P8451\_HW10\_ML

Ruixi Li

2024-03-26

# Research Question

My research question is to generate a hypothesis of which factors among a wide range of prenatal lifestyles and chemical exposures affect birth outcome(measured by birthweight) using data-driven methods. (Although I propose my research question after conducting EDA, I would put my research question on the top)

# Load .Rdata file and Data Preparation

# Load data using path of where file is stored  
load("exposome.RData")  
  
# I am planning on exploring the effect of prenatal exposome towards babies' birth weight. So I just removed all postnatal exposure.  
  
codebook|> group\_by(period) |> count()

## # A tibble: 2 × 2  
## # Groups: period [2]  
## period n  
## <fct> <int>  
## 1 Postnatal 142  
## 2 Pregnancy 99

pre = codebook |> filter(period == "Pregnancy")   
name = rownames(pre)  
pre\_exp = exposome |> select(ID,any\_of(name))

# Data Exploration

1. Since this dataset is a combine data from 6 cohorts, I would explore population characteristics(covariates) and outcomes(phenotypes) by cohorts.
2. Correlation between exposures

## 1. Covariates and phenotypes

cov\_phe = inner\_join(covariates, phenotype, by = "ID")

### categorical variables

cate\_cov\_phe = cov\_phe |> select(where(is.factor))  
  
# Frequency table  
frequency\_tables\_cov\_phe <- cate\_cov\_phe %>% map(~ as.data.frame(table(.x)))  
frequency\_tables\_cov\_phe |>knitr::kable()# name of variables in these freq tables are displayed in the plot below

| .x | Freq |
| --- | --- |
| 1 | 202 |
| 2 | 198 |
| 3 | 224 |
| 4 | 207 |
| 5 | 272 |
| 6 | 198 |

| .x | Freq |
| --- | --- |
| female | 608 |
| male | 693 |

| .x | Freq |
| --- | --- |
| 2003 | 55 |
| 2004 | 107 |
| 2005 | 241 |
| 2006 | 256 |
| 2007 | 250 |
| 2008 | 379 |
| 2009 | 13 |

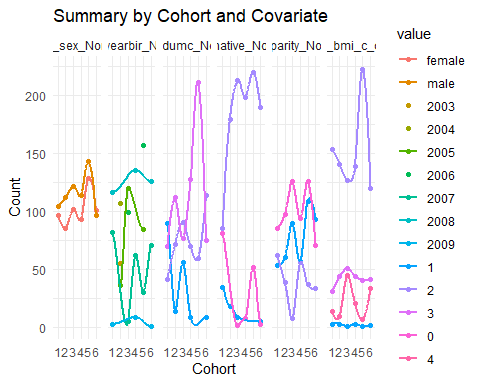
| .x | Freq |
| --- | --- |
| 1 | 178 |
| 2 | 449 |
| 3 | 674 |

| .x | Freq |
| --- | --- |
| 0 | 146 |
| 1 | 67 |
| 2 | 1088 |

| .x | Freq |
| --- | --- |
| 0 | 601 |
| 1 | 464 |
| 2 | 236 |

| .x | Freq |
| --- | --- |
| 1 | 13 |
| 2 | 904 |
| 3 | 253 |
| 4 | 131 |

# Difference by cohort  
cate\_cov\_phe\_summ = cate\_cov\_phe %>%  
 pivot\_longer(cols = -h\_cohort, names\_to = "covariate", values\_to = "value") %>%  
 group\_by(h\_cohort, covariate,value) %>%  
 summarize(n = n(), .groups = 'drop') %>%  
 ungroup()   
  
cate\_cov\_phe\_summ %>%  
 ggplot(aes(x = h\_cohort, y = n, color = value)) +  
 geom\_point() +  
 geom\_smooth(aes(group=value), method = "loess", se = FALSE) +   
 facet\_grid(. ~ covariate) +  
 theme\_minimal() + # For a cleaner look  
 labs(x = "Cohort", y = "Count", title = "Summary by Cohort and Covariate")

