

# Stratified Analysis

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```
library(here)

## Warning in readLines(f, n): line 1 appears to contain an embedded nul
## here() starts at /Volumes/ALVINDRIVE/usb_NIEHS_work/flood-risk-health-effects
library(coda)
library(CARBayes)

## Loading required package: MASS
## Loading required package: Rcpp
## Registered S3 method overwritten by 'GGally':
##   method from
##   +.gg      ggplot2
library(ggplot2)
library(tidyverse)

## -- Attaching packages ----- tidyverse 1.3.1 --
## v tibble  3.1.6      v dplyr    1.0.7
## v tidyr   1.1.4      v stringr 1.4.0
## v readr   2.1.1      v forcats 0.5.1
## v purrr   0.3.4
## -- Conflicts ----- tidyverse_conflicts() --
## x dplyr::filter() masks stats::filter()
## x dplyr::lag()     masks stats::lag()
## x dplyr::select() masks MASS::select()
fhs_model_df <- readRDS("intermediary_data/fhs_model_df_all_census_tract_pc.rds")
```

## CAR model results, Coronary Heart Disease Stratified on Poverty

Inference is based on 3 markov chains, each of which has been run for 110000 samples, the first 10000 of which has been removed for burn-in. The remaining 100000 samples are thinned by 2, resulting in 150000 samples for inference across the 3 Markov chains.

```
load(here("modeling_files/model_stratif_poverty.RData"))
```

### Beta samples

```
beta_samples <- mcmc.list(chain1$samples$beta, chain2$samples$beta,
                          chain3$samples$beta)
```

```
effectiveSize(beta_samples)
```

```
##      var1      var2      var3      var4      var5      var6      var7
## 68447.2046 36382.4841 37761.1319 53281.5366 68914.2531 78405.5864 87890.6361
##      var8      var9      var10     var11     var12     var13     var14
## 41973.9980 61353.3136 50147.4980 60253.3373 74957.3127 89787.3447 35155.2520
##      var15     var16     var17     var18     var19     var20     var21
## 63037.1789 62136.1468 70022.6252 73724.5058 32342.7837 88478.5492 57534.7711
##      var22     var23     var24     var25     var26     var27     var28
## 10909.7609 6229.8757  323.8625  4500.4463  2003.7053  2883.0879  996.6574
##      var29     var30     var31     var32     var33     var34     var35
##   161.4431   672.4907  1167.2441 28855.9245 78428.6550 39030.9892 34364.0083
##      var36     var37     var38     var39     var40     var41     var42
## 52293.7785 66509.7765 69269.6952 76671.2019 56050.2334 50185.4620 50495.6724
##      var43     var44     var45     var46     var47     var48     var49
## 60423.8387 60221.4781 80050.1425 28753.4787 41256.5990 55529.6434 37611.9176
##      var50     var51     var52     var53     var54     var55     var56
## 63008.8724 35946.8002 79938.2627 47002.3867 8686.7542 6769.6085  325.5017
##      var57     var58     var59     var60     var61     var62     var63
##  3937.8319  2135.7717  2707.4575  1039.3790   163.8511   680.0737  1232.0642
##      var64
## 28006.0742
```

### Examining sigma2, nu2, rho

```
sigma2_samples <- mcmc.list(chain1$samples$sigma2, chain2$samples$sigma2,
                           chain3$samples$sigma2)
```

```
nu2_samples <- mcmc.list(chain1$samples$nu2, chain2$samples$nu2,
                        chain3$samples$nu2)
```

```
effectiveSize(sigma2_samples)
```

```
##      var1
## 6808.768
```

```
effectiveSize(nu2_samples)
```

```
##      var1
## 9364.658
```

### Examining a sample of the 3108 phi parameters

```
phi_samples <- mcmc.list(chain1$samples$phi, chain2$samples$phi, chain3$samples$phi)
```

```
set.seed(1157, kind = "Mersenne-Twister", normal.kind = "Inversion", sample.kind = "Rejection")
```

```
phi_subset_idx <- sample(1:ncol(phi_samples[[1]]), size = 10)
```

```
phi_samples_subset <- phi_samples[, phi_subset_idx]
```

```
effectiveSize(phi_samples_subset)
```

```
##      var1      var2      var3      var4      var5      var6      var7      var8
## 37202.660 4572.161 6806.516 20135.793 93307.470 39089.413 33554.743 40535.330
##      var9      var10
## 70212.189 4821.368
```

## Inference

```
beta_samples_matrix <- rbind(chain1$samples$beta, chain2$samples$beta, chain3$samples$beta)
colnames(beta_samples_matrix) <- var_names
```

```
(beta_inference <- round(t(apply(beta_samples_matrix, 2, quantile, c(0.5, 0.025, 0.975))),5))
```

```
##              50%      2.5%      97.5%
## strat0              6.43057  6.41684  6.44428
## strat0:flood_risk_pc1 -0.01479 -0.02603 -0.00362
## strat0:flood_risk_pc2  0.00961 -0.00341  0.02245
## strat0:flood_risk_pc3 -0.00201 -0.01169  0.00766
## strat0:flood_risk_pc4  0.00792 -0.00135  0.01719
## strat0:flood_risk_pc5  0.00190 -0.00692  0.01075
## strat0:EP_UNEMP       0.05020  0.03500  0.06527
## strat0:EP_PCI        -0.04941 -0.06333 -0.03545
## strat0:EP_NOHSDP      0.23345  0.20579  0.26097
## strat0:EP_AGE65       1.23105  1.21750  1.24458
## strat0:EP_AGE17       0.15970  0.14417  0.17523
## strat0:EP_DISABL      0.22445  0.20776  0.24128
## strat0:EP_SNGPNT      0.01504 -0.00063  0.03067
## strat0:EP_MINRTY     -0.17432 -0.19679 -0.15201
## strat0:EP_LIMENG     -0.02997 -0.05533 -0.00480
## strat0:EP_MUNIT      -0.05975 -0.07265 -0.04682
## strat0:EP_MOBILE      0.07762  0.06456  0.09065
## strat0:EP_CROWD       0.01336 -0.00717  0.03394
## strat0:EP_NOVEH       0.08992  0.06770  0.11209
## strat0:EP_GROUPQ     -0.09386 -0.10680 -0.08081
## strat0:EP_UNINSUR     0.13585  0.11884  0.15277
## strat0:co            -0.11942 -0.15848 -0.07998
## strat0:no2            0.01534 -0.03633  0.06636
## strat0:o3            -0.14595 -0.21856 -0.07619
## strat0:pm10          -0.19961 -0.23314 -0.16712
## strat0:pm25           0.43798  0.39060  0.48763
## strat0:so2           0.05621  0.02290  0.09022
## strat0:summer_tmmx    0.13280  0.08339  0.18615
## strat0:winter_tmmx   -0.31593 -0.47846 -0.18847
## strat0:summer_rmax    0.00254 -0.06569  0.07049
## strat0:winter_rmax    0.05320  0.00389  0.10322
## strat0:Data_Value_CSMOKING 0.70817  0.67899  0.73708
## strat1              6.74754  6.73568  6.75929
## strat1:flood_risk_pc1 -0.01268 -0.02315 -0.00227
## strat1:flood_risk_pc2  0.00658 -0.00523  0.01846
## strat1:flood_risk_pc3  0.00569 -0.00365  0.01504
## strat1:flood_risk_pc4 -0.00259 -0.01103  0.00583
## strat1:flood_risk_pc5  0.00154 -0.00691  0.00993
## strat1:EP_UNEMP       0.05283  0.04390  0.06177
```

## strat1:EP_PCI	-0.08201	-0.10645	-0.05750
## strat1:EP_NOHSDP	0.14347	0.12630	0.16066
## strat1:EP_AGE65	1.63400	1.61986	1.64827
## strat1:EP_AGE17	0.30099	0.28704	0.31510
## strat1:EP_DISABL	0.22420	0.21232	0.23611
## strat1:EP_SNGPNT	-0.05794	-0.06914	-0.04666
## strat1:EP_MINRTY	0.01348	-0.00424	0.03122
## strat1:EP_LIMENG	-0.04214	-0.05721	-0.02698
## strat1:EP_MUNIT	-0.00647	-0.01763	0.00469
## strat1:EP_MOBILE	0.05158	0.04197	0.06119
## strat1:EP_CROWD	-0.02294	-0.03467	-0.01119
## strat1:EP_NOVEH	0.19940	0.18479	0.21408
## strat1:EP_GROUPQ	-0.05314	-0.06171	-0.04457
## strat1:EP_UNINSUR	0.08819	0.07621	0.10005
## strat1:co	-0.14840	-0.19083	-0.10638
## strat1:no2	-0.02954	-0.08115	0.02160
## strat1:o3	-0.15649	-0.22953	-0.08649
## strat1:pm10	-0.14592	-0.18058	-0.11255
## strat1:pm25	0.45173	0.40449	0.50151
## strat1:so2	0.01675	-0.01555	0.04973
## strat1:summer_tmmx	0.04595	-0.00426	0.09936
## strat1:winter_tmmx	-0.16618	-0.32870	-0.03905
## strat1:summer_rmax	-0.07471	-0.14382	-0.00705
## strat1:winter_rmax	0.04073	-0.00820	0.09070
## strat1:Data_Value_CSMOKING	1.03745	1.01707	1.05807

List of significant beta coefficients:

```
colnames(beta_samples_matrix)[sign(beta_inference[, 2]) == sign(beta_inference[, 3])]
```

## [1] "strat0"	"strat0:flood_risk_pc1"
## [3] "strat0:EP_UNEMP"	"strat0:EP_PCI"
## [5] "strat0:EP_NOHSDP"	"strat0:EP_AGE65"
## [7] "strat0:EP_AGE17"	"strat0:EP_DISABL"
## [9] "strat0:EP_MINRTY"	"strat0:EP_LIMENG"
## [11] "strat0:EP_MUNIT"	"strat0:EP_MOBILE"
## [13] "strat0:EP_NOVEH"	"strat0:EP_GROUPQ"
## [15] "strat0:EP_UNINSUR"	"strat0:co"
## [17] "strat0:o3"	"strat0:pm10"
## [19] "strat0:pm25"	"strat0:so2"
## [21] "strat0:summer_tmmx"	"strat0:winter_tmmx"
## [23] "strat0:winter_rmax"	"strat0:Data_Value_CSMOKING"
## [25] "strat1"	"strat1:flood_risk_pc1"
## [27] "strat1:EP_UNEMP"	"strat1:EP_PCI"
## [29] "strat1:EP_NOHSDP"	"strat1:EP_AGE65"
## [31] "strat1:EP_AGE17"	"strat1:EP_DISABL"
## [33] "strat1:EP_SNGPNT"	"strat1:EP_LIMENG"
## [35] "strat1:EP_MOBILE"	"strat1:EP_CROWD"
## [37] "strat1:EP_NOVEH"	"strat1:EP_GROUPQ"
## [39] "strat1:EP_UNINSUR"	"strat1:co"
## [41] "strat1:o3"	"strat1:pm10"
## [43] "strat1:pm25"	"strat1:winter_tmmx"
## [45] "strat1:summer_rmax"	"strat1:Data_Value_CSMOKING"

## Credible Interval plots for the coefficients, in ggplot

```
# first, process the beta_inference matrix in a form ggplot can understand
```

```
beta_inference_df <- as.data.frame(beta_inference)
```

```
beta_inference_df <- mutate(beta_inference_df, var_name = row.names(beta_inference_df))
```

```
beta_inference_df <- rename(beta_inference_df,  
  post_median = `50%`,  
  post_2.5 = `2.5%`,  
  post_97.5 = `97.5%`)
```

