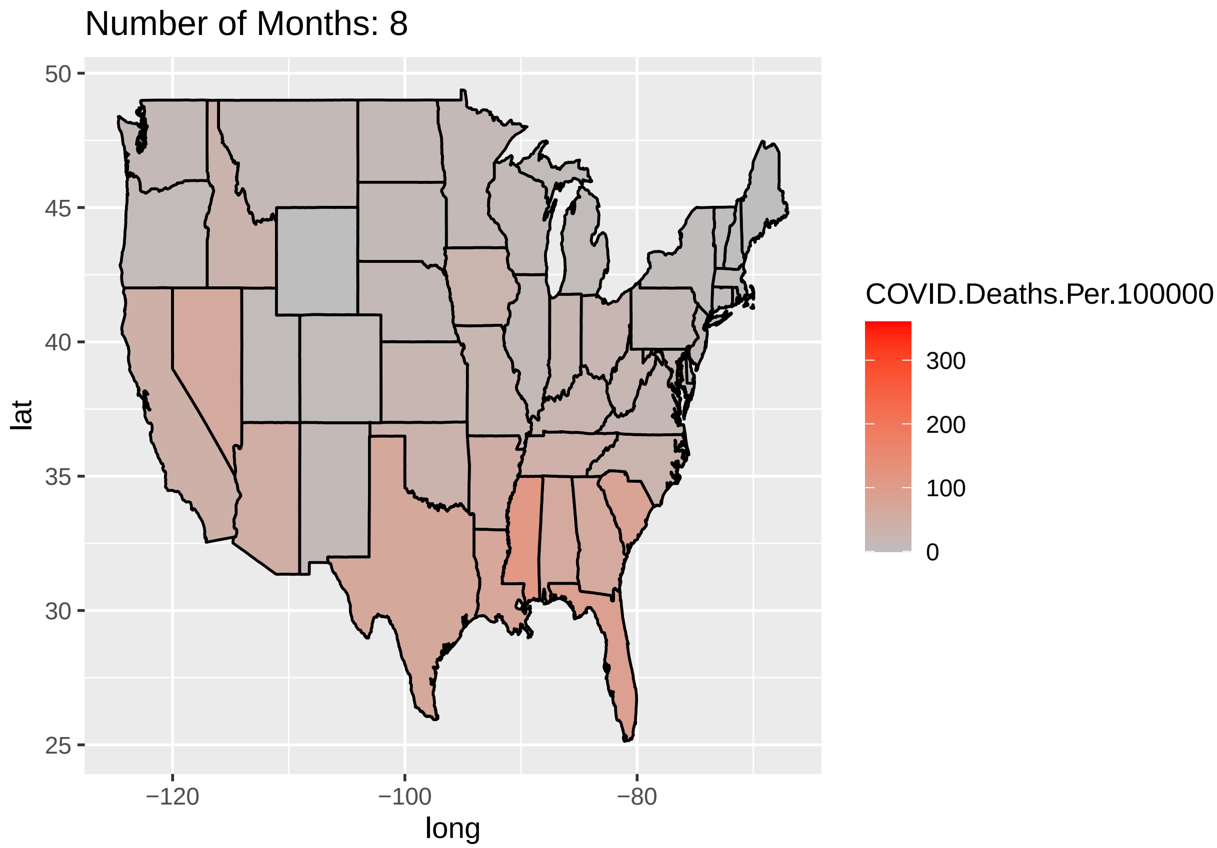
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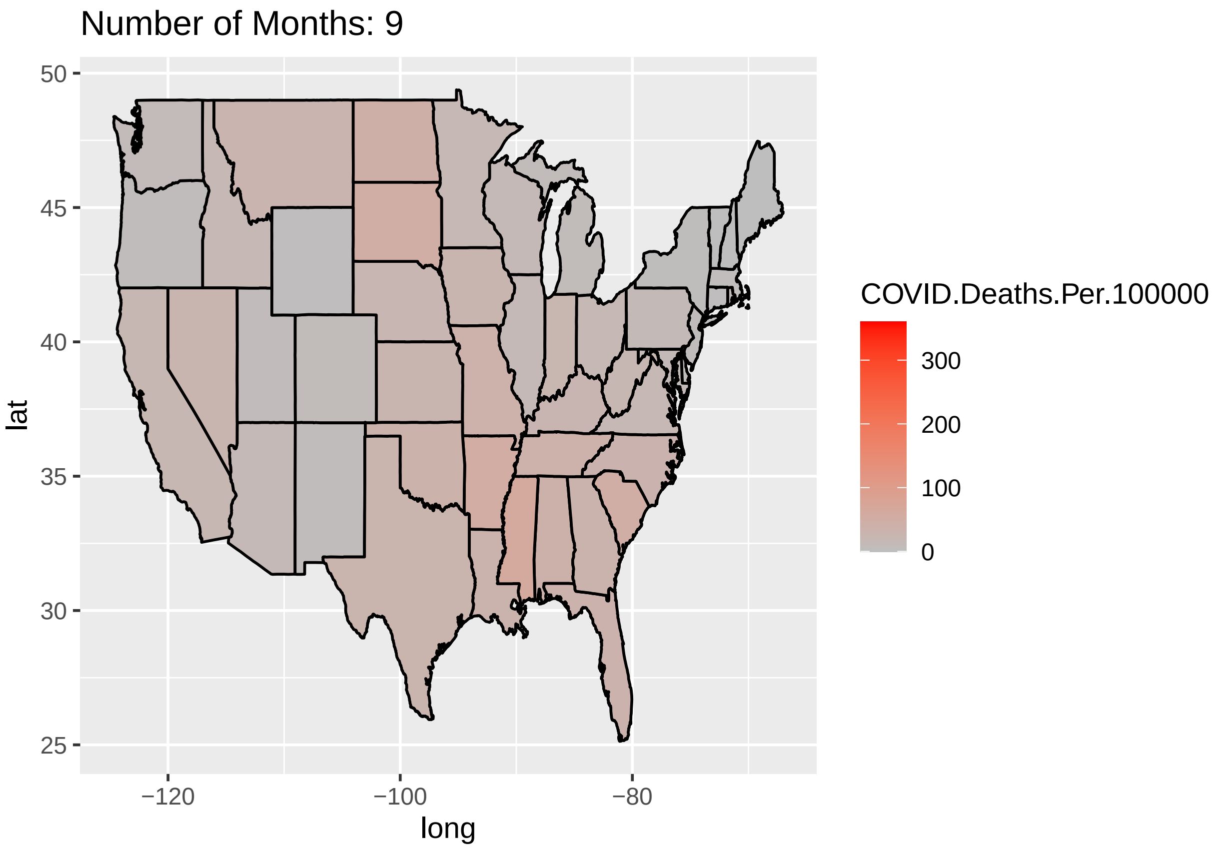

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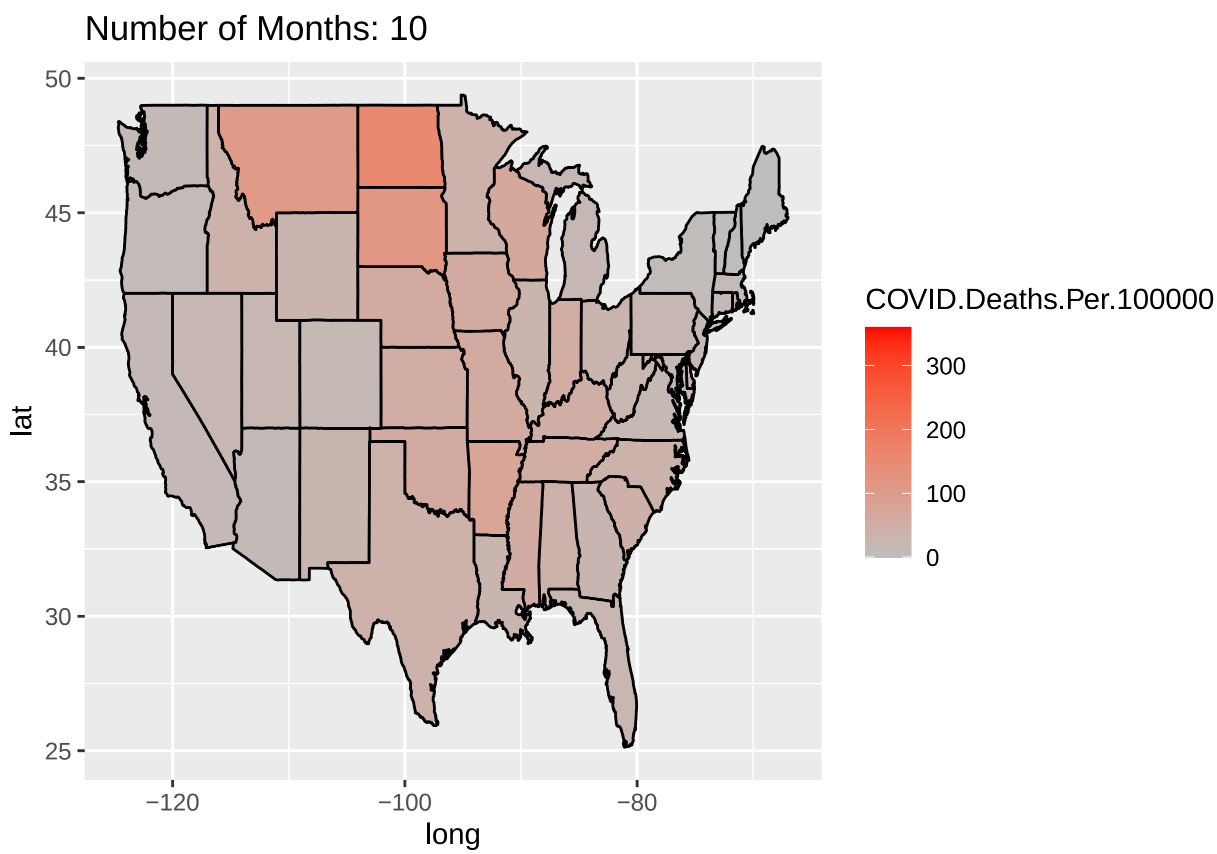

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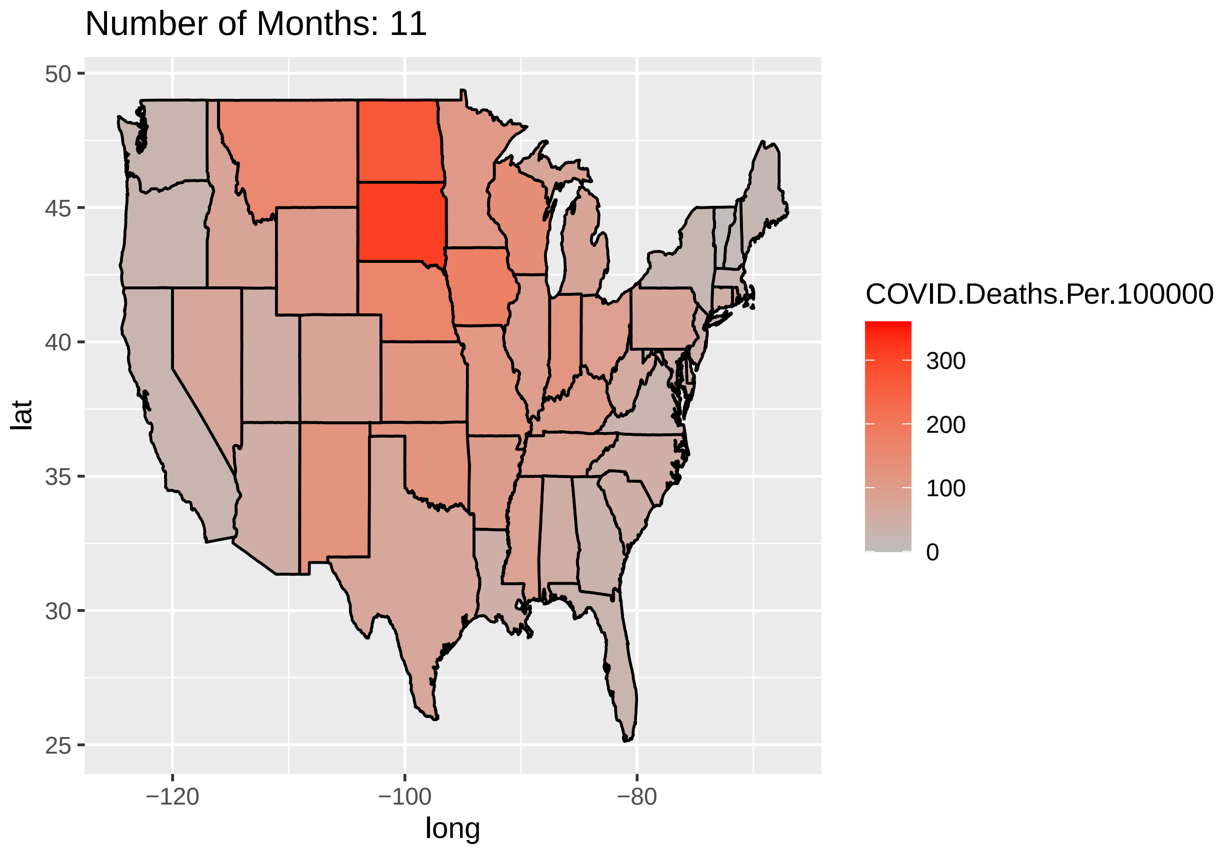

