

# State\_by\_year

2025-02-12

```
library(ggplot2)
library(dplyr)
```

```
##
## Attaching package: 'dplyr'
```

```
## The following objects are masked from 'package:stats':
##
##   filter, lag
```

```
## The following objects are masked from 'package:base':
##
##   intersect, setdiff, setequal, union
```

```
library(tidyr)
library(readxl)
library(latexpdf)
library(tinytex)
```

```
Covid_Year <- read_excel("C:/Users/Union Loaner #06/Desktop/Spring 2025/capstone 2/This semester project/COVID-19-Deaths.xlsx")
```

```
View(Covid_Year)
```

```
Covid_Year <- Covid_Year %>%
  mutate(Year = as.numeric(Year))
```

```
# Select columns by index rather than by name
```

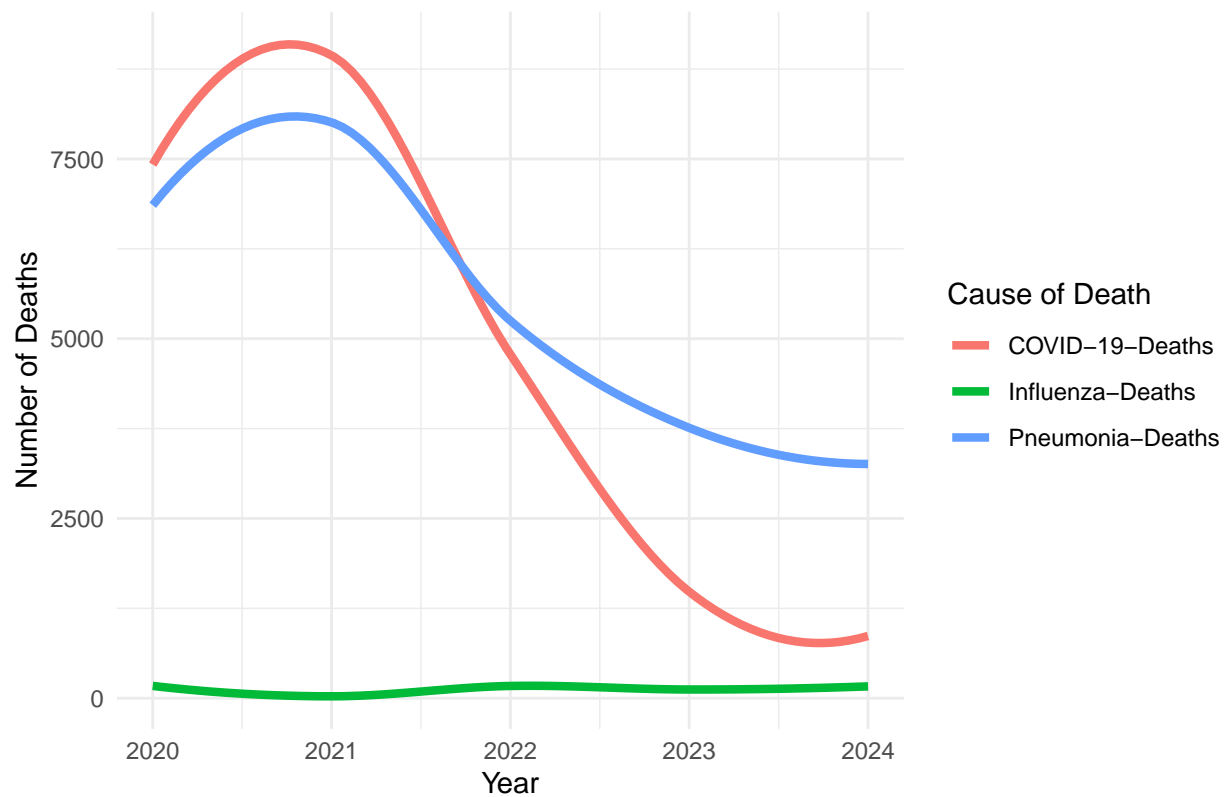
```
df_long <- Covid_Year[, c("Year", "COVID-19-Deaths", "Pneumonia-Deaths", "Influenza-Deaths")] %>%
  pivot_longer(cols = c("COVID-19-Deaths", "Pneumonia-Deaths", "Influenza-Deaths"),
               names_to = "cause_of_death",
               values_to = "deaths")
```

```
# Create a smooth trend line graph to show trends of death types throughout the years
```

```
ggplot(df_long, aes(x = Year, y = deaths, color = cause_of_death, group = cause_of_death)) +
  geom_smooth(se = FALSE, method = "loess", linewidth = 1.5) +
  labs(title = "Trend of Death Types Throughout the Years",
       x = "Year",
       y = "Number of Deaths",
       color = "Cause of Death") +
  theme_minimal()
```

```
## 'geom_smooth()' using formula = 'y ~ x'
```

### Trend of Death Types Throughout the Years



```
str(df_long)
```

```
## tibble [780 x 3] (S3: tbl_df/tbl/data.frame)
##  $ Year      : num [1:780] 2020 2020 2020 2021 2021 ...
##  $ cause_of_death: chr [1:780] "COVID-19-Deaths" "Pneumonia-Deaths" "Influenza-Deaths" "COVID-19-Dea
##  $ deaths      : num [1:780] 6706 5213 140 9719 6356 ...
```

```
library(ggplot2)
library(GGally)
```

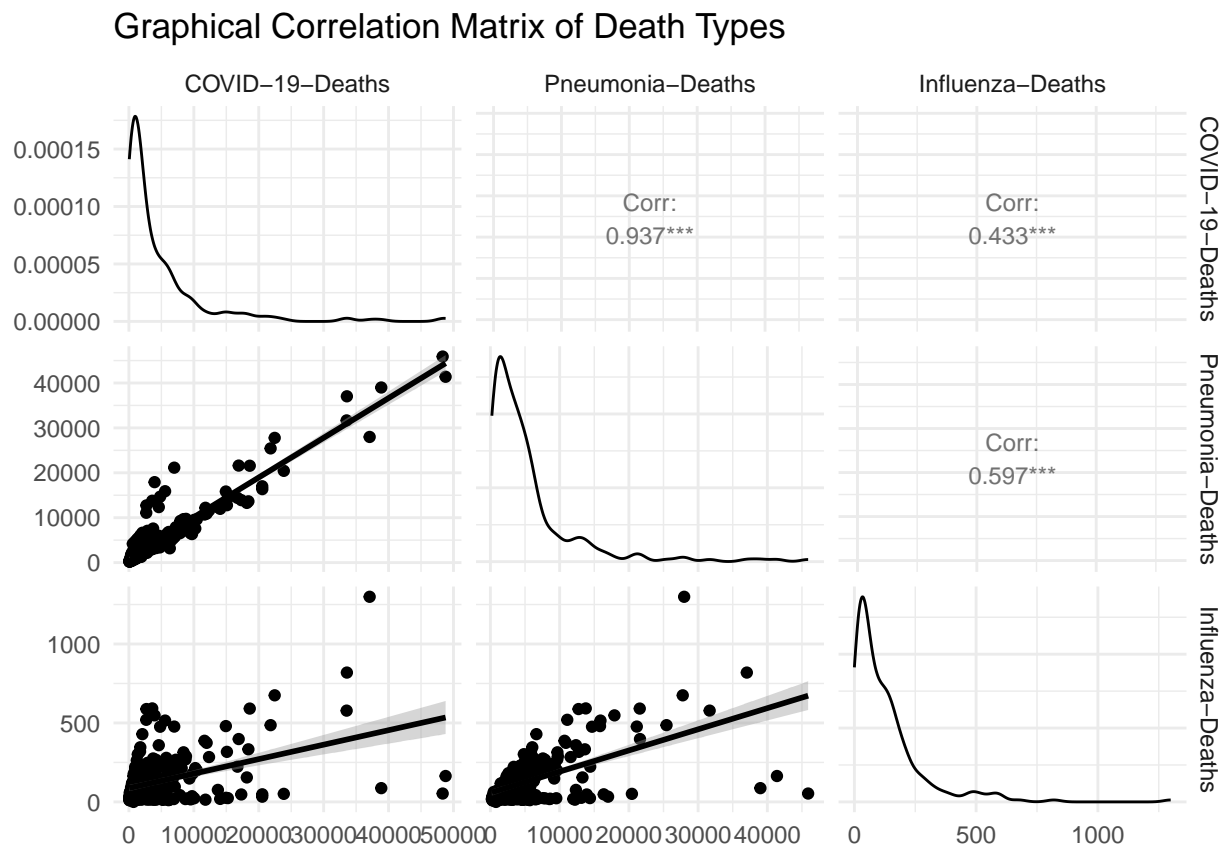
```
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg      ggplot2
```

```
##
## Attaching package: 'GGally'
```

```
## The following object is masked from 'package:latexpdf':
##
##   wrap
```

```
# Select relevant columns for correlation analysis
df_numeric <- Covid_Year[, c("COVID-19-Deaths", "Pneumonia-Deaths", "Influenza-Deaths")]
```

```
# Create a graphical correlation matrix
ggpairs(df_numeric,
  title = "Graphical Correlation Matrix of Death Types",
  upper = list(continuous = wrap("cor", size = 3)),
  lower = list(continuous = "smooth")) +
theme_minimal()
```



```
library(tidyr)
library(dplyr)
library(writexl)
```

```
## Warning: package 'writexl' was built under R version 4.4.3
```

