Analysis before fitting the CAR model

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```
library(here)
```

```
## here() starts at /Users/Alvin/Documents/NCSU_Fall_2021/NIH_SIP/flood-risk-health-effects
```

```
library(ape)
library(GGally)
```

```
## Loading required package: ggplot2
```

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

```
fls_model_df <- readRDS(here("intermediary_data/fls_model_df.rds"))
```

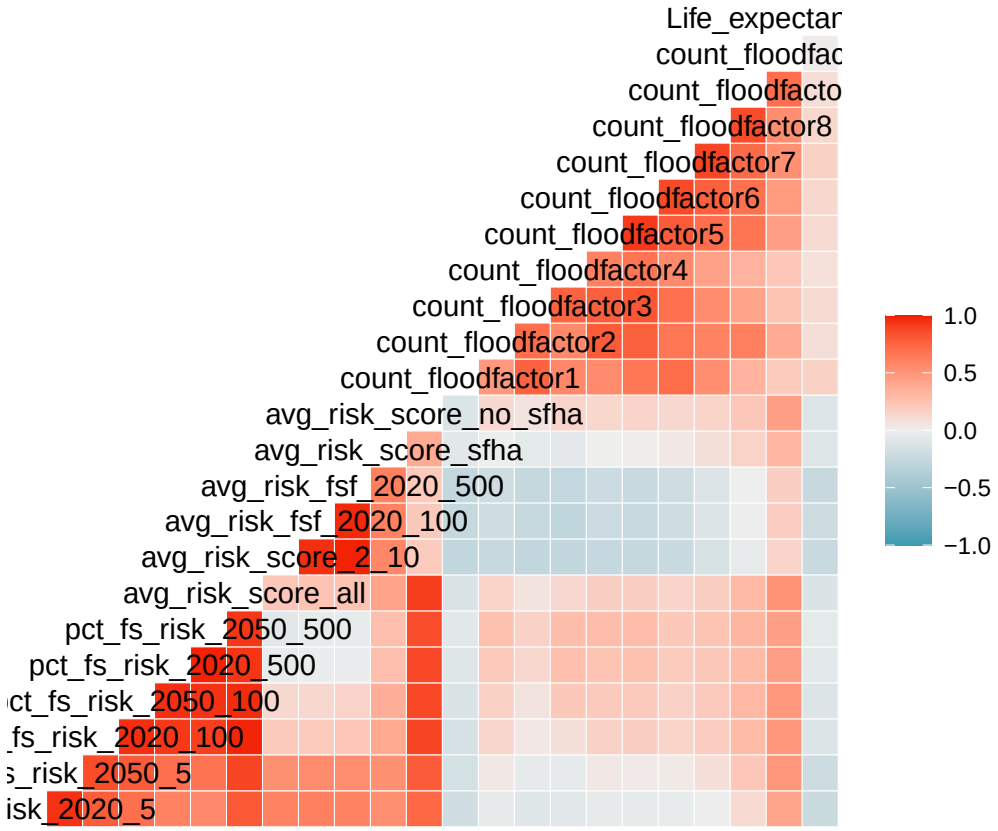
Checking for multicollinearity among the covariates

`S.CARleroux()` automatically puts a fixed ridge penalty on the beta coefficients. Therefore, the large number of covariates and multicollinearity would be accounted for.

Flood risk variables

```
ggcorr(data = fls_model_df[, c(17:38, 63)], progress = F)
```

```
## Warning: Ignoring unknown parameters: progress
```




```
flood_cor <- cor(fls_model_df[complete.cases(fls_model_df[, c(17:38, 63)]), c(17:38, 63)])

flood_cor[nrow(flood_cor), ]
```

```
##     pct_fs_risk_2020_5     pct_fs_risk_2050_5   pct_fs_risk_2020_100
##            -0.22403513            -0.20639134            -0.11964945
##   pct_fs_risk_2050_100   pct_fs_risk_2020_500   pct_fs_risk_2050_500
##            -0.11188615            -0.06844810            -0.06162909
##     avg_risk_score_all    avg_risk_score_2_10  avg_risk_fsf_2020_100
##            -0.12602894            -0.23725350            -0.21519007
##  avg_risk_fsf_2020_500    avg_risk_score_sfha avg_risk_score_no_sfha
##            -0.24188687            -0.09702686            -0.10459813
##     count_floodfactor1     count_floodfactor2     count_floodfactor3
##             0.17419155             0.09575350             0.11731203
##     count_floodfactor4     count_floodfactor5     count_floodfactor6
##             0.08615427             0.11787995             0.13456285
##     count_floodfactor7     count_floodfactor8     count_floodfactor9
##             0.17544096             0.14032523             0.09370198
##    count_floodfactor10 Life expectancy, 2014*
##             0.01983854             1.00000000
```

For each variable, I take the summary of its correlations with other variables, not including itself.