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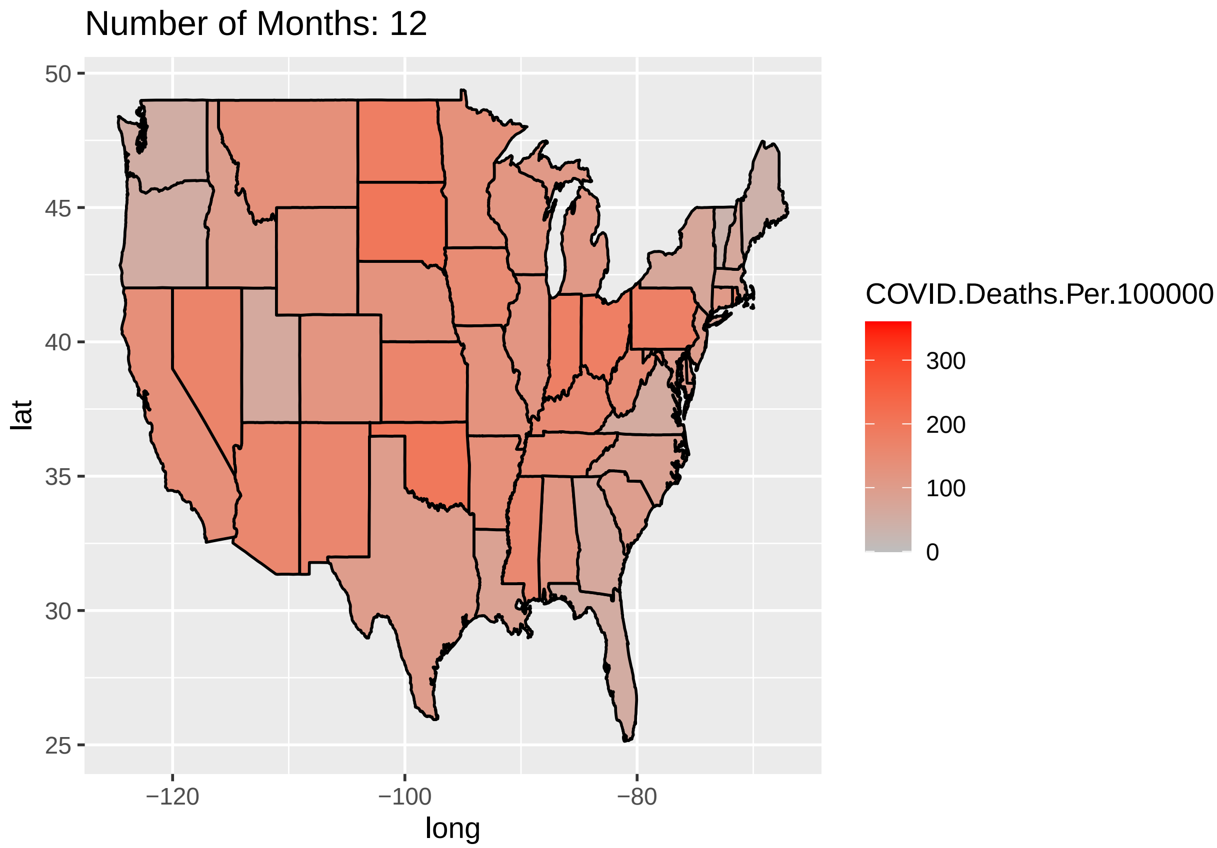
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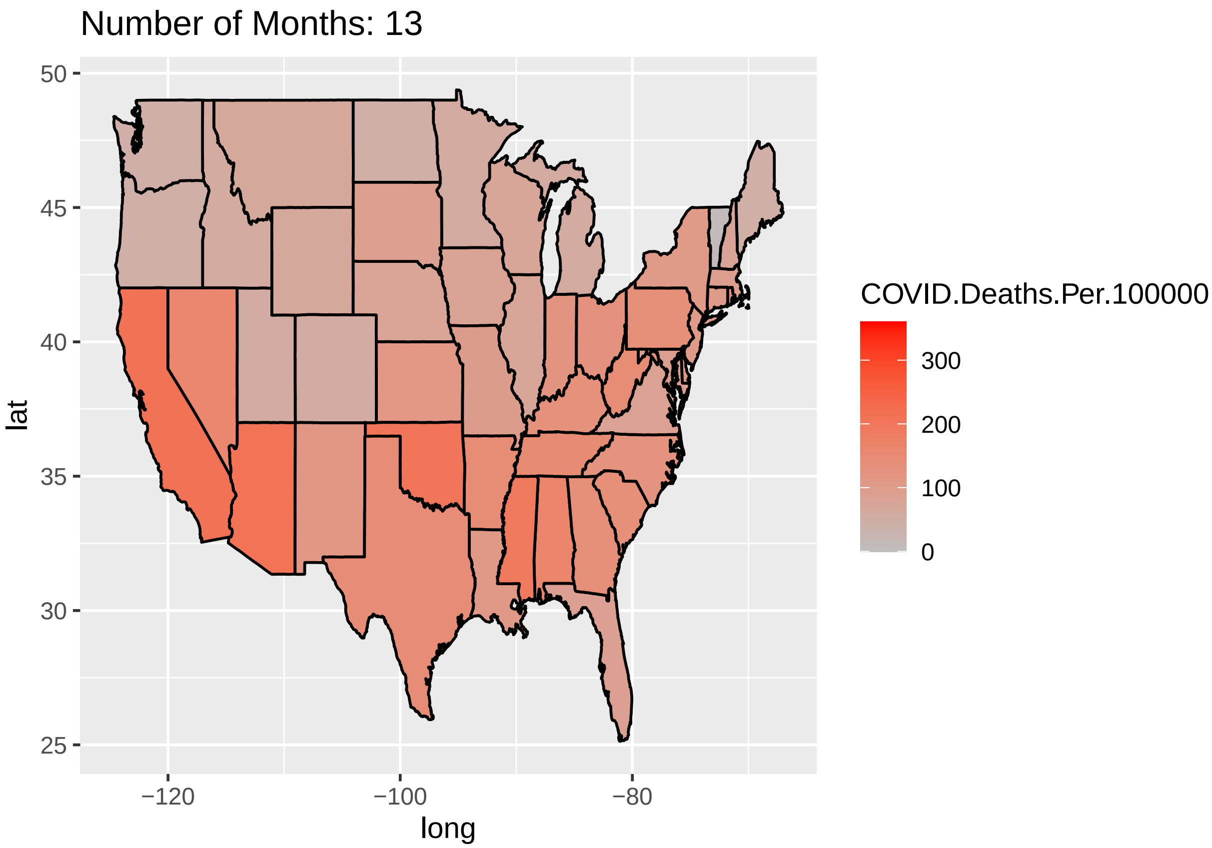

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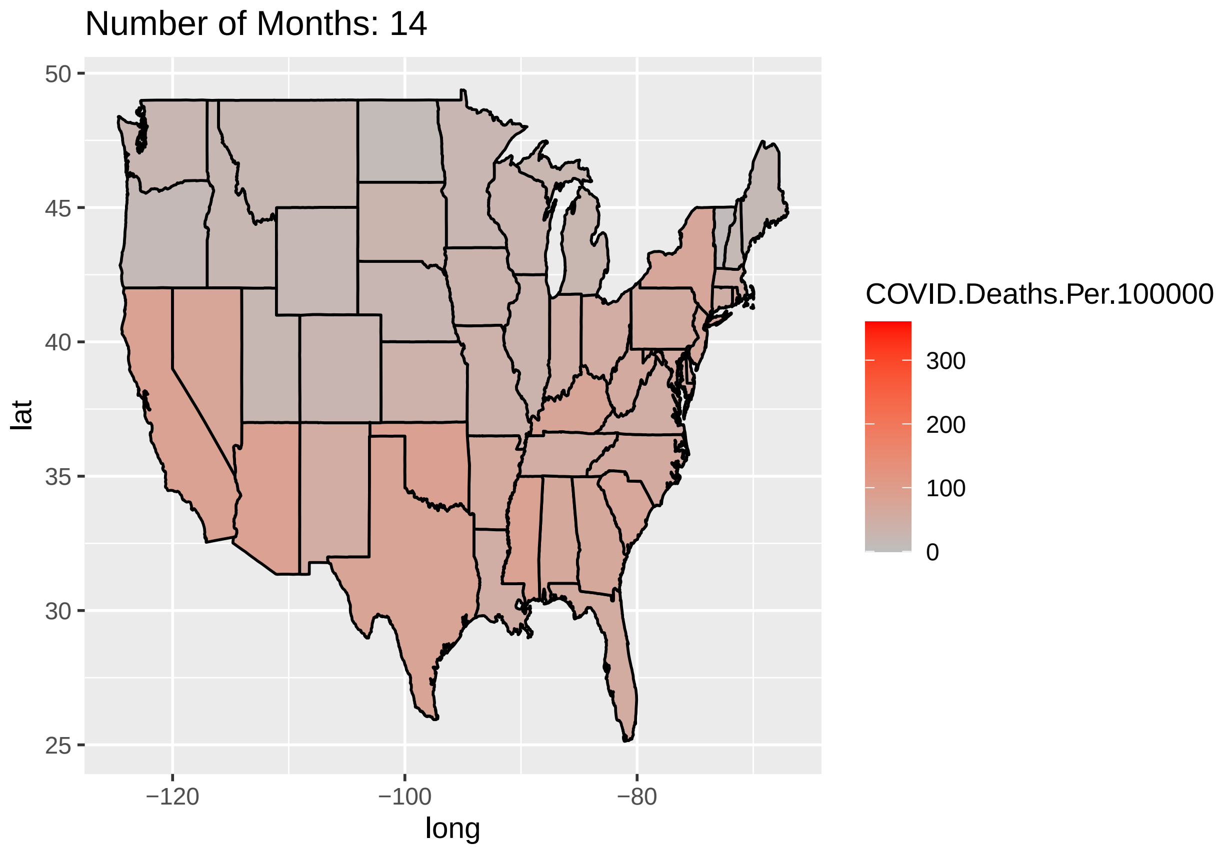
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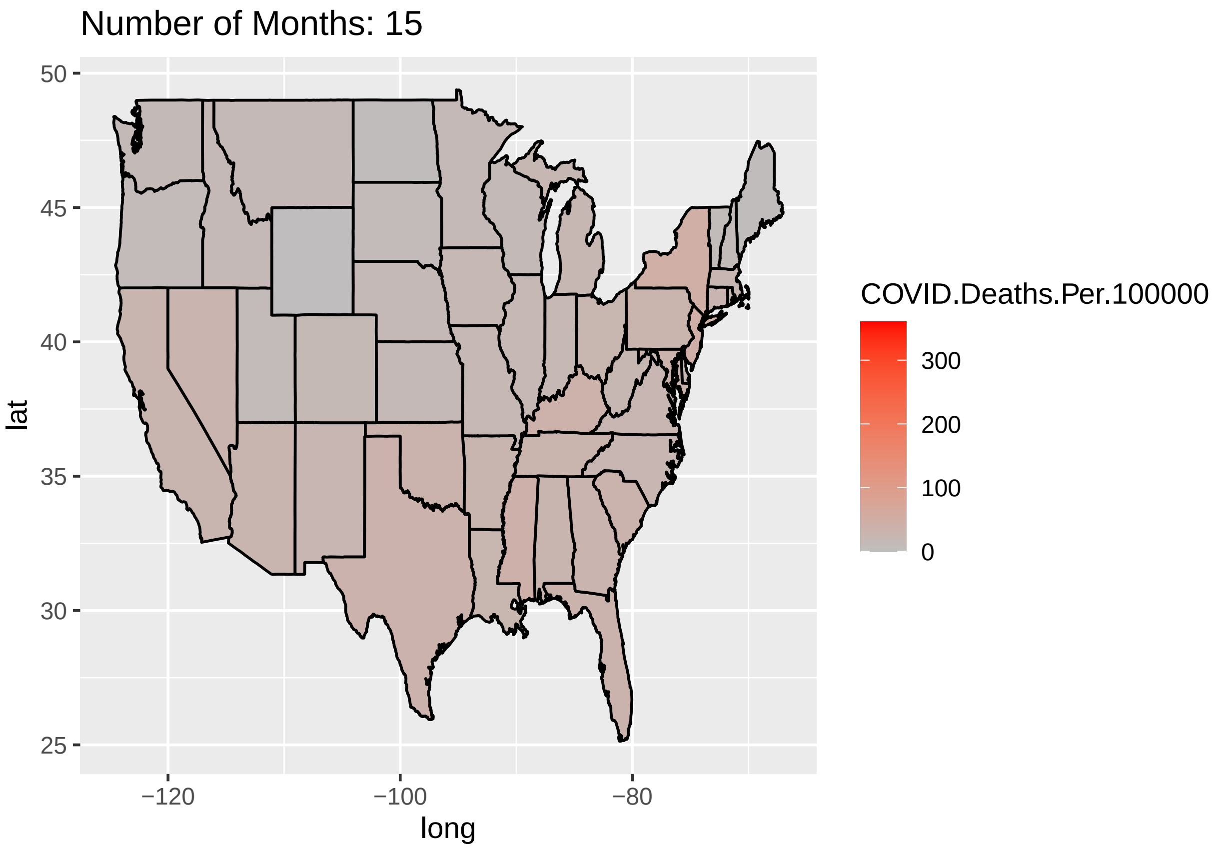

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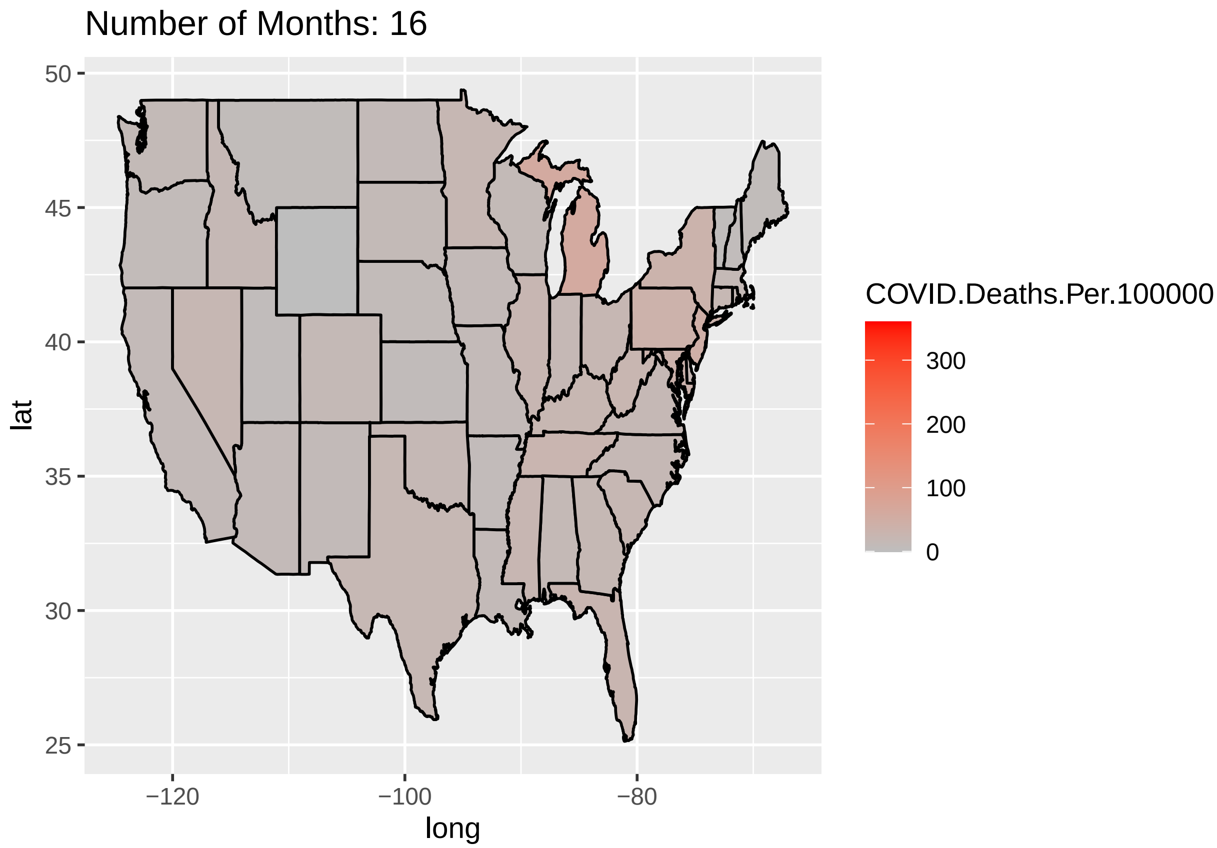