```
beta_inference_df$var_name <- factor(beta_inference_df$var_name, levels = beta_inference_df$var_name)
```

Splitting up the beta coefficients for each strata

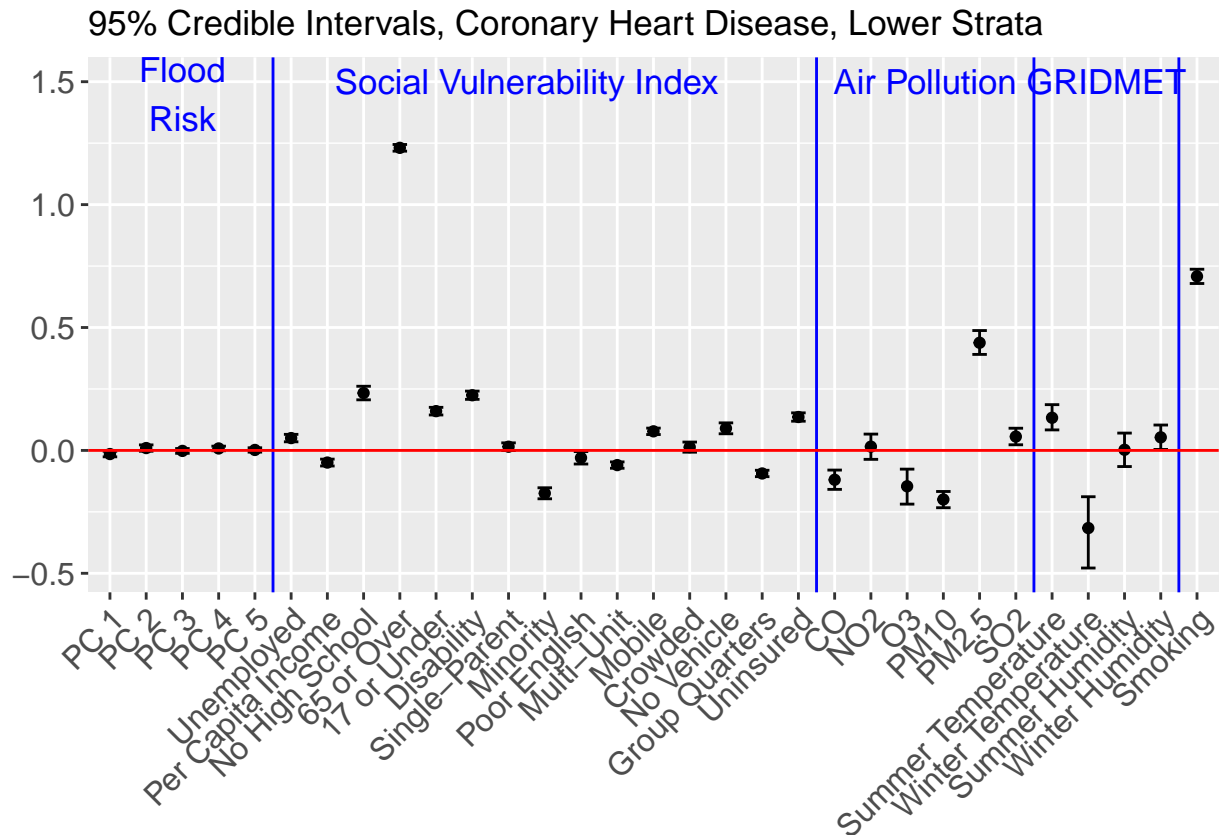
```
beta_inference_df_strat0 <- beta_inference_df[1:(nrow(beta_inference_df)/2),]
```

```
beta_inference_df_strat1 <- beta_inference_df[(nrow(beta_inference_df)/2 + 1):nrow(beta_inference_df),]
```

Note: The intercept for both strata (corresponding to poverty) is not included.

```
p <- ggplot(beta_inference_df_strat0[-1, ], aes(x = var_name, y = post_median)) +  
  geom_point() +  
  theme(axis.text.x = element_text(angle = 45, vjust = 1, hjust=1), axis.title.x = element_blank(), axis.  
    axis.text=element_text(size=12),  
    plot.margin = margin(5.5, 5.5, 5.5, 10)) +  
  geom_errorbar(aes(ymin = post_2.5, ymax = post_97.5, width = 0.4)) +  
  geom_vline(xintercept = c(5.5, 20.5, 26.5, 30.5), col = "blue") +  
  geom_hline(yintercept = 0, col = "red") +  
  annotate(geom = "text", x = 3, y = 1.45, label = "Flood\nRisk",  
    col = "blue", size = 4.5) +  
  annotate(geom = "text", x = 12.5, y = 1.5, label = "Social Vulnerability Index",  
    col = "blue", size = 4.5) +  
  annotate(geom = "text", x = 23.5, y = 1.5, label = "Air Pollution",  
    col = "blue", size = 4.5) +  
  annotate(geom = "text", x = 28.5, y = 1.5, label = "GRIDMET",  
    col = "blue", size = 4.5) +  
  scale_x_discrete(labels = c("PC 1", "PC 2", "PC 3", "PC 4", "PC 5",  
    "Unemployed", "Per Capita Income", "No High School",  
    "65 or Over", "17 or Under", "Disability",  
    "Single-Parent", "Minority", "Poor English",  
    "Multi-Unit", "Mobile", "Crowded",  
    "No Vehicle", "Group Quarters", "Uninsured",  
    "CO", "NO2", "O3", "PM10", "PM2.5", "SO2",  
    "Summer Temperature", "Winter Temperature", "Summer Humidity", "Winter Humidity",  
    "Smoking")) + ggtitle("95% Credible Intervals, Coronary Heart Disease, Low Income")
```

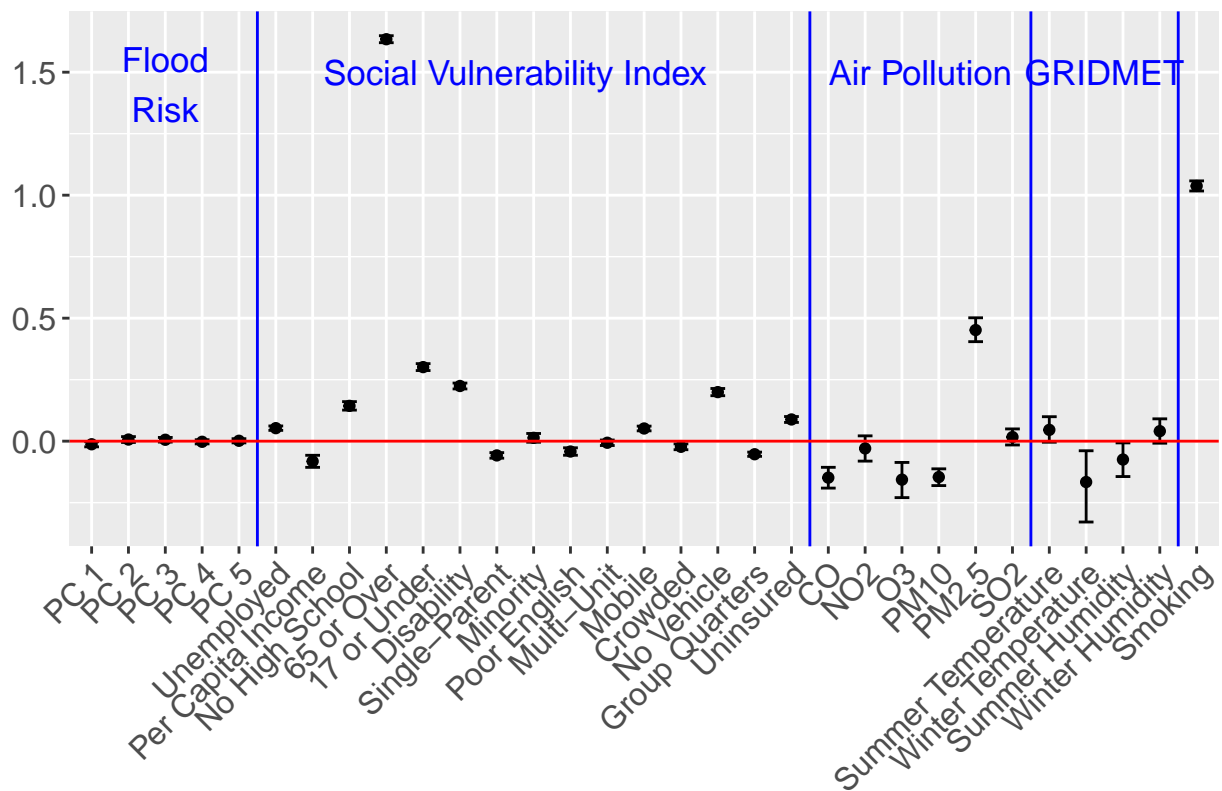
p



```
p <- ggplot(beta_inference_df_strat1[-1, ], aes(x = var_name, y = post_median)) +
  geom_point() +
  theme(axis.text.x = element_text(angle = 45, vjust = 1, hjust=1), axis.title.x = element_blank(), axis.title.y = element_text(size=12),
        plot.margin = margin(5.5, 5.5, 5.5, 10)) +
  geom_errorbar(aes(ymin = post_2.5, ymax = post_97.5, width = 0.4)) +
  geom_vline(xintercept = c(5.5, 20.5, 26.5, 30.5), col = "blue") +
  geom_hline(yintercept = 0, col = "red") +
  annotate(geom = "text", x = 3, y = 1.45, label = "Flood\nRisk",
    col = "blue", size = 4.5) +
  annotate(geom = "text", x = 12.5, y = 1.5, label = "Social Vulnerability Index",
    col = "blue", size = 4.5) +
  annotate(geom = "text", x = 23.5, y = 1.5, label = "Air Pollution",
    col = "blue", size = 4.5) +
  annotate(geom = "text", x = 28.5, y = 1.5, label = "GRIDMET",
    col = "blue", size = 4.5) +
  scale_x_discrete(labels = c("PC 1", "PC 2", "PC 3", "PC 4", "PC 5",
    "Unemployed", "Per Capita Income", "No High School",
    "65 or Over", "17 or Under", "Disability",
    "Single-Parent", "Minority", "Poor English",
    "Multi-Unit", "Mobile", "Crowded",
    "No Vehicle", "Group Quarters", "Uninsured",
    "CO", "NO2", "O3", "PM10", "PM2.5", "SO2",
    "Summer Temperature", "Winter Temperature", "Summer Humidity", "Winter Humidity",
    "Smoking")) + ggtitle("95% Credible Intervals, Coronary Heart Disease, Lower Strata")
```

p

## 95% Credible Intervals, Coronary Heart Disease, Upper Strata



## CAR model results, Coronary Heart Disease Stratified on RPL\_THEME1

```
load(here("modeling_files/model_stratif_rpl1.RData"))
```

```
beta_samples_matrix <- rbind(chain1$samples$beta, chain2$samples$beta, chain3$samples$beta)
```

```
colnames(beta_samples_matrix) <- var_names
```

```
(beta_inference <- round(t(apply(beta_samples_matrix, 2, quantile, c(0.5, 0.025, 0.975))),5))
```

	50%	2.5%	97.5%
## strat0	6.45402	6.43867	6.46944
## strat0:flood_risk_pc1	-0.01373	-0.02504	-0.00250
## strat0:flood_risk_pc2	0.01940	0.00628	0.03251
## strat0:flood_risk_pc3	-0.00281	-0.01244	0.00678
## strat0:flood_risk_pc4	0.01097	0.00171	0.02027
## strat0:flood_risk_pc5	-0.00040	-0.00931	0.00847
## strat0:EP_AGE65	1.25700	1.24396	1.27002
## strat0:EP_AGE17	0.19428	0.17933	0.20931
## strat0:EP_DISABL	0.23010	0.21400	0.24622
## strat0:EP_SNGPNT	0.00391	-0.01205	0.01993
## strat0:EP_MINRTY	-0.13127	-0.15406	-0.10848
## strat0:EP_LIMENG	0.05495	0.02828	0.08153
## strat0:EP_MUNIT	-0.05162	-0.06380	-0.03945

```
## strat0:EP_MOBILE      0.08315  0.06849  0.09783
## strat0:EP_CROWD       0.03774  0.01391  0.06135
## strat0:EP_NOVEH       0.11075  0.08929  0.13216
## strat0:EP_GROUPQ      -0.05570 -0.06636 -0.04511
## strat0:EP_UNINSUR     0.15819  0.14010  0.17630
## strat0:co             -0.10803 -0.14862 -0.06744
## strat0:no2            0.01240 -0.04062  0.06543
## strat0:o3             -0.18017 -0.25288 -0.10678
## strat0:pm10           -0.22289 -0.25677 -0.18884
## strat0:pm25           0.49051  0.44084  0.53994
## strat0:so2            0.05745  0.02305  0.09116
## strat0:summer_tmmx    0.12253  0.07118  0.17360
## strat0:winter_tmmx   -0.31262 -0.43899 -0.17723
## strat0:summer_rmax    -0.00054 -0.06838  0.06803
## strat0:winter_rmax    0.05775  0.00683  0.10815
## strat0:Data_Value_CSMOKING 0.89818  0.87352  0.92311
## strat1               6.68605  6.67465  6.69750
## strat1:flood_risk_pc1 -0.01704 -0.02776 -0.00619
## strat1:flood_risk_pc2  0.00178 -0.01015  0.01371
## strat1:flood_risk_pc3  0.00354 -0.00636  0.01337
## strat1:flood_risk_pc4 -0.00033 -0.00887  0.00824
## strat1:flood_risk_pc5  0.00002 -0.00852  0.00859
## strat1:EP_AGE65       1.70414  1.68925  1.71910
## strat1:EP_AGE17       0.28821  0.27392  0.30257
## strat1:EP_DISABL      0.24440  0.23236  0.25646
## strat1:EP_SNGPNT      -0.02580 -0.03688 -0.01474
## strat1:EP_MINRTY      0.06665  0.04966  0.08361
## strat1:EP_LIMENG      0.02108  0.00815  0.03399
## strat1:EP_MUNIT       -0.01386 -0.02566 -0.00205
## strat1:EP_MOBILE      0.05589  0.04646  0.06526
## strat1:EP_CROWD       0.00304 -0.00842  0.01452
## strat1:EP_NOVEH       0.21061  0.19575  0.22548
## strat1:EP_GROUPQ      -0.02986 -0.03868 -0.02099
## strat1:EP_UNINSUR     0.11241  0.10070  0.12410
## strat1:co             -0.15616 -0.19852 -0.11415
## strat1:no2            -0.02130 -0.07389  0.03080
## strat1:o3             -0.17981 -0.25226 -0.10658
## strat1:pm10           -0.13845 -0.17356 -0.10333
## strat1:pm25           0.49868  0.44917  0.54790
## strat1:so2            0.02675 -0.00619  0.05901
## strat1:summer_tmmx    0.02545 -0.02723  0.07781
## strat1:winter_tmmx   -0.15659 -0.28254 -0.02076
## strat1:summer_rmax    -0.08239 -0.15016 -0.01307
## strat1:winter_rmax    0.06055  0.00976  0.11082
## strat1:Data_Value_CSMOKING 1.19512  1.17709  1.21304
```

List of significant beta coefficients:

```
colnames(beta_samples_matrix)[sign(beta_inference[, 2]) == sign(beta_inference[, 3])]
```

```
## [1] "strat0"                "strat0:flood_risk_pc1"
## [3] "strat0:flood_risk_pc2" "strat0:flood_risk_pc4"
## [5] "strat0:EP_AGE65"       "strat0:EP_AGE17"
## [7] "strat0:EP_DISABL"      "strat0:EP_MINRTY"
## [9] "strat0:EP_LIMENG"      "strat0:EP_MUNIT"
```



```
## [11] "strat0:EP_MOBILE"      "strat0:EP_CROWD"
## [13] "strat0:EP_NOVEH"      "strat0:EP_GROUPQ"
## [15] "strat0:EP_UNINSUR"    "strat0:co"
## [17] "strat0:o3"            "strat0:pm10"
## [19] "strat0:pm25"          "strat0:so2"
## [21] "strat0:summer_tmmx"   "strat0:winter_tmmx"
## [23] "strat0:winter_rmax"   "strat0:Data_Value_CSMOKING"
## [25] "strat1"               "strat1:flood_risk_pc1"
## [27] "strat1:EP_AGE65"      "strat1:EP_AGE17"
## [29] "strat1:EP_DISABL"     "strat1:EP_SNGPNT"
## [31] "strat1:EP_MINRTY"     "strat1:EP_LIMENG"
## [33] "strat1:EP_MUNIT"      "strat1:EP_MOBILE"
## [35] "strat1:EP_NOVEH"      "strat1:EP_GROUPQ"
## [37] "strat1:EP_UNINSUR"    "strat1:co"
## [39] "strat1:o3"            "strat1:pm10"
## [41] "strat1:pm25"          "strat1:winter_tmmx"
## [43] "strat1:summer_rmax"   "strat1:winter_rmax"
## [45] "strat1:Data_Value_CSMOKING"
```

Credible Interval plots for the coefficients, in ggplot

```
# first, process the beta_inference matrix in a form ggplot can understand

beta_inference_df <- as.data.frame(beta_inference)

beta_inference_df <- mutate(beta_inference_df, var_name = row.names(beta_inference_df))

beta_inference_df <- rename(beta_inference_df,
                             post_median = `50%`,
                             post_2.5 = `2.5%`,
                             post_97.5 = `97.5%`)

beta_inference_df$var_name <- factor(beta_inference_df$var_name, levels = beta_inference_df$var_name)
```

Splitting up the beta coefficients for each strata

```
beta_inference_df_strat0 <- beta_inference_df[1:(nrow(beta_inference_df)/2),]

beta_inference_df_strat1 <- beta_inference_df[(nrow(beta_inference_df)/2 + 1):nrow(beta_inference_df),]
```

Note: The intercept for both strata (corresponding to poverty) is not included.

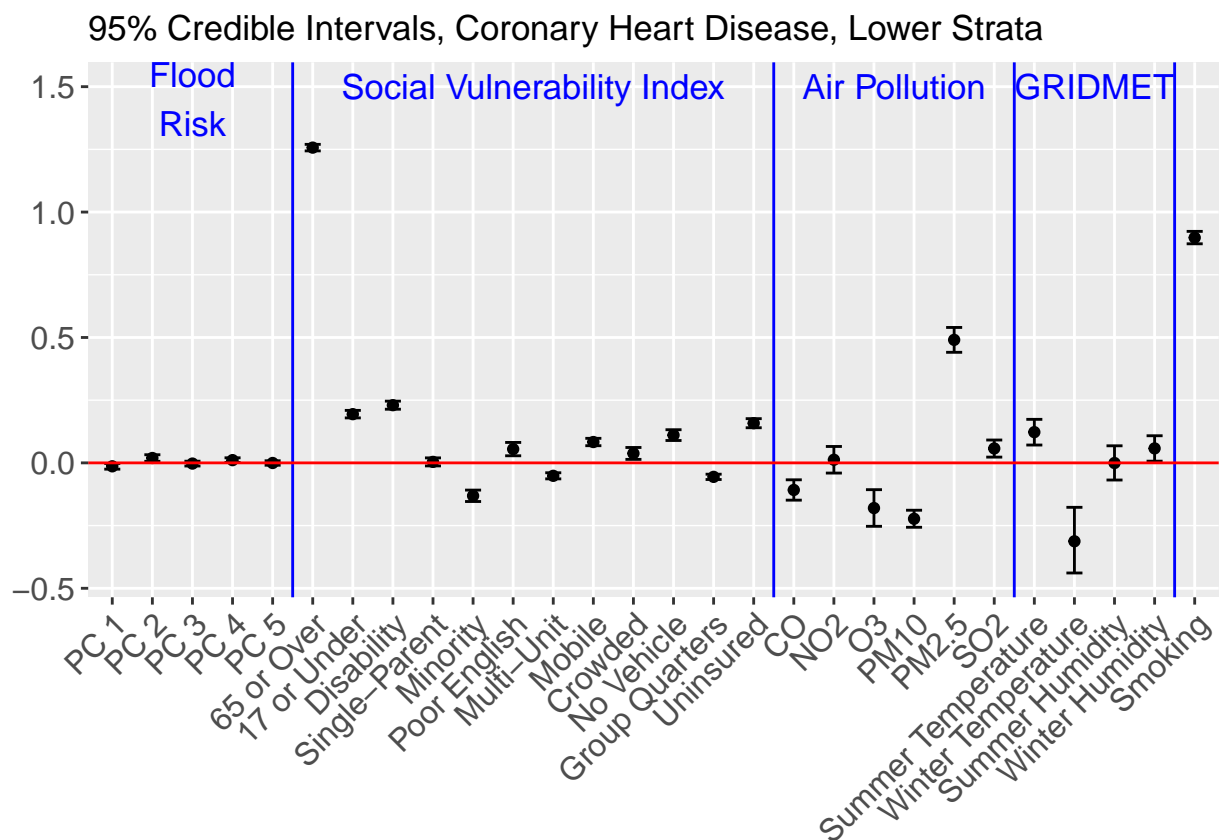
```
p <- ggplot(beta_inference_df_strat0[-1, ], aes(x = var_name, y = post_median)) +
  geom_point() +
  theme(axis.text.x = element_text(angle = 45, vjust = 1, hjust=1), axis.title.x = element_blank(), axis.title.y = element_text(size=12),
        plot.margin = margin(5.5, 5.5, 5.5, 10)) +
  geom_errorbar(aes(ymin = post_2.5, ymax = post_97.5, width = 0.4)) +
  geom_vline(xintercept = c(5.5, 17.5, 23.5, 27.5), col = "blue") +
  geom_hline(yintercept = 0, col = "red") +
  annotate(geom = "text", x = 3, y = 1.45, label = "Flood\nRisk",
          col = "blue", size = 4.5) +
  annotate(geom = "text", x = 11.5, y = 1.5, label = "Social Vulnerability Index",
          col = "blue", size = 4.5) +
```

```

annotate(geom = "text", x = 20.5, y = 1.5, label = "Air Pollution",
         col = "blue", size = 4.5) +
annotate(geom = "text", x = 25.5, y = 1.5, label = "GRIDMET",
         col = "blue", size = 4.5) +
scale_x_discrete(labels = c("PC 1", "PC 2", "PC 3", "PC 4", "PC 5",
                           "65 or Over", "17 or Under", "Disability",
                           "Single-Parent", "Minority", "Poor English",
                           "Multi-Unit", "Mobile", "Crowded",
                           "No Vehicle", "Group Quarters", "Uninsured",
                           "CO", "NO2", "O3", "PM10", "PM2.5", "SO2",
                           "Summer Temperature", "Winter Temperature", "Summer Humidity", "Winter Humidity",
                           "Smoking")) + ggtitle("95% Credible Intervals, Coronary Heart Disease, Lower Strata")

```

p



```

p <- ggplot(beta_inference_df_strat1[-1, ], aes(x = var_name, y = post_median)) +
  geom_point() +
  theme(axis.text.x = element_text(angle = 45, vjust = 1, hjust=1), axis.title.x = element_blank(), axis.title.y = element_text(size=12),
        plot.margin = margin(5.5, 5.5, 5.5, 10)) +
  geom_errorbar(aes(ymin = post_2.5, ymax = post_97.5, width = 0.4)) +
  geom_vline(xintercept = c(5.5, 17.5, 23.5, 27.5), col = "blue") +
  geom_hline(yintercept = 0, col = "red") +
  annotate(geom = "text", x = 3, y = 1.45, label = "Flood\nRisk",
         col = "blue", size = 4.5) +
  annotate(geom = "text", x = 11.5, y = 1.5, label = "Social Vulnerability Index",
         col = "blue", size = 4.5) +

```

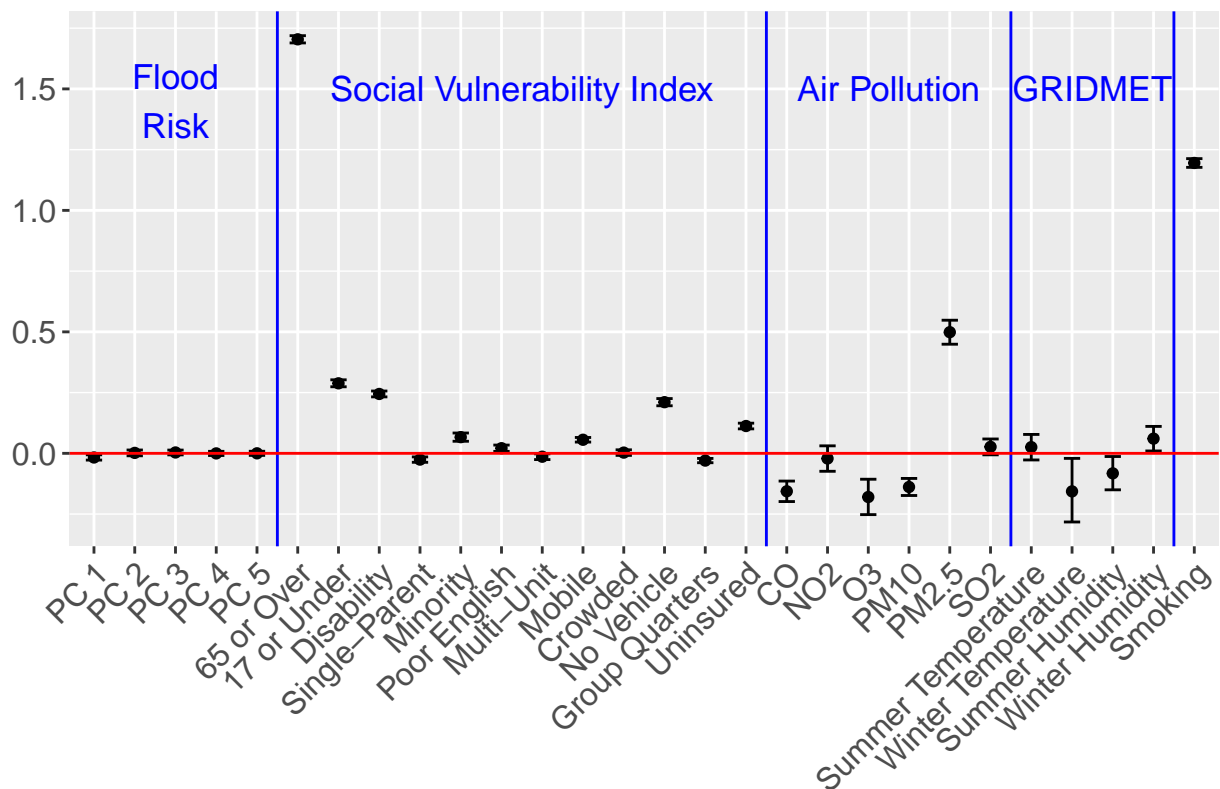
```

annotate(geom = "text", x = 20.5, y = 1.5, label = "Air Pollution",
         col = "blue", size = 4.5) +
annotate(geom = "text", x = 25.5, y = 1.5, label = "GRIDMET",
         col = "blue", size = 4.5) +
scale_x_discrete(labels = c("PC 1", "PC 2", "PC 3", "PC 4", "PC 5",
                           "65 or Over", "17 or Under", "Disability",
                           "Single-Parent", "Minority", "Poor English",
                           "Multi-Unit", "Mobile", "Crowded",
                           "No Vehicle", "Group Quarters", "Uninsured",
                           "CO", "NO2", "O3", "PM10", "PM2.5", "SO2",
                           "Summer Temperature", "Winter Temperature", "Summer Humidity", "Winter Humidity",
                           "Smoking")) + ggtitle("95% Credible Intervals, Coronary Heart Disease, Upper Strata")

```

p

95% Credible Intervals, Coronary Heart Disease, Upper Strata



## CAR model results, Coronary Heart Disease Stratified on RPL\_THEME2