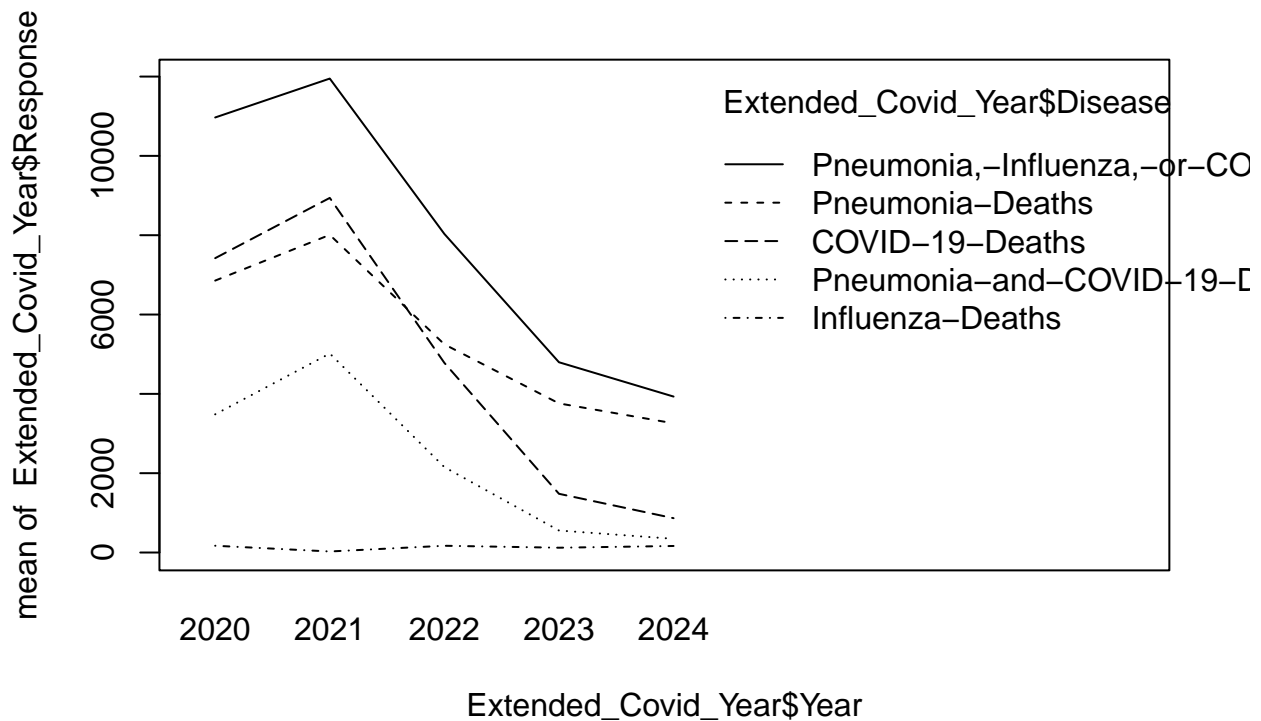
```
Extended_Covid_Year <- Covid_Year %>%
  pivot_longer(cols = c(`COVID-19-Deaths`, `Pneumonia-Deaths`, `Influenza-Deaths`, `Pneumonia-and-COVID-19-Deaths`),
    names_to = "Disease",
    values_to = "Response")

head(Extended_Covid_Year)
```

```
## # A tibble: 6 x 6
##   Group   Year State   'Total-Deaths' Disease      Response
##   <chr>   <dbl> <chr>         <dbl> <chr>         <dbl>
```

```
## 1 By Year 2020 Alabama 63362 COVID-19-Deaths 6706
## 2 By Year 2020 Alabama 63362 Pneumonia-Deaths 5213
## 3 By Year 2020 Alabama 63362 Influenza-Deaths 140
## 4 By Year 2020 Alabama 63362 Pneumonia-and-COVID-19-Deaths 2177
## 5 By Year 2020 Alabama 63362 Pneumonia,-Influenza,-or-COVID-- 9870
## 6 By Year 2021 Alabama 67323 COVID-19-Deaths 9719
```

```
interaction.plot(Extended_Covid_Year$Year,Extended_Covid_Year$Disease,Extended_Covid_Year$Response)
```



```
P_model <- glm(Response ~ as.factor(Year) * Disease, family = poisson, data = Extended_Covid_Year)
summary(P_model)
```

```
##
## Call:
## glm(formula = Response ~ as.factor(Year) * Disease, family = poisson,
##      data = Extended_Covid_Year)
##
## Coefficients:
##                                     Estimate
## (Intercept)                        8.912116
## as.factor(Year)2021                  0.186244
## as.factor(Year)2022                 -0.439602
## as.factor(Year)2023                 -1.611942
## as.factor(Year)2024                 -2.148875
## DiseaseInfluenza-Deaths             -3.771352
```

## DiseasePneumonia-and-COVID-19-Deaths	-0.756080
## DiseasePneumonia-Deaths	-0.079256
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	0.390646
## as.factor(Year)2021:DiseaseInfluenza-Deaths	-2.052770
## as.factor(Year)2022:DiseaseInfluenza-Deaths	0.436445
## as.factor(Year)2023:DiseaseInfluenza-Deaths	1.268239
## as.factor(Year)2024:DiseaseInfluenza-Deaths	2.110554
## as.factor(Year)2021:DiseasePneumonia-and-COVID-19-Deaths	0.178292
## as.factor(Year)2022:DiseasePneumonia-and-COVID-19-Deaths	-0.041557
## as.factor(Year)2023:DiseasePneumonia-and-COVID-19-Deaths	-0.225819
## as.factor(Year)2024:DiseasePneumonia-and-COVID-19-Deaths	-0.162057
## as.factor(Year)2021:DiseasePneumonia-Deaths	-0.030807
## as.factor(Year)2022:DiseasePneumonia-Deaths	0.172572
## as.factor(Year)2023:DiseasePneumonia-Deaths	1.011184
## as.factor(Year)2024:DiseasePneumonia-Deaths	1.404713
## as.factor(Year)2021:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	-0.100588
## as.factor(Year)2022:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	0.128089
## as.factor(Year)2023:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	0.784926
## as.factor(Year)2024:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	1.122992
##	Std. Error
## (Intercept)	0.001610
## as.factor(Year)2021	0.002178
## as.factor(Year)2022	0.002572
## as.factor(Year)2023	0.003947
## as.factor(Year)2024	0.004981
## DiseaseInfluenza-Deaths	0.010731
## DiseasePneumonia-and-COVID-19-Deaths	0.002848
## DiseasePneumonia-Deaths	0.002323
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	0.002084
## as.factor(Year)2021:DiseaseInfluenza-Deaths	0.029071
## as.factor(Year)2022:DiseaseInfluenza-Deaths	0.015235
## as.factor(Year)2023:DiseaseInfluenza-Deaths	0.016937
## as.factor(Year)2024:DiseaseInfluenza-Deaths	0.015948
## as.factor(Year)2021:DiseasePneumonia-and-COVID-19-Deaths	0.003754
## as.factor(Year)2022:DiseasePneumonia-and-COVID-19-Deaths	0.004589
## as.factor(Year)2023:DiseasePneumonia-and-COVID-19-Deaths	0.007468
## as.factor(Year)2024:DiseasePneumonia-and-COVID-19-Deaths	0.009273
## as.factor(Year)2021:DiseasePneumonia-Deaths	0.003154
## as.factor(Year)2022:DiseasePneumonia-Deaths	0.003617
## as.factor(Year)2023:DiseasePneumonia-Deaths	0.004848
## as.factor(Year)2024:DiseasePneumonia-Deaths	0.005790
## as.factor(Year)2021:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	0.002847
## as.factor(Year)2022:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	0.003280
## as.factor(Year)2023:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	0.004620
## as.factor(Year)2024:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	0.005609
##	z value
## (Intercept)	5536.400
## as.factor(Year)2021	85.525
## as.factor(Year)2022	-170.945
## as.factor(Year)2023	-408.380
## as.factor(Year)2024	-431.401
## DiseaseInfluenza-Deaths	-351.449
## DiseasePneumonia-and-COVID-19-Deaths	-265.492
## DiseasePneumonia-Deaths	-34.118

```

## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths 187.418
## as.factor(Year)2021:DiseaseInfluenza-Deaths -70.613
## as.factor(Year)2022:DiseaseInfluenza-Deaths 28.648
## as.factor(Year)2023:DiseaseInfluenza-Deaths 74.879
## as.factor(Year)2024:DiseaseInfluenza-Deaths 132.342
## as.factor(Year)2021:DiseasePneumonia-and-COVID-19-Deaths 47.491
## as.factor(Year)2022:DiseasePneumonia-and-COVID-19-Deaths -9.055
## as.factor(Year)2023:DiseasePneumonia-and-COVID-19-Deaths -30.238
## as.factor(Year)2024:DiseasePneumonia-and-COVID-19-Deaths -17.477
## as.factor(Year)2021:DiseasePneumonia-Deaths -9.767
## as.factor(Year)2022:DiseasePneumonia-Deaths 47.713
## as.factor(Year)2023:DiseasePneumonia-Deaths 208.592
## as.factor(Year)2024:DiseasePneumonia-Deaths 242.623
## as.factor(Year)2021:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths -35.333
## as.factor(Year)2022:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths 39.048
## as.factor(Year)2023:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths 169.906
## as.factor(Year)2024:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths 200.228
## Pr(>|z|)
## (Intercept) <2e-16
## as.factor(Year)2021 <2e-16
## as.factor(Year)2022 <2e-16
## as.factor(Year)2023 <2e-16
## as.factor(Year)2024 <2e-16
## DiseaseInfluenza-Deaths <2e-16
## DiseasePneumonia-and-COVID-19-Deaths <2e-16
## DiseasePneumonia-Deaths <2e-16
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths <2e-16
## as.factor(Year)2021:DiseaseInfluenza-Deaths <2e-16
## as.factor(Year)2022:DiseaseInfluenza-Deaths <2e-16
## as.factor(Year)2023:DiseaseInfluenza-Deaths <2e-16
## as.factor(Year)2024:DiseaseInfluenza-Deaths <2e-16
## as.factor(Year)2021:DiseasePneumonia-and-COVID-19-Deaths <2e-16
## as.factor(Year)2022:DiseasePneumonia-and-COVID-19-Deaths <2e-16
## as.factor(Year)2023:DiseasePneumonia-and-COVID-19-Deaths <2e-16
## as.factor(Year)2024:DiseasePneumonia-and-COVID-19-Deaths <2e-16
## as.factor(Year)2021:DiseasePneumonia-Deaths <2e-16
## as.factor(Year)2022:DiseasePneumonia-Deaths <2e-16
## as.factor(Year)2023:DiseasePneumonia-Deaths <2e-16
## as.factor(Year)2024:DiseasePneumonia-Deaths <2e-16
## as.factor(Year)2021:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths <2e-16
## as.factor(Year)2022:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths <2e-16
## as.factor(Year)2023:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths <2e-16
## as.factor(Year)2024:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths <2e-16
##
## (Intercept) ***
## as.factor(Year)2021 ***
## as.factor(Year)2022 ***
## as.factor(Year)2023 ***
## as.factor(Year)2024 ***
## DiseaseInfluenza-Deaths ***
## DiseasePneumonia-and-COVID-19-Deaths ***
## DiseasePneumonia-Deaths ***
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths ***
## as.factor(Year)2021:DiseaseInfluenza-Deaths ***