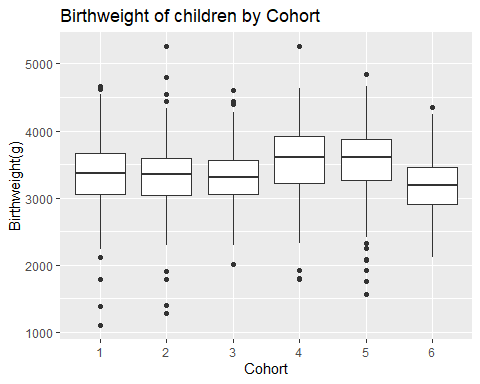


### continuous variables

cont\_cov\_phe = cov\_phe|> select(where(is.numeric))  
  
summary\_table\_cov\_phe <- cont\_cov\_phe %>%  
 summarise(across(where(is.numeric), list(  
 Mean = ~mean(.x, na.rm = TRUE),  
 SD = ~sd(.x, na.rm = TRUE),  
 Median = ~median(.x, na.rm = TRUE),  
 IQR = ~IQR(.x, na.rm = TRUE)  
 ))) |>  
 pivot\_longer(  
 cols = everything(),   
 names\_to = c(".value", "Statistic"),   
 names\_pattern = "(.\*)\_(.\*)"  
 )   
summary\_table\_cov\_phe|> knitr::kable()

| Statistic | ID | h\_mbmi\_None | hs\_wgtgain\_None | e3\_gac\_None | h\_age\_None | hs\_child\_age\_None | hs\_c\_height\_None | hs\_c\_weight\_None | e3\_bw | hs\_asthma | hs\_zbmi\_who | hs\_correct\_raven | hs\_Gen\_Tot |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Mean | 651.0000 | 25.030708 | 13.504842 | 39.625673 | 30.795058 | 7.975708 | 1.2914643 | 28.517218 | 3389.3021 | 0.1091468 | 0.403236 | 26.28824 | 24.37672 |
| SD | 375.7107 | 5.183072 | 6.240749 | 1.708398 | 4.857010 | 1.612297 | 0.1050532 | 7.689055 | 509.9945 | 0.3119432 | 1.189894 | 6.44485 | 19.02823 |
| Median | 651.0000 | 24.023809 | 12.000000 | 40.000000 | 31.000000 | 8.032854 | 1.2800000 | 26.900000 | 3398.0000 | 0.0000000 | 0.280000 | 27.00000 | 20.00000 |
| IQR | 650.0000 | 6.077137 | 9.000000 | 2.000000 | 6.418957 | 2.420032 | 0.1560000 | 9.800000 | 640.0000 | 0.0000000 | 1.530000 | 10.00000 | 23.43750 |

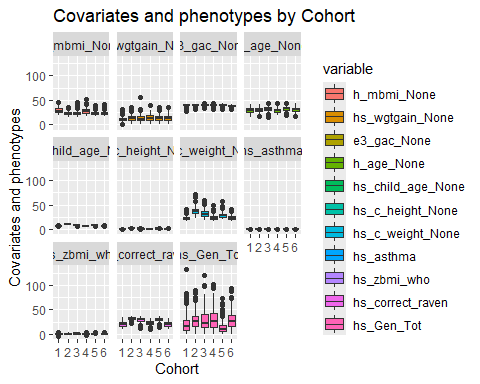
# I specify the continuous variables' names in 'name' vector to add h\_cohort in this dataset(I want to assess if there's difference between cohorts-especially the exposome)  
name\_cont\_cov\_phe = colnames(cont\_cov\_phe)[-1]  
results\_cov\_phe = cov\_phe |> select(h\_cohort, any\_of(name\_cont\_cov\_phe))  
  
results\_summary\_cov\_phe = results\_cov\_phe %>%  
 group\_by(h\_cohort) %>%  
 summarize(across(where(is.numeric),   
 list(mean = ~mean(.x, na.rm = TRUE),   
 std = ~sd(.x, na.rm = TRUE))))   
  
# Since birthweight is too large(also my outcome), I displayed it separately.  
results\_cov\_phe |> ggplot(aes(x=h\_cohort, y=e3\_bw)) + geom\_boxplot() +  
 labs(x = "Cohort", y = "Birthweight(g)", title = "Birthweight of children by Cohort")



results\_cov\_phe\_nobw = results\_cov\_phe |> select(-e3\_bw)  
  