```

load(here("modeling_files/model_stratif_rpl2.RData"))

beta_samples_matrix <- rbind(chain1$samples$beta, chain2$samples$beta, chain3$samples$beta)

colnames(beta_samples_matrix) <- var_names

```

```
(beta_inference <- round(t(apply(beta_samples_matrix, 2, quantile, c(0.5, 0.025, 0.975))),5))
```

##	50%	2.5%	97.5%
## strat0	6.30423	6.28996	6.31858
## strat0:flood_risk_pc1	-0.06673	-0.08370	-0.04983
## strat0:flood_risk_pc2	0.03380	0.01456	0.05310
## strat0:flood_risk_pc3	-0.02927	-0.04362	-0.01490
## strat0:flood_risk_pc4	0.01555	0.00232	0.02886
## strat0:flood_risk_pc5	-0.01854	-0.03140	-0.00567
## strat0:EP_POV	0.17521	0.15077	0.19948
## strat0:EP_UNEMP	0.14020	0.12108	0.15921
## strat0:EP_PCI	0.05835	0.03835	0.07856
## strat0:EP_NOHSDP	0.84768	0.81526	0.88063
## strat0:EP_MINRTY	-0.69547	-0.72610	-0.66503
## strat0:EP_LIMENG	-0.02521	-0.05299	0.00254
## strat0:EP_MUNIT	-0.07892	-0.09462	-0.06322
## strat0:EP_MOBILE	0.26763	0.24778	0.28737
## strat0:EP_CROWD	-0.25308	-0.27413	-0.23196
## strat0:EP_NOVEH	0.50768	0.48130	0.53391
## strat0:EP_GROUPQ	-0.29208	-0.30253	-0.28167
## strat0:EP_UNINSUR	-0.06808	-0.08957	-0.04657
## strat0:co	-0.26079	-0.32410	-0.19767
## strat0:no2	0.00479	-0.08237	0.09049
## strat0:o3	0.03266	-0.10392	0.16851
## strat0:pm10	-0.52101	-0.57945	-0.46236
## strat0:pm25	0.53864	0.45407	0.62318
## strat0:so2	-0.06112	-0.11984	-0.00350
## strat0:summer_tmmx	-0.00153	-0.09792	0.09139
## strat0:winter_tmmx	-0.25447	-0.48549	0.01561
## strat0:summer_rmax	0.00042	-0.12539	0.12497
## strat0:winter_rmax	0.01963	-0.07374	0.11369
## strat0:Data_Value_CSMOKING	-0.04856	-0.08570	-0.01111
## strat1	7.02421	7.00937	7.03925
## strat1:flood_risk_pc1	-0.05120	-0.06865	-0.03360
## strat1:flood_risk_pc2	-0.00071	-0.01997	0.01843
## strat1:flood_risk_pc3	-0.00739	-0.02342	0.00851
## strat1:flood_risk_pc4	0.01246	-0.00160	0.02677
## strat1:flood_risk_pc5	-0.01306	-0.02721	0.00109
## strat1:EP_POV	0.65182	0.62551	0.67798
## strat1:EP_UNEMP	0.07042	0.05548	0.08540
## strat1:EP_PCI	-0.03986	-0.07767	-0.00180
## strat1:EP_NOHSDP	0.60882	0.57970	0.63782
## strat1:EP_MINRTY	-0.54699	-0.57551	-0.51871
## strat1:EP_LIMENG	-0.17493	-0.20235	-0.14773
## strat1:EP_MUNIT	0.07210	0.04990	0.09420
## strat1:EP_MOBILE	0.20244	0.18781	0.21696
## strat1:EP_CROWD	-0.23715	-0.25767	-0.21643
## strat1:EP_NOVEH	0.54499	0.51862	0.57143
## strat1:EP_GROUPQ	0.12809	0.09979	0.15653
## strat1:EP_UNINSUR	-0.04980	-0.06976	-0.02978
## strat1:co	-0.30915	-0.38079	-0.23805
## strat1:no2	-0.19977	-0.29126	-0.10965
## strat1:o3	0.06285	-0.07316	0.19868
## strat1:pm10	-0.45389	-0.51216	-0.39624

```
## strat1:pm25          0.61054  0.52651  0.69397
## strat1:so2          -0.03964 -0.09686  0.01733
## strat1:summer_tmmx   0.01070 -0.08642  0.10425
## strat1:winter_tmmx  -0.28525 -0.51747 -0.01566
## strat1:summer_rmax   0.02450 -0.10133  0.14917
## strat1:winter_rmax   0.03539 -0.05743  0.12851
## strat1:Data_Value_CSMOKING -0.21323 -0.24947 -0.17705
```

List of significant beta coefficients:

```
colnames(beta_samples_matrix)[sign(beta_inference[, 2]) == sign(beta_inference[, 3])]
```

```
## [1] "strat0"          "strat0:flood_risk_pc1"
## [3] "strat0:flood_risk_pc2" "strat0:flood_risk_pc3"
## [5] "strat0:flood_risk_pc4" "strat0:flood_risk_pc5"
## [7] "strat0:EP_POV"      "strat0:EP_UNEMP"
## [9] "strat0:EP_PCI"      "strat0:EP_NOHSDP"
## [11] "strat0:EP_MINRTY"   "strat0:EP_MUNIT"
## [13] "strat0:EP_MOBILE"   "strat0:EP_CROWD"
## [15] "strat0:EP_NOVEH"    "strat0:EP_GROUPQ"
## [17] "strat0:EP_UNINSUR"  "strat0:co"
## [19] "strat0:pm10"        "strat0:pm25"
## [21] "strat0:so2"         "strat0:Data_Value_CSMOKING"
## [23] "strat1"            "strat1:flood_risk_pc1"
## [25] "strat1:EP_POV"      "strat1:EP_UNEMP"
## [27] "strat1:EP_PCI"      "strat1:EP_NOHSDP"
## [29] "strat1:EP_MINRTY"   "strat1:EP_LIMENG"
## [31] "strat1:EP_MUNIT"    "strat1:EP_MOBILE"
## [33] "strat1:EP_CROWD"    "strat1:EP_NOVEH"
## [35] "strat1:EP_GROUPQ"   "strat1:EP_UNINSUR"
## [37] "strat1:co"          "strat1:no2"
## [39] "strat1:pm10"        "strat1:pm25"
## [41] "strat1:winter_tmmx" "strat1:Data_Value_CSMOKING"
```

Credible Interval plots for the coefficients, in ggplot

```
# first, process the beta_inference matrix in a form ggplot can understand
```

```
beta_inference_df <- as.data.frame(beta_inference)
```

```
beta_inference_df <- mutate(beta_inference_df, var_name = row.names(beta_inference_df))
```

```
beta_inference_df <- rename(beta_inference_df,
                             post_median = `50%`,
                             post_2.5 = `2.5%`,
                             post_97.5 = `97.5%`)
```

```
beta_inference_df$var_name <- factor(beta_inference_df$var_name, levels = beta_inference_df$var_name)
```

Splitting up the beta coefficients for each strata

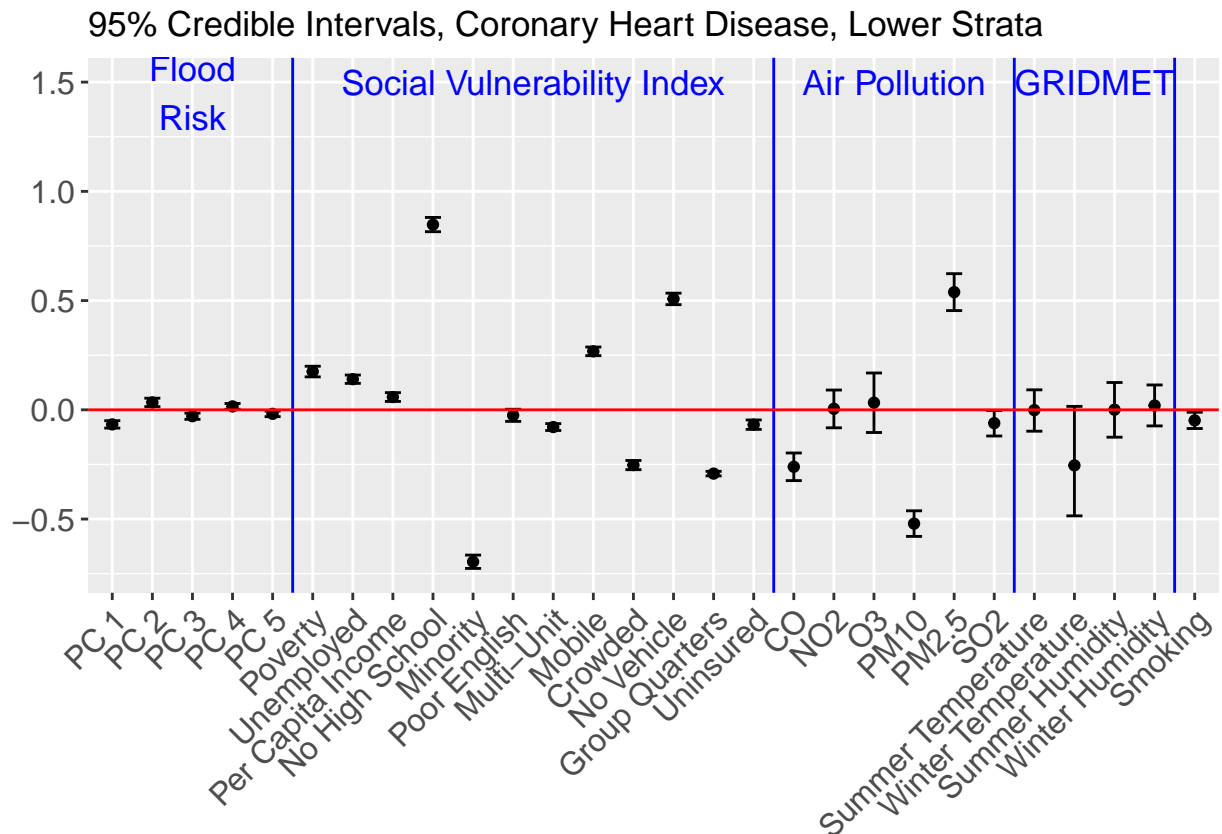
```
beta_inference_df_strat0 <- beta_inference_df[1:(nrow(beta_inference_df)/2),]
```