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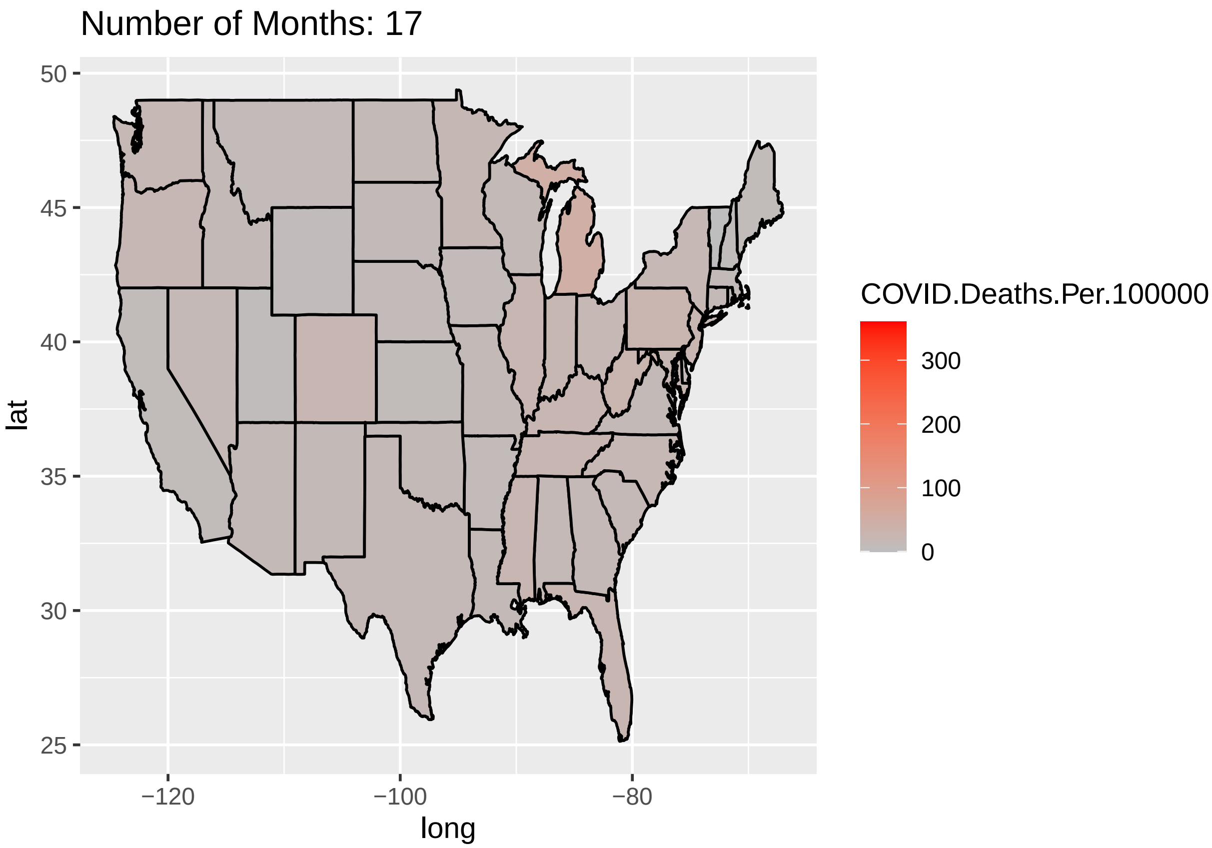
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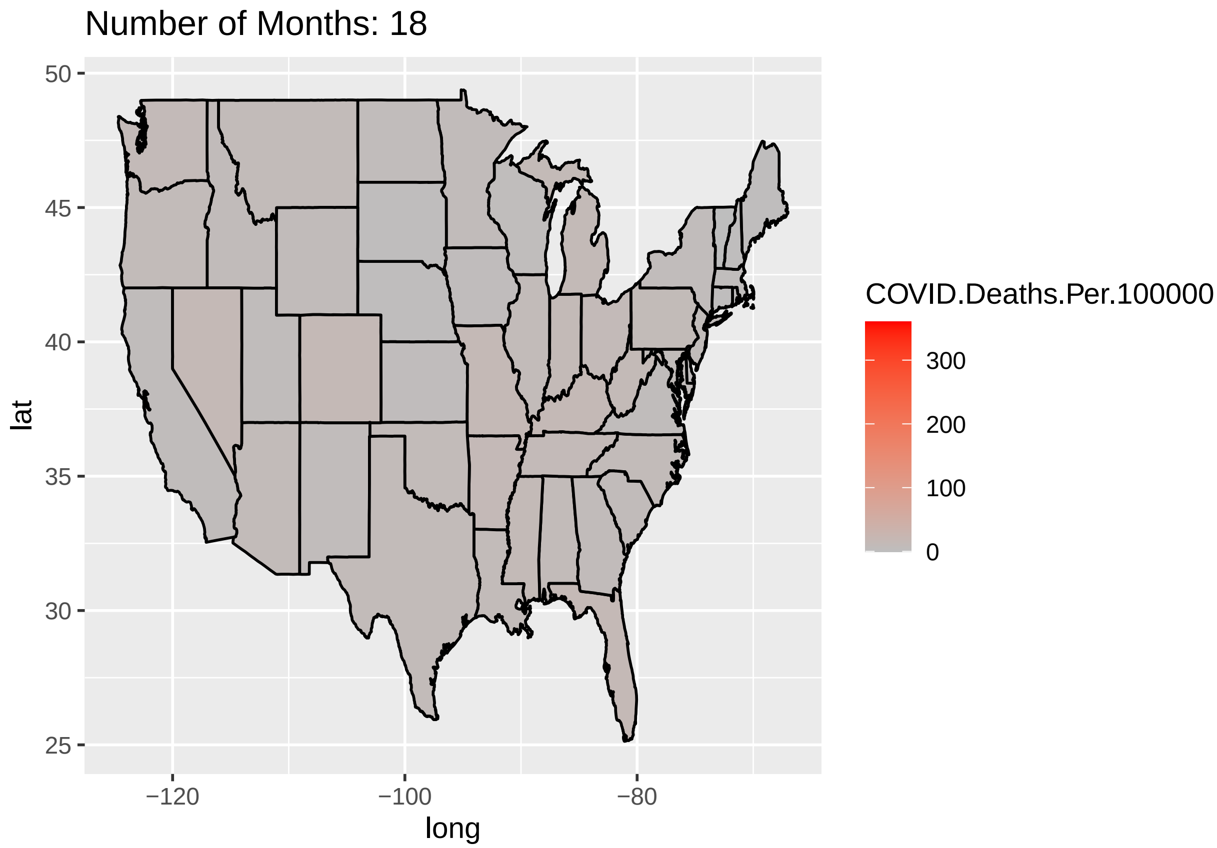
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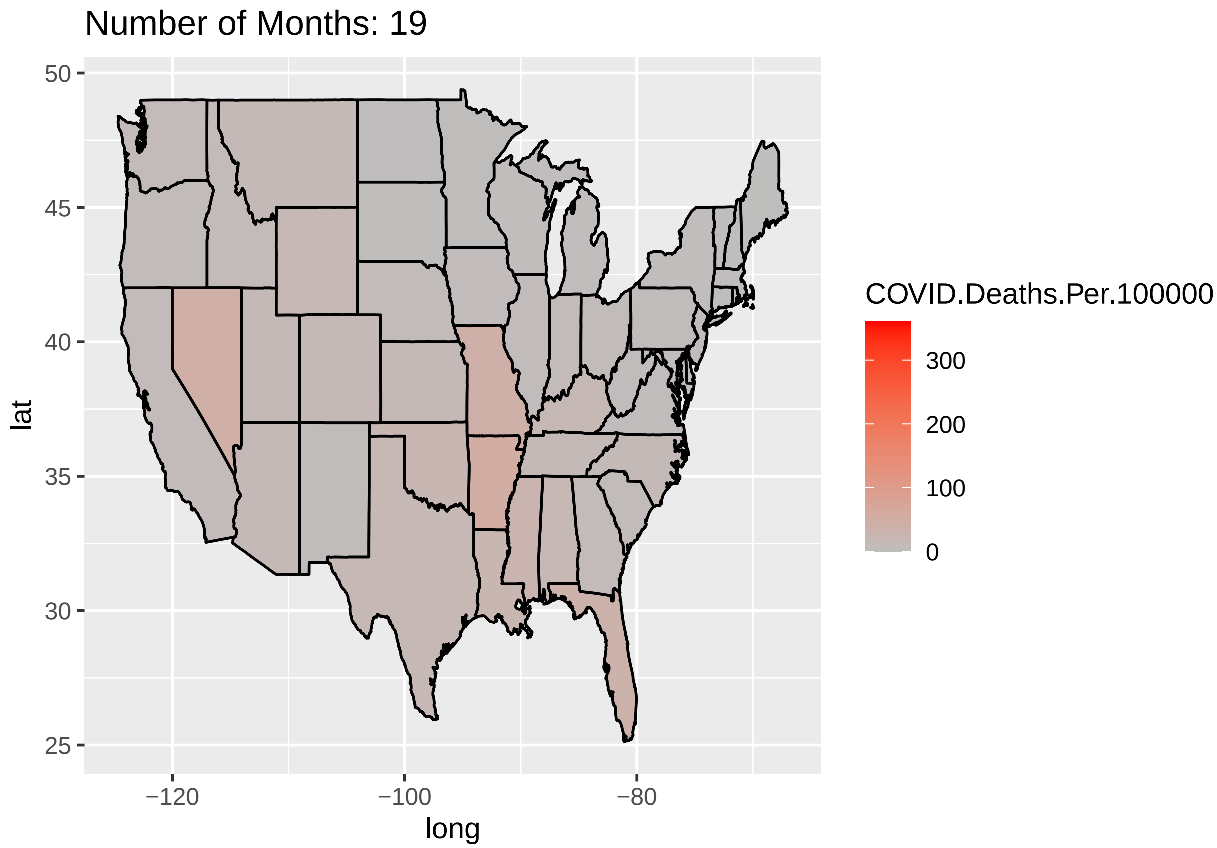

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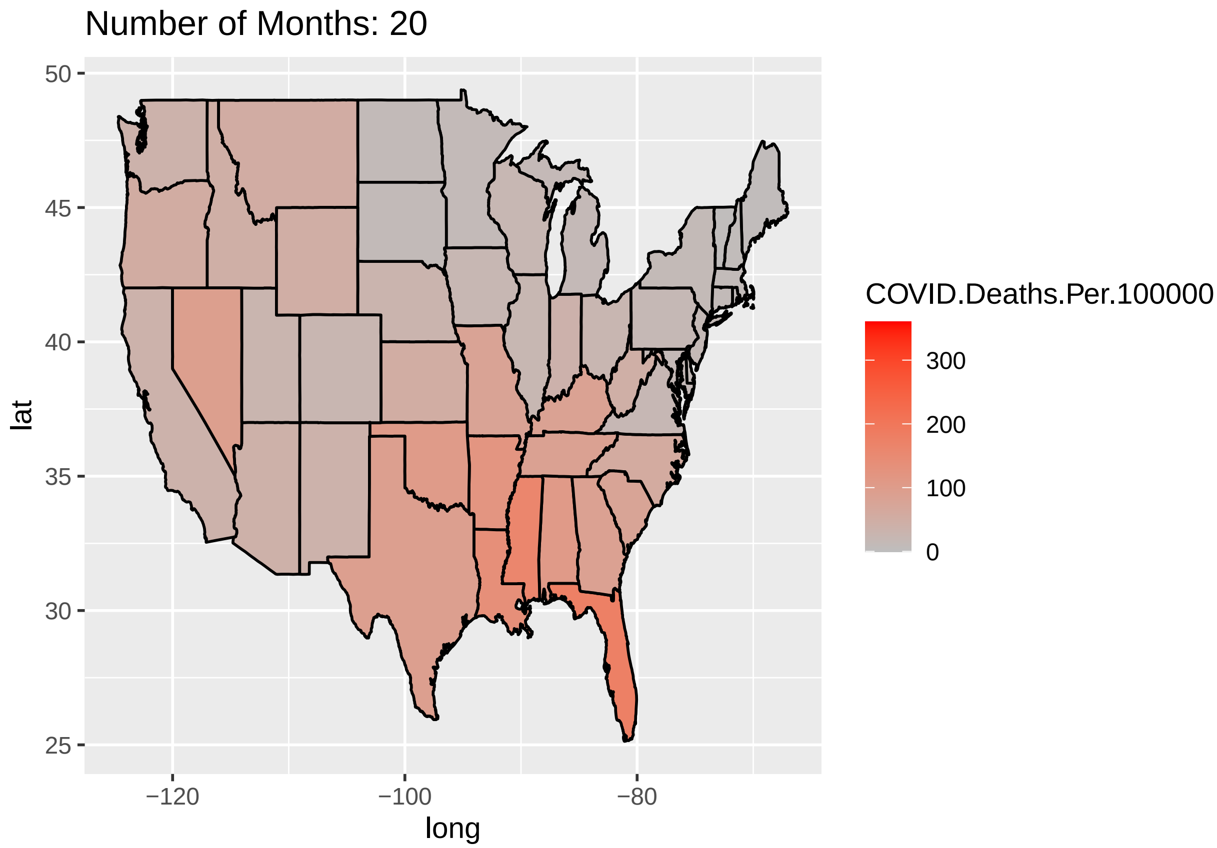
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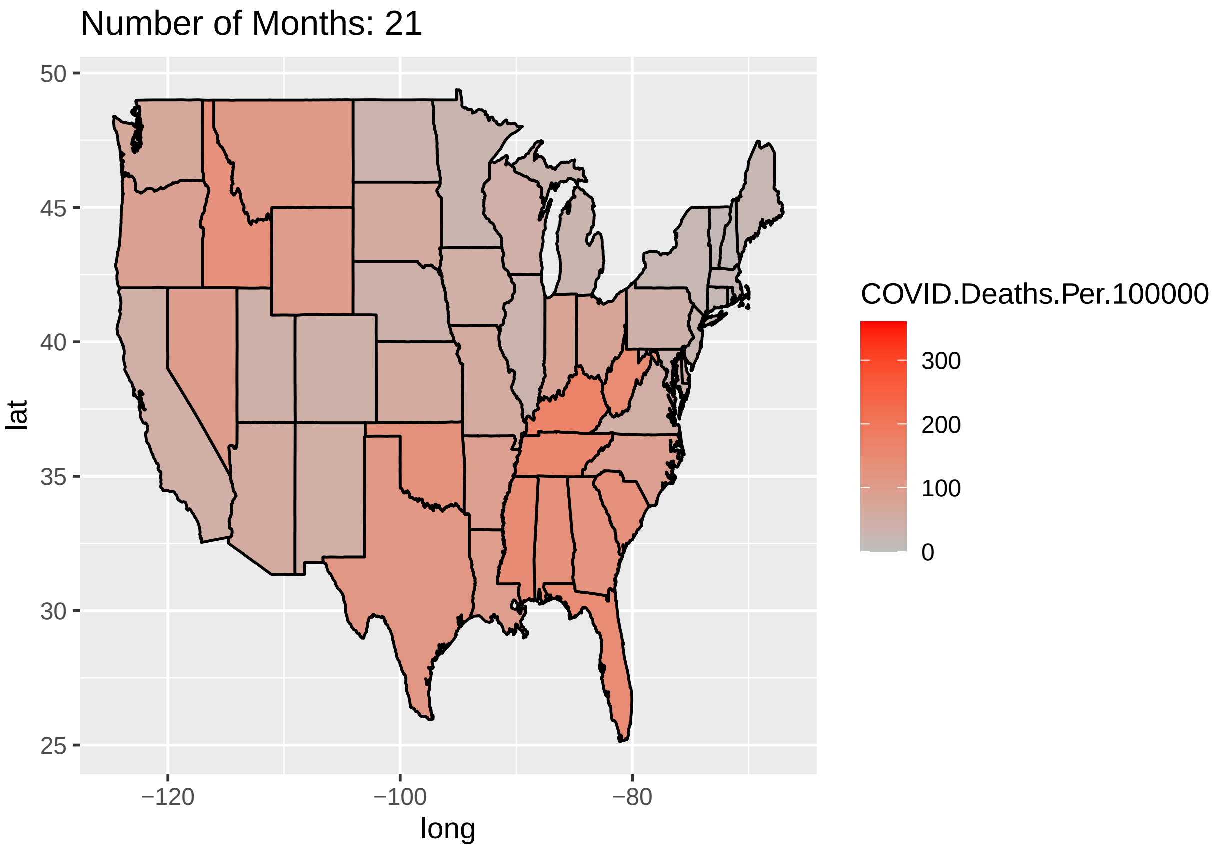