# difference across cohorts  
results\_melted\_cov\_phe = melt(results\_cov\_phe\_nobw)

## Using h\_cohort as id variables

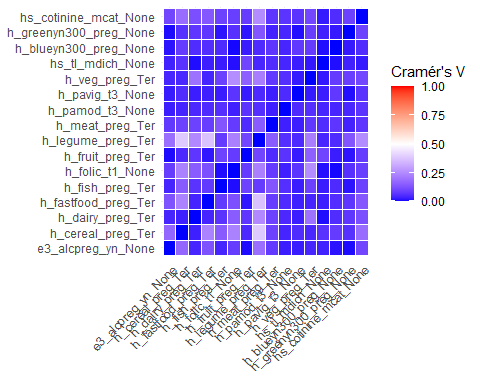
results\_melted\_cov\_phe |>  
 ggplot(aes(x=h\_cohort, y=value, fill=variable)) + geom\_boxplot() + facet\_wrap(~variable)+  
 labs(x = "Cohort", y = "Covariates and phenotypes", title = "Covariates and phenotypes by Cohort")



## 2.Exposome(pre exp)

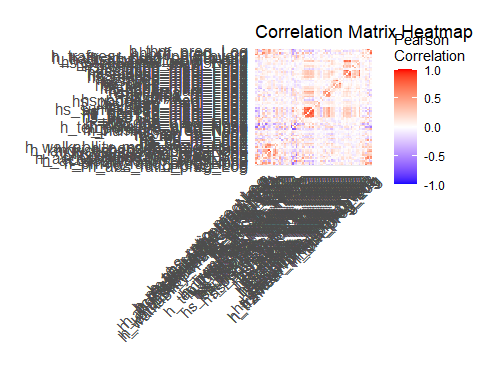
### Categorical

cate\_exp = pre\_exp |> select(where(is.factor))  
## Correlations  
### Function to calculate Cramér's V  
cramers\_v <- function(x, y) {  
 tbl <- table(x, y)  
 chi2 <- chisq.test(tbl, correct = FALSE)$statistic  
 n <- sum(tbl)  
 phi2 <- chi2 / n  
 r <- nrow(tbl) - 1  
 k <- ncol(tbl) - 1  
 min\_rk <- min(r, k)  
 v <- sqrt(phi2 / min\_rk)  
 return(v)  
}  
  
### Create an empty matrix to store the results  
vars <- names(cate\_exp)  
n <- length(vars)  
cramer\_matrix <- matrix(NA, n, n, dimnames = list(vars, vars))  
  
### Calculate Cramér's V for every pair of variables  
for (i in 1:n) {  
 for (j in 1:n) {  
 cramer\_matrix[i, j] <- cramers\_v(cate\_exp[[i]], cate\_exp[[j]])  
 }  
}  
  
### Replace diagonals with 0 for better visualization  
diag(cramer\_matrix) <- 0  
  
melted\_cramer\_matrix <- melt(cramer\_matrix)  
  
ggplot(melted\_cramer\_matrix, aes(Var1, Var2, fill = value)) +  
 geom\_tile(color = "white") +  
 scale\_fill\_gradient2(low = "blue", high = "red", mid = "white", midpoint = 0.5, limit = c(0,1), space = "Lab", name="Cramér's V") +  
 theme\_minimal() +  
 theme(axis.text.x = element\_text(angle = 45, vjust = 1, hjust = 1),  
 axis.title = element\_blank()) +  
 labs(fill = "Cramér's\nV")



### Categorical

cont\_exp = pre\_exp |> select(where(is.numeric)) |> select(-ID)  
  
## Correlation  
## Calculate correlation matrix  
cor\_matrix <- cor(cont\_exp, use = "complete.obs")  
  
### Replace diagonals with 0 for better visualization  
diag(cor\_matrix) <- 0  
  
  
  
# Melt the correlation matrix  
melted\_cor\_matrix <- melt(cor\_matrix)  
  
# Plotting  
ggplot(melted\_cor\_matrix, aes(Var1, Var2, fill = value)) +  
 geom\_tile() +  
 scale\_fill\_gradient2(low = "blue", high = "red", mid = "white",   
 midpoint = 0, limit = c(-1,1), space = "Lab",   
 name="Pearson\nCorrelation") +  
 theme\_minimal() +  
 theme(axis.text.x = element\_text(angle = 45, vjust = 1, size = 12, hjust = 1),  
 axis.text.y = element\_text(size = 12)) +  
 coord\_fixed() +  
 labs(x = '', y = '', title = 'Correlation Matrix Heatmap')