```
diag(flood_cor) <- NA

summary(flood_cor)
```

```
##  pct_fs_risk_2020_5 pct_fs_risk_2050_5 pct_fs_risk_2020_100
##  Min.   :-0.22404   Min.   :-0.20639   Min.   :-0.1512
```

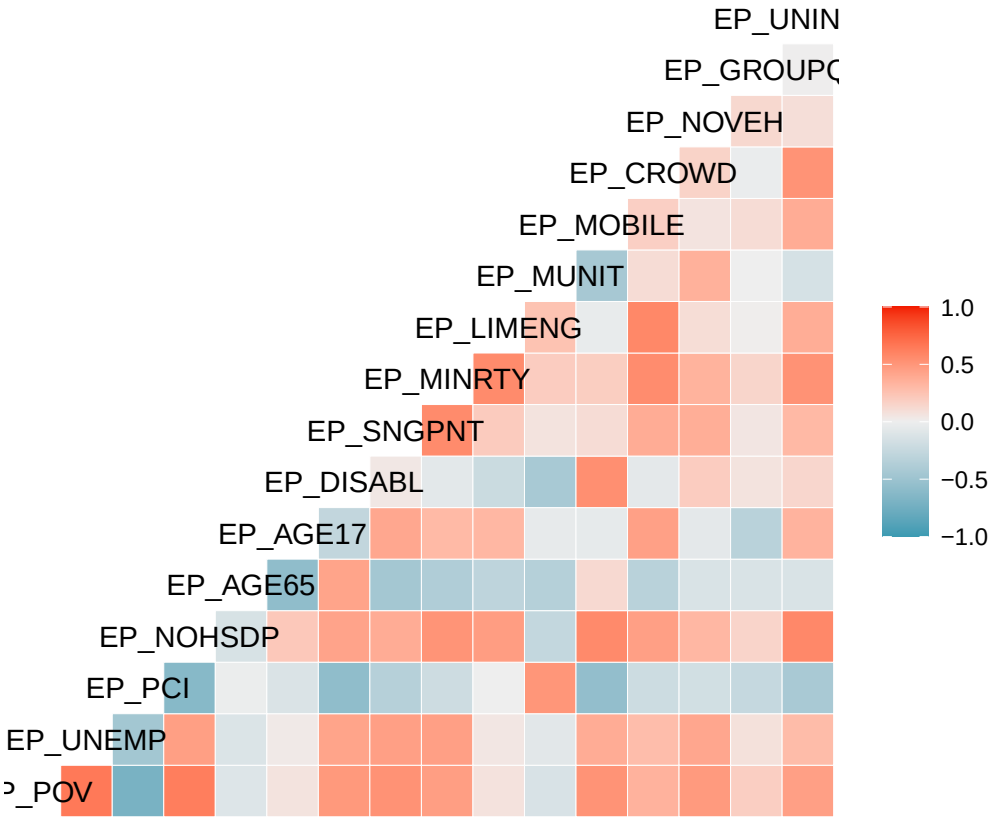
```
##  1st Qu.:-0.05041   1st Qu.: 0.02851   1st Qu.: 0.1543
##  Median : 0.47554   Median : 0.50932   Median : 0.2148
##  Mean   : 0.33026   Mean   : 0.37722   Mean   : 0.4001
##  3rd Qu.: 0.60862   3rd Qu.: 0.69591   3rd Qu.: 0.8431
##  Max.   : 0.94988   Max.   : 0.94988   Max.   : 0.9788
##  NA's   :1          NA's   :1          NA's   :1
##  pct_fs_risk_2050_100 pct_fs_risk_2020_500 pct_fs_risk_2050_500
##  Min.   :-0.1285      Min.   :-0.09583     Min.   :-0.07983
##  1st Qu.: 0.1552      1st Qu.: 0.14909     1st Qu.: 0.17938
##  Median : 0.2129      Median : 0.26484     Median : 0.28013
##  Mean   : 0.3980      Mean   : 0.37627     Mean   : 0.37949
##  3rd Qu.: 0.7707      3rd Qu.: 0.67703     3rd Qu.: 0.65310
##  Max.   : 0.9621      Max.   : 0.98498     Max.   : 0.98498
##  NA's   :1            NA's   :1            NA's   :1
##  avg_risk_score_all avg_risk_score_2_10 avg_risk_fsf_2020_100
##  Min.   :-0.1368    Min.   :-0.28506    Min.   :-0.2882
##  1st Qu.: 0.1579    1st Qu.:-0.24220    1st Qu.:-0.2135
##  Median : 0.2452    Median :-0.03899    Median :-0.0122
##  Mean   : 0.4155    Mean   : 0.09857    Mean   : 0.1187
##  3rd Qu.: 0.8695    3rd Qu.: 0.21800    3rd Qu.: 0.2354
##  Max.   : 0.9788    Max.   : 0.98490    Max.   : 0.9710
##  NA's   :1          NA's   :1           NA's   :1
##  avg_risk_fsf_2020_500 avg_risk_score_sfha avg_risk_score_no_sfha
##  Min.   :-0.27439      Min.   :-0.097027   Min.   :-0.1182
##  1st Qu.:-0.21768      1st Qu.: 0.004842   1st Qu.: 0.1391
##  Median :-0.01299      Median : 0.270244   Median : 0.2119
##  Mean   : 0.12008      Mean   : 0.240516   Mean   : 0.3783
##  3rd Qu.: 0.24025      3rd Qu.: 0.416973   3rd Qu.: 0.7856
##  Max.   : 0.98490      Max.   : 0.617917   Max.   : 0.9171
##  NA's   :1             NA's   :1           NA's   :1
##  count_floodfactor1 count_floodfactor2 count_floodfactor3 count_floodfactor4
##  Min.   :-0.28320   Min.   :-0.24385   Min.   :-0.28506   Min.   :-0.28823
##  1st Qu.:-0.14762   1st Qu.: 0.05059   1st Qu.:-0.02227   1st Qu.:-0.01094
##  Median :-0.07789   Median : 0.19250   Median : 0.12532   Median : 0.22058
##  Mean   : 0.13839   Mean   : 0.27673   Mean   : 0.24533   Mean   : 0.22392
##  3rd Qu.: 0.52988   3rd Qu.: 0.59582   3rd Qu.: 0.66215   3rd Qu.: 0.53137
##  Max.   : 0.75921   Max.   : 0.79496   Max.   : 0.81661   Max.   : 0.75425
##  NA's   :1          NA's   :1          NA's   :1          NA's   :1
##  count_floodfactor5 count_floodfactor6 count_floodfactor7 count_floodfactor8
##  Min.   :-0.25776   Min.   :-0.26234   Min.   :-0.23272   Min.   :-0.14887
##  1st Qu.: 0.05226   1st Qu.: 0.05325   1st Qu.: 0.06055   1st Qu.: 0.09966
##  Median : 0.22586   Median : 0.23420   Median : 0.18590   Median : 0.21198
##  Mean   : 0.31403   Mean   : 0.33201   Mean   : 0.31803   Mean   : 0.31894
##  3rd Qu.: 0.65814   3rd Qu.: 0.68591   3rd Qu.: 0.69068   3rd Qu.: 0.55224
##  Max.   : 0.92654   Max.   : 0.92654   Max.   : 0.88642   Max.   : 0.88642
##  NA's   :1          NA's   :1          NA's   :1          NA's   :1
##  count_floodfactor9 count_floodfactor10 Life expectancy, 2014*
##  Min.   :-0.03991   Min.   :0.01984     Min.   :-0.24189
##  1st Qu.: 0.17504   1st Qu.:0.23030     1st Qu.:-0.12443
##  Median : 0.30295   Median :0.44377     Median :-0.06504
##  Mean   : 0.34803   Mean   :0.37985     Mean   :-0.02995
##  3rd Qu.: 0.56997   3rd Qu.:0.49119     3rd Qu.: 0.11192
##  Max.   : 0.85641   Max.   :0.69958     Max.   : 0.17544
##  NA's   :1          NA's   :1           NA's   :1
```

Many of the flood risk variables are very correlated.

SVI Variables