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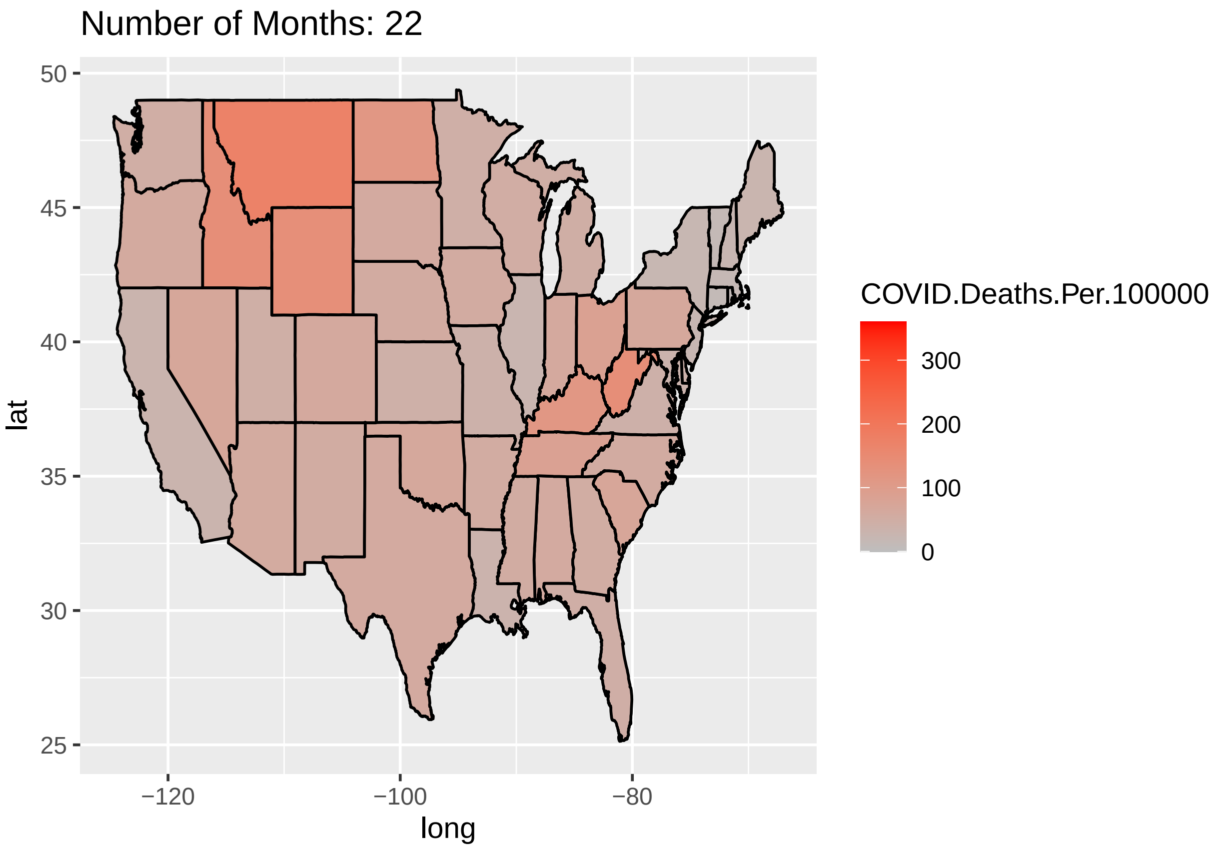
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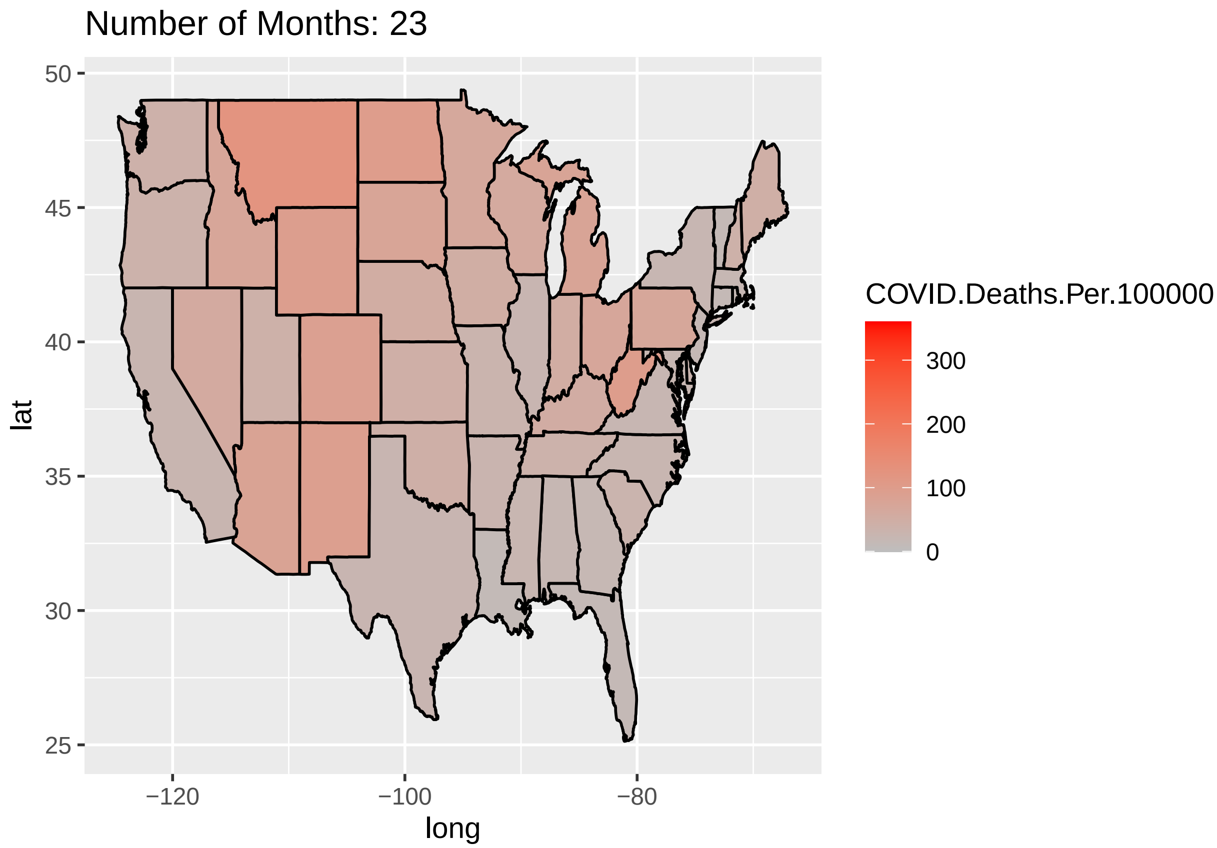
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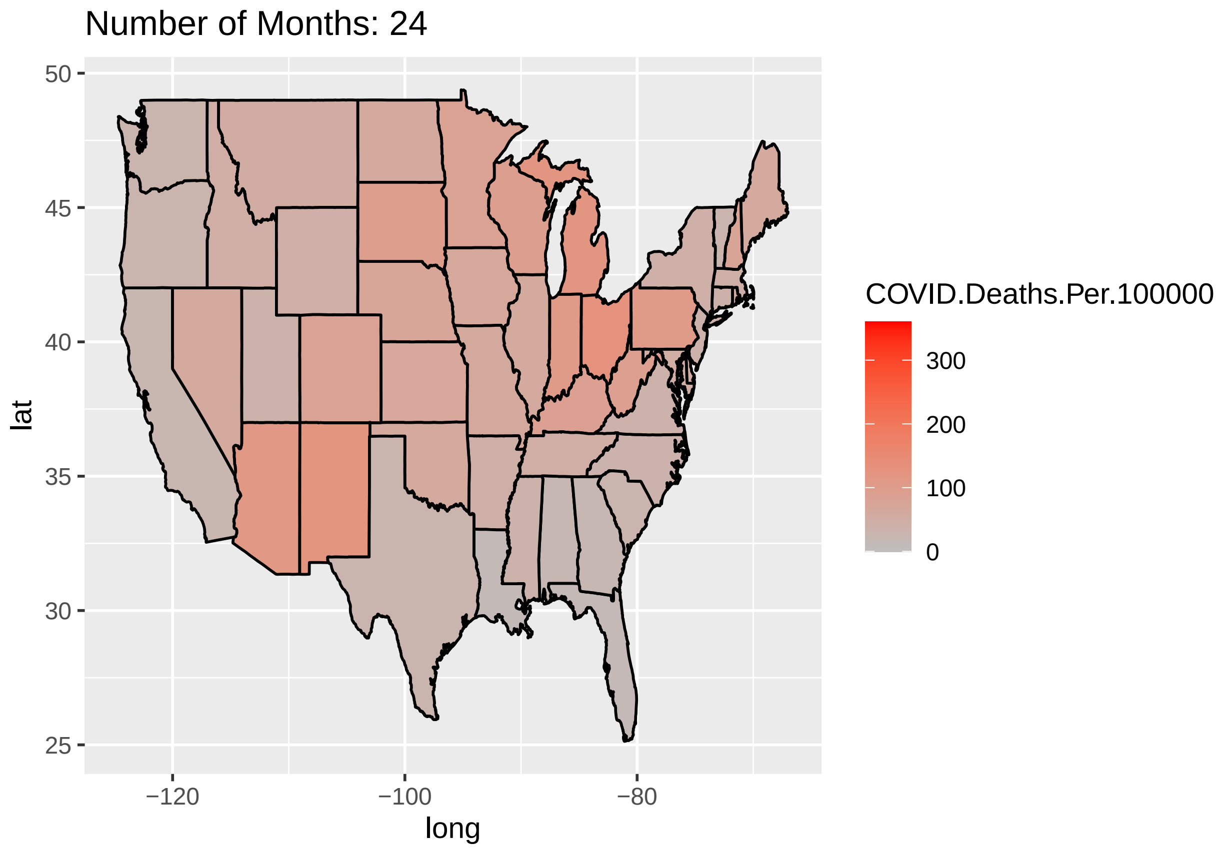
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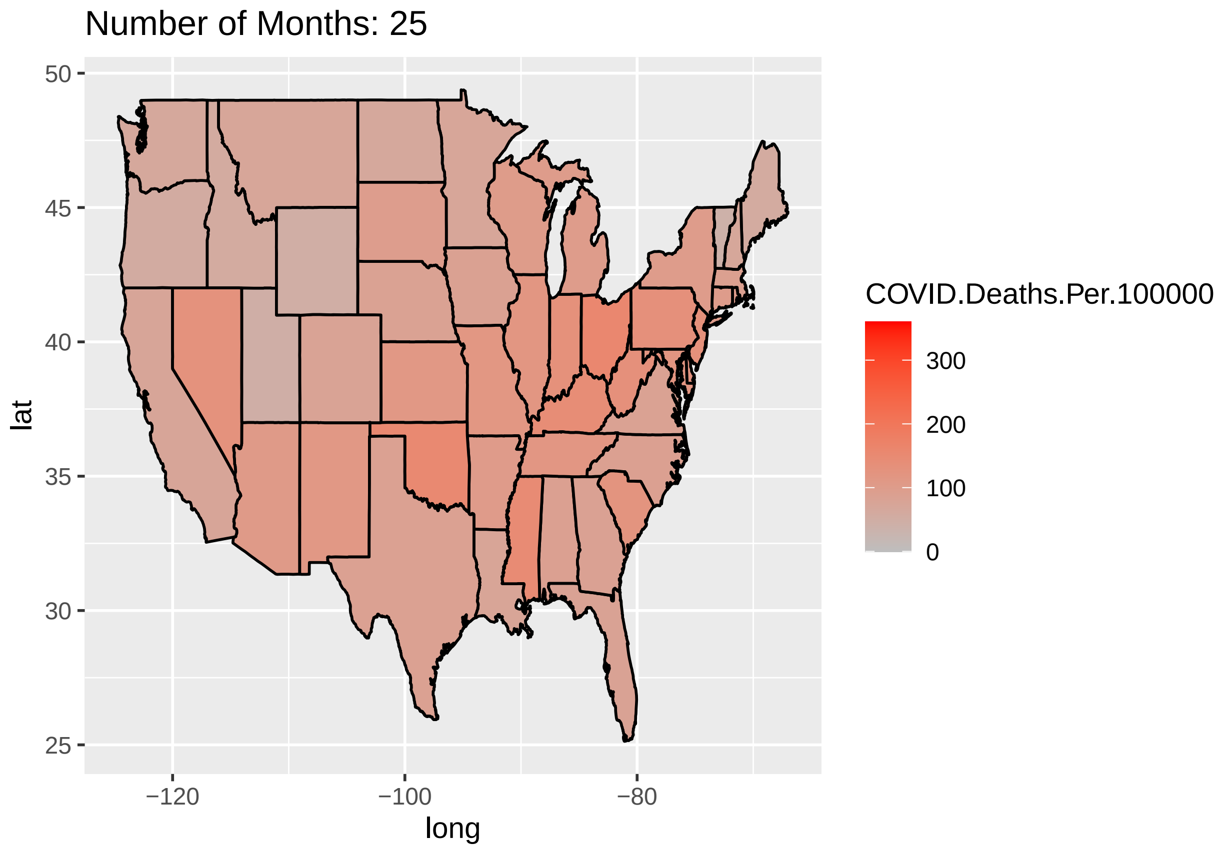

