Statistical Analysis for COVID in California

Thomas McHale

Table of contents

Cleaning Data

See quarto document for code

Table 1: Univariate LME Model of Smoke on COVID-19 Incidence

Lag_Period	estimate	lower_95	upper_95	p_value
1 Month	235.64	192.46	278.82	0
2 Months	128.26	81.19	175.33	0

Table 2: Univariate LME Model of Smoke on COVID-19 Death

Lag_Period	estimate	lower_95	upper_95	p_value
1 Month	2.87	1.99	3.75	0.0000
2 Months	0.66	-0.31	1.63	0.1847

Statistical Analysis

Linear Mixed Effects Regression

Univariate

Multivariate

```
Table for: 1-COVID Incidence 1-Month Lag
# A tibble: 10 x 6
   term                estimate std.error   p.value conf.low conf.high
   <chr>                  <dbl>     <dbl>     <dbl>    <dbl>     <dbl>
 1 (Intercept)            432.       55.9  1.52e-11     327.      538.
 2 I(smoke/10)            234.       22.6  1.08e-22     189.      278.
 3 median_income          -54.2      68.8  4.34e- 1    -184.       74.6
 4 outdoor_laborer_rate   -40.9      61.9  5.11e- 1    -157.       76.1
 5 avg_temp               224.       99.5  2.88e- 2      37.4     410.
 6 precip                -195.       62.3  2.71e- 3    -313.      -78.9
 7 elevation               55.4      87.6  5.30e- 1    -108.      220.
 8 ALWAYS                 -36.6      57.2  5.24e- 1    -143.       71.8
 9 sd__(Intercept)        241.       NA   NA            NA        NA
10 sd__Observation        791.       NA   NA            NA        NA

Table for: 2-COVID Incidence 2-Month Lag
# A tibble: 10 x 6
   term                estimate std.error   p.value conf.low conf.high
   <chr>                  <dbl>     <dbl>     <dbl>    <dbl>     <dbl>
 1 (Intercept)            444.       54.3  4.50e-13     342.      548.
 2 I(smoke/10)            137.       24.4  3.22e- 8      88.2     184.
 3 median_income          -58.4      64.1  3.65e- 1    -180.       61.5
 4 outdoor_laborer_rate   -17.4      57.0  7.61e- 1    -125.       90.5
 5 avg_temp               190.       90.2  3.97e- 2      21.0     360.
 6 precip                -177.       56.9  2.85e- 3    -285.      -70.4
 7 ALWAYS                  17.5      52.6  7.40e- 1     -80.7     117.
 8 elevation                5.74     79.1  9.42e- 1    -142.      155.
 9 sd__(Intercept)        137.       NA   NA            NA        NA
```

```
10 sd__Observation           846.        NA    NA          NA          NA
```

Table for: 3-COVID Death 1-Month Lag
```
# A tibble: 10 x 6
   term                  estimate std.error   p.value conf.low conf.high
   <chr>                    <dbl>     <dbl>     <dbl>    <dbl>     <dbl>
 1 (Intercept)               6.47     1.12   8.68e- 8     4.36      8.59
 2 I(smoke/10)               2.96     0.462  3.85e-10     2.04      3.85
 3 median_income            -1.63     1.37   2.39e- 1    -4.21      0.938
 4 outdoor_laborer_rate     -0.899    1.23   4.68e- 1    -3.21      1.43
 5 avg_temp                  9.51     1.97   1.20e- 5     5.80     13.2
 6 precip                   -0.853    1.24   4.93e- 1    -3.18      1.47
 7 elevation                 4.51     1.73   1.21e- 2     1.25      7.76
 8 ALWAYS                    1.90     1.14   9.97e- 2    -0.232     4.04
 9 sd__(Intercept)           4.58      NA    NA          NA         NA
10 sd__Observation          16.2       NA    NA          NA         NA
```

Table for: 4-COVID Death 2-Month Lag
```
# A tibble: 10 x 6
   term                  estimate std.error   p.value conf.low conf.high
   <chr>                    <dbl>     <dbl>     <dbl>    <dbl>     <dbl>
 1 (Intercept)               8.44     1.16   4.64e-11     6.25     10.7
 2 I(smoke/10)               0.854    0.502  8.96e- 2    -0.147     1.82
 3 median_income            -2.07     1.38   1.39e- 1    -4.70      0.524
 4 outdoor_laborer_rate     -0.613    1.23   6.19e- 1    -2.93      1.71
 5 avg_temp                  8.64     1.96   4.77e- 5     4.96     12.3
 6 precip                   -0.696    1.23   5.73e- 1    -3.02      1.62
 7 ALWAYS                    2.21     1.14   5.64e- 2     0.0757    4.36
 8 elevation                 4.12     1.72   1.99e- 2     0.889     7.35
 9 sd__(Intercept)           3.61      NA    NA          NA         NA
10 sd__Observation          17.4       NA    NA          NA         NA
```

```
[[1]]
NULL

[[2]]
NULL

[[3]]
NULL

[[4]]
NULL
```