```
beta_inference_df_strat1 <- beta_inference_df[(nrow(beta_inference_df)/2 + 1):nrow(beta_inference_df),]
```

Note: The intercept for both strata (corresponding to poverty) is not included.

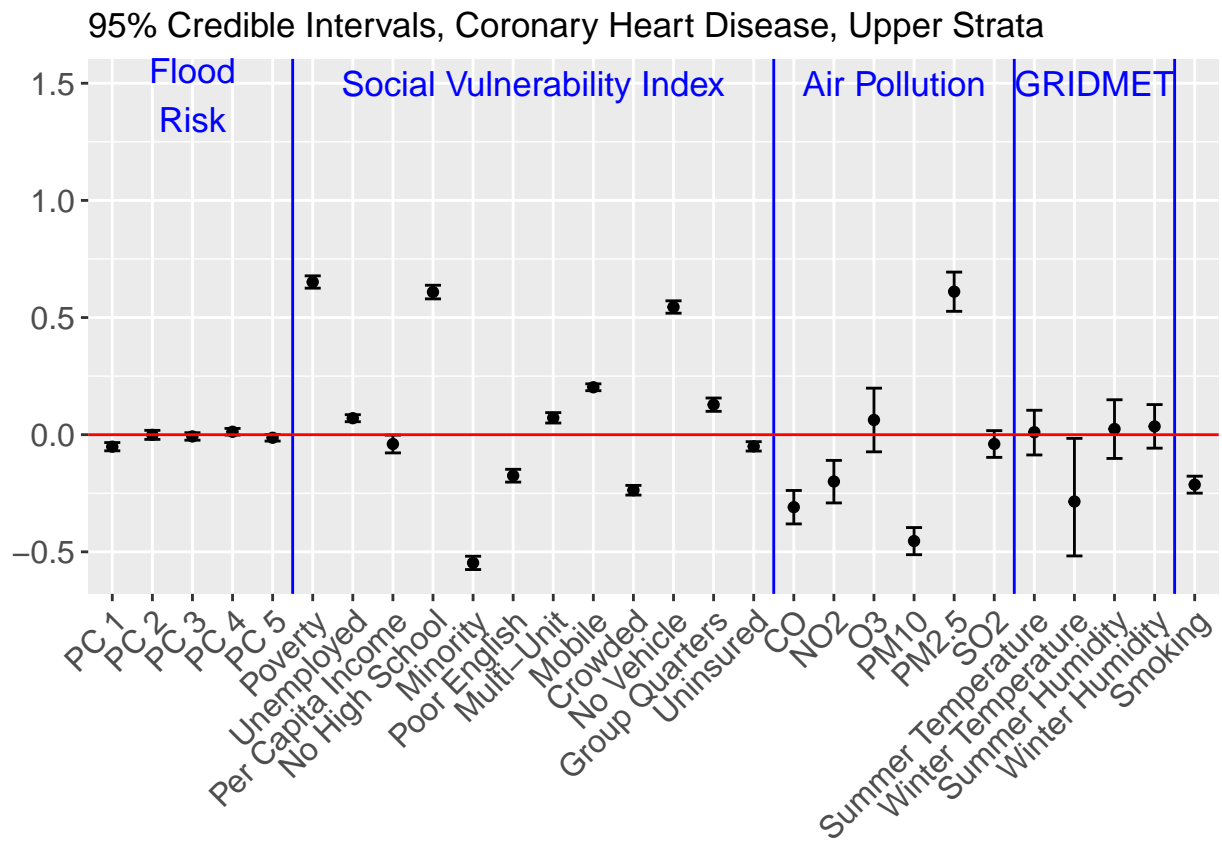
```
p <- ggplot(beta_inference_df_strat0[-1, ], aes(x = var_name, y = post_median)) +
  geom_point() +
  theme(axis.text.x = element_text(angle = 45, vjust = 1, hjust=1), axis.title.x = element_blank(), axis.title.y = element_text(size=12),
        plot.margin = margin(5.5, 5.5, 5.5, 10)) +
  geom_errorbar(aes(ymin = post_2.5, ymax = post_97.5, width = 0.4)) +
  geom_vline(xintercept = c(5.5, 17.5, 23.5, 27.5), col = "blue") +
  geom_hline(yintercept = 0, col = "red") +
  annotate(geom = "text", x = 3, y = 1.45, label = "Flood\nRisk",
          col = "blue", size = 4.5) +
  annotate(geom = "text", x = 11.5, y = 1.5, label = "Social Vulnerability Index",
          col = "blue", size = 4.5) +
  annotate(geom = "text", x = 20.5, y = 1.5, label = "Air Pollution",
          col = "blue", size = 4.5) +
  annotate(geom = "text", x = 25.5, y = 1.5, label = "GRIDMET",
          col = "blue", size = 4.5) +
  scale_x_discrete(labels = c("PC 1", "PC 2", "PC 3", "PC 4", "PC 5",
                              "Poverty", "Unemployed", "Per Capita Income", "No High School",
                              "Minority", "Poor English",
                              "Multi-Unit", "Mobile", "Crowded",
                              "No Vehicle", "Group Quarters", "Uninsured",
                              "CO", "NO2", "O3", "PM10", "PM2.5", "SO2",
                              "Summer Temperature", "Winter Temperature", "Summer Humidity", "Winter Humidity",
                              "Smoking")) + ggtitle("95% Credible Intervals, Coronary Heart Disease, Lower Strata")
```

p



```
p <- ggplot(beta_inference_df_strat1[-1, ], aes(x = var_name, y = post_median)) +
  geom_point() +
  theme(axis.text.x = element_text(angle = 45, vjust = 1, hjust=1), axis.title.x = element_blank(), axis.
        axis.text=element_text(size=12),
        plot.margin = margin(5.5, 5.5, 5.5, 10)) +
  geom_errorbar(aes(ymin = post_2.5, ymax = post_97.5, width = 0.4)) +
  geom_vline(xintercept = c(5.5, 17.5, 23.5, 27.5), col = "blue") +
  geom_hline(yintercept = 0, col = "red") +
  annotate(geom = "text", x = 3, y = 1.45, label = "Flood\nRisk",
         col = "blue", size = 4.5) +
  annotate(geom = "text", x = 11.5, y = 1.5, label = "Social Vulnerability Index",
         col = "blue", size = 4.5) +
  annotate(geom = "text", x = 20.5, y = 1.5, label = "Air Pollution",
         col = "blue", size = 4.5) +
  annotate(geom = "text", x = 25.5, y = 1.5, label = "GRIDMET",
         col = "blue", size = 4.5) +
  scale_x_discrete(labels = c("PC 1", "PC 2", "PC 3", "PC 4", "PC 5",
                             "Poverty", "Unemployed", "Per Capita Income", "No High School",
                             "Minority", "Poor English",
                             "Multi-Unit", "Mobile", "Crowded",
                             "No Vehicle", "Group Quarters", "Uninsured",
                             "CO", "NO2", "O3", "PM10", "PM2.5", "SO2",
                             "Summer Temperature", "Winter Temperature", "Summer Humidity", "Winter Humidity",
                             "Smoking")) + ggtitle("95% Credible Intervals, Coronary Heart Disease, Up
```

p



## CAR model results, Coronary Heart Disease Stratified on RPL\_THEME3

Inference is based on 3 markov chains, each of which has been run for 110000 samples, the first 10000 of which has been removed for burn-in. The remaining 100000 samples are thinned by 2, resulting in 150000 samples for inference across the 3 Markov chains.

```
load(here("modeling_files/model_stratif_rpl3.RData"))

beta_samples_matrix <- rbind(chain1$samples$beta, chain2$samples$beta, chain3$samples$beta)

colnames(beta_samples_matrix) <- var_names

(beta_inference <- round(t(apply(beta_samples_matrix, 2, quantile, c(0.5, 0.025, 0.975))),5))
```

##	50%	2.5%	97.5%
## strat0	6.76501	6.74767	6.78232
## strat0:flood_risk_pc1	-0.01483	-0.02636	-0.00329
## strat0:flood_risk_pc2	0.01941	0.00585	0.03304
## strat0:flood_risk_pc3	0.01204	0.00166	0.02237
## strat0:flood_risk_pc4	0.01696	0.00631	0.02751
## strat0:flood_risk_pc5	0.00355	-0.00677	0.01390
## strat0:EP_POV	0.31113	0.29337	0.32879
## strat0:EP_UNEMP	0.03773	0.02563	0.04977
## strat0:EP_PCI	-0.02874	-0.04289	-0.01464
## strat0:EP_NOHSDP	0.27300	0.24645	0.29950
## strat0:EP_AGE65	1.30345	1.29075	1.31612
## strat0:EP_AGE17	0.29597	0.28110	0.31068
## strat0:EP_DISABL	0.26693	0.25282	0.28102
## strat0:EP_SNGPNT	-0.01633	-0.03074	-0.00193
## strat0:EP_MUNIT	-0.05652	-0.07218	-0.04082
## strat0:EP_MOBILE	0.06397	0.05291	0.07506
## strat0:EP_CROWD	-0.00750	-0.03182	0.01660
## strat0:EP_NOVEH	0.13557	0.11469	0.15648
## strat0:EP_GROUPQ	-0.12827	-0.13845	-0.11820
## strat0:EP_UNINSUR	0.10768	0.09121	0.12411
## strat0:co	-0.12087	-0.16222	-0.07935
## strat0:no2	-0.04947	-0.10435	0.00505
## strat0:o3	-0.15967	-0.23060	-0.07892
## strat0:pm10	-0.14755	-0.18179	-0.11344
## strat0:pm25	0.39031	0.33941	0.44041
## strat0:so2	0.04042	0.00561	0.07503
## strat0:summer_tmmx	0.07608	0.02380	0.12765
## strat0:winter_tmmx	-0.27667	-0.40808	-0.15117
## strat0:summer_rmax	-0.01973	-0.08950	0.04666
## strat0:winter_rmax	0.07179	0.01947	0.12320
## strat0:Data_Value_CSMOKING	0.69089	0.66326	0.71846
## strat1	6.70294	6.69188	6.71406
## strat1:flood_risk_pc1	-0.02118	-0.03244	-0.00987
## strat1:flood_risk_pc2	0.00852	-0.00349	0.02045
## strat1:flood_risk_pc3	-0.00779	-0.01750	0.00194
## strat1:flood_risk_pc4	-0.00117	-0.00917	0.00686
## strat1:flood_risk_pc5	0.00156	-0.00624	0.00930
## strat1:EP_POV	0.32643	0.31130	0.34164



```
## strat1:EP_UNEMP      0.02950  0.01973  0.03931
## strat1:EP_PCI       -0.03701 -0.05396 -0.02003
## strat1:EP_NOHSDP    0.13020  0.11521  0.14521
## strat1:EP_AGE65     1.55164  1.53707  1.56633
## strat1:EP_AGE17     0.24312  0.22915  0.25720
## strat1:EP_DISABL    0.24637  0.23310  0.25961
## strat1:EP_SNGPNT   -0.06454 -0.07580 -0.05327
## strat1:EP_MUNIT    -0.06197 -0.07234 -0.05155
## strat1:EP_MOBILE    0.09291  0.08235  0.10348
## strat1:EP_CROWD    -0.02666 -0.03815 -0.01518
## strat1:EP_NOVEH     0.09375  0.07817  0.10935
## strat1:EP_GROUPQ   -0.06692 -0.07650 -0.05736
## strat1:EP_UNINSUR   0.08772  0.07555  0.09989
## strat1:co          -0.12116 -0.16478 -0.07813
## strat1:no2         -0.05278 -0.10570  0.00006
## strat1:o3          -0.15822 -0.22952 -0.07679
## strat1:pm10        -0.16850 -0.20472 -0.13198
## strat1:pm25         0.44519  0.39367  0.49574
## strat1:so2          0.02409 -0.01298  0.06035
## strat1:summer_tmmx  0.04815 -0.00518  0.10083
## strat1:winter_tmmx -0.21012 -0.34171 -0.08545
## strat1:summer_rmax -0.07801 -0.14827 -0.01132
## strat1:winter_rmax  0.04087 -0.01191  0.09299
## strat1:Data_Value_CSMOKING 0.84659 0.82323 0.86998
```

List of significant beta coefficients:

```
colnames(beta_samples_matrix)[sign(beta_inference[, 2]) == sign(beta_inference[, 3])]
```

```
## [1] "strat0" "strat0:flood_risk_pc1"
## [3] "strat0:flood_risk_pc2" "strat0:flood_risk_pc3"
## [5] "strat0:flood_risk_pc4" "strat0:EP_POV"
## [7] "strat0:EP_UNEMP" "strat0:EP_PCI"
## [9] "strat0:EP_NOHSDP" "strat0:EP_AGE65"
## [11] "strat0:EP_AGE17" "strat0:EP_DISABL"
## [13] "strat0:EP_SNGPNT" "strat0:EP_MUNIT"
## [15] "strat0:EP_MOBILE" "strat0:EP_NOVEH"
## [17] "strat0:EP_GROUPQ" "strat0:EP_UNINSUR"
## [19] "strat0:co" "strat0:o3"
## [21] "strat0:pm10" "strat0:pm25"
## [23] "strat0:so2" "strat0:summer_tmmx"
## [25] "strat0:winter_tmmx" "strat0:winter_rmax"
## [27] "strat0:Data_Value_CSMOKING" "strat1"
## [29] "strat1:flood_risk_pc1" "strat1:EP_POV"
## [31] "strat1:EP_UNEMP" "strat1:EP_PCI"
## [33] "strat1:EP_NOHSDP" "strat1:EP_AGE65"
## [35] "strat1:EP_AGE17" "strat1:EP_DISABL"
## [37] "strat1:EP_SNGPNT" "strat1:EP_MUNIT"
## [39] "strat1:EP_MOBILE" "strat1:EP_CROWD"
## [41] "strat1:EP_NOVEH" "strat1:EP_GROUPQ"
## [43] "strat1:EP_UNINSUR" "strat1:co"
## [45] "strat1:o3" "strat1:pm10"
## [47] "strat1:pm25" "strat1:winter_tmmx"
## [49] "strat1:summer_rmax" "strat1:Data_Value_CSMOKING"
```

## Credible Interval plots for the coefficients, in ggplot

```
# first, process the beta_inference matrix in a form ggplot can understand
```

```
beta_inference_df <- as.data.frame(beta_inference)
```

```
beta_inference_df <- mutate(beta_inference_df, var_name = row.names(beta_inference_df))
```

```
beta_inference_df <- rename(beta_inference_df,  
  post_median = `50%`,  
  post_2.5 = `2.5%`,  
  post_97.5 = `97.5%`)
```