```

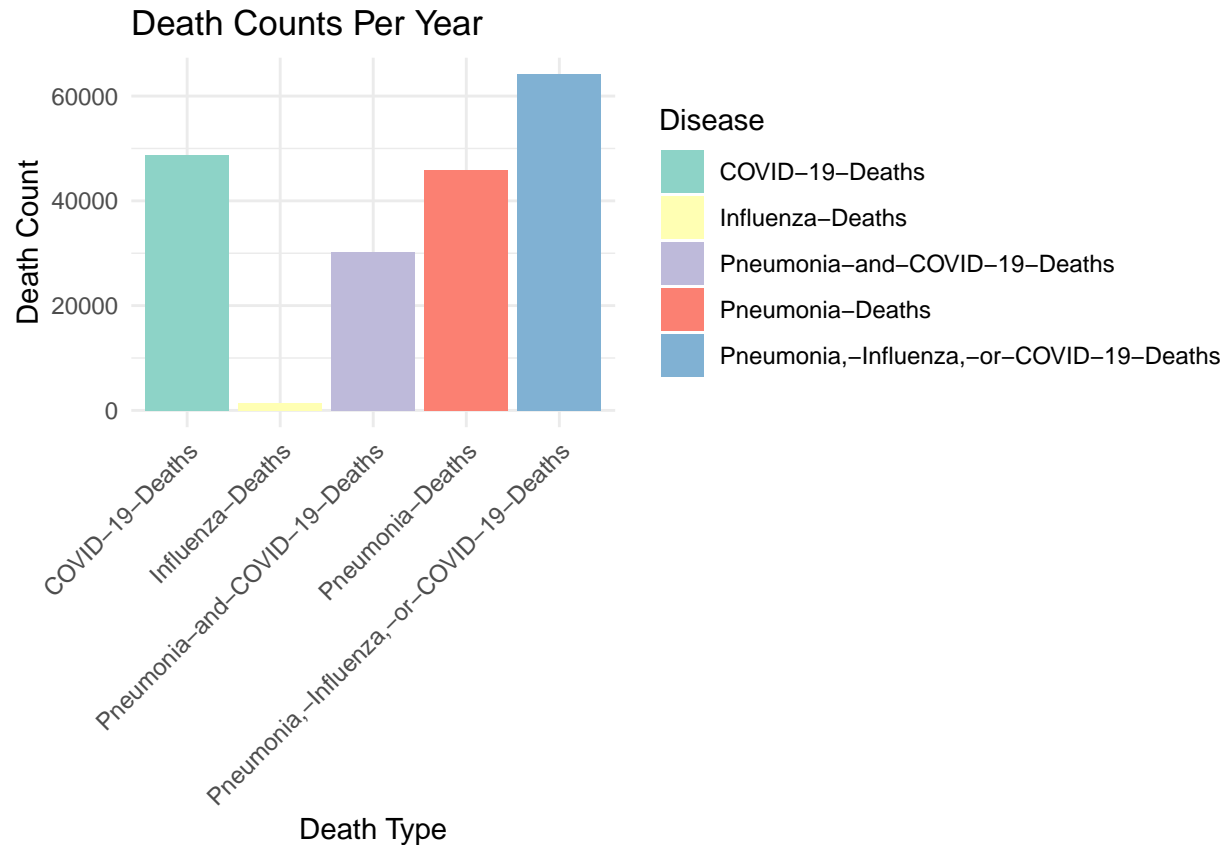
```
## as.factor(Year)2022:DiseaseInfluenza-Deaths ***
## as.factor(Year)2023:DiseaseInfluenza-Deaths ***
## as.factor(Year)2024:DiseaseInfluenza-Deaths ***
## as.factor(Year)2021:DiseasePneumonia-and-COVID-19-Deaths ***
## as.factor(Year)2022:DiseasePneumonia-and-COVID-19-Deaths ***
## as.factor(Year)2023:DiseasePneumonia-and-COVID-19-Deaths ***
## as.factor(Year)2024:DiseasePneumonia-and-COVID-19-Deaths ***
## as.factor(Year)2021:DiseasePneumonia-Deaths ***
## as.factor(Year)2022:DiseasePneumonia-Deaths ***
## as.factor(Year)2023:DiseasePneumonia-Deaths ***
## as.factor(Year)2024:DiseasePneumonia-Deaths ***
## as.factor(Year)2021:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths ***
## as.factor(Year)2022:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths ***
## as.factor(Year)2023:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths ***
## as.factor(Year)2024:DiseasePneumonia,-Influenza,-or-COVID-19-Deaths ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for poisson family taken to be 1)
##
##      Null deviance: 9567386  on 1299  degrees of freedom
## Residual deviance: 5111728  on 1275  degrees of freedom
## AIC: 5123264
##
## Number of Fisher Scoring iterations: 5
```

```
expected_counts <- predict(P_model, type = "response")
```

```
head(expected_counts)
```

```
##           1           2           3           4           5           6
## 7421.3462  6855.8654  170.8462  3484.3462 10968.2692  8940.6154
```

```
library(ggplot2)
ggplot(Extended_Covid_Year, aes(x = Disease, y = `Response`, fill = Disease)) +
  geom_bar(stat = "identity", position = "dodge") +
  theme_minimal() +
  labs(title = "Death Counts Per Year",
       x = "Death Type",
       y = "Death Count") +
  scale_fill_brewer(palette = "Set3") +
  theme(axis.text.x = element_text(angle = 45, hjust = 1))
```



```
model_qp <- glm(Response~Disease*as.factor(Year), family = quasipoisson,data = Extended_Covid_Year)
summary(model_qp)
```

```
##
## Call:
## glm(formula = Response ~ Disease * as.factor(Year), family = quasipoisson,
##      data = Extended_Covid_Year)
##
## Coefficients:
##                                     Estimate
## (Intercept)                        8.91212
## DiseaseInfluenza-Deaths            -3.77135
## DiseasePneumonia-and-COVID-19-Deaths -0.75608
## DiseasePneumonia-Deaths            -0.07926
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths 0.39065
## as.factor(Year)2021                 0.18624
## as.factor(Year)2022                -0.43960
## as.factor(Year)2023                -1.61194
## as.factor(Year)2024                -2.14888
## DiseaseInfluenza-Deaths:as.factor(Year)2021 -2.05277
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2021 0.17829
## DiseasePneumonia-Deaths:as.factor(Year)2021 -0.03081
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2021 -0.10059
## DiseaseInfluenza-Deaths:as.factor(Year)2022 0.43645
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2022 -0.04156
```