# Merge datasets

# merge features together  
feature = merge(pre\_exp,covariates,by="ID")  
outcome = phenotype |> select(ID, e3\_bw)  
studydata = merge(feature,outcome,by="ID") |>  
 select(-c(hs\_c\_weight\_None, hs\_c\_height\_None, hs\_child\_age\_None)) |>  
 select(-ID)  
  
skimr::skim(studydata)

Data summary

|  |  |
| --- | --- |
| Name | studydata |
| Number of rows | 1301 |
| Number of columns | 99 |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  |
| Column type frequency: |  |
| factor | 22 |
| numeric | 77 |
| \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |  |
| Group variables | None |

**Variable type: factor**

| skim\_variable | n\_missing | complete\_rate | ordered | n\_unique | top\_counts |
| --- | --- | --- | --- | --- | --- |
| e3\_alcpreg\_yn\_None | 0 | 1 | FALSE | 2 | 0: 896, 1: 405 |
| h\_cereal\_preg\_Ter | 0 | 1 | FALSE | 3 | (0,: 531, (9,: 459, (27: 311 |
| h\_dairy\_preg\_Ter | 0 | 1 | FALSE | 3 | (27: 651, (17: 380, (0,: 270 |
| h\_fastfood\_preg\_Ter | 0 | 1 | FALSE | 3 | (0.: 672, (0.: 535, (0,: 94 |
| h\_fish\_preg\_Ter | 0 | 1 | FALSE | 3 | (1.: 490, (4.: 468, (0,: 343 |
| h\_folic\_t1\_None | 0 | 1 | FALSE | 2 | 1: 695, 0: 606 |
| h\_fruit\_preg\_Ter | 0 | 1 | FALSE | 3 | (0.: 922, (18: 373, (0,: 6 |
| h\_legume\_preg\_Ter | 0 | 1 | FALSE | 3 | (2,: 787, (0.: 269, (0,: 245 |
| h\_meat\_preg\_Ter | 0 | 1 | FALSE | 3 | (10: 487, (0,: 427, (6.: 387 |
| h\_pamod\_t3\_None | 0 | 1 | FALSE | 4 | Ver: 594, Oft: 474, Som: 191, Non: 42 |
| h\_pavig\_t3\_None | 0 | 1 | FALSE | 3 | Low: 952, Med: 302, Hig: 47 |
| h\_veg\_preg\_Ter | 0 | 1 | FALSE | 3 | (0,: 539, (8.: 470, (16: 292 |
| hs\_tl\_mdich\_None | 0 | 1 | FALSE | 2 | Und: 1284, Det: 17 |
| h\_blueyn300\_preg\_None | 0 | 1 | FALSE | 2 | 0: 1194, 1: 107 |
| h\_greenyn300\_preg\_None | 0 | 1 | FALSE | 2 | 1: 980, 0: 321 |
| hs\_cotinine\_mcat\_None | 0 | 1 | FALSE | 3 | Non: 759, Smo: 385, SHS: 157 |
| h\_cohort | 0 | 1 | FALSE | 6 | 5: 272, 3: 224, 4: 207, 1: 202 |
| e3\_sex\_None | 0 | 1 | FALSE | 2 | mal: 693, fem: 608 |
| e3\_yearbir\_None | 0 | 1 | FALSE | 7 | 200: 379, 200: 256, 200: 250, 200: 241 |
| h\_edumc\_None | 0 | 1 | FALSE | 3 | 3: 674, 2: 449, 1: 178 |
| h\_native\_None | 0 | 1 | FALSE | 3 | 2: 1088, 0: 146, 1: 67 |
| h\_parity\_None | 0 | 1 | FALSE | 3 | 0: 601, 1: 464, 2: 236 |