```
beta_inference_df$var_name <- factor(beta_inference_df$var_name, levels = beta_inference_df$var_name)
```

Splitting up the beta coefficients for each strata

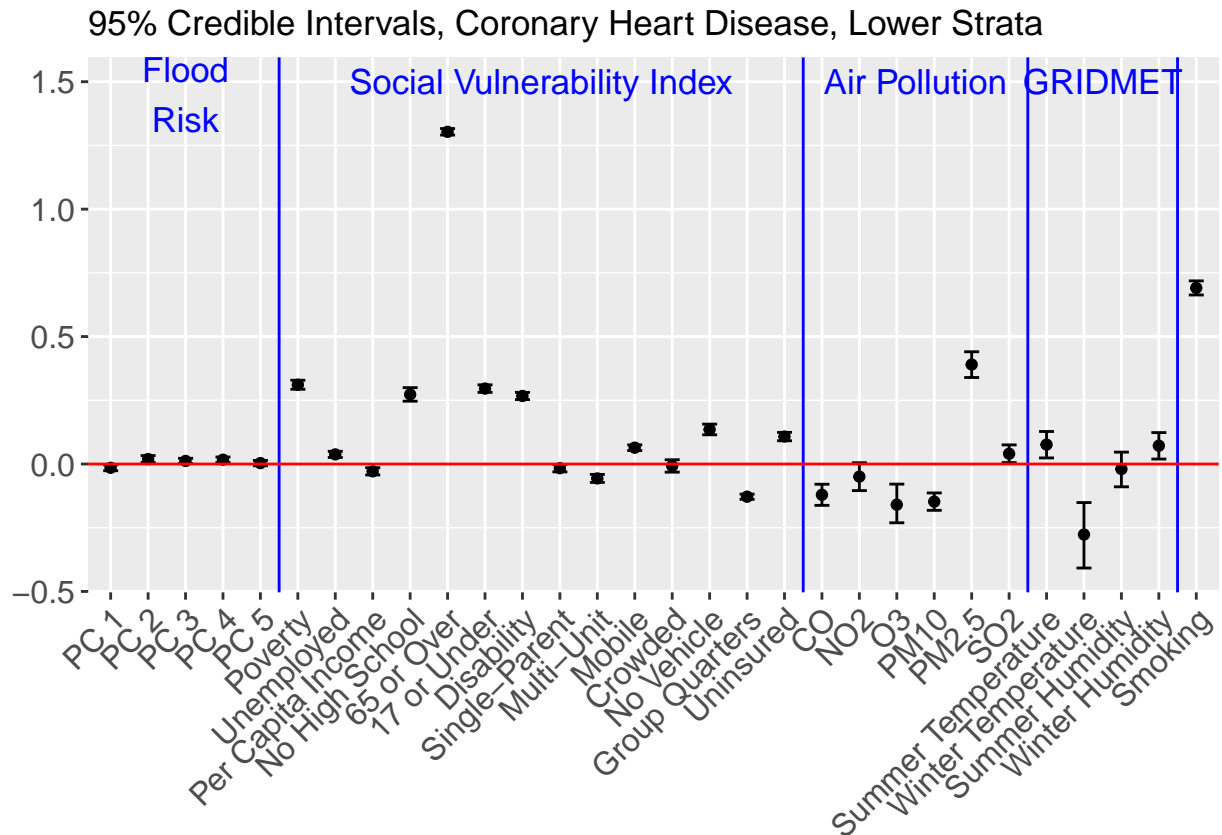
```
beta_inference_df_strat0 <- beta_inference_df[1:(nrow(beta_inference_df)/2),]
```

```
beta_inference_df_strat1 <- beta_inference_df[(nrow(beta_inference_df)/2 + 1):nrow(beta_inference_df),]
```

Note: The intercept for both strata (corresponding to poverty) is not included.

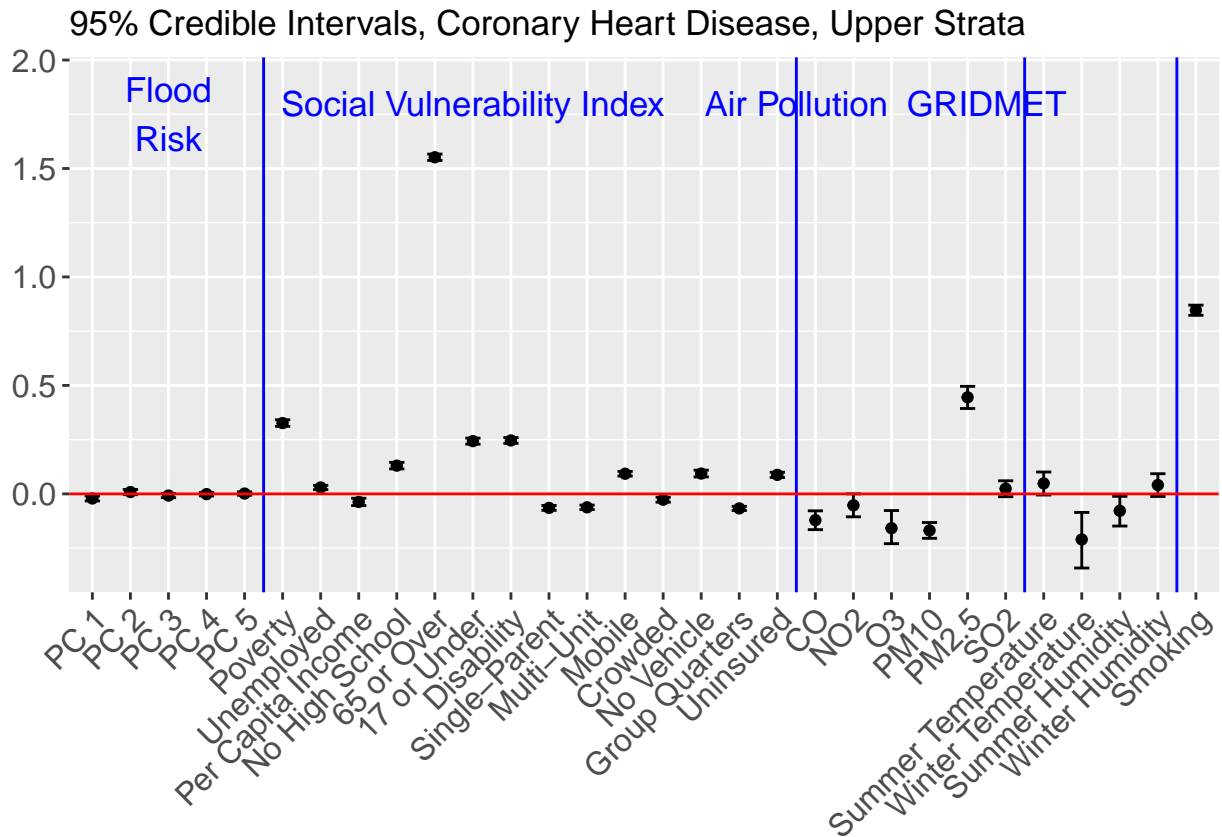
```
p <- ggplot(beta_inference_df_strat0[-1, ], aes(x = var_name, y = post_median)) +  
  geom_point() +  
  theme(axis.text.x = element_text(angle = 45, vjust = 1, hjust=1), axis.title.x = element_blank(), axis.  
    axis.text=element_text(size=12),  
    plot.margin = margin(5.5, 5.5, 5.5, 10)) +  
  geom_errorbar(aes(ymin = post_2.5, ymax = post_97.5, width = 0.4)) +  
  geom_vline(xintercept = c(5.5, 19.5, 25.5, 29.5), col = "blue") +  
  geom_hline(yintercept = 0, col = "red") +  
  annotate(geom = "text", x = 3, y = 1.45, label = "Flood\nRisk",  
    col = "blue", size = 4.5) +  
  annotate(geom = "text", x = 12.5, y = 1.5, label = "Social Vulnerability Index",  
    col = "blue", size = 4.5) +  
  annotate(geom = "text", x = 22.5, y = 1.5, label = "Air Pollution",  
    col = "blue", size = 4.5) +  
  annotate(geom = "text", x = 27.5, y = 1.5, label = "GRIDMET",  
    col = "blue", size = 4.5) +  
  scale_x_discrete(labels = c("PC 1", "PC 2", "PC 3", "PC 4", "PC 5",  
    "Poverty", "Unemployed", "Per Capita Income", "No High School",  
    "65 or Over", "17 or Under", "Disability",  
    "Single-Parent",  
    "Multi-Unit", "Mobile", "Crowded",  
    "No Vehicle", "Group Quarters", "Uninsured",  
    "CO", "NO2", "O3", "PM10", "PM2.5", "SO2",  
    "Summer Temperature", "Winter Temperature", "Summer Humidity", "Winter Humidity",  
    "Smoking")) + ggtitle("95% Credible Intervals, Coronary Heart Disease, Low Income")
```

p



```
p <- ggplot(beta_inference_df_strat1[-1, ], aes(x = var_name, y = post_median)) +
  geom_point() + ylim(NA, 1.9) +
  theme(axis.text.x = element_text(angle = 45, vjust = 1, hjust=1), axis.title.x = element_blank(), axis.title.y = element_text(size=12),
    plot.margin = margin(5.5, 5.5, 5.5, 10)) +
  geom_errorbar(aes(ymin = post_2.5, ymax = post_97.5, width = 0.4)) +
  geom_vline(xintercept = c(5.5, 19.5, 25.5, 29.5), col = "blue") +
  geom_hline(yintercept = 0, col = "red") +
  annotate(geom = "text", x = 3, y = 1.75, label = "Flood\nRisk",
    col = "blue", size = 4.5) +
  annotate(geom = "text", x = 11, y = 1.8, label = "Social Vulnerability Index",
    col = "blue", size = 4.5) +
  annotate(geom = "text", x = 19.5, y = 1.8, label = "Air Pollution",
    col = "blue", size = 4.5) +
  annotate(geom = "text", x = 24.5, y = 1.8, label = "GRIDMET",
    col = "blue", size = 4.5) +
  scale_x_discrete(labels = c("PC 1", "PC 2", "PC 3", "PC 4", "PC 5",
    "Poverty", "Unemployed", "Per Capita Income", "No High School",
    "65 or Over", "17 or Under", "Disability",
    "Single-Parent",
    "Multi-Unit", "Mobile", "Crowded",
    "No Vehicle", "Group Quarters", "Uninsured",
    "CO", "NO2", "O3", "PM10", "PM2.5", "SO2",
    "Summer Temperature", "Winter Temperature", "Summer Humidity", "Winter Humidity",
    "Smoking")) + ggtitle("95% Credible Intervals, Coronary Heart Disease, Up")
```

p



## CAR model results, Coronary Heart Disease Stratified on RPL\_THEME3

Inference is based on 3 markov chains, each of which has been run for 110000 samples, the first 10000 of which has been removed for burn-in. The remaining 100000 samples are thinned by 2, resulting in 150000 samples for inference across the 3 Markov chains.

```
load(here("modeling_files/model_stratif_rpl4.RData"))

beta_samples_matrix <- rbind(chain1$samples$beta, chain2$samples$beta, chain3$samples$beta)

colnames(beta_samples_matrix) <- var_names

(beta_inference <- round(t(apply(beta_samples_matrix, 2, quantile, c(0.5, 0.025, 0.975))),5))
```

	50%	2.5%	97.5%
## strat0	6.63735	6.62864	6.64598
## strat0:flood_risk_pc1	-0.00364	-0.01457	0.00737
## strat0:flood_risk_pc2	0.02375	0.01129	0.03624
## strat0:flood_risk_pc3	0.00200	-0.00753	0.01157
## strat0:flood_risk_pc4	0.00945	0.00023	0.01875
## strat0:flood_risk_pc5	0.00102	-0.00800	0.01002
## strat0:EP_POV	0.35369	0.33530	0.37222
## strat0:EP_UNEMP	0.02864	0.01693	0.04041
## strat0:EP_PCI	0.00055	-0.01324	0.01443
## strat0:EP_NOHSDP	0.25463	0.23257	0.27695