## DiseasePneumonia-Deaths:as.factor(Year)2022	0.17257
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2022	0.12809
## DiseaseInfluenza-Deaths:as.factor(Year)2023	1.26824
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2023	-0.22582
## DiseasePneumonia-Deaths:as.factor(Year)2023	1.01118
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2023	0.78493
## DiseaseInfluenza-Deaths:as.factor(Year)2024	2.11055
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2024	-0.16206
## DiseasePneumonia-Deaths:as.factor(Year)2024	1.40471
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2024	1.12299
##	Std. Error
## (Intercept)	0.11741
## DiseaseInfluenza-Deaths	0.78271
## DiseasePneumonia-and-COVID-19-Deaths	0.20772
## DiseasePneumonia-Deaths	0.16944
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	0.15203
## as.factor(Year)2021	0.15884
## as.factor(Year)2022	0.18757
## as.factor(Year)2023	0.28791
## as.factor(Year)2024	0.36333
## DiseaseInfluenza-Deaths:as.factor(Year)2021	2.12042
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2021	0.27383
## DiseasePneumonia-Deaths:as.factor(Year)2021	0.23006
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2021	0.20765
## DiseaseInfluenza-Deaths:as.factor(Year)2022	1.11121
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2022	0.33475
## DiseasePneumonia-Deaths:as.factor(Year)2022	0.26381
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2022	0.23927
## DiseaseInfluenza-Deaths:as.factor(Year)2023	1.23541
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2023	0.54473
## DiseasePneumonia-Deaths:as.factor(Year)2023	0.35359
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2023	0.33697
## DiseaseInfluenza-Deaths:as.factor(Year)2024	1.16323
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2024	0.67636
## DiseasePneumonia-Deaths:as.factor(Year)2024	0.42230
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2024	0.40909
##	t value
## (Intercept)	75.903
## DiseaseInfluenza-Deaths	-4.818
## DiseasePneumonia-and-COVID-19-Deaths	-3.640
## DiseasePneumonia-Deaths	-0.468
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	2.569
## as.factor(Year)2021	1.173
## as.factor(Year)2022	-2.344
## as.factor(Year)2023	-5.599
## as.factor(Year)2024	-5.914
## DiseaseInfluenza-Deaths:as.factor(Year)2021	-0.968
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2021	0.651
## DiseasePneumonia-Deaths:as.factor(Year)2021	-0.134
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2021	-0.484
## DiseaseInfluenza-Deaths:as.factor(Year)2022	0.393
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2022	-0.124
## DiseasePneumonia-Deaths:as.factor(Year)2022	0.654
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2022	0.535

```

## DiseaseInfluenza-Deaths:as.factor(Year)2023 1.027
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2023 -0.415
## DiseasePneumonia-Deaths:as.factor(Year)2023 2.860
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2023 2.329
## DiseaseInfluenza-Deaths:as.factor(Year)2024 1.814
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2024 -0.240
## DiseasePneumonia-Deaths:as.factor(Year)2024 3.326
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2024 2.745
## Pr(>|t|)
## (Intercept) < 2e-16
## DiseaseInfluenza-Deaths 1.62e-06
## DiseasePneumonia-and-COVID-19-Deaths 0.000284
## DiseasePneumonia-Deaths 0.640039
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths 0.010298
## as.factor(Year)2021 0.241199
## as.factor(Year)2022 0.019250
## as.factor(Year)2023 2.64e-08
## as.factor(Year)2024 4.27e-09
## DiseaseInfluenza-Deaths:as.factor(Year)2021 0.333181
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2021 0.515101
## DiseasePneumonia-Deaths:as.factor(Year)2021 0.893497
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2021 0.628181
## DiseaseInfluenza-Deaths:as.factor(Year)2022 0.694558
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2022 0.901220
## DiseasePneumonia-Deaths:as.factor(Year)2022 0.513139
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2022 0.592510
## DiseaseInfluenza-Deaths:as.factor(Year)2023 0.304815
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2023 0.678538
## DiseasePneumonia-Deaths:as.factor(Year)2023 0.004309
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2023 0.019994
## DiseaseInfluenza-Deaths:as.factor(Year)2024 0.069853
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2024 0.810678
## DiseasePneumonia-Deaths:as.factor(Year)2024 0.000905
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2024 0.006134
##
## (Intercept) ***
## DiseaseInfluenza-Deaths ***
## DiseasePneumonia-and-COVID-19-Deaths ***
## DiseasePneumonia-Deaths
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths *
## as.factor(Year)2021
## as.factor(Year)2022 *
## as.factor(Year)2023 ***
## as.factor(Year)2024 ***
## DiseaseInfluenza-Deaths:as.factor(Year)2021
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2021
## DiseasePneumonia-Deaths:as.factor(Year)2021
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2021
## DiseaseInfluenza-Deaths:as.factor(Year)2022
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2022
## DiseasePneumonia-Deaths:as.factor(Year)2022
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2022
## DiseaseInfluenza-Deaths:as.factor(Year)2023
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2023

```

```
## DiseasePneumonia-Deaths:as.factor(Year)2023 **
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2023 *
## DiseaseInfluenza-Deaths:as.factor(Year)2024 .
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2024
## DiseasePneumonia-Deaths:as.factor(Year)2024 ***
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2024 **
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for quasipoisson family taken to be 5320.285)
##
## Null deviance: 9567386 on 1299 degrees of freedom
## Residual deviance: 5111728 on 1275 degrees of freedom
## AIC: NA
##
## Number of Fisher Scoring iterations: 5
```

```
library(MASS)
```

```
## Warning: package 'MASS' was built under R version 4.4.3
```

```
##
```

```
## Attaching package: 'MASS'
```

```
## The following object is masked from 'package:dplyr':
```

```
##
```

```
## select
```

```
model_nb_interact <- glm.nb(Response ~ Disease * as.factor(Year), data = Extended_Covid_Year)
summary(model_nb_interact)
```

```
##
```

```
## Call:
```

```
## glm.nb(formula = Response ~ Disease * as.factor(Year), data = Extended_Covid_Year,
## init.theta = 1.120514533, link = log)
```

```
##
```

```
## Coefficients:
```

```
##
```

	Estimate
## (Intercept)	8.91212
## DiseaseInfluenza-Deaths	-3.77135
## DiseasePneumonia-and-COVID-19-Deaths	-0.75608
## DiseasePneumonia-Deaths	-0.07926
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	0.39065
## as.factor(Year)2021	0.18624
## as.factor(Year)2022	-0.43960
## as.factor(Year)2023	-1.61194
## as.factor(Year)2024	-2.14888
## DiseaseInfluenza-Deaths:as.factor(Year)2021	-2.05277
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2021	0.17829
## DiseasePneumonia-Deaths:as.factor(Year)2021	-0.03081
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2021	-0.10059
## DiseaseInfluenza-Deaths:as.factor(Year)2022	0.43645

## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2022	-0.04156
## DiseasePneumonia-Deaths:as.factor(Year)2022	0.17257
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2022	0.12809
## DiseaseInfluenza-Deaths:as.factor(Year)2023	1.26824
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2023	-0.22582
## DiseasePneumonia-Deaths:as.factor(Year)2023	1.01118
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2023	0.78493
## DiseaseInfluenza-Deaths:as.factor(Year)2024	2.11055
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2024	-0.16206
## DiseasePneumonia-Deaths:as.factor(Year)2024	1.40471
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2024	1.12299
##	Std. Error
## (Intercept)	0.13102
## DiseaseInfluenza-Deaths	0.18558
## DiseasePneumonia-and-COVID-19-Deaths	0.18529
## DiseasePneumonia-Deaths	0.18528
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	0.18528
## as.factor(Year)2021	0.18528
## as.factor(Year)2022	0.18529
## as.factor(Year)2023	0.18531
## as.factor(Year)2024	0.18534
## DiseaseInfluenza-Deaths:as.factor(Year)2021	0.26362
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2021	0.26204
## DiseasePneumonia-Deaths:as.factor(Year)2021	0.26203
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2021	0.26203
## DiseaseInfluenza-Deaths:as.factor(Year)2022	0.26245
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2022	0.26205
## DiseasePneumonia-Deaths:as.factor(Year)2022	0.26204
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2022	0.26203
## DiseaseInfluenza-Deaths:as.factor(Year)2023	0.26256
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2023	0.26212
## DiseasePneumonia-Deaths:as.factor(Year)2023	0.26206
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2023	0.26205
## DiseaseInfluenza-Deaths:as.factor(Year)2024	0.26250
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2024	0.26218
## DiseasePneumonia-Deaths:as.factor(Year)2024	0.26207
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2024	0.26207
##	z value
## (Intercept)	68.023
## DiseaseInfluenza-Deaths	-20.322
## DiseasePneumonia-and-COVID-19-Deaths	-4.080
## DiseasePneumonia-Deaths	-0.428
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths	2.108
## as.factor(Year)2021	1.005
## as.factor(Year)2022	-2.373
## as.factor(Year)2023	-8.699
## as.factor(Year)2024	-11.594
## DiseaseInfluenza-Deaths:as.factor(Year)2021	-7.787
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2021	0.680
## DiseasePneumonia-Deaths:as.factor(Year)2021	-0.118
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2021	-0.384
## DiseaseInfluenza-Deaths:as.factor(Year)2022	1.663
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2022	-0.159
## DiseasePneumonia-Deaths:as.factor(Year)2022	0.659

```

## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2022    0.489
## DiseaseInfluenza-Deaths:as.factor(Year)2023                            4.830
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2023               -0.862
## DiseasePneumonia-Deaths:as.factor(Year)2023                            3.859
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2023    2.995
## DiseaseInfluenza-Deaths:as.factor(Year)2024                            8.040
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2024               -0.618
## DiseasePneumonia-Deaths:as.factor(Year)2024                            5.360
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2024    4.285
##                                                                           Pr(>|z|)
## (Intercept)                                                             < 2e-16
## DiseaseInfluenza-Deaths                                                 < 2e-16
## DiseasePneumonia-and-COVID-19-Deaths                                   4.49e-05
## DiseasePneumonia-Deaths                                                0.668831
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths                      0.034997
## as.factor(Year)2021                                                    0.314806
## as.factor(Year)2022                                                    0.017666
## as.factor(Year)2023                                                     < 2e-16
## as.factor(Year)2024                                                     < 2e-16
## DiseaseInfluenza-Deaths:as.factor(Year)2021                          6.87e-15
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2021              0.496247
## DiseasePneumonia-Deaths:as.factor(Year)2021                          0.906409
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2021  0.701063
## DiseaseInfluenza-Deaths:as.factor(Year)2022                          0.096324
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2022              0.873997
## DiseasePneumonia-Deaths:as.factor(Year)2022                          0.510165
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2022  0.624962
## DiseaseInfluenza-Deaths:as.factor(Year)2023                          1.36e-06
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2023              0.388952
## DiseasePneumonia-Deaths:as.factor(Year)2023                          0.000114
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2023  0.002742
## DiseaseInfluenza-Deaths:as.factor(Year)2024                          8.96e-16
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2024              0.536494
## DiseasePneumonia-Deaths:as.factor(Year)2024                          8.32e-08
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2024  1.83e-05
##
## (Intercept)                                                             ***
## DiseaseInfluenza-Deaths                                                 ***
## DiseasePneumonia-and-COVID-19-Deaths                                   ***
## DiseasePneumonia-Deaths
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths                       *
## as.factor(Year)2021
## as.factor(Year)2022                                                     *
## as.factor(Year)2023                                                     ***
## as.factor(Year)2024                                                     ***
## DiseaseInfluenza-Deaths:as.factor(Year)2021                          ***
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2021
## DiseasePneumonia-Deaths:as.factor(Year)2021
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2021
## DiseaseInfluenza-Deaths:as.factor(Year)2022                          .
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2022
## DiseasePneumonia-Deaths:as.factor(Year)2022
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2022
## DiseaseInfluenza-Deaths:as.factor(Year)2023                          ***