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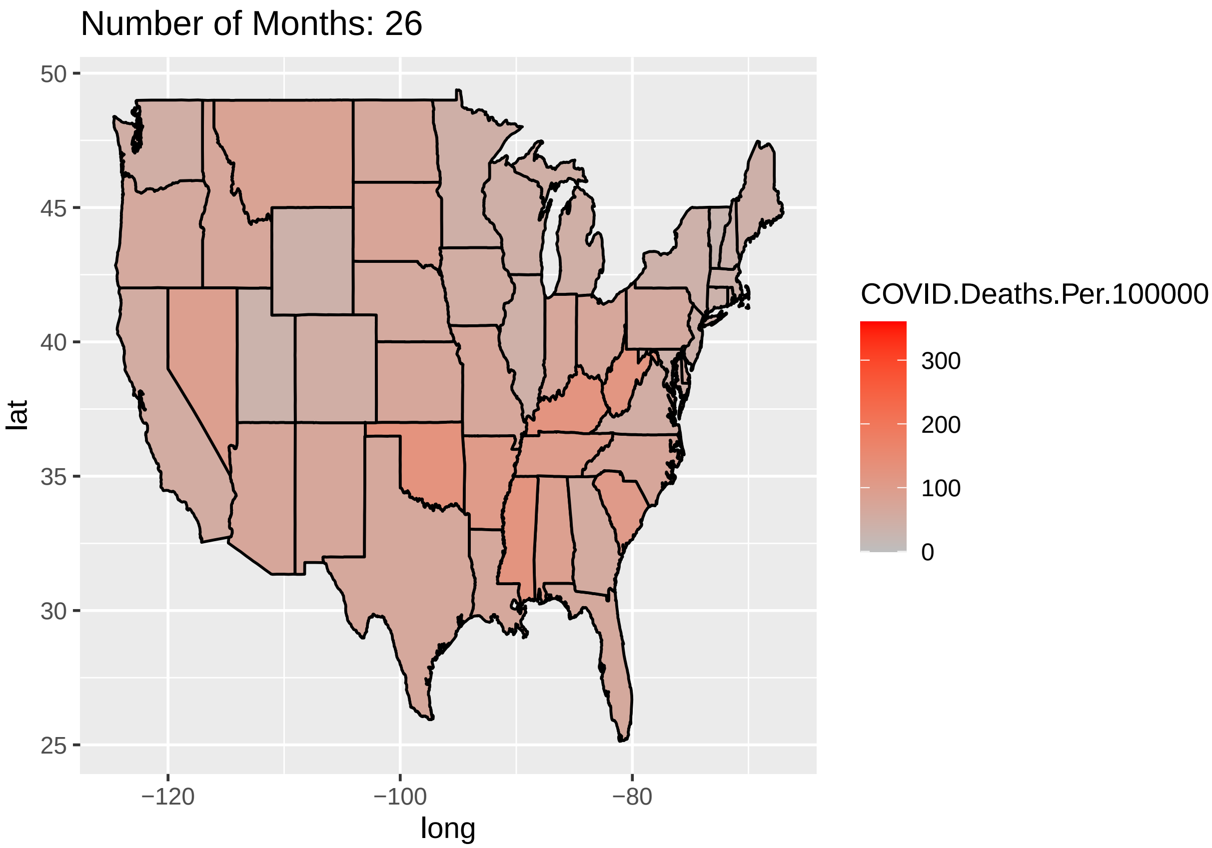
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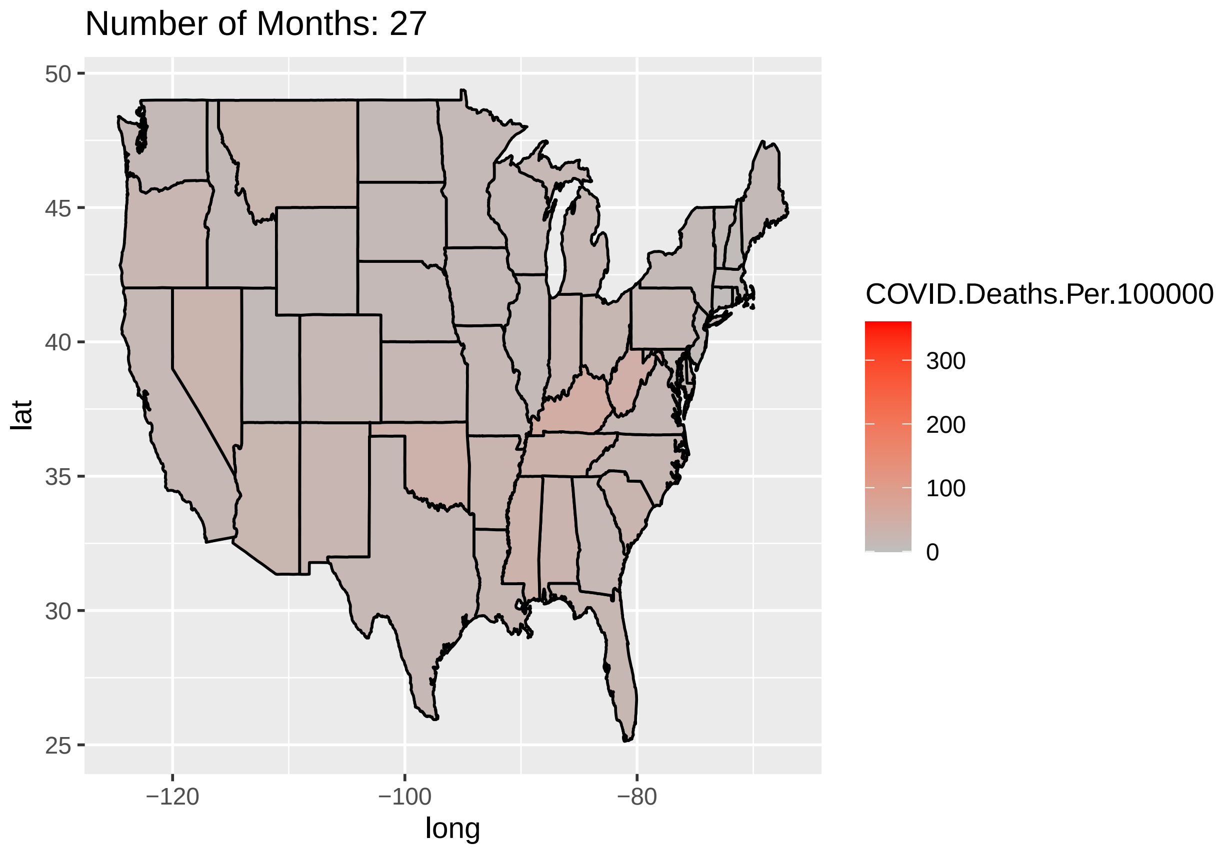
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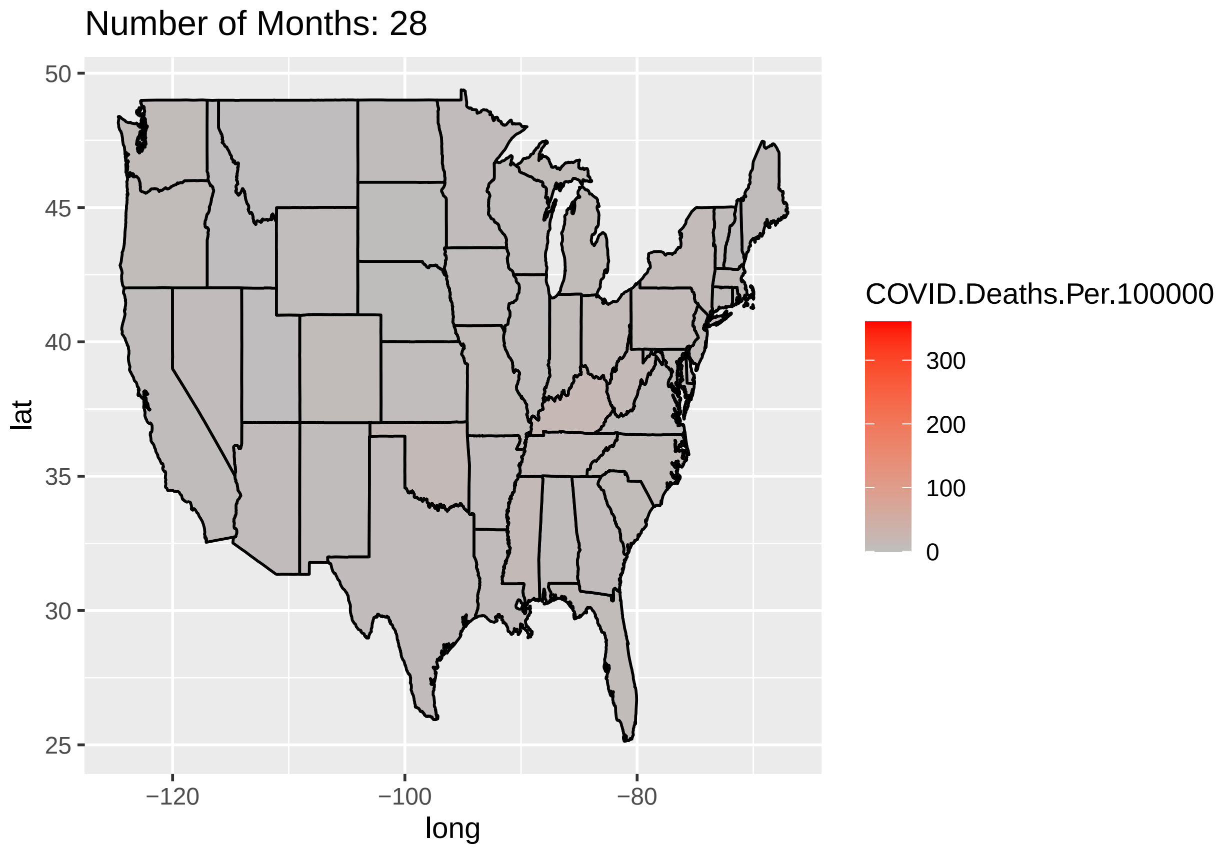