```

## strat0:EP_AGE65      1.31732  1.30509  1.32956
## strat0:EP_AGE17      0.28532  0.27281  0.29780
## strat0:EP_DISABL     0.24523  0.23103  0.25938
## strat0:EP_SNGPNT    -0.05462 -0.06811 -0.04103
## strat0:EP_MINRTY    -0.11497 -0.13396 -0.09593
## strat0:EP_LIMENG    -0.10944 -0.13225 -0.08678
## strat0:EP_UNINSUR     0.15000  0.13483  0.16519
## strat0:co           -0.14266 -0.18588 -0.09948
## strat0:no2          -0.01346 -0.06727  0.04026
## strat0:o3           -0.18840 -0.25888 -0.11536
## strat0:pm10         -0.18489 -0.21851 -0.15140
## strat0:pm25          0.39730  0.34927  0.44605
## strat0:so2           0.04539  0.01126  0.07893
## strat0:summer_tmmx   0.11469  0.06126  0.16597
## strat0:winter_tmmx  -0.27003 -0.39622 -0.11920
## strat0:summer_rmax  -0.03065 -0.09464  0.03626
## strat0:winter_rmax   0.06184  0.01007  0.11092
## strat0:Data_Value_CSMOKING 0.76785  0.74208  0.79377
## strat1              6.69248  6.68424  6.70077
## strat1:flood_risk_pc1 -0.01305 -0.02363 -0.00250
## strat1:flood_risk_pc2 -0.00001 -0.01185  0.01190
## strat1:flood_risk_pc3  0.00253 -0.00697  0.01204
## strat1:flood_risk_pc4  0.00372 -0.00465  0.01210
## strat1:flood_risk_pc5  0.00187 -0.00655  0.01020
## strat1:EP_POV        0.27532  0.26177  0.28878
## strat1:EP_UNEMP       0.02950  0.01933  0.03962
## strat1:EP_PCI        -0.02088 -0.03821 -0.00346
## strat1:EP_NOHSDP     0.12811  0.11050  0.14567
## strat1:EP_AGE65      1.58104  1.56781  1.59430
## strat1:EP_AGE17      0.36873  0.35667  0.38077
## strat1:EP_DISABL     0.29361  0.28102  0.30624
## strat1:EP_SNGPNT    -0.08524 -0.09724 -0.07322
## strat1:EP_MINRTY    -0.00064 -0.01896  0.01768
## strat1:EP_LIMENG    -0.03896 -0.05410 -0.02382
## strat1:EP_UNINSUR     0.10881  0.09672  0.12092
## strat1:co           -0.13901 -0.17730 -0.10084
## strat1:no2          -0.06750 -0.11743 -0.01767
## strat1:o3           -0.20967 -0.28003 -0.13643
## strat1:pm10         -0.13527 -0.16996 -0.10129
## strat1:pm25          0.40482  0.35736  0.45303
## strat1:so2           0.04802  0.01488  0.08091
## strat1:summer_tmmx   0.08015  0.02752  0.13014
## strat1:winter_tmmx  -0.20823 -0.33365 -0.05768
## strat1:summer_rmax  -0.06400 -0.12763  0.00301
## strat1:winter_rmax   0.05103 -0.00009  0.09987
## strat1:Data_Value_CSMOKING 0.92192  0.89936  0.94454

```

List of significant beta coefficients:

```
colnames(beta_samples_matrix)[sign(beta_inference[, 2]) == sign(beta_inference[, 3])]
```

```

## [1] "strat0"                "strat0:flood_risk_pc2"
## [3] "strat0:flood_risk_pc4" "strat0:EP_POV"
## [5] "strat0:EP_UNEMP"       "strat0:EP_NOHSDP"
## [7] "strat0:EP_AGE65"       "strat0:EP_AGE17"

```

```
## [9] "strat0:EP_DISABL"      "strat0:EP_SNGPNT"
## [11] "strat0:EP_MINRTY"      "strat0:EP_LIMENG"
## [13] "strat0:EP_UNINSUR"     "strat0:co"
## [15] "strat0:o3"             "strat0:pm10"
## [17] "strat0:pm25"           "strat0:so2"
## [19] "strat0:summer_tmmx"    "strat0:winter_tmmx"
## [21] "strat0:winter_rmax"    "strat0:Data_Value_CSMOKING"
## [23] "strat1"                "strat1:flood_risk_pc1"
## [25] "strat1:EP_POV"         "strat1:EP_UNEMP"
## [27] "strat1:EP_PCI"         "strat1:EP_NOHSDP"
## [29] "strat1:EP_AGE65"       "strat1:EP_AGE17"
## [31] "strat1:EP_DISABL"      "strat1:EP_SNGPNT"
## [33] "strat1:EP_LIMENG"      "strat1:EP_UNINSUR"
## [35] "strat1:co"             "strat1:no2"
## [37] "strat1:o3"             "strat1:pm10"
## [39] "strat1:pm25"           "strat1:so2"
## [41] "strat1:summer_tmmx"    "strat1:winter_tmmx"
## [43] "strat1:Data_Value_CSMOKING"
```

Credible Interval plots for the coefficients, in ggplot

```
# first, process the beta_inference matrix in a form ggplot can understand
```

```
beta_inference_df <- as.data.frame(beta_inference)

beta_inference_df <- mutate(beta_inference_df, var_name = row.names(beta_inference_df))

beta_inference_df <- rename(beta_inference_df,
                             post_median = `50%`,
                             post_2.5 = `2.5%`,
                             post_97.5 = `97.5%`)

beta_inference_df$var_name <- factor(beta_inference_df$var_name, levels = beta_inference_df$var_name)
```

Splitting up the beta coefficients for each strata

```
beta_inference_df_strat0 <- beta_inference_df[1:(nrow(beta_inference_df)/2),]

beta_inference_df_strat1 <- beta_inference_df[(nrow(beta_inference_df)/2 + 1):nrow(beta_inference_df),]
```

Note: The intercept for both strata (corresponding to poverty) is not included.

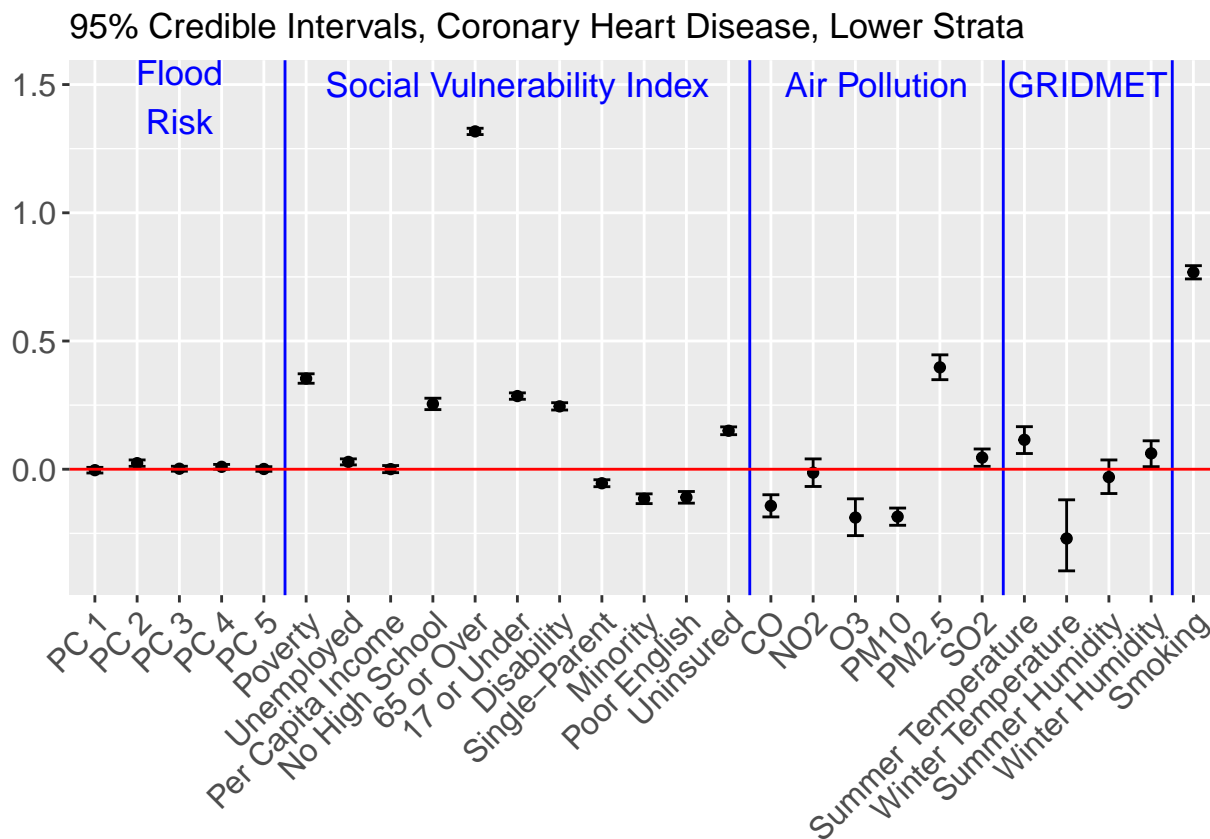
```
p <- ggplot(beta_inference_df_strat0[-1, ], aes(x = var_name, y = post_median)) +
  geom_point() +
  theme(axis.text.x = element_text(angle = 45, vjust = 1, hjust=1), axis.title.x = element_blank(), axis.title.y = element_text(size=12),
        plot.margin = margin(5.5, 5.5, 5.5, 10)) +
  geom_errorbar(aes(ymin = post_2.5, ymax = post_97.5, width = 0.4)) +
  geom_vline(xintercept = c(5.5, 16.5, 22.5, 26.5), col = "blue") +
  geom_hline(yintercept = 0, col = "red") +
  annotate(geom = "text", x = 3, y = 1.45, label = "Flood\nRisk",
          col = "blue", size = 4.5) +
  annotate(geom = "text", x = 11, y = 1.5, label = "Social Vulnerability Index",
          col = "blue", size = 4.5) +
```

```

annotate(geom = "text", x = 19.5, y = 1.5, label = "Air Pollution",
         col = "blue", size = 4.5) +
annotate(geom = "text", x = 24.5, y = 1.5, label = "GRIDMET",
         col = "blue", size = 4.5) +
scale_x_discrete(labels = c("PC 1", "PC 2", "PC 3", "PC 4", "PC 5",
                           "Poverty", "Unemployed", "Per Capita Income", "No High School",
                           "65 or Over", "17 or Under", "Disability",
                           "Single-Parent",
                           "Minority", "Poor English",
                           "Uninsured",
                           "CO", "NO2", "O3", "PM10", "PM2.5", "SO2",
                           "Summer Temperature", "Winter Temperature", "Summer Humidity", "Winter Humidity",
                           "Smoking")) + ggtitle("95% Credible Intervals, Coronary Heart Disease, Lower Strata")

```

p



```

p <- ggplot(beta_inference_df_strat1[-1, ], aes(x = var_name, y = post_median)) +
  geom_point() + ylim(NA, 1.9) +
  theme(axis.text.x = element_text(angle = 45, vjust = 1, hjust=1), axis.title.x = element_blank(), axis.title.y = element_text(size=12),
        plot.margin = margin(5.5, 5.5, 5.5, 10)) +
  geom_errorbar(aes(ymin = post_2.5, ymax = post_97.5, width = 0.4)) +
  geom_vline(xintercept = c(5.5, 16.5, 22.5, 26.5), col = "blue") +
  geom_hline(yintercept = 0, col = "red") +
  annotate(geom = "text", x = 3, y = 1.75, label = "Flood\nRisk",
         col = "blue", size = 4.5) +
  annotate(geom = "text", x = 11, y = 1.8, label = "Social Vulnerability Index",