```

```
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2023
## DiseasePneumonia-Deaths:as.factor(Year)2023 ***
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2023 **
## DiseaseInfluenza-Deaths:as.factor(Year)2024 ***
## DiseasePneumonia-and-COVID-19-Deaths:as.factor(Year)2024
## DiseasePneumonia-Deaths:as.factor(Year)2024 ***
## DiseasePneumonia,-Influenza,-or-COVID-19-Deaths:as.factor(Year)2024 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for Negative Binomial(1.1205) family taken to be 1)
##
##      Null deviance: 3841.8  on 1299  degrees of freedom
## Residual deviance: 1478.9  on 1275  degrees of freedom
## AIC: 22162
##
## Number of Fisher Scoring iterations: 1
##
##
##              Theta:  1.1205
##             Std. Err.:  0.0392
##
## 2 x log-likelihood:  -22109.8030
```

```
library(ggplot2)
library(usmap)
```

```
## Warning: package 'usmap' was built under R version 4.4.3
```

```
library(dplyr)

# STEP 1: Organize your data
panel_data_long <- Extended_Covid_Year %>%
  group_by(State, Year, Disease) %>%
  summarize(Deaths = sum(Response), .groups = "drop") %>%
  mutate(State = toupper(State)) # Convert state names to uppercase

# STEP 2: Visualize spatial patterns by year (Extremely Minimal Code)
selected_disease_plot <- "COVID-19-Deaths" # Choose a disease to visualize

map_data <- map_data("state") %>% rename(State = region) %>% mutate(State = toupper(State))

years <- unique(panel_data_long$Year)

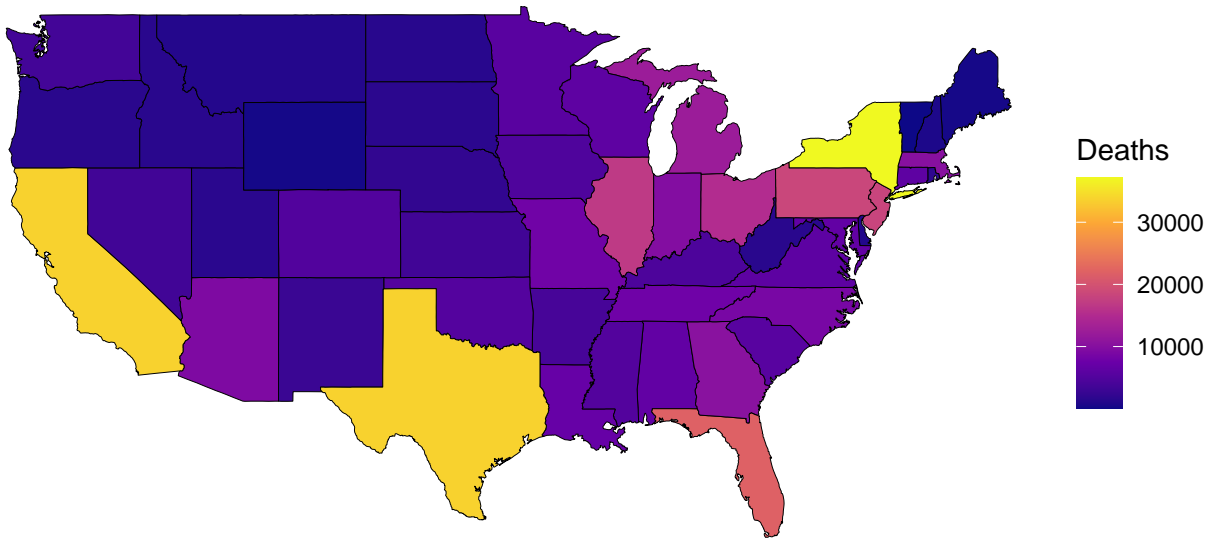
for (yr in years) {
  year_data <- panel_data_long %>%
    filter(Year == yr, Disease == selected_disease_plot)

  merged_data <- map_data %>%
    left_join(year_data, by = "State")

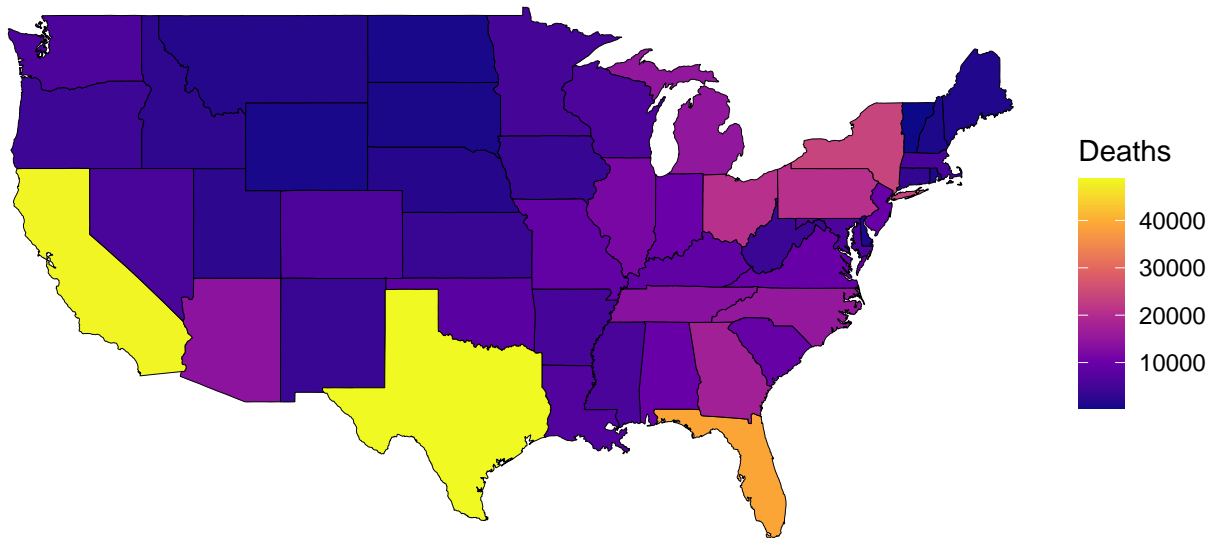
  print(
    ggplot(merged_data, aes(long, lat, group = group, fill = Deaths)) +
```

```
geom_polygon(color = "black", linewidth = 0.1) +
coord_quickmap() +
scale_fill_viridis_c(option = "plasma", na.value = "lightgray") +
labs(title = paste(selected_disease_plot, "Deaths -", yr), fill = "Deaths") +
theme_void()
)
```