Spatial Auto-regressive Model

Spatial Lag Model

```
Table for: 1-Unadjusted COVID Incidence 1-Month Lag
# A tibble: 3 x 6
  term         estimate std.error  p.value conf.low conf.high
  <chr>           <dbl>     <dbl>    <dbl>    <dbl>     <dbl>
1 rho             0.675    0.0849 1.78e-15    0.509     0.841
2 (Intercept)   -50.0     72.0    4.87e- 1 -191.       91.1
3 I(smoke/10)   224.      22.8    0         179.      268.
```

```
Table for: 2-Unadjusted COVID Incidence 2-Month Lag
# A tibble: 3 x 6
  term         estimate std.error  p.value conf.low conf.high
  <chr>           <dbl>     <dbl>    <dbl>    <dbl>     <dbl>
1 rho             0.664    0.0949 2.69e-12    0.478     0.850
2 (Intercept)    45.6     76.9    5.53e- 1 -105.      196.
3 I(smoke/10)   123.      24.1    3.12e- 7   76.1     171.
```

```
Table for: 3-Adjusted COVID Incidence 1-Month Lag
# A tibble: 9 x 6
  term                 estimate std.error p.value  conf.low conf.high
  <chr>                   <dbl>     <dbl>   <dbl>     <dbl>     <dbl>
1 rho                     0.234     0.159 0.143    -0.0789    0.546
2 (Intercept)           266.      128.    0.0381    14.6     517.
3 I(smoke/10)           230.       23.1   0        185.      275.
4 median_income         -52.2      54.4   0.338   -159.       54.4
5 outdoor_laborer_rate  -33.4      49.4   0.499   -130.       63.4
6 avg_temp              198.       78.7   0.0117    44.2     353.
7 precip               -176.       52.0   0.000717 -278.      -74.0
8 elevation              38.7      67.5   0.567    -93.7     171.
9 ALWAYS                -35.7      44.7   0.425   -123.       52.0
```

```
Table for: 4-Adjusted COVID Incidence 2-Month Lag
# A tibble: 9 x 6
  term                 estimate std.error      p.value conf.low conf.high
  <chr>                   <dbl>     <dbl>        <dbl>    <dbl>     <dbl>
1 rho                     0.166     0.172 0.335         -0.171    0.503
2 (Intercept)           340.      122.    0.00545       100.     580.
3 I(smoke/10)           136.       24.3   0.0000000209   88.6    184.
4 median_income         -60.0      58.9   0.308        -176.      55.5
```

```
5 outdoor_laborer_rate  -15.1      52.6   0.773        -118.      88.0
6 avg_temp               170.      85.0   0.0458          3.20   337.
7 precip                -162.      54.8   0.00309      -270.     -54.7
8 elevation               -5.51    72.1   0.939        -147.     136.
9 ALWAYS                   9.50    48.6   0.845         -85.8    105.


[[1]]
NULL

[[2]]
NULL

[[3]]
NULL

[[4]]
NULL


Table for: 1-Unadjusted COVID Death 1-Month Lag
# A tibble: 3 x 6
  term         estimate std.error       p.value conf.low conf.high
  <chr>           <dbl>     <dbl>         <dbl>    <dbl>     <dbl>
1 rho             0.758    0.0743 0                0.613     0.904
2 (Intercept)    -0.934    1.15   0.419           -3.20      1.33
3 I(smoke/10)     2.67     0.462  0.00000000800    1.76      3.57


Table for: 2-Unadjusted COVID Death 2-Month Lag
# A tibble: 3 x 6
  term         estimate std.error  p.value conf.low conf.high
  <chr>           <dbl>     <dbl>    <dbl>    <dbl>     <dbl>
1 rho             0.705    0.0902 5.55e-15   0.528     0.882
2 (Intercept)     2.07     1.37   1.31e- 1  -0.616     4.76
3 I(smoke/10)     0.570    0.501  2.55e- 1  -0.412     1.55


Table for: 3-Adjusted COVID Death 1-Month Lag
# A tibble: 9 x 6
  term            estimate std.error  p.value conf.low conf.high
  <chr>              <dbl>     <dbl>    <dbl>    <dbl>     <dbl>
1 rho                0.139    0.164  3.98e- 1 -0.183     0.461
2 (Intercept)        5.09     1.98   1.02e- 2  1.21      8.97
3 I(smoke/10)        2.89     0.470  7.62e-10  1.97      3.82
4 median_income     -1.78     1.10   1.07e- 1 -3.94      0.386
```

```
5 outdoor_laborer_rate    -0.840      1.01  4.04e- 1  -2.81         1.13
6 avg_temp                 8.58       1.92  7.93e- 6   4.82        12.4
7 precip                  -0.751      1.00  4.55e- 1  -2.72         1.22
8 elevation                3.81       1.53  1.28e- 2   0.810        6.81
9 ALWAYS                   1.78       0.936 5.74e- 2  -0.0557       3.61
```