**Variable type: numeric**

| skim\_variable | n\_missing | complete\_rate | mean | sd | p0 | p25 | p50 | p75 | p100 | hist |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| h\_abs\_ratio\_preg\_Log | 0 | 1 | 0.39 | 0.40 | -0.48 | 0.10 | 0.30 | 0.73 | 1.71 | ▂▇▅▃▁ |
| h\_no2\_ratio\_preg\_Log | 0 | 1 | 3.00 | 0.47 | 2.10 | 2.67 | 2.96 | 3.30 | 4.52 | ▅▇▆▂▁ |
| h\_pm10\_ratio\_preg\_None | 0 | 1 | 23.50 | 7.94 | 8.07 | 17.54 | 23.02 | 27.68 | 47.70 | ▃▇▅▃▁ |
| h\_pm25\_ratio\_preg\_None | 0 | 1 | 15.03 | 2.70 | 6.96 | 13.29 | 14.88 | 17.00 | 22.24 | ▁▃▇▅▁ |
| h\_accesslines300\_preg\_dic0 | 0 | 1 | 0.20 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 1.00 | ▇▁▁▁▂ |
| h\_accesspoints300\_preg\_Log | 0 | 1 | 2.67 | 0.82 | 1.27 | 1.96 | 2.88 | 3.35 | 4.53 | ▅▆▇▇▁ |
| h\_builtdens300\_preg\_Sqrt | 0 | 1 | 417.06 | 143.48 | 11.02 | 340.04 | 401.49 | 502.97 | 807.57 | ▁▃▇▃▁ |
| h\_connind300\_preg\_Sqrt | 0 | 1 | 12.74 | 4.67 | 1.89 | 9.98 | 12.93 | 15.90 | 27.28 | ▂▆▇▂▁ |
| h\_fdensity300\_preg\_Log | 0 | 1 | 11.61 | 1.30 | 10.26 | 10.26 | 11.36 | 12.83 | 15.60 | ▇▃▅▂▁ |
| h\_frichness300\_preg\_None | 0 | 1 | 0.07 | 0.08 | 0.00 | 0.00 | 0.04 | 0.12 | 0.42 | ▇▃▁▁▁ |
| h\_landuseshan300\_preg\_None | 0 | 1 | 0.42 | 0.13 | 0.00 | 0.34 | 0.42 | 0.51 | 1.00 | ▁▆▇▁▁ |
| h\_popdens\_preg\_Sqrt | 0 | 1 | 77.02 | 44.62 | 0.00 | 53.79 | 74.98 | 96.21 | 261.50 | ▃▇▂▁▁ |
| h\_walkability\_mean\_preg\_None | 0 | 1 | 0.27 | 0.07 | 0.10 | 0.20 | 0.25 | 0.32 | 0.62 | ▅▇▅▁▁ |
| hs\_as\_m\_Log2 | 0 | 1 | -3.01 | 5.72 | -38.62 | -5.42 | -1.93 | 1.01 | 6.49 | ▁▁▁▇▇ |
| hs\_cd\_m\_Log2 | 0 | 1 | -2.18 | 0.91 | -7.84 | -2.67 | -2.43 | -1.71 | 4.80 | ▁▂▇▁▁ |
| hs\_co\_m\_Log2 | 0 | 1 | -1.69 | 1.19 | -5.18 | -2.51 | -2.01 | -0.55 | 2.50 | ▁▇▅▆▁ |
| hs\_cs\_m\_Log2 | 0 | 1 | 0.48 | 0.57 | -1.16 | 0.07 | 0.40 | 0.81 | 3.45 | ▁▇▃▁▁ |
| hs\_cu\_m\_Log2 | 0 | 1 | 10.40 | 0.26 | 9.04 | 10.25 | 10.44 | 10.54 | 11.17 | ▁▁▃▇▁ |
| hs\_hg\_m\_Log2 | 0 | 1 | 0.57 | 1.40 | -9.02 | -0.31 | 0.58 | 1.57 | 5.44 | ▁▁▂▇▁ |
| hs\_mn\_m\_Log2 | 0 | 1 | 3.54 | 0.47 | 1.66 | 3.29 | 3.57 | 3.81 | 5.45 | ▁▂▇▂▁ |