## COVID-19-Deaths Deaths – 2020

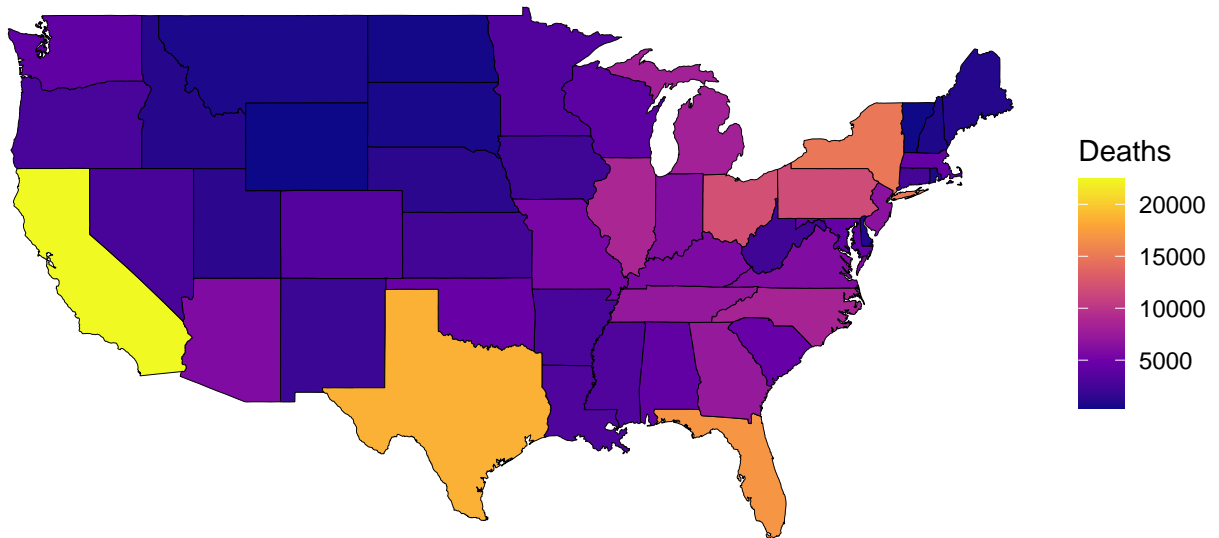


## COVID-19-Deaths Deaths – 2021

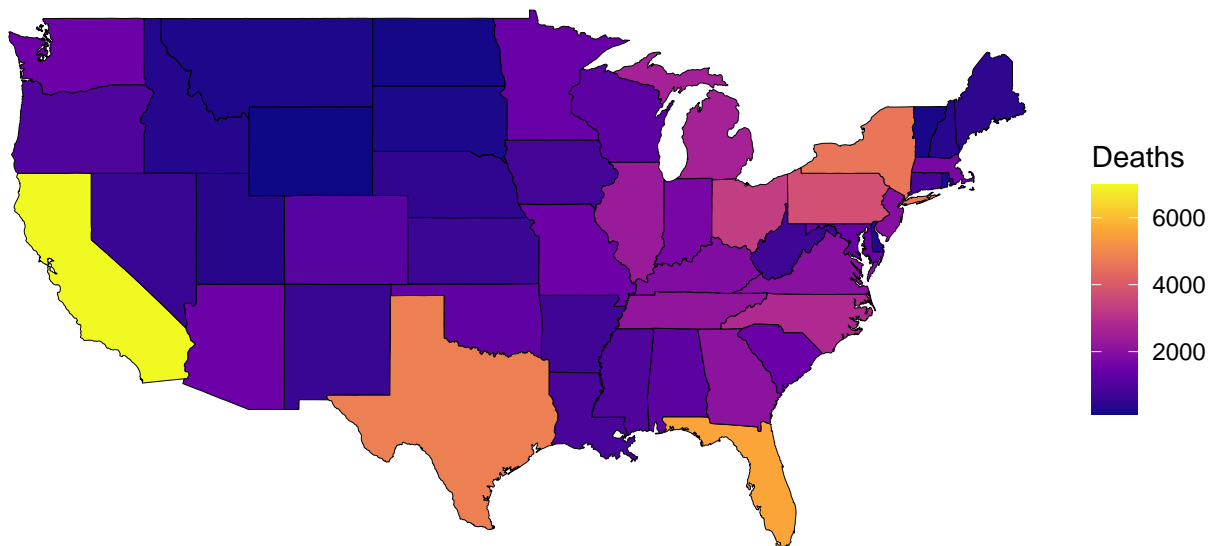




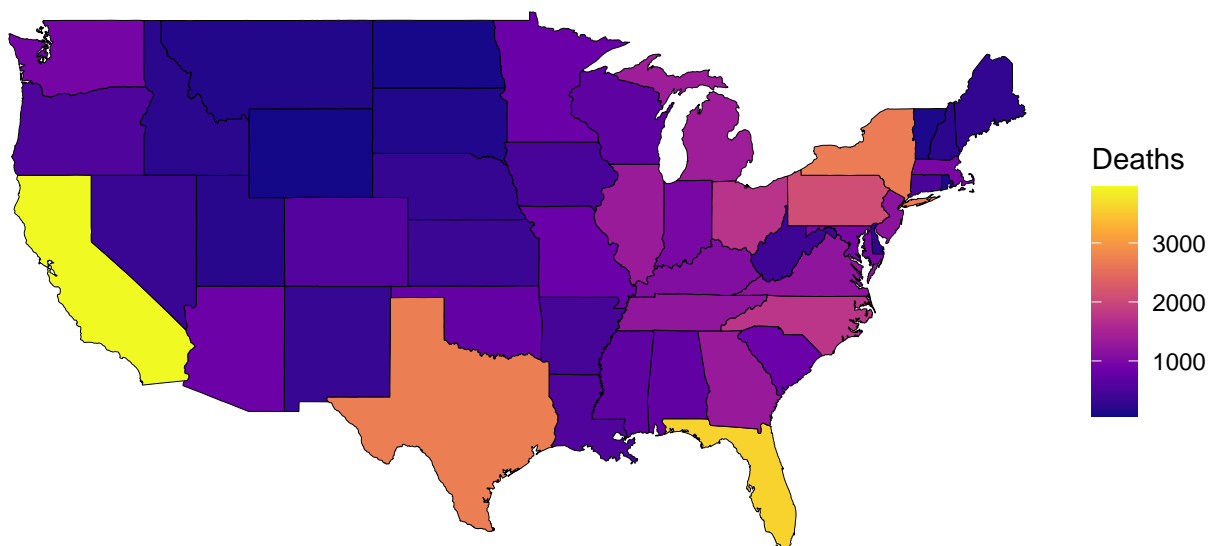
## COVID-19-Deaths Deaths – 2022



## COVID-19-Deaths Deaths – 2023



## COVID-19-Deaths Deaths – 2024



```
library(ggplot2)
library(usmap)
library(dplyr)

# STEP 1: Organize your data
panel_data_long <- Extended_Covid_Year %>%
  filter(Disease %in% c("Pneumonia-Deaths", "Influenza-Deaths")) %>%
  group_by(State, Year, Disease) %>%
  summarize(Deaths = sum(Response), .groups = "drop") %>%
  mutate(State = toupper(State)) # Convert state names to uppercase

# STEP 2: Visualize spatial patterns by year for Pneumonia and Influenza
map_data_states <- map_data("state") %>%
  mutate(state_name_upper = toupper(region))

years <- unique(panel_data_long$Year)
diseases_to_plot <- unique(panel_data_long$Disease)

for (dis in diseases_to_plot) {
  for (yr in years) {
    year_disease_data <- panel_data_long %>%
      filter(Year == yr, Disease == dis)

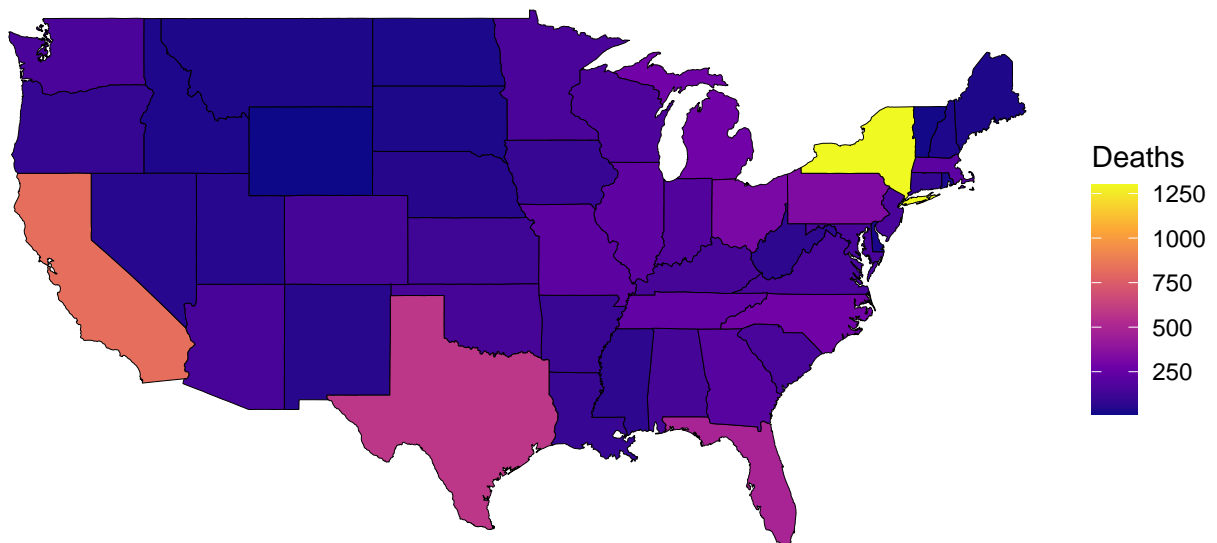
    merged_data <- map_data_states %>%
      left_join(year_disease_data, by = c("state_name_upper" = "State"))
```

```

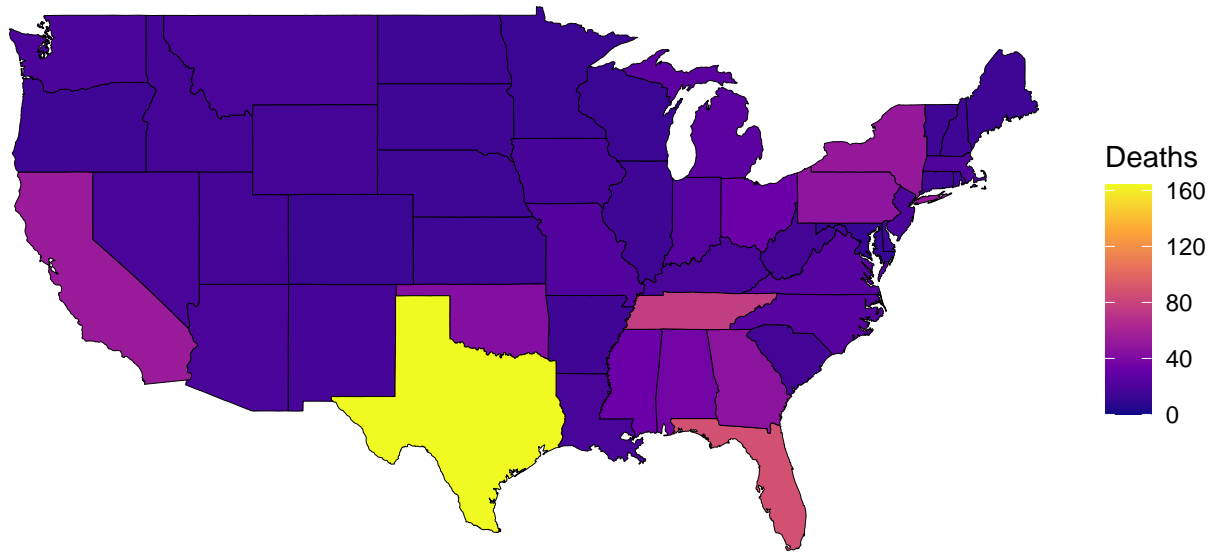
print(
  ggplot(merged_data, aes(long, lat, group = group, fill = Deaths)) +
  geom_polygon(color = "black", linewidth = 0.1) +
  coord_quickmap() +
  scale_fill_viridis_c(option = "plasma", na.value = "lightgray") +
  labs(title = paste(dis, "Deaths -", yr), fill = "Deaths") +
  theme_void()
)
}
}