```
ggcorr(data = fls_model_df[, 39:54], progress = F)
```

```
## Warning: Ignoring unknown parameters: progress
```




```
(svi_cor <- cor(fls_model_df[complete.cases(fls_model_df[, 39:54]), 39:54]))
```

```
##                 EP_POV    EP_UNEMP        EP_PCI  EP_NOHSDP    EP_AGE65
## EP_POV      1.00000000  0.65154857 -0.7103056275  0.6254853 -0.10657946
## EP_UNEMP    0.65154857  1.00000000 -0.4612103295  0.4532279 -0.12022992
## EP_PCI     -0.71030563 -0.46121033  1.0000000000 -0.6262797 -0.01683822
## EP_NOHSDP   0.62548531  0.45322790 -0.6262796652  1.0000000 -0.14111559
## EP_AGE65   -0.10657946 -0.12022992 -0.0168382185 -0.1411156  1.00000000
## EP_AGE17    0.06475125  0.02827912 -0.1243383212  0.2177170 -0.57476412
## EP_DISABL   0.48586544  0.42395670 -0.5794913164  0.4271945  0.42412972
## EP_SNGPNT   0.51887260  0.44944620 -0.3470227931  0.3785708 -0.45743733
## EP_MINRTY   0.45604006  0.44889574 -0.2090773909  0.5090794 -0.38753061
## EP_LIMENG   0.07009639  0.04580458 -0.0009591033  0.4598988 -0.29887556
## EP_MUNIT   -0.13836697 -0.07605523  0.4995965155 -0.2657774 -0.35262468
## EP_MOBILE   0.51545109  0.37718262 -0.5600628496  0.5625601  0.12101238
## EP_CROWD    0.34431163  0.28356947 -0.2148883334  0.4496746 -0.32904339
## EP_NOVEH    0.48055115  0.40918645 -0.1791498409  0.3147644 -0.12910911
## EP_GROUPQ   0.18226204  0.07750866 -0.2538691690  0.1511509 -0.13308534
## EP_UNINSUR  0.44883447  0.28895719 -0.4289763742  0.5736897 -0.12938690
```

```
##               EP_AGE17   EP_DISABL   EP_SNGPNT   EP_MINRTY     EP_LIMENG
## EP_POV      0.06475125  0.48586544  0.51887260  0.45604006  0.0700963895
## EP_UNEMP    0.02827912  0.42395670  0.44944620  0.44889574  0.0458045846
## EP_PCI     -0.12433832 -0.57949132 -0.34702279 -0.20907739 -0.0009591033
## EP_NOHSDP   0.21771701  0.42719446  0.37857077  0.50907944  0.4598988190
## EP_AGE65   -0.57476412  0.42412972 -0.45743733 -0.38753061 -0.2988755623
## EP_AGE17    1.00000000 -0.27658786  0.40354000  0.30149642  0.3149737539
## EP_DISABL  -0.27658786  1.00000000  0.04096641 -0.07177311 -0.2240600940
## EP_SNGPNT   0.40354000  0.04096641  1.00000000  0.56026164  0.2001874832
## EP_MINRTY   0.30149642 -0.07177311  0.56026164  1.00000000  0.5624017490
## EP_LIMENG   0.31497375 -0.22406009  0.20018748  0.56240175  1.0000000000
## EP_MUNIT   -0.04236691 -0.43118805  0.06426726  0.19472114  0.2498708116
## EP_MOBILE  -0.05200253  0.53993350  0.10384622  0.18382861 -0.0380200909
## EP_CROWD    0.44438111 -0.06539029  0.37813629  0.55290358  0.5775159407
## EP_NOVEH   -0.06444933  0.19360660  0.36659333  0.34205431  0.1000213363
## EP_GROUPQ  -0.32948858  0.06484295  0.05079929  0.14754534  0.0065066513
## EP_UNINSUR  0.33667300  0.13672110  0.30741216  0.52056679  0.3744399807
##                EP_MUNIT   EP_MOBILE    EP_CROWD    EP_NOVEH    EP_GROUPQ
## EP_POV     -0.138366969  0.51545109  0.34431163  0.48055115  0.182262045
## EP_UNEMP   -0.076055227  0.37718262  0.28356947  0.40918645  0.077508662
## EP_PCI      0.499596515 -0.56006285 -0.21488833 -0.17914984 -0.253869169
## EP_NOHSDP  -0.265777410  0.56256010  0.44967465  0.31476438  0.151150853
## EP_AGE65   -0.352624675  0.12101238 -0.32904339 -0.12910911 -0.133085338
## EP_AGE17   -0.042366909 -0.05200253  0.44438111 -0.06444933 -0.329488580
## EP_DISABL  -0.431188049  0.53993350 -0.06539029  0.19360660  0.064842953
## EP_SNGPNT   0.064267262  0.10384622  0.37813629  0.36659333  0.050799287
## EP_MINRTY   0.194721142  0.18382861  0.55290358  0.34205431  0.147545344
## EP_LIMENG   0.249870812 -0.03802009  0.57751594  0.10002134  0.006506651
## EP_MUNIT    1.000000000 -0.44223776  0.10540992  0.35186391 -0.000369879
## EP_MOBILE  -0.442237763  1.00000000  0.17663229  0.06226905  0.105594681
## EP_CROWD    0.105409916  0.17663229  1.00000000  0.15812169 -0.023615080
## EP_NOVEH    0.351863906  0.06226905  0.15812169  1.00000000  0.129367093
## EP_GROUPQ  -0.000369879  0.10559468 -0.02361508  0.12936709  1.000000000
## EP_UNINSUR -0.155772925  0.37796514  0.51676600  0.09040975  0.003735602
##              EP_UNINSUR
## EP_POV      0.448834467
## EP_UNEMP    0.288957193
## EP_PCI     -0.428976374
## EP_NOHSDP   0.573689707
## EP_AGE65   -0.129386901
## EP_AGE17    0.336673001
## EP_DISABL   0.136721103
## EP_SNGPNT   0.307412160
## EP_MINRTY   0.520566789
## EP_LIMENG   0.374439981
## EP_MUNIT   -0.155772925
## EP_MOBILE   0.377965140
## EP_CROWD    0.516766001
## EP_NOVEH    0.090409750
## EP_GROUPQ   0.003735602
## EP_UNINSUR  1.000000000
```