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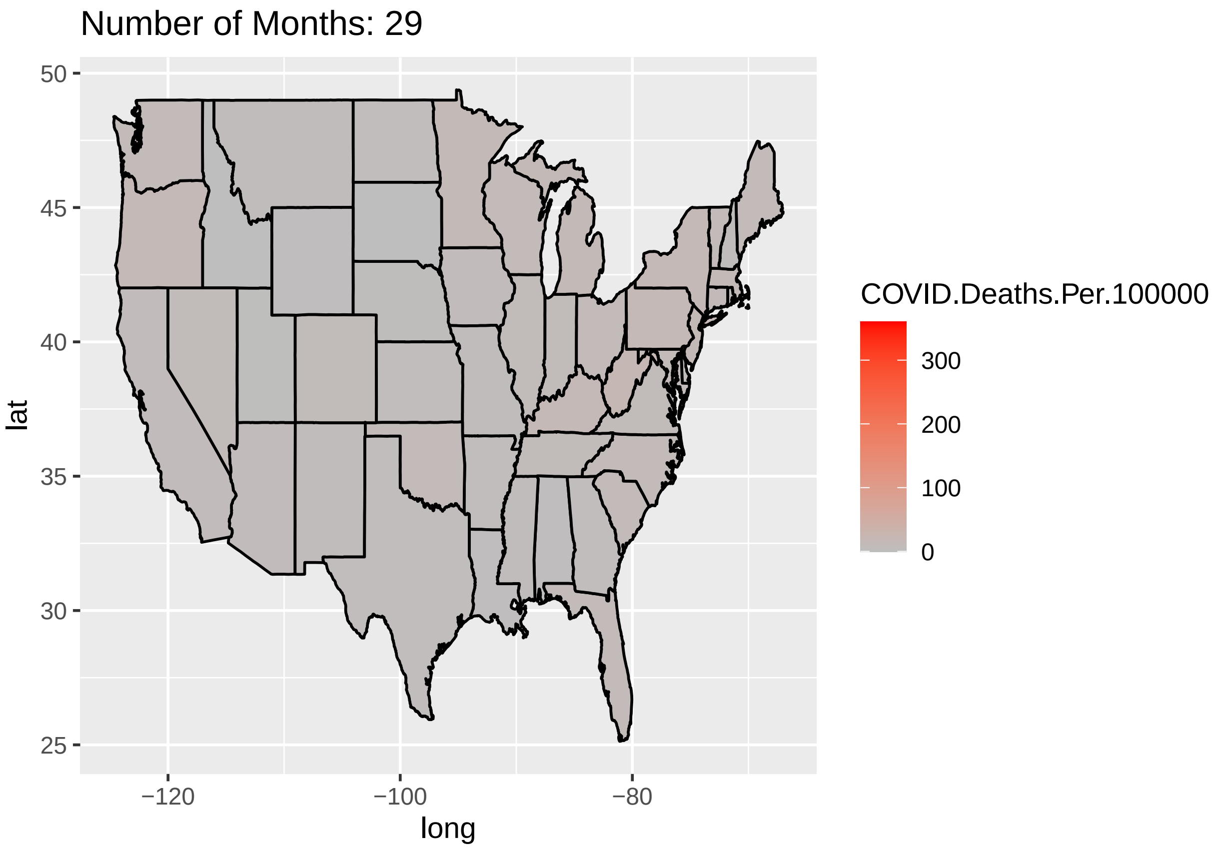
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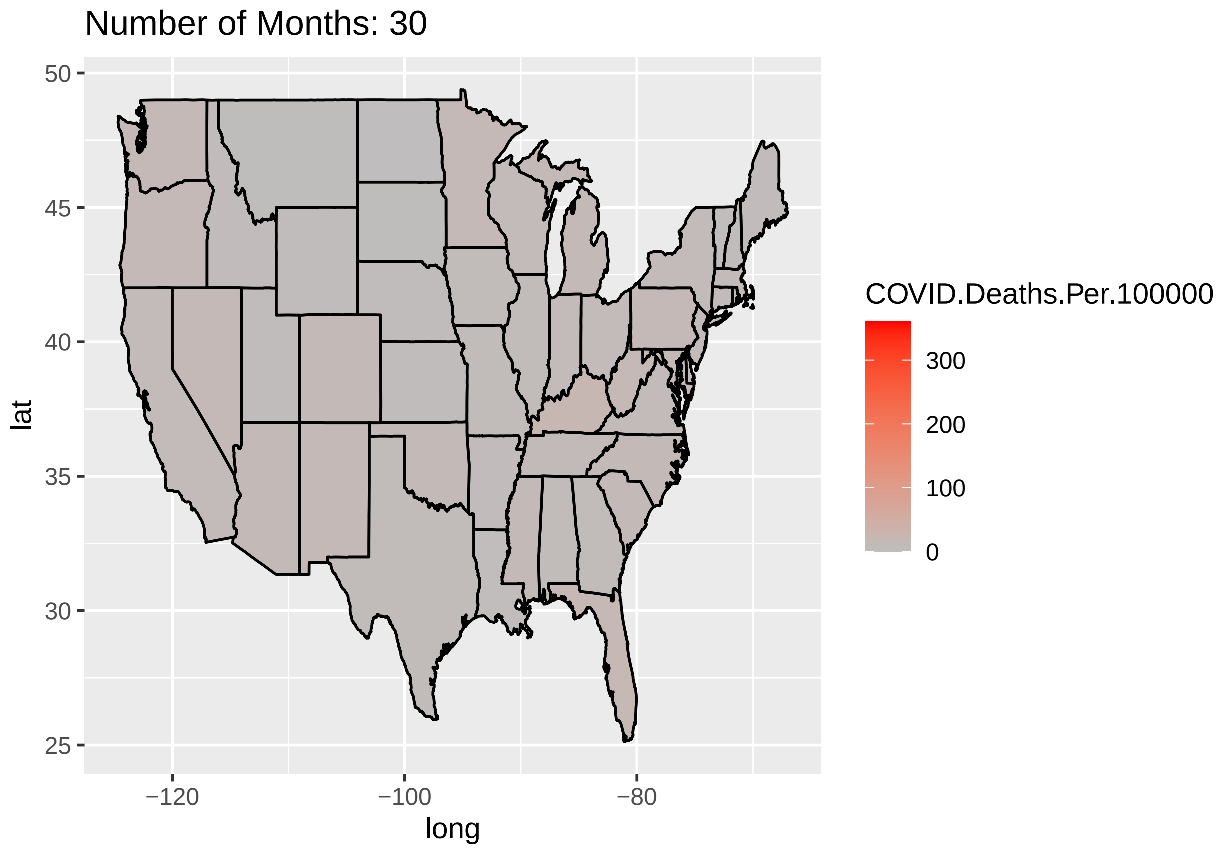

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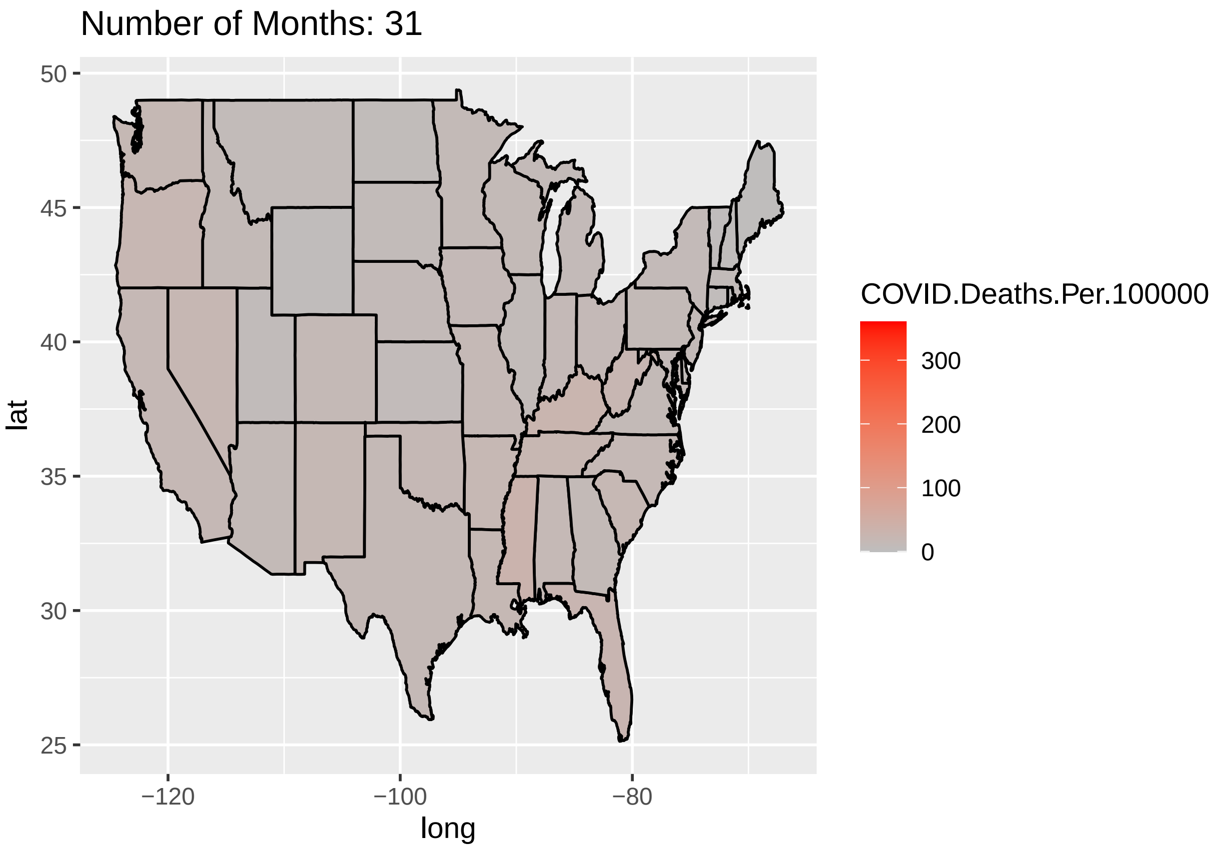
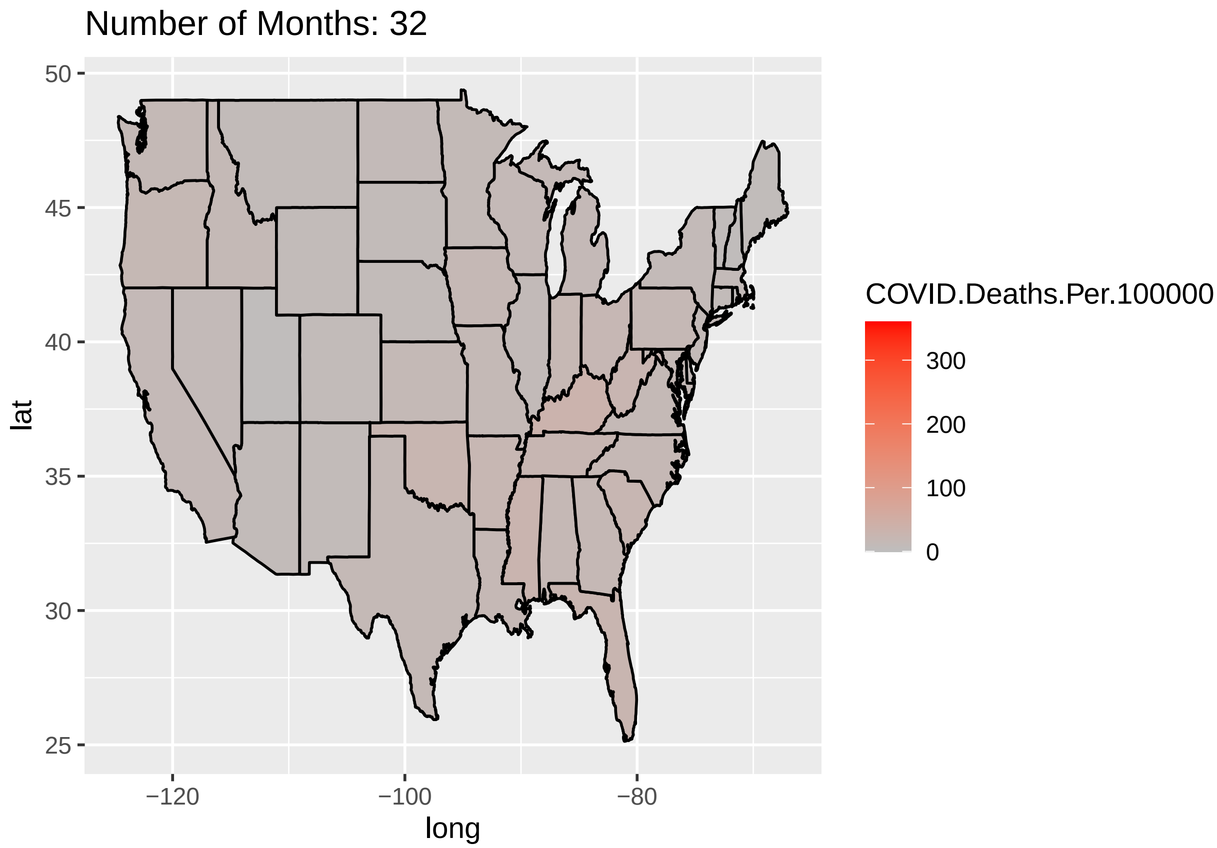
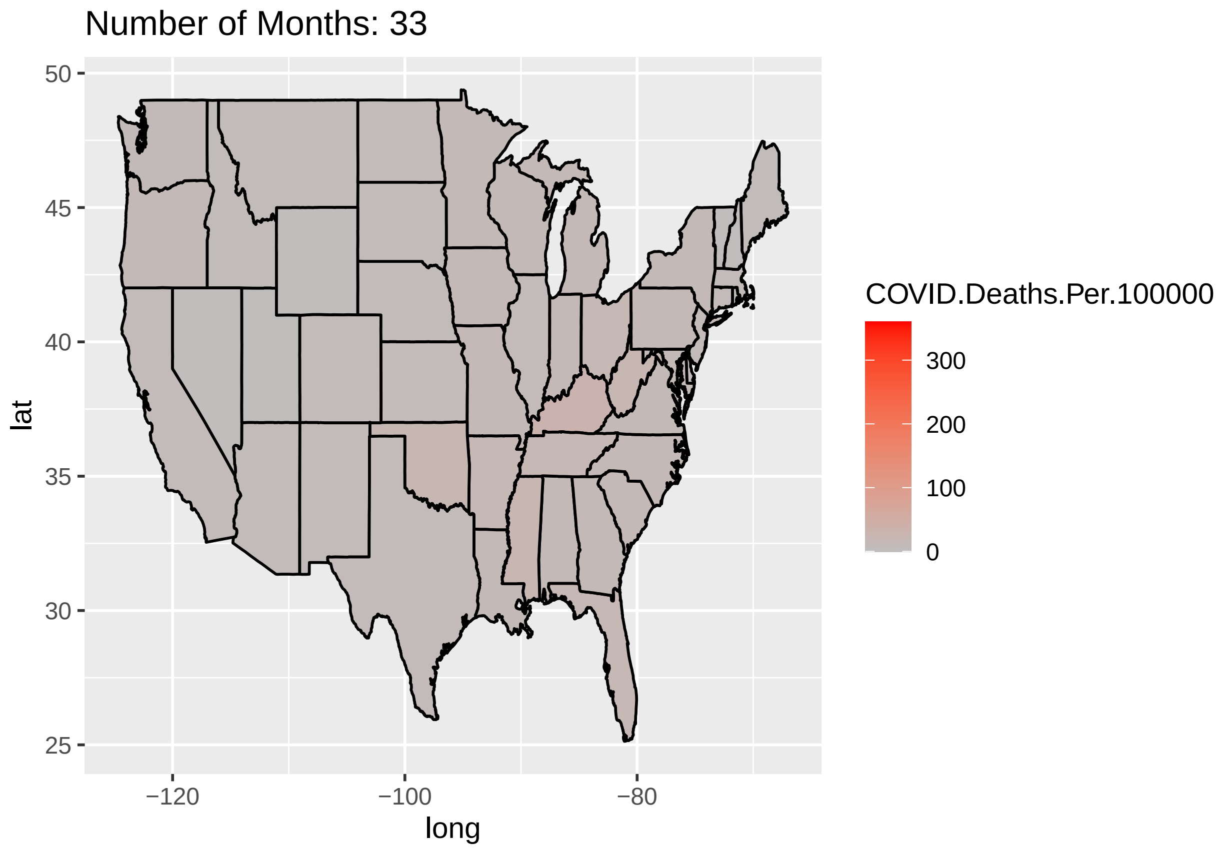
100
0