```

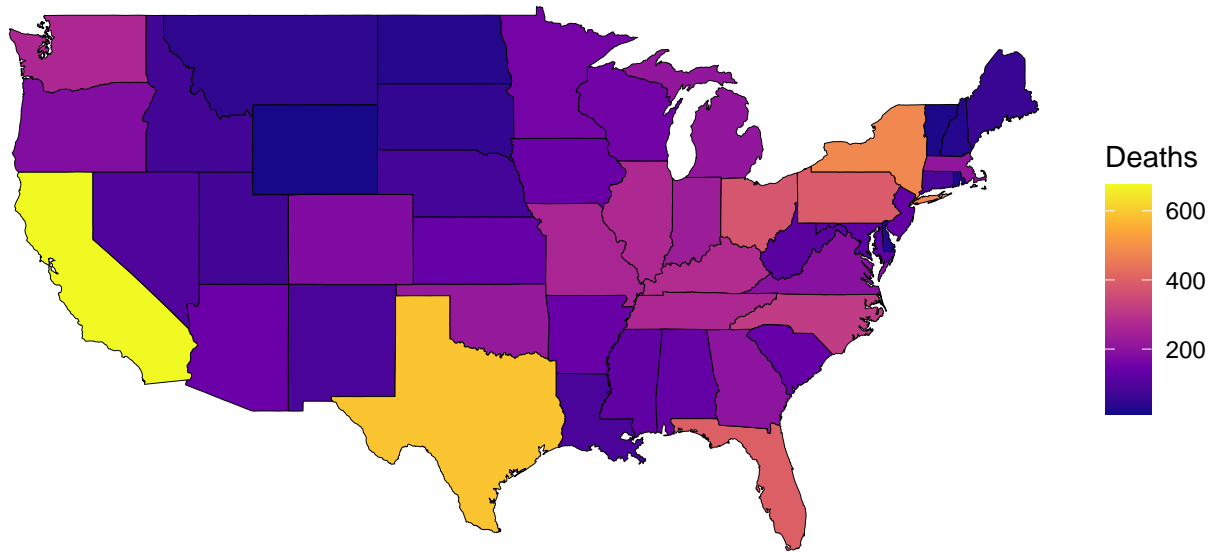
## Influenza–Deaths Deaths – 2020



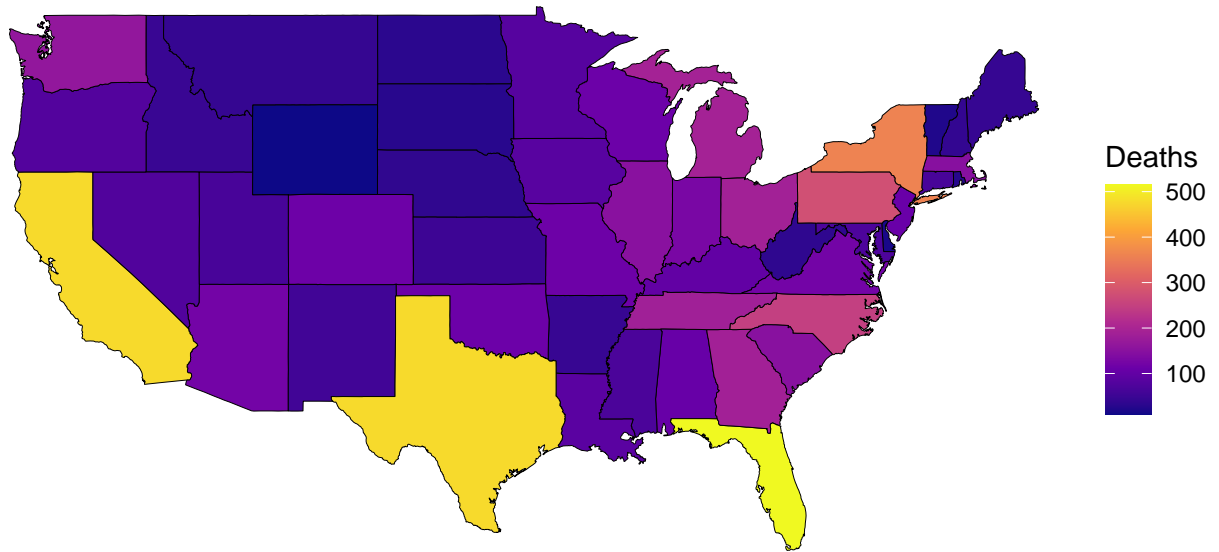
## Influenza–Deaths Deaths – 2021



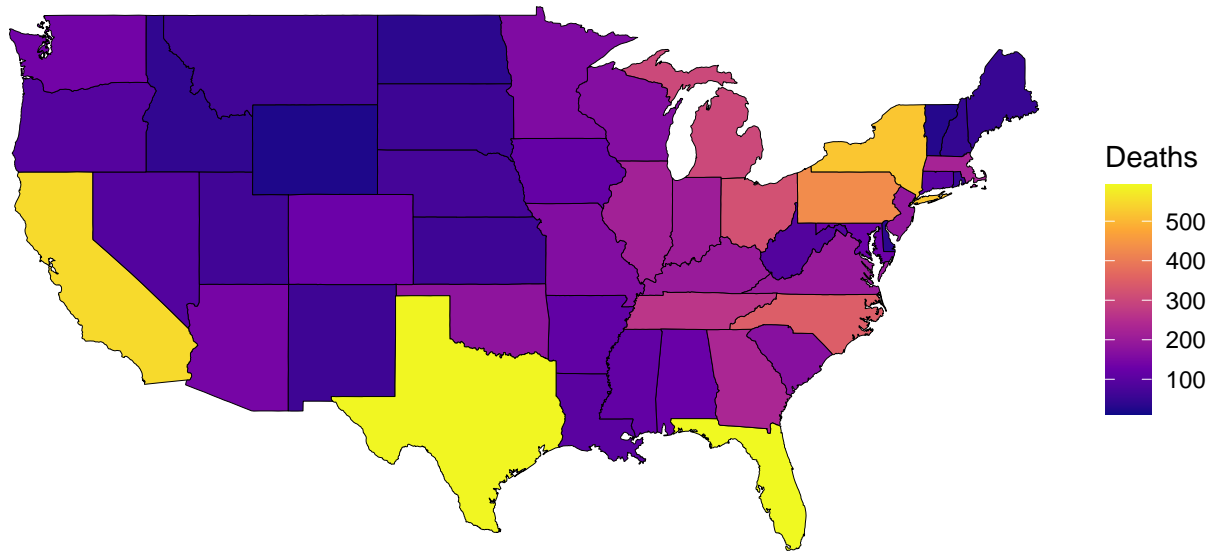
## Influenza–Deaths Deaths – 2022



## Influenza–Deaths Deaths – 2023

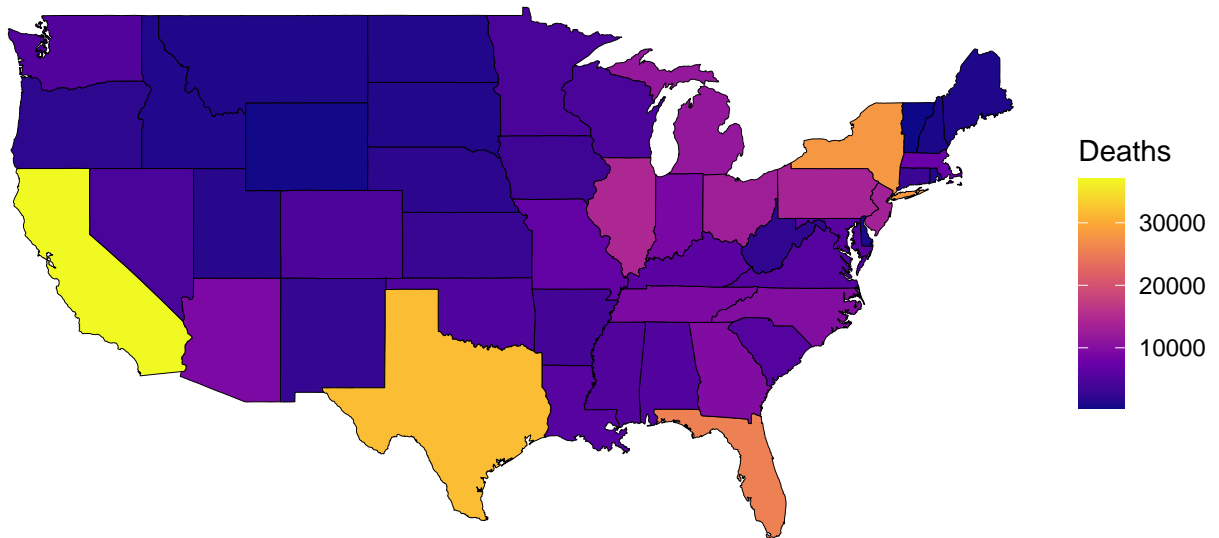