```
diag(svi_cor) <- NA
```

```
summary(svi_cor)
```

```
##      EP_POV            EP_UNEMP           EP_PCI          EP_NOHSDP
##  Min.   :-0.71031   Min.   :-0.46121   Min.   :-0.7103   Min.   :-0.6263
##  1st Qu.: 0.06742   1st Qu.: 0.03704   1st Qu.:-0.5106   1st Qu.: 0.1844
##  Median : 0.44883   Median : 0.28896   Median :-0.2539   Median : 0.4272
##  Mean   : 0.25925   Mean   : 0.21867   Mean   :-0.2809   Mean   : 0.2727
##  3rd Qu.: 0.50066   3rd Qu.: 0.43643   3rd Qu.:-0.1517   3rd Qu.: 0.4845
##  Max.   : 0.65155   Max.   : 0.65155   Max.   : 0.4996   Max.   : 0.6255
##  NA's   :1          NA's   :1          NA's   :1         NA's   :1
##     EP_AGE65          EP_AGE17          EP_DISABL         EP_SNGPNT
##  Min.   :-0.5748   Min.   :-0.57476   Min.   :-0.57949   Min.   :-0.45744
##  1st Qu.:-0.3408   1st Qu.:-0.09439   1st Qu.:-0.14792   1st Qu.: 0.05753
##  Median :-0.1331   Median : 0.02828   Median : 0.06484   Median : 0.30741
##  Mean   :-0.1754   Mean   : 0.04319   Mean   : 0.07258   Mean   : 0.20123
##  3rd Qu.:-0.1134   3rd Qu.: 0.30824   3rd Qu.: 0.42404   3rd Qu.: 0.39106
##  Max.   : 0.4241   Max.   : 0.44438   Max.   : 0.53993   Max.   : 0.56026
##  NA's   :1         NA's   :1          NA's   :1          NA's   :1
##    EP_MINRTY         EP_LIMENG           EP_MUNIT          EP_MOBILE
##  Min.   :-0.3875   Min.   :-0.298876   Min.   :-0.44224   Min.   :-0.56006
##  1st Qu.: 0.1657   1st Qu.: 0.002774   1st Qu.:-0.21078   1st Qu.: 0.01212
##  Median : 0.3421   Median : 0.100021   Median :-0.04237   Median : 0.12101
##  Mean   : 0.2741   Mean   : 0.159987   Mean   :-0.02927   Mean   : 0.13560
##  3rd Qu.: 0.5148   3rd Qu.: 0.344707   3rd Qu.: 0.15007   3rd Qu.: 0.37757
##  Max.   : 0.5624   Max.   : 0.577516   Max.   : 0.49960   Max.   : 0.56256
##  NA's   :1         NA's   :1           NA's   :1          NA's   :1
##     EP_CROWD          EP_NOVEH          EP_GROUPQ          EP_UNINSUR
##  Min.   :-0.3290   Min.   :-0.17915   Min.   :-0.32949   Min.   :-0.42898
##  1st Qu.: 0.0409   1st Qu.: 0.07634   1st Qu.:-0.01199   1st Qu.: 0.04707
##  Median : 0.2836   Median : 0.15812   Median : 0.05080   Median : 0.30741
##  Mean   : 0.2236   Mean   : 0.17507   Mean   : 0.01193   Mean   : 0.21747
##  3rd Qu.: 0.4470   3rd Qu.: 0.34696   3rd Qu.: 0.11748   3rd Qu.: 0.41340
##  Max.   : 0.5775   Max.   : 0.48055   Max.   : 0.18226   Max.   : 0.57369
##  NA's   :1         NA's   :1          NA's   :1          NA's   :1
```

Air pollution variables