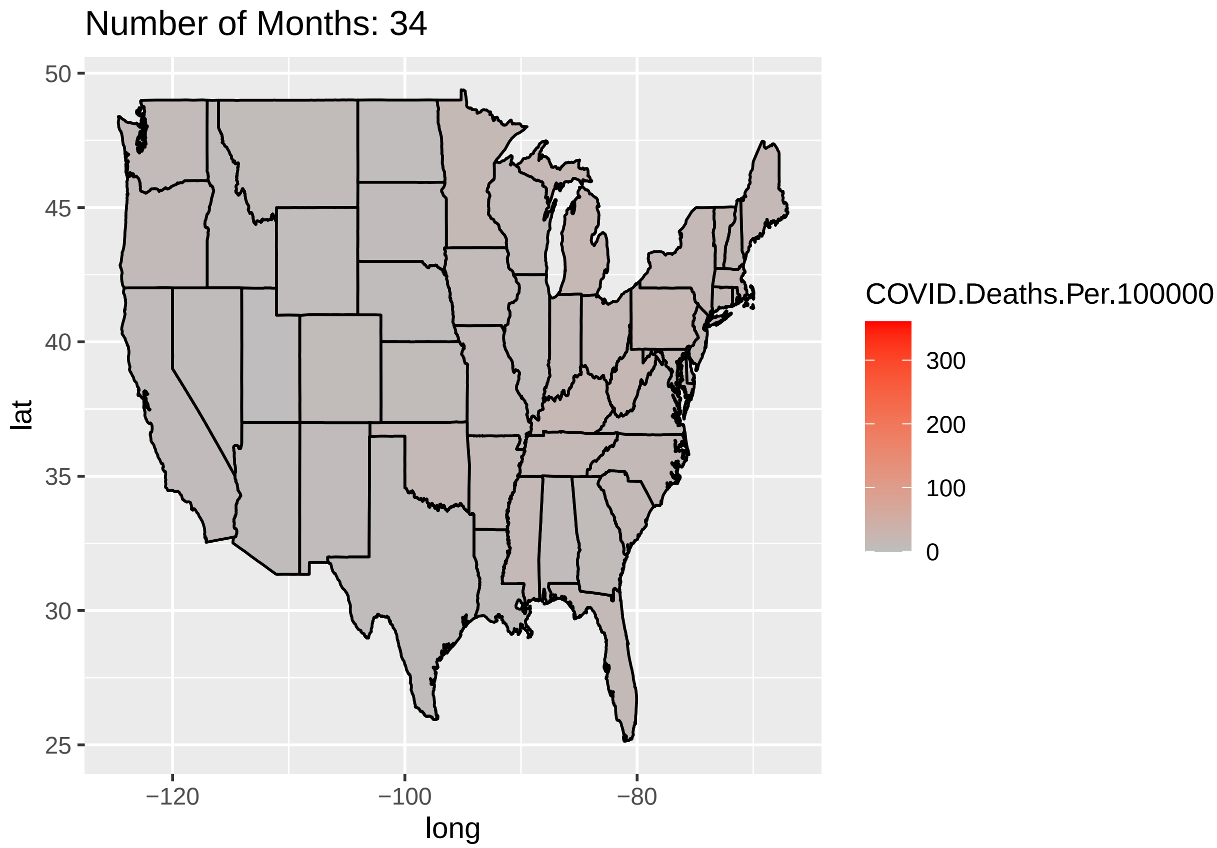


Number of Months: 31
50
45
40
35
30
25
lat
−120
−100
−80
long
COVID.Deaths.Per.100000
300
200
100
0

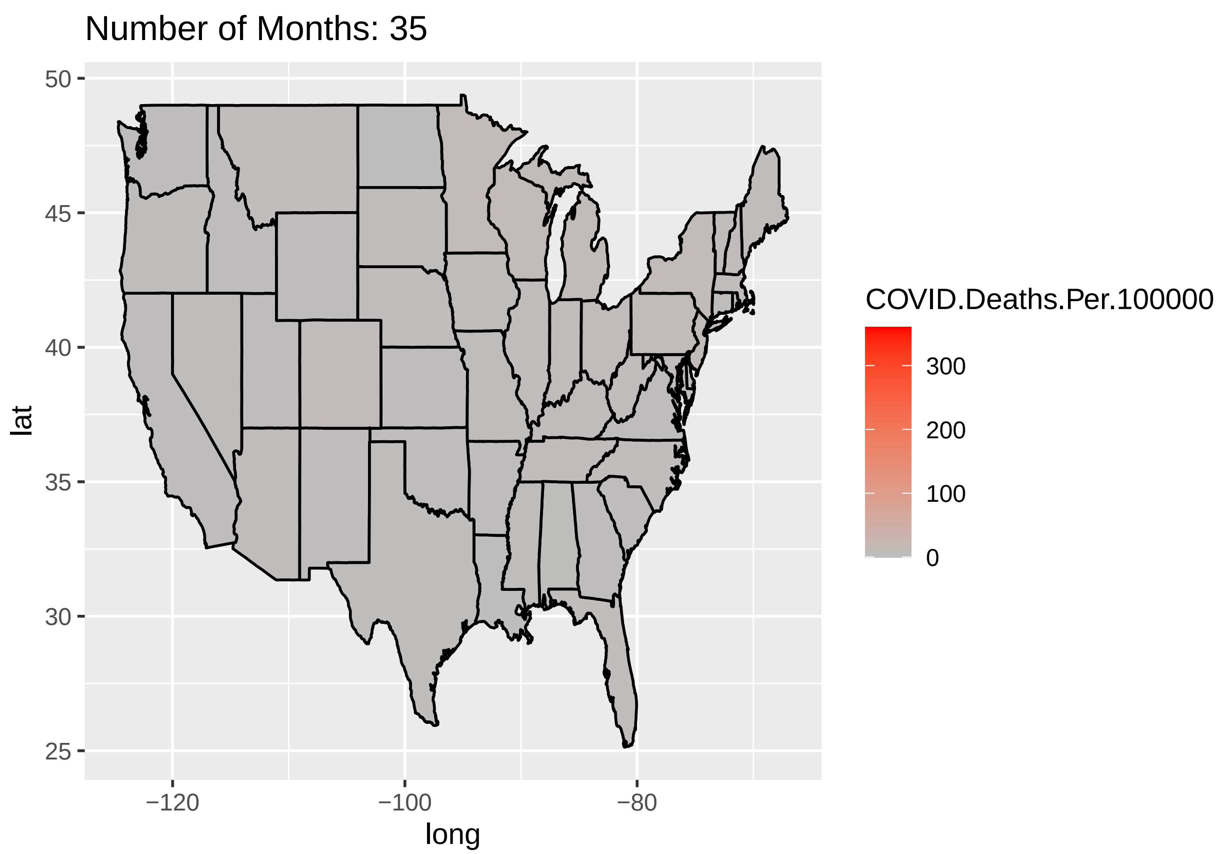

Number of Months: 32
50
45
40
35
30
25
lat
−120
−100
−80
long
COVID.Deaths.Per.100000
300
200
100
0



Number of Months: 33
50
45
40
35
30
25
lat
−120
−100
−80
long
COVID.Deaths.Per.100000
300
200
100
0

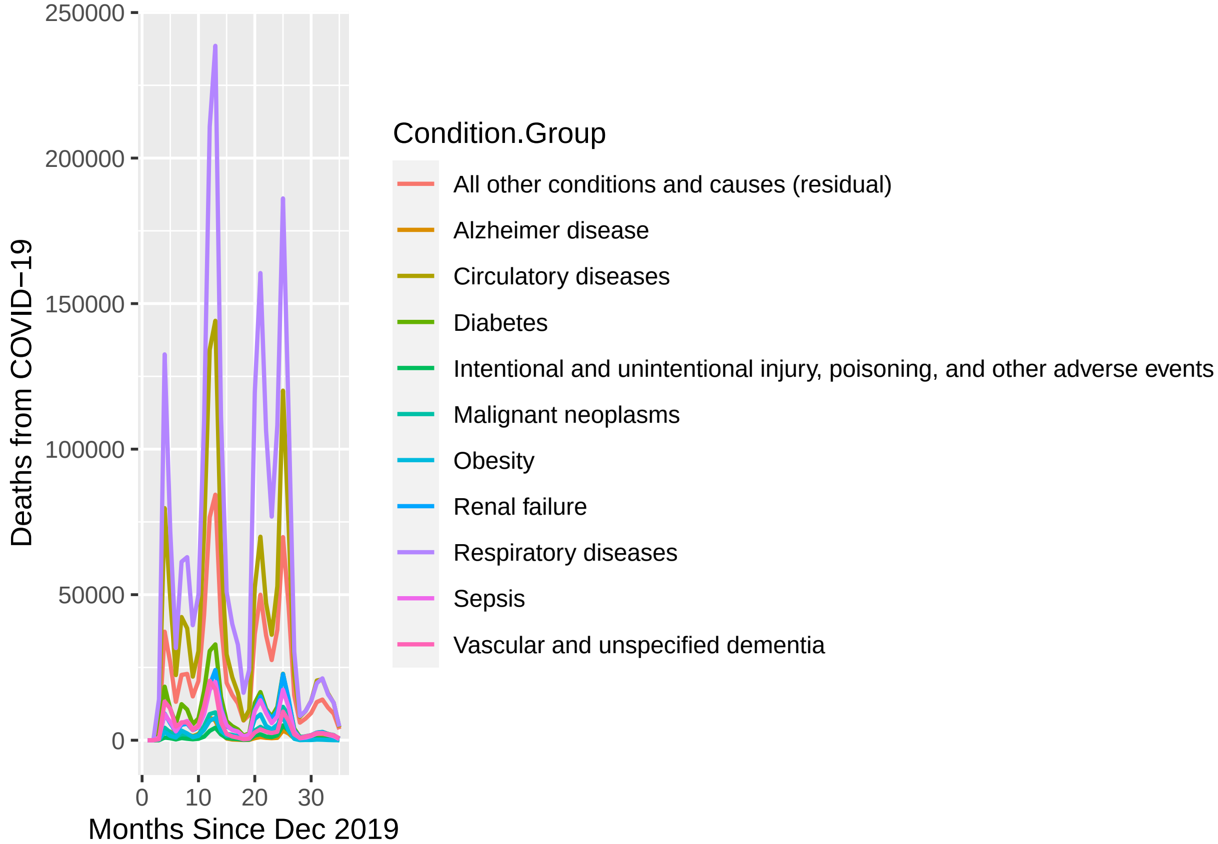


Number of Months: 34
50
45
40
35
30
25
lat
−120
−100
−80
long
COVID.Deaths.Per.100000
300
200
100
0



[Figure 1 is of spatial analysis - a few maps of COVID-19 Deaths per 10000 at different time points]

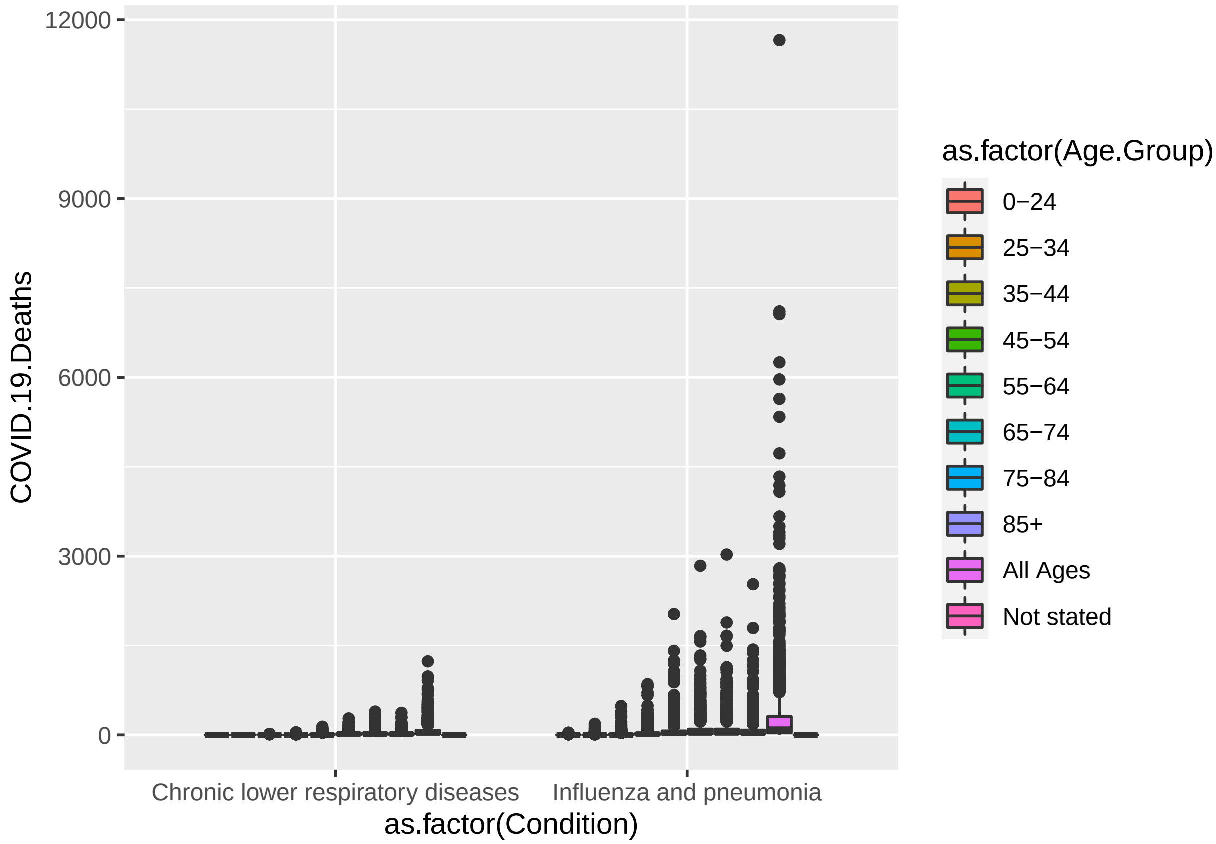
```
###### Time series for condition group - Temporal and conditions analysis #####
## Subset the data for time series analysis
d.625.c <- d.625[d.625$Condition.Group != "COVID-19", ]

## Aggregate COVID Deaths over date and Condition group
d.625.c <- aggregate(COVID.19.Deaths ~ totMonth + Condition.Group, data = d.625.c, FUN = sum)

## Plot time series of COVID Deaths
ggplot(d.625.c, aes(x = totMonth, y = COVID.19.Deaths, group = Condition.Group)) + geom_line(aes(color =
```



[Figure 2 is of temporal analysis - time series plot separated by Condition Group]

```
ggplot(subset(d.625,d.625$Condition%in%unique(d.625$Condition)[1:2]), aes(x=as.factor(Condition), y=COVI
```

```
## Warning: Removed 11093 rows containing non-finite values (stat_boxplot).
```