Table for: 4-Adjusted COVID Death 2-Month Lag

A tibble: 9 x 6

term	estimate	std.error	p.value	conf.low	conf.high
<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1 rho	0.0793	0.174	0.649	-0.262	0.421
2 (Intercept)	7.71	2.04	0.000153	3.72	11.7
3 I(smoke/10)	0.811	0.504	0.107	-0.177	1.80
4 median_income	-2.21	1.22	0.0706	-4.60	0.186
5 outdoor_laborer_rate	-0.582	1.09	0.594	-2.72	1.56
6 avg_temp	8.11	2.10	0.000109	4.00	12.2
7 precip	-0.652	1.09	0.549	-2.78	1.48
8 elevation	3.73	1.67	0.0255	0.456	7.00
9 ALWAYS	2.16	1.03	0.0353	0.149	4.18

```
[[1]]
NULL

[[2]]
NULL

[[3]]
NULL

[[4]]
NULL
```

Spatial Error Model

Table for: 1-Unadjusted COVID Incidence 1-Month Lag

A tibble: 3 x 6

term	estimate	std.error	p.value	conf.low	conf.high
<chr>	<dbl>	<dbl>	<dbl>	<dbl>	<dbl>
1 (Intercept)	392.	120.	1.05e- 3	158.	627.
2 I(smoke/10)	240.	22.8	0	195.	284.
3 lambda	0.689	0.0938	2.00e-13	0.505	0.873

```
Table for: 2-Unadjusted COVID Incidence 2-Month Lag
# A tibble: 3 x 6
  term        estimate std.error  p.value conf.low conf.high
  <chr>          <dbl>     <dbl>    <dbl>    <dbl>     <dbl>
1 (Intercept) 440.      126.      4.55e- 4 194.      687.
2 I(smoke/10) 137.       24.4     2.05e- 8  89.1     185.
3 lambda        0.668     0.0984  1.09e-11   0.476     0.861

Table for: 3-Adjusted COVID Incidence 1-Month Lag
# A tibble: 9 x 6
  term                 estimate std.error        p.value conf.low conf.high
  <chr>                   <dbl>     <dbl>          <dbl>    <dbl>     <dbl>
1 (Intercept)          440.        74.6   0.00000000369   294.      586.
2 I(smoke/10)          235.        22.8   0                190.      280.
3 median_income        -65.9       62.5   0.291           -188.      56.5
4 outdoor_laborer_rate -29.9       50.3   0.552           -128.      68.6
5 avg_temp             211.       106.    0.0468             2.95    420.
6 precip              -206.        59.4   0.000528        -323.     -89.5
7 elevation             10.4       94.3   0.912           -174.      195.
8 ALWAYS               -54.8       51.5   0.288           -156.      46.2
9 lambda                 0.470      0.138 0.000636           0.200     0.739

Table for: 4-Adjusted COVID Incidence 2-Month Lag
# A tibble: 9 x 6
  term                 estimate std.error  p.value  conf.low conf.high
  <chr>                   <dbl>     <dbl>    <dbl>     <dbl>     <dbl>
1 (Intercept)          445.        65.8   1.37e-11  316.      574.
2 I(smoke/10)          139.        24.2   8.39e- 9   92.0     187.
3 median_income        -63.5       64.5   3.25e- 1 -190.       62.9
4 outdoor_laborer_rate -10.3       53.3   8.47e- 1 -115.       94.2
5 avg_temp             184.       101.    6.86e- 2  -14.1     383.
6 precip              -178.        59.7   2.86e- 3 -295.      -61.0
7 elevation            -20.5       89.2   8.18e- 1 -195.      154.
8 ALWAYS                 0.843     53.0   9.87e- 1 -103.      105.
9 lambda                 0.313      0.165 5.81e- 2   -0.0107    0.637

[[1]]
NULL

[[2]]
NULL
```

```
[[3]]
NULL

[[4]]
NULL
```