```
ggpairs(data = fls_model_df, columns = 55:60, progress = F)
```

```
## Warning: Removed 1 rows containing non-finite values (stat_density).
```

```
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
```

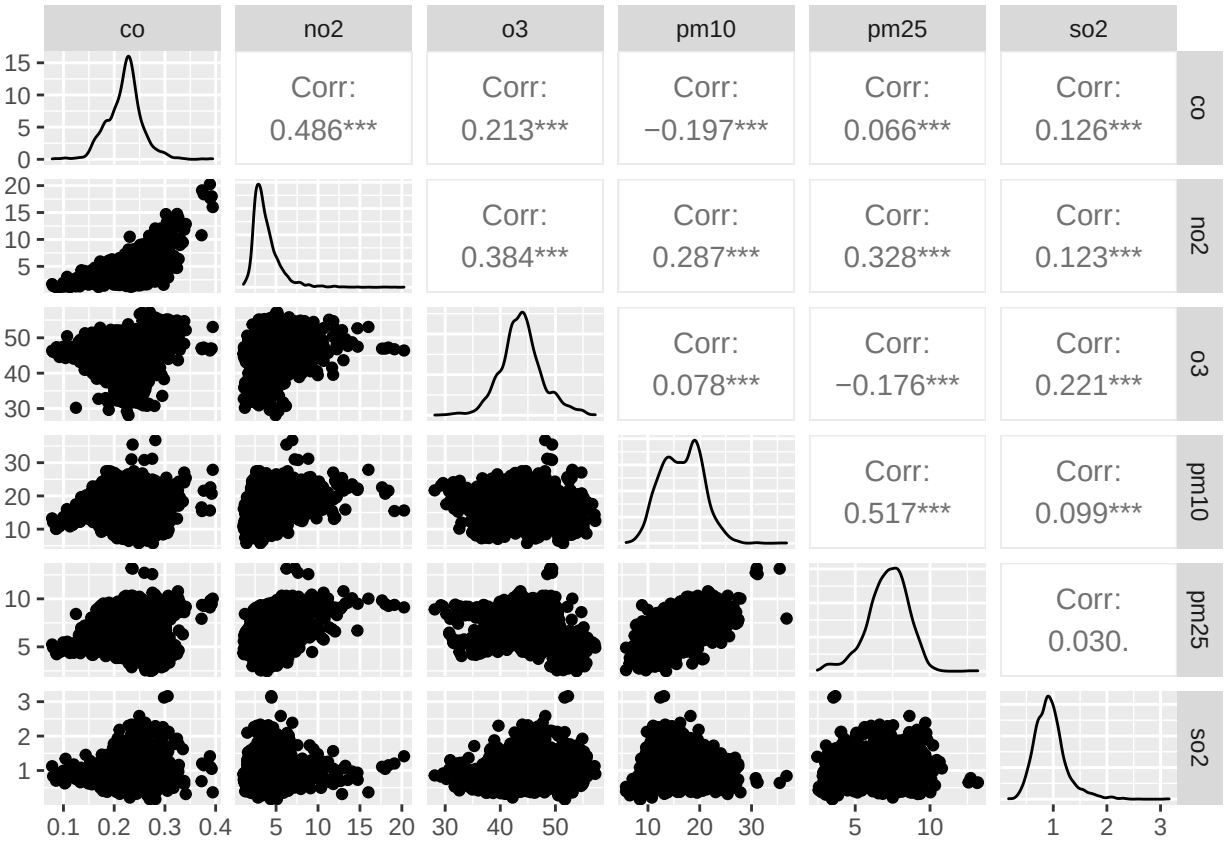
```
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
```