[Figure 3 is of boxplot of COVID-19 deaths versus few of conidtions factored by age groups]

```
summary(m.nb.spline)$coefficients
```

```
##                                                                                   Estimate
## (Intercept)                                                                   -8.039798439
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))1                 6.250079030
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))2                 5.6668193317
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))3                 6.8400263622
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))4                 5.1756187773
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))5                 6.8714933349
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))6                 6.3939430559
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))7                 6.5198863619
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))8                 4.6949173364
## Condition.GroupCirculatory diseases                                            1.2623500047
## Condition.GroupDiabetes                                                        1.6256734000
## Condition.GroupIntentional and unintentional injury, poisoning, and other adverse events  0.7816780911
## Condition.GroupMalignant neoplasms                                             1.0023780000
## Condition.GroupObesity                                                         1.3479388970
## Condition.GroupRenal failure                                                   1.4581102688
## Condition.GroupRespiratory diseases                                            1.7927078788
## Condition.GroupSepsis                                                          1.4253175970
## Condition.GroupVascular and unspecified dementia                               0.6906045644
## Age.Group25-34                                                                 0.8329969570
## Age.Group35-44                                                                 1.5090863730
## Age.Group45-54                                                                 2.1716047770
```

```
## Age.Group55-64                                                                      2.807130453
## Age.Group65-74                                                                      3.270373258
## Age.Group75-84                                                                      3.473551920
## Age.Group85+                                                                        3.534885202
## StateAlaska                                                                        -1.814417888
## StateArizona                                                                        0.356367339
## StateArkansas                                                                      -0.343176852
## StateCalifornia                                                                     1.548980744
## StateColorado                                                                      -0.088779365
## StateConnecticut                                                                   -0.584582972
## StateDelaware                                                                      -1.310439250
## StateDistrict of Columbia                                                          -1.360661538
## StateFlorida                                                                        1.224918975
## StateGeorgia                                                                        0.509791515
## StateHawaii                                                                        -1.524415719
## StateIdaho                                                                         -1.009824173
## StateIllinois                                                                       0.500590537
## StateIndiana                                                                        0.188289748
## StateIowa                                                                          -0.566293407
## StateKansas                                                                        -0.604851802
## StateKentucky                                                                       0.021499168
## StateLouisiana                                                                      0.024734102
## StateMaine                                                                         -1.668075557
## StateMaryland                                                                      -0.047808849
## StateMassachusetts                                                                 -0.143768925
## StateMichigan                                                                       0.422081893
## StateMinnesota                                                                     -0.157494249
## StateMississippi                                                                   -0.039809784
## StateMissouri                                                                      -0.047632857
## StateMontana                                                                       -1.175892894
## StateNebraska                                                                      -0.876697619
## StateNevada                                                                        -0.288112235
## StateNew Hampshire                                                                 -1.573268771
## StateNew Jersey                                                                     0.438973421
## StateNew Mexico                                                                    -0.622280820
## StateNew York                                                                       1.186026954
## StateNorth Carolina                                                                 0.340244723
## StateNorth Dakota                                                                  -1.307817360
## StateOhio                                                                           0.535755605
## StateOklahoma                                                                       0.002202344
## StateOregon                                                                        -0.574765961
## StatePennsylvania                                                                   0.651646970
## StatePuerto Rico                                                                   -0.722580674
## StateRhode Island                                                                  -1.320182109
## StateSouth Carolina                                                                 0.039973790
## StateSouth Dakota                                                                  -1.193100683
## StateTennessee                                                                      0.265288240
## StateTexas                                                                          1.492491404
## StateUtah                                                                          -0.758925951
## StateVermont                                                                       -2.184503632
## StateVirginia                                                                      -0.087712741
## StateWashington                                                                    -0.018936915
## StateWest Virginia                                                                 -0.846963883
## StateWisconsin                                                                     -0.175923742
```

```
## StateWyoming                                                                              -1.79440907
##                                                                                           Std. Error
## (Intercept)                                                                               0.04525982
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))1                           0.04036489
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))2                           0.03660288
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))3                           0.03746722
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))4                           0.03753867
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))5                           0.03798130
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))6                           0.03829770
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))7                           0.03711115
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))8                           0.03734760
## Condition.GroupCirculatory diseases                                                       0.01573080
## Condition.GroupDiabetes                                                                   0.01949166
## Condition.GroupIntentional and unintentional injury, poisoning, and other adverse events 0.02014793
## Condition.GroupMalignant neoplasms                                                        0.01994303
## Condition.GroupObesity                                                                    0.01967201
## Condition.GroupRenal failure                                                              0.01959681
## Condition.GroupRespiratory diseases                                                       0.01579639
## Condition.GroupSepsis                                                                     0.01961867
## Condition.GroupVascular and unspecified dementia                                          0.02024070
## Age.Group25-34                                                                            0.01443347
## Age.Group35-44                                                                            0.01387547
## Age.Group45-54                                                                            0.01354634
## Age.Group55-64                                                                            0.01335667
## Age.Group65-74                                                                            0.01326865
## Age.Group75-84                                                                            0.01323962
## Age.Group85+                                                                              0.01323180
## StateAlaska                                                                               0.03093243
## StateArizona                                                                              0.02719739
## StateArkansas                                                                             0.02792591
## StateCalifornia                                                                           0.02649605
## StateColorado                                                                             0.02762489
## StateConnecticut                                                                          0.02825700
## StateDelaware                                                                             0.02959363
## StateDistrict of Columbia                                                                 0.02970939
## StateFlorida                                                                              0.02663715
## StateGeorgia                                                                              0.02707501
## StateHawaii                                                                               0.03011223
## StateIdaho                                                                                0.02896925
## StateIllinois                                                                             0.02708202
## StateIndiana                                                                              0.02734539
## StateIowa                                                                                 0.02823022
## StateKansas                                                                               0.02828702
## StateKentucky                                                                             0.02750801
## StateLouisiana                                                                            0.02750470
## StateMaine                                                                                0.03050030
## StateMaryland                                                                             0.02758056
## StateMassachusetts                                                                        0.02768613
## StateMichigan                                                                             0.02714355
## StateMinnesota                                                                            0.02770174
## StateMississippi                                                                          0.02757203
## StateMissouri                                                                             0.02758037
## StateMontana                                                                              0.02930023
## StateNebraska                                                                             0.02872663
```

```
## StateNevada                                                                                   0.02785682
## StateNew Hampshire                                                                            0.03024039
## StateNew Jersey                                                                               0.02713006
## StateNew Mexico                                                                               0.02831313
## StateNew York                                                                                 0.02665618
## StateNorth Carolina                                                                           0.02721093
## StateNorth Dakota                                                                             0.02958768
## StateOhio                                                                                     0.02705542
## StateOklahoma                                                                                 0.02752791
## StateOregon                                                                                   0.02824259
## StatePennsylvania                                                                             0.02697176
## StatePuerto Rico                                                                              0.02846873
## StateRhode Island                                                                             0.02961582
## StateSouth Carolina                                                                           0.02748918
## StateSouth Dakota                                                                             0.02933645
## StateTennessee                                                                                0.02727570
## StateTexas                                                                                    0.02651854
## StateUtah                                                                                     0.02852744
## StateVermont                                                                                  0.03221821
## StateVirginia                                                                                 0.02762372
## StateWashington                                                                               0.02754997
## StateWest Virginia                                                                            0.02867502
## StateWisconsin                                                                                0.02772289
## StateWyoming                                                                                  0.03087102
##                                                                                                    z valu
## (Intercept)                                                                                   -177.6365412
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))1                                 154.8394742
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))2                                 154.8189431
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))3                                 182.5602727
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))4                                 137.8743122
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))5                                 180.9178161
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))6                                 166.9536963
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))7                                 175.6853671
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))8                                 125.7086700
## Condition.GroupCirculatory diseases                                                             80.2470235
## Condition.GroupDiabetes                                                                         83.4035428
## Condition.GroupIntentional and unintentional injury, poisoning, and other adverse events        38.7969424
## Condition.GroupMalignant neoplasms                                                              50.2620801
## Condition.GroupObesity                                                                          68.5206497
## Condition.GroupRenal failure                                                                    74.4054758
## Condition.GroupRespiratory diseases                                                            113.4884461
## Condition.GroupSepsis                                                                           72.6510647
## Condition.GroupVascular and unspecified dementia                                                34.1196069
## Age.Group25-34                                                                                  57.7128615
## Age.Group35-44                                                                                 108.7592759
## Age.Group45-54                                                                                 160.3093179
## Age.Group55-64                                                                                 210.1669918
## Age.Group65-74                                                                                 246.4736091
## Age.Group75-84                                                                                 262.3604503
## Age.Group85+                                                                                   267.1507282
## StateAlaska                                                                                    -58.6574610
## StateArizona                                                                                    13.1029980
## StateArkansas                                                                                  -12.2888353
## StateCalifornia                                                                                 58.4608250
```

```
## StateColorado                                                            -3.213745
## StateConnecticut                                                        -20.688073
## StateDelaware                                                           -44.281121
## StateDistrict of Columbia                                               -45.799042
## StateFlorida                                                             45.985356
## StateGeorgia                                                             18.828859
## StateHawaii                                                             -50.624470
## StateIdaho                                                              -34.858479
## StateIllinois                                                            18.484236
## StateIndiana                                                              6.885612
## StateIowa                                                               -20.059828
## StateKansas                                                             -21.382659
## StateKentucky                                                             0.781560
## StateLouisiana                                                            0.899268
## StateMaine                                                              -54.690472
## StateMaryland                                                            -1.733425
## StateMassachusetts                                                       -5.192813
## StateMichigan                                                            15.549989
## StateMinnesota                                                           -5.685356
## StateMississippi                                                         -1.443846
## StateMissouri                                                            -1.727056
## StateMontana                                                            -40.132545
## StateNebraska                                                           -30.518638
## StateNevada                                                             -10.342612
## StateNew Hampshire                                                      -52.025410
## StateNew Jersey                                                          16.180334
## StateNew Mexico                                                         -21.978524
## StateNew York                                                            44.493512
## StateNorth Carolina                                                      12.503970
## StateNorth Dakota                                                       -44.201409
## StateOhio                                                                19.802152
## StateOklahoma                                                             0.080004
## StateOregon                                                             -20.351034
## StatePennsylvania                                                        24.160341
## StatePuerto Rico                                                        -25.381558
## StateRhode Island                                                       -44.576928
## StateSouth Carolina                                                       1.454164
## StateSouth Dakota                                                       -40.669570
## StateTennessee                                                            9.726176
## StateTexas                                                               56.281050
## StateUtah                                                               -26.603369
## StateVermont                                                            -67.803379
## StateVirginia                                                            -3.175268
## StateWashington                                                          -0.687366
## StateWest Virginia                                                      -29.536648
## StateWisconsin                                                           -6.345793
## StateWyoming                                                            -58.126008
##                                                                            Pr(>|z
## (Intercept)                                                             0.000000e+
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))1          0.000000e+
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))2          0.000000e+
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))3          0.000000e+
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))4          0.000000e+
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))5          0.000000e+
```

```
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))6                      0.000000e+0
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))7                      0.000000e+0
## bs(totMonth, degree = 1, knots = c(4, 9, 13, 18, 21, 23, 25))8                      0.000000e+0
## Condition.GroupCirculatory diseases                                                 0.000000e+0
## Condition.GroupDiabetes                                                             0.000000e+0
## Condition.GroupIntentional and unintentional injury, poisoning, and other adverse events  0.000000e+0
## Condition.GroupMalignant neoplasms                                                  0.000000e+0
## Condition.GroupObesity                                                              0.000000e+0
## Condition.GroupRenal failure                                                        0.000000e+0
## Condition.GroupRespiratory diseases                                                 0.000000e+0
## Condition.GroupSepsis                                                               0.000000e+0
## Condition.GroupVascular and unspecified dementia                                   3.776844e-25
## Age.Group25-34                                                                      0.000000e+0
## Age.Group35-44                                                                      0.000000e+0
## Age.Group45-54                                                                      0.000000e+0
## Age.Group55-64                                                                      0.000000e+0
## Age.Group65-74                                                                      0.000000e+0
## Age.Group75-84                                                                      0.000000e+0
## Age.Group85+                                                                        0.000000e+0
## StateAlaska                                                                         0.000000e+0
## StateArizona                                                                        3.165040e-3
## StateArkansas                                                                       1.039935e-3
## StateCalifornia                                                                     0.000000e+0
## StateColorado                                                                       1.310158e-0
## StateConnecticut                                                                    4.435866e-9
## StateDelaware                                                                       0.000000e+0
## StateDistrict of Columbia                                                           0.000000e+0
## StateFlorida                                                                        0.000000e+0
## StateGeorgia                                                                        4.380922e-7
## StateHawaii                                                                         0.000000e+0
## StateIdaho                                                                         3.167427e-20
## StateIllinois                                                                       2.765878e-7
## StateIndiana                                                                        5.753948e-1
## StateIowa                                                                           1.656548e-8
## StateKansas                                                                        1.937670e-10
## StateKentucky                                                                       4.344730e-0
## StateLouisiana                                                                      3.685098e-0
## StateMaine                                                                          0.000000e+0
## StateMaryland                                                                       8.302005e-0
## StateMassachusetts                                                                  2.071397e-0
## StateMichigan                                                                       1.591328e-5
## StateMinnesota                                                                      1.305399e-0
## StateMississippi                                                                    1.487821e-0
## StateMissouri                                                                       8.415753e-0
## StateMontana                                                                        0.000000e+0
## StateNebraska                                                                      1.474799e-20
## StateNevada                                                                         4.520453e-1
## StateNew Hampshire                                                                  0.000000e+0
## StateNew Jersey                                                                     6.941653e-5
## StateNew Mexico                                                                    4.622377e-10
## StateNew York                                                                       0.000000e+0
## StateNorth Carolina                                                                 7.101399e-3
## StateNorth Dakota                                                                   0.000000e+0
## StateOhio                                                                           2.852399e-8
```

```
## StateOklahoma                                                                       9.362340e-0
## StateOregon                                                                         4.545788e-9
## StatePennsylvania                                                                  5.813701e-12
## StatePuerto Rico                                                                   4.030788e-14
## StateRhode Island                                                                   0.000000e+0
## StateSouth Carolina                                                                 1.459006e-0
## StateSouth Dakota                                                                   0.000000e+0
## StateTennessee                                                                      2.331949e-1
## StateTexas                                                                          0.000000e+0
## StateUtah                                                                          6.205315e-15
## StateVermont                                                                        0.000000e+0
## StateVirginia                                                                       1.496978e-0
## StateWashington                                                                     4.918521e-0
## StateWest Virginia                                                                 9.746960e-19
## StateWisconsin                                                                      2.212814e-1
## StateWyoming                                                                        0.000000e+0
```

[Table 1 is of Condition Group regression coefficients, as well as exponentiated coefficients and CIs]