| hs\_mo\_m\_Log2 | 0 | 1 | -0.69 | 0.59 | -2.72 | -0.98 | -0.73 | -0.40 | 6.13 | ▅▇▁▁▁ |
| hs\_pb\_m\_Log2 | 0 | 1 | 3.21 | 0.70 | 1.22 | 2.62 | 3.19 | 3.81 | 7.55 | ▂▇▃▁▁ |
| h\_humidity\_preg\_None | 0 | 1 | 76.56 | 9.87 | 55.83 | 70.63 | 77.10 | 86.54 | 90.67 | ▃▂▆▅▇ |
| h\_pressure\_preg\_None | 0 | 1 | 991.51 | 13.22 | 974.90 | 980.84 | 983.45 | 1002.32 | 1015.49 | ▇▁▁▅▂ |
| h\_temperature\_preg\_None | 0 | 1 | 11.20 | 4.47 | 3.12 | 8.13 | 10.16 | 13.80 | 22.57 | ▂▇▃▂▂ |
| h\_ndvi100\_preg\_None | 0 | 1 | 0.39 | 0.16 | 0.11 | 0.25 | 0.41 | 0.52 | 0.74 | ▇▆▇▇▂ |
| h\_lden\_cat\_preg\_None | 0 | 1 | 57.47 | 7.81 | 33.92 | 50.00 | 58.63 | 64.36 | 77.40 | ▁▆▇▇▁ |
| hs\_dde\_madj\_Log2 | 0 | 1 | 5.84 | 1.87 | 0.86 | 4.46 | 5.57 | 7.00 | 10.89 | ▁▇▇▅▂ |
| hs\_ddt\_madj\_Log2 | 0 | 1 | 0.87 | 2.43 | -14.14 | -0.26 | 0.68 | 1.51 | 6.56 | ▁▁▁▇▂ |
| hs\_hcb\_madj\_Log2 | 0 | 1 | 2.95 | 1.27 | -9.42 | 2.32 | 2.80 | 3.49 | 7.36 | ▁▁▁▇▂ |
| hs\_pcb118\_madj\_Log2 | 0 | 1 | 1.25 | 0.97 | -1.17 | 0.63 | 1.05 | 1.83 | 7.43 | ▃▇▂▁▁ |
| hs\_pcb138\_madj\_Log2 | 0 | 1 | 2.87 | 1.36 | -10.19 | 1.79 | 2.92 | 3.79 | 8.21 | ▁▁▁▇▁ |
| hs\_pcb153\_madj\_Log2 | 0 | 1 | 3.89 | 1.17 | 1.11 | 2.85 | 3.85 | 4.74 | 9.84 | ▅▇▅▁▁ |
| hs\_pcb170\_madj\_Log2 | 0 | 1 | 1.09 | 1.70 | -2.04 | -0.32 | 0.87 | 2.20 | 7.78 | ▆▇▅▂▁ |
| hs\_pcb180\_madj\_Log2 | 0 | 1 | 2.95 | 1.61 | -10.12 | 2.07 | 2.99 | 4.03 | 9.35 | ▁▁▂▇▁ |
| hs\_sumPCBs5\_madj\_Log2 | 0 | 1 | 4.86 | 1.30 | 2.30 | 4.01 | 4.71 | 5.74 | 9.34 | ▃▇▅▂▁ |
| hs\_dep\_madj\_Log2 | 0 | 1 | 1.70 | 1.59 | -13.41 | 0.99 | 1.66 | 2.67 | 7.59 | ▁▁▁▇▁ |
| hs\_detp\_madj\_Log2 | 0 | 1 | -1.57 | 4.03 | -28.38 | -3.93 | -0.53 | 1.01 | 5.47 | ▁▁▁▅▇ |
| hs\_dmp\_madj\_Log2 | 0 | 1 | 2.24 | 2.91 | -17.14 | 2.01 | 2.80 | 3.76 | 8.33 | ▁▁▁▇▅ |
| hs\_dmtp\_madj\_Log2 | 0 | 1 | 1.61 | 3.15 | -15.33 | 1.07 | 2.23 | 3.49 | 7.78 | ▁▁▂▇▅ |
| hs\_pbde153\_madj\_Log2 | 0 | 1 | -1.74 | 2.85 | -15.00 | -1.88 | -0.95 | -0.03 | 6.43 | ▁▁▁▇▁ |
| hs\_pbde47\_madj\_Log2 | 0 | 1 | -0.78 | 1.42 | -11.58 | -1.76 | -0.97 | 0.12 | 5.12 | ▁▁▃▇▁ |