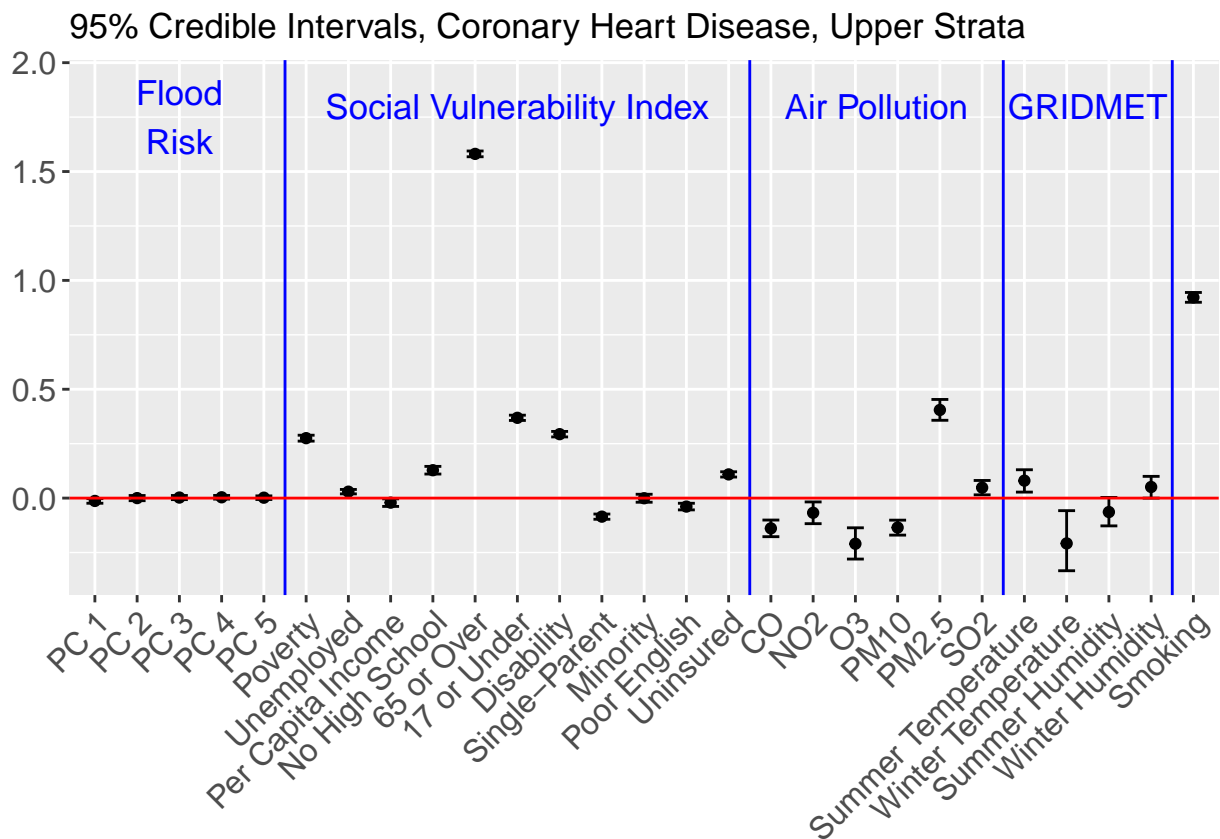
```

```

col = "blue", size = 4.5) +
annotate(geom = "text", x = 19.5, y = 1.8, label = "Air Pollution",
col = "blue", size = 4.5) +
annotate(geom = "text", x = 24.5, y = 1.8, label = "GRIDMET",
col = "blue", size = 4.5) +
scale_x_discrete(labels = c("PC 1", "PC 2", "PC 3", "PC 4", "PC 5",
"Poverty", "Unemployed", "Per Capita Income", "No High School",
"65 or Over", "17 or Under", "Disability",
"Single-Parent",
"Minority", "Poor English",
"Uninsured",
"CO", "NO2", "O3", "PM10", "PM2.5", "SO2",
"Summer Temperature", "Winter Temperature", "Summer Humidity", "Winter Humidity",
"Smoking")) + ggtitle("95% Credible Intervals, Coronary Heart Disease, Up

```

p



## CAR model results, Coronary Heart Disease Stratified on RPL\_THEMES

Inference is based on 3 markov chains, each of which has been run for 110000 samples, the first 10000 of which has been removed for burn-in. The remaining 100000 samples are thinned by 2, resulting in 150000 samples for inference across the 3 Markov chains.



```
load(here("modeling_files/model_stratif_rpls.RData"))

beta_samples_matrix <- rbind(chain1$samples$beta, chain2$samples$beta, chain3$samples$beta)

colnames(beta_samples_matrix) <- var_names

(beta_inference <- round(t(apply(beta_samples_matrix, 2, quantile, c(0.5, 0.025, 0.975))),5))
```

##	50%	2.5%	97.5%
## strat0	6.22923	6.20960	6.24873
## strat0:flood_risk_pc1	-0.09529	-0.11554	-0.07482
## strat0:flood_risk_pc2	0.02648	0.00304	0.04975
## strat0:flood_risk_pc3	-0.03070	-0.04791	-0.01340
## strat0:flood_risk_pc4	0.01623	-0.00086	0.03324
## strat0:flood_risk_pc5	-0.03153	-0.04782	-0.01522
## strat0:EP_UNINSUR	-0.00946	-0.03789	0.01914
## strat0:co	-0.31590	-0.39066	-0.24136
## strat0:no2	-0.34359	-0.44004	-0.24469
## strat0:o3	-0.41323	-0.57595	-0.26473
## strat0:pm10	-0.69297	-0.76084	-0.62591
## strat0:pm25	0.81704	0.72026	0.91460
## strat0:so2	0.02995	-0.03554	0.09841
## strat0:summer_tmmx	0.08278	-0.03023	0.20197
## strat0:winter_tmmx	-0.46540	-0.80970	-0.12863
## strat0:summer_rmax	-0.02028	-0.15795	0.12244
## strat0:winter_rmax	0.12838	0.02425	0.23107
## strat0:Data_Value_CSMOKING	0.36589	0.33407	0.39785
## strat1	6.86194	6.84507	6.87874
## strat1:flood_risk_pc1	-0.06508	-0.08469	-0.04536
## strat1:flood_risk_pc2	0.03272	0.01137	0.05412
## strat1:flood_risk_pc3	-0.02048	-0.03820	-0.00300
## strat1:flood_risk_pc4	0.01250	-0.00257	0.02757
## strat1:flood_risk_pc5	-0.00153	-0.01654	0.01355
## strat1:EP_UNINSUR	-0.13812	-0.15672	-0.11934
## strat1:co	-0.49377	-0.57383	-0.41376
## strat1:no2	-0.04214	-0.14042	0.05686
## strat1:o3	-0.52150	-0.68436	-0.37188
## strat1:pm10	-0.62719	-0.69743	-0.55768
## strat1:pm25	0.82231	0.72475	0.91947
## strat1:so2	0.03199	-0.03275	0.09900
## strat1:summer_tmmx	0.00419	-0.10952	0.12432
## strat1:winter_tmmx	-0.25761	-0.59916	0.07707
## strat1:summer_rmax	-0.07899	-0.21757	0.06513
## strat1:winter_rmax	0.10485	0.00059	0.20788
## strat1:Data_Value_CSMOKING	0.86591	0.84219	0.88957

List of significant beta coefficients:

```
colnames(beta_samples_matrix)[sign(beta_inference[, 2]) == sign(beta_inference[, 3])]

## [1] "strat0" "strat0:flood_risk_pc1"
## [3] "strat0:flood_risk_pc2" "strat0:flood_risk_pc3"
## [5] "strat0:flood_risk_pc5" "strat0:co"
## [7] "strat0:no2" "strat0:o3"
## [9] "strat0:pm10" "strat0:pm25"
```

```
## [11] "strat0:winter_tmmx"      "strat0:winter_rmax"
## [13] "strat0:Data_Value_CSMOKING" "strat1"
## [15] "strat1:flood_risk_pc1"    "strat1:flood_risk_pc2"
## [17] "strat1:flood_risk_pc3"    "strat1:EP_UNINSUR"
## [19] "strat1:co"                "strat1:o3"
## [21] "strat1:pm10"              "strat1:pm25"
## [23] "strat1:winter_rmax"      "strat1:Data_Value_CSMOKING"
```

Credible Interval plots for the coefficients, in ggplot

*# first, process the beta\_inference matrix in a form ggplot can understand*

```
beta_inference_df <- as.data.frame(beta_inference)

beta_inference_df <- mutate(beta_inference_df, var_name = row.names(beta_inference_df))

beta_inference_df <- rename(beta_inference_df,
                             post_median = `50%`,
                             post_2.5 = `2.5%`,
                             post_97.5 = `97.5%`)

beta_inference_df$var_name <- factor(beta_inference_df$var_name, levels = beta_inference_df$var_name)
```

Splitting up the beta coefficients for each strata

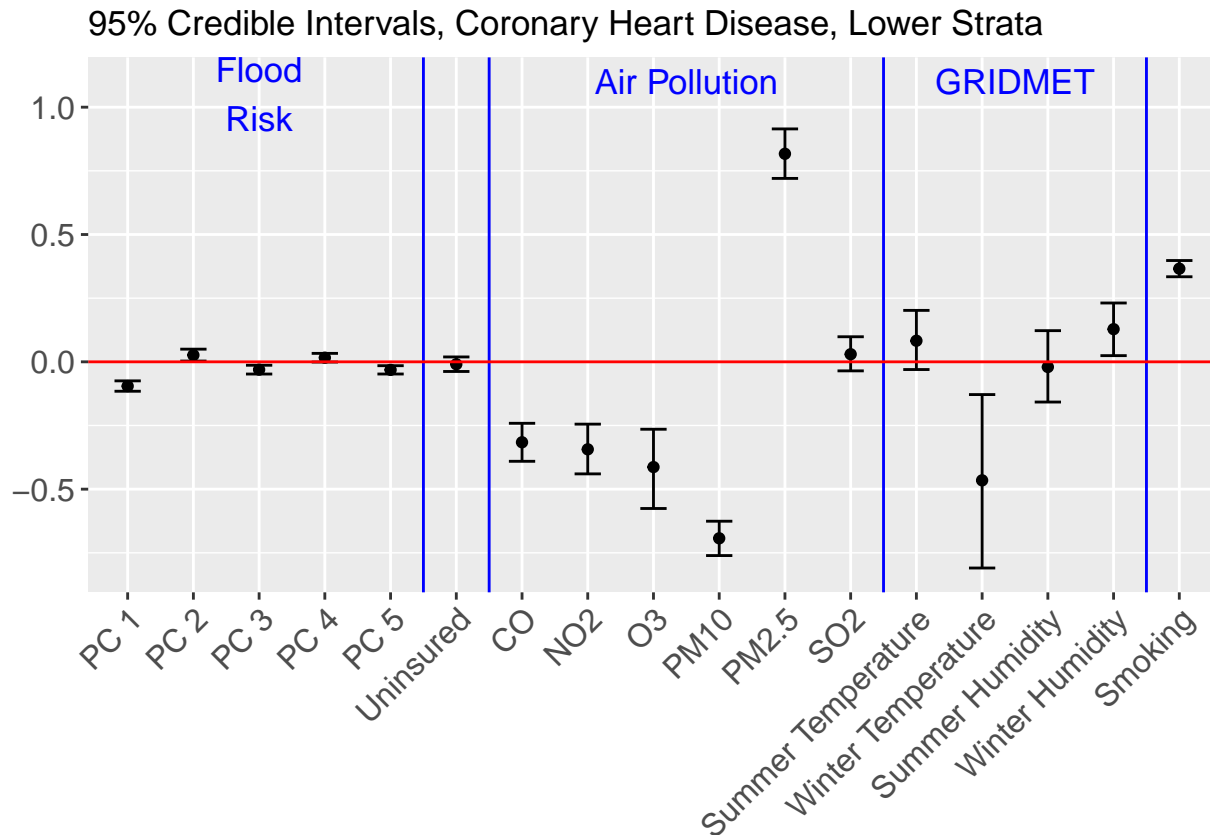
```
beta_inference_df_strat0 <- beta_inference_df[1:(nrow(beta_inference_df)/2),]

beta_inference_df_strat1 <- beta_inference_df[(nrow(beta_inference_df)/2 + 1):nrow(beta_inference_df),]
```

Note: The intercept for both strata (corresponding to poverty) is not included.

```
p <- ggplot(beta_inference_df_strat0[-1, ], aes(x = var_name, y = post_median)) +
  geom_point() +
  theme(axis.text.x = element_text(angle = 45, vjust = 1, hjust=1), axis.title.x = element_blank(), axis.title.y = element_text(size=12),
        plot.margin = margin(5.5, 5.5, 5.5, 10)) +
  geom_errorbar(aes(ymin = post_2.5, ymax = post_97.5, width = 0.4)) +
  geom_vline(xintercept = c(5.5, 6.5, 12.5, 16.5), col = "blue") +
  geom_hline(yintercept = 0, col = "red") +
  annotate(geom = "text", x = 3, y = 1.05, label = "Flood\nRisk",
          col = "blue", size = 4.5) +
  annotate(geom = "text", x = 9.5, y = 1.1, label = "Air Pollution",
          col = "blue", size = 4.5) +
  annotate(geom = "text", x = 14.5, y = 1.1, label = "GRIDMET",
          col = "blue", size = 4.5) +
  scale_x_discrete(labels = c("PC 1", "PC 2", "PC 3", "PC 4", "PC 5",
                              "Uninsured",
                              "CO", "NO2", "O3", "PM10", "PM2.5", "SO2",
                              "Summer Temperature", "Winter Temperature", "Summer Humidity", "Winter Humidity",
                              "Smoking")) + ggtitle("95% Credible Intervals, Coronary Heart Disease, Low Birth Weight")

p
```



```
p <- ggplot(beta_inference_df_strat1[-1, ], aes(x = var_name, y = post_median)) +
  geom_point() +
  theme(axis.text.x = element_text(angle = 45, vjust = 1, hjust=1), axis.title.x = element_blank(), axis.title.y = element_text(size=12),
        plot.margin = margin(5.5, 5.5, 5.5, 10)) +
  geom_errorbar(aes(ymin = post_2.5, ymax = post_97.5, width = 0.4)) +
  geom_vline(xintercept = c(5.5, 6.5, 12.5, 16.5), col = "blue") +
  geom_hline(yintercept = 0, col = "red") +
  annotate(geom = "text", x = 3, y = 1.05, label = "Flood\nRisk",
          col = "blue", size = 4.5) +
  annotate(geom = "text", x = 9.5, y = 1.1, label = "Air Pollution",
          col = "blue", size = 4.5) +
  annotate(geom = "text", x = 14.5, y = 1.1, label = "GRIDMET",
          col = "blue", size = 4.5) +
  scale_x_discrete(labels = c("PC 1", "PC 2", "PC 3", "PC 4", "PC 5",
                              "Uninsured",
                              "CO", "NO2", "O3", "PM10", "PM2.5", "SO2",
                              "Summer Temperature", "Winter Temperature", "Summer Humidity", "Winter Humidity",
                              "Smoking")) + ggtitle("95% Credible Intervals, Coronary Heart Disease, Up")
```

p