```
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
```

```
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
```

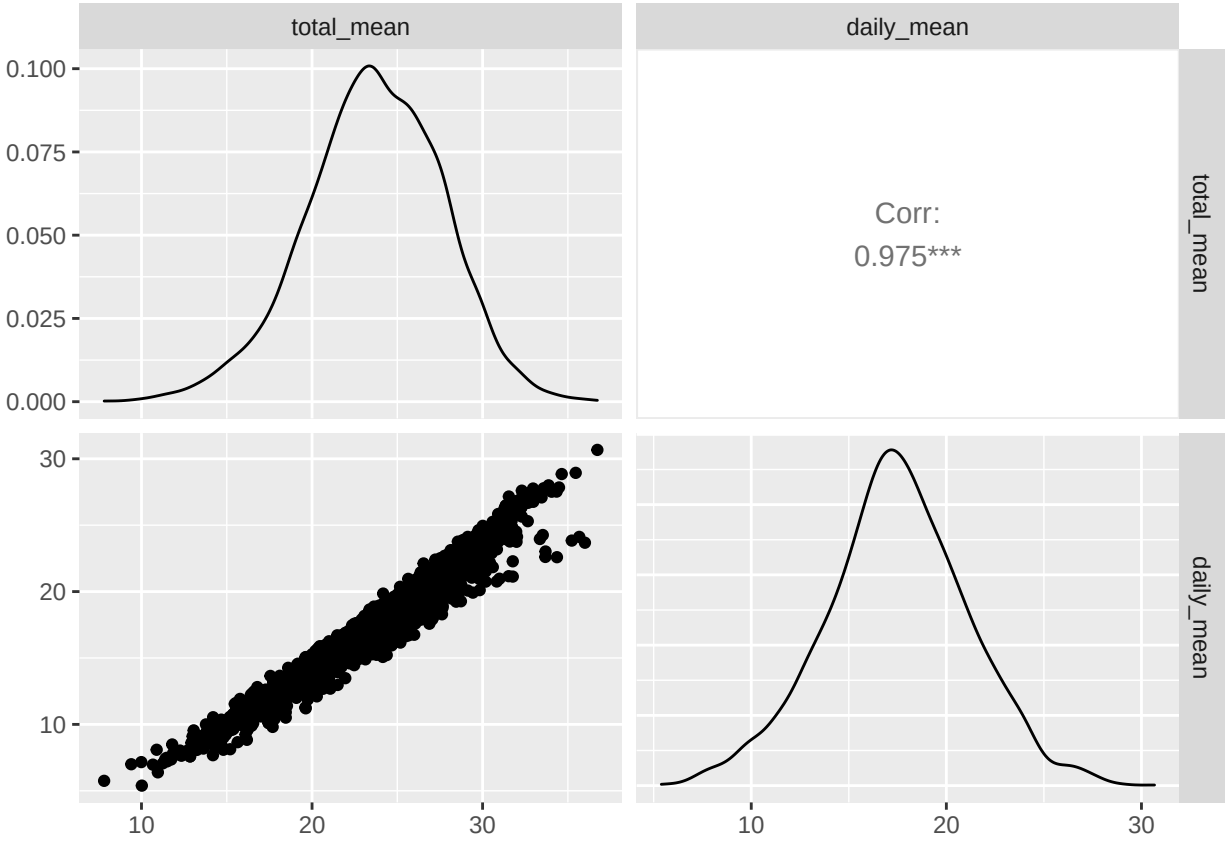
```
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
## Warning: Removed 1 rows containing missing values (geom_point).
## Warning: Removed 1 rows containing non-finite values (stat_density).
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
## Warning: Removed 1 rows containing missing values (geom_point).
## Warning: Removed 1 rows containing missing values (geom_point).
## Warning: Removed 1 rows containing non-finite values (stat_density).
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
## Warning: Removed 1 rows containing missing values (geom_point).
## Warning: Removed 1 rows containing missing values (geom_point).
## Warning: Removed 1 rows containing missing values (geom_point).
## Warning: Removed 1 rows containing non-finite values (stat_density).
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
## Warning: Removed 1 rows containing missing values (geom_point).
## Warning: Removed 1 rows containing missing values (geom_point).
## Warning: Removed 1 rows containing missing values (geom_point).
## Warning: Removed 1 rows containing missing values (geom_point).
## Warning: Removed 1 rows containing non-finite values (stat_density).
## Warning in ggally_statistic(data = data, mapping = mapping, na.rm = na.rm, :
## Removing 1 row that contained a missing value
```

```
## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing missing values (geom_point).

## Warning: Removed 1 rows containing missing values (geom_point).
## Warning: Removed 1 rows containing non-finite values (stat_density).
```



Smoking prevalence variables

```
ggpairs(data = fls_model_df, columns = 61:62, progress = F)
```



The correlation between total_mean and daily_mean is almost one.

Non-spatial modeling

```
Y <- fls_model_df$`Life expectancy, 2014*`

# extract the covariates matrix

X <- fls_model_df[, 17:(ncol(fls_model_df) - 1)]

X           <- scale(X) # Scale covariates
X[is.na(X)] <- 0        # Fill in missing values with the mean
```

```
fls_lm <- lm(Y ~ X)
```

```
summary(fls_lm)
```

```
##
## Call:
## lm(formula = Y ~ X)
##
## Residuals:
##     Min      1Q  Median      3Q     Max
## -7.5725 -0.5750  0.0077  0.6014  4.8003
##
## Coefficients:
```