## Influenza–Deaths Deaths – 2024

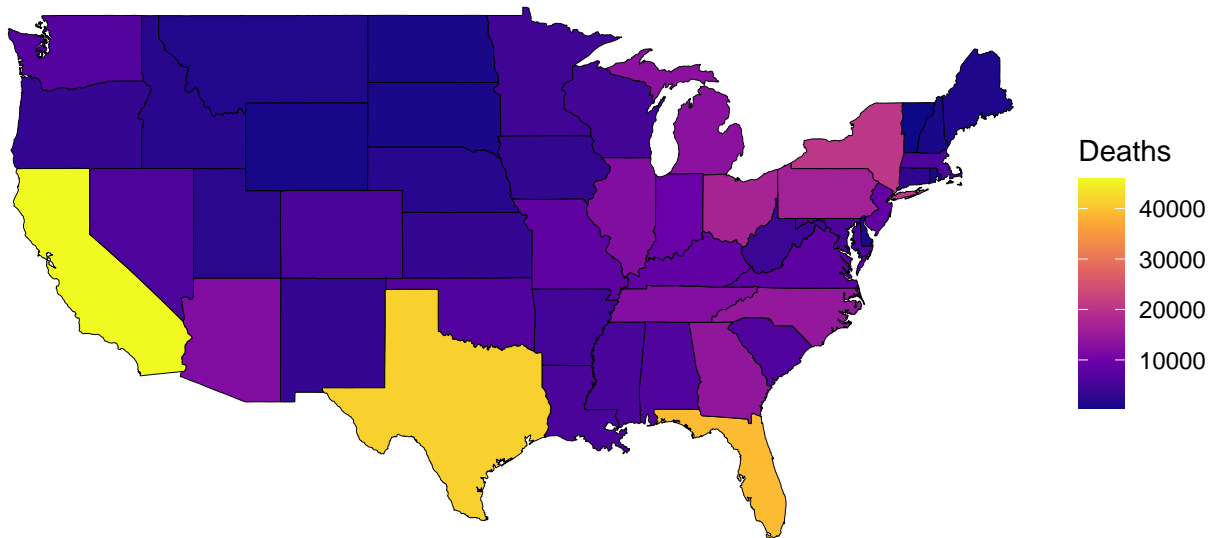




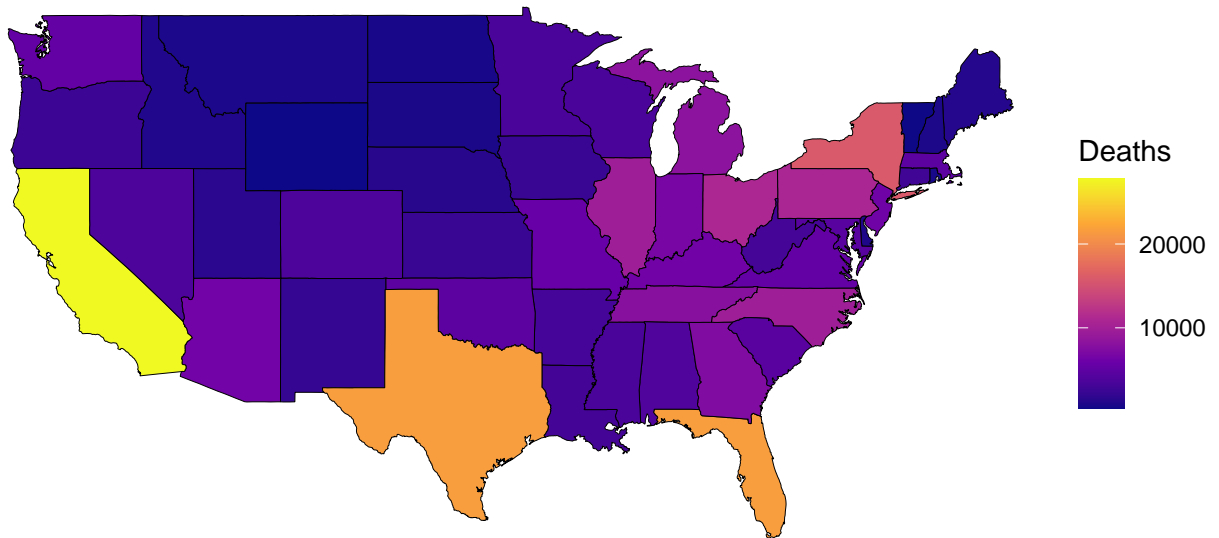
## Pneumonia-Deaths Deaths – 2020



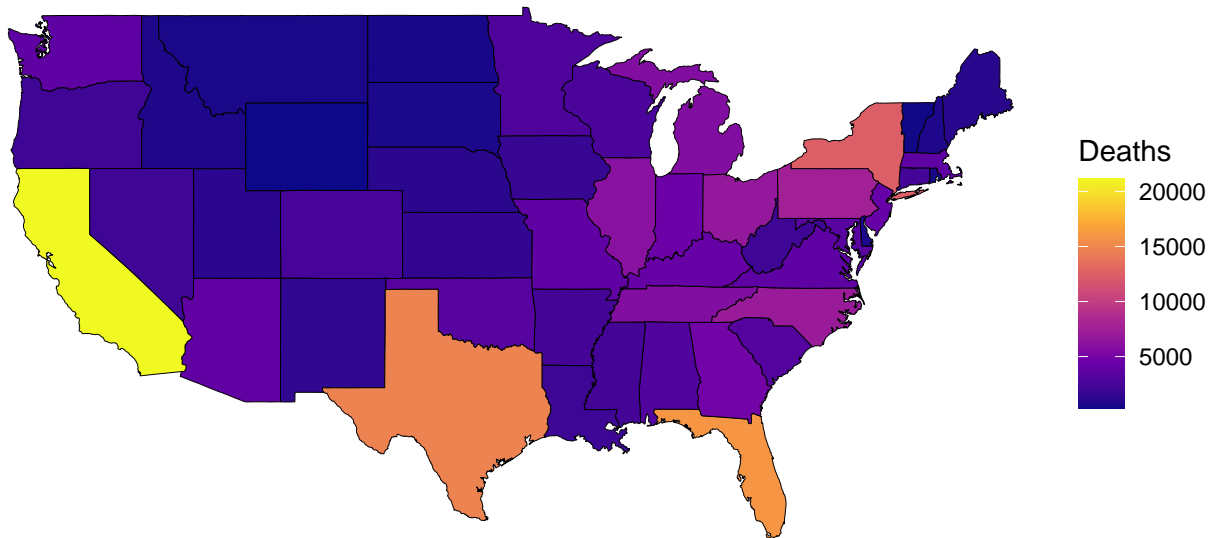
## Pneumonia–Deaths Deaths – 2021



## Pneumonia-Deaths Deaths – 2022



## Pneumonia–Deaths Deaths – 2023



## Pneumonia–Deaths Deaths – 2024