```
##                          Estimate Std. Error  t value Pr(>|t|)
## (Intercept)             77.745396   0.018108 4293.442  < 2e-16 ***
## Xpct_fs_risk_2020_5     -0.188265   0.077345   -2.434 0.014986 *
## Xpct_fs_risk_2050_5     -0.200759   0.117685   -1.706 0.088127 .
## Xpct_fs_risk_2020_100   -0.026687   0.151999   -0.176 0.860641
## Xpct_fs_risk_2050_100    0.039996   0.120445    0.332 0.739857
## Xpct_fs_risk_2020_500   -0.079293   0.206882   -0.383 0.701543
## Xpct_fs_risk_2050_500   -0.267589   0.227326   -1.177 0.239241
## Xavg_risk_score_all      0.526576   0.279929    1.881 0.060052 .
## Xavg_risk_score_2_10     0.348188   0.179437    1.940 0.052417 .
## Xavg_risk_fsf_2020_100   0.193625   0.098582    1.964 0.049609 *
## Xavg_risk_fsf_2020_500  -0.454947   0.199225   -2.284 0.022464 *
## Xavg_risk_score_sfha     0.052979   0.028168    1.881 0.060088 .
## Xavg_risk_score_no_sfha  0.107126   0.049701    2.155 0.031209 *
## Xcount_floodfactor1      0.018315   0.042284    0.433 0.664945
## Xcount_floodfactor2     -0.008241   0.034513   -0.239 0.811293
## Xcount_floodfactor3      0.081514   0.055962    1.457 0.145333
## Xcount_floodfactor4     -0.013925   0.046940   -0.297 0.766757
## Xcount_floodfactor5      0.015626   0.058547    0.267 0.789562
## Xcount_floodfactor6     -0.138838   0.069825   -1.988 0.046862 *
## Xcount_floodfactor7      0.014634   0.062224    0.235 0.814088
## Xcount_floodfactor8      0.041180   0.059619    0.691 0.489789
## Xcount_floodfactor9      0.003937   0.050589    0.078 0.937972
## Xcount_floodfactor10    -0.083203   0.032864   -2.532 0.011400 *
## XEP_POV                 -0.298893   0.037986   -7.868 4.94e-15 ***
## XEP_UNEMP                0.022584   0.027449    0.823 0.410709
## XEP_PCI                  0.082858   0.038570    2.148 0.031773 *
## XEP_NOHSDP              -0.307066   0.041909   -7.327 2.99e-13 ***
## XEP_AGE65                0.344564   0.034931    9.864  < 2e-16 ***
## XEP_AGE17               -0.195055   0.036910   -5.285 1.35e-07 ***
## XEP_DISABL              -0.448172   0.032867  -13.636  < 2e-16 ***
## XEP_SNGPNT              -0.081855   0.028990   -2.824 0.004780 **
## XEP_MINRTY              -0.442043   0.048837   -9.051  < 2e-16 ***
## XEP_LIMENG               0.621274   0.035062   17.719  < 2e-16 ***
## XEP_MUNIT                0.111142   0.033662    3.302 0.000972 ***
## XEP_MOBILE              -0.145125   0.030142   -4.815 1.55e-06 ***
## XEP_CROWD                0.100600   0.027392    3.673 0.000244 ***
## XEP_NOVEH               -0.025438   0.029280   -0.869 0.385026
## XEP_GROUPQ               0.089414   0.025571    3.497 0.000478 ***
## XEP_UNINSUR             -0.186906   0.027652   -6.759 1.66e-11 ***
## Xco                     -0.196342   0.027325   -7.185 8.38e-13 ***
## Xno2                     0.092789   0.042572    2.180 0.029364 *
## Xo3                     -0.099113   0.025793   -3.843 0.000124 ***
## Xpm10                    0.067576   0.028630    2.360 0.018320 *
## Xpm25                   -0.291291   0.028982  -10.051  < 2e-16 ***
## Xso2                     0.042539   0.021095    2.017 0.043830 *
## Xtotal_mean             -0.980946   0.150086   -6.536 7.38e-11 ***
## Xdaily_mean              0.111012   0.156050    0.711 0.476899
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 1.01 on 3061 degrees of freedom
## Multiple R-squared:  0.8221, Adjusted R-squared:  0.8194
## F-statistic: 307.4 on 46 and 3061 DF,  p-value: < 2.2e-16
```

Checking for spatial autocorrelation

```
W <- readRDS(here("intermediary_data", "countyadj_reorganize.rds"))
```

Moran's I

```
(moran_results <- Moran.I(residuals(fls_lm), W))
```

```
## $observed
## [1] 0.2936814
##
## $expected
## [1] -0.0003218539
##
## $sd
## [1] 0.01057667
##
## $p.value
## [1] 0
```

The p-value is negligible, so we can reject the null hypothesis of zero spatial autocorrelation. Since the observed value of I is significantly greater then the expected value, the life expectancies are positively autocorrelated, in contrast to negatively autocorrelated. Thus, using a CAR model is justified.