| hs\_pfhxs\_m\_Log2 | 0 | 1 | -0.98 | 1.43 | -17.83 | -1.73 | -0.93 | -0.16 | 3.76 | ▁▁▁▇▅ |
| hs\_pfna\_m\_Log2 | 0 | 1 | -0.75 | 1.36 | -10.75 | -1.31 | -0.59 | 0.09 | 2.56 | ▁▁▁▇▅ |
| hs\_pfoa\_m\_Log2 | 0 | 1 | 1.05 | 1.04 | -5.48 | 0.41 | 1.20 | 1.74 | 4.98 | ▁▁▅▇▁ |
| hs\_pfos\_m\_Log2 | 0 | 1 | 2.56 | 1.12 | -1.82 | 1.96 | 2.65 | 3.21 | 5.58 | ▁▂▇▇▂ |
| hs\_pfunda\_m\_Log2 | 0 | 1 | -2.66 | 1.50 | -26.21 | -3.21 | -2.48 | -1.71 | -0.04 | ▁▁▁▁▇ |
| hs\_bpa\_madj\_Log2 | 0 | 1 | 1.47 | 1.71 | -11.02 | 0.29 | 1.15 | 2.34 | 6.74 | ▁▁▁▇▂ |
| hs\_bupa\_madj\_Log2 | 0 | 1 | 1.02 | 3.46 | -15.58 | -1.34 | 1.42 | 3.60 | 8.53 | ▁▁▅▇▃ |
| hs\_etpa\_madj\_Log2 | 0 | 1 | 3.33 | 3.58 | -12.12 | 1.24 | 3.28 | 5.13 | 12.73 | ▁▁▆▇▁ |
| hs\_mepa\_madj\_Log2 | 0 | 1 | 7.30 | 2.37 | -0.31 | 5.88 | 7.72 | 8.62 | 15.26 | ▁▃▇▃▁ |
| hs\_oxbe\_madj\_Log2 | 0 | 1 | 3.03 | 3.14 | -10.51 | 0.76 | 2.55 | 4.78 | 13.65 | ▁▂▇▅▁ |
| hs\_prpa\_madj\_Log2 | 0 | 1 | 5.23 | 3.18 | -14.15 | 3.75 | 5.77 | 7.07 | 13.61 | ▁▁▂▇▂ |
| hs\_trcs\_madj\_Log2 | 0 | 1 | 3.43 | 3.44 | -4.81 | 0.55 | 2.66 | 6.59 | 10.69 | ▁▇▇▅▅ |
| hs\_mbzp\_madj\_Log2 | 0 | 1 | 2.98 | 1.60 | -3.74 | 1.86 | 2.89 | 4.10 | 9.30 | ▁▂▇▃▁ |
| hs\_mecpp\_madj\_Log2 | 0 | 1 | 5.03 | 0.98 | 2.43 | 4.33 | 4.85 | 5.63 | 10.41 | ▂▇▃▁▁ |
| hs\_mehhp\_madj\_Log2 | 0 | 1 | 4.16 | 1.25 | -0.46 | 3.46 | 4.07 | 4.79 | 9.92 | ▁▅▇▁▁ |
| hs\_mehp\_madj\_Log2 | 0 | 1 | 2.94 | 1.43 | -7.47 | 1.79 | 3.06 | 3.81 | 8.70 | ▁▁▅▇▁ |
| hs\_meohp\_madj\_Log2 | 0 | 1 | 3.78 | 1.22 | -0.02 | 3.10 | 3.68 | 4.42 | 9.61 | ▁▇▆▁▁ |
| hs\_mep\_madj\_Log2 | 0 | 1 | 7.77 | 1.82 | 3.29 | 6.40 | 7.78 | 8.91 | 14.11 | ▂▇▇▃▁ |
| hs\_mibp\_madj\_Log2 | 0 | 1 | 5.31 | 1.05 | 0.93 | 4.59 | 5.34 | 5.92 | 9.46 | ▁▂▇▂▁ |
| hs\_mnbp\_madj\_Log2 | 0 | 1 | 4.96 | 1.21 | -0.71 | 4.20 | 4.86 | 5.57 | 12.65 | ▁▆▇▁▁ |
| hs\_ohminp\_madj\_Log2 | 0 | 1 | -0.30 | 1.53 | -11.46 | -0.72 | -0.21 | 0.27 | 6.06 | ▁▁▁▇▁ |
| hs\_oxominp\_madj\_Log2 | 0 | 1 | -0.06 | 1.59 | -11.55 | -0.70 | -0.02 | 0.52 | 5.55 | ▁▁▁▇▁ |
| hs\_sumDEHP\_madj\_Log2 | 0 | 1 | 6.01 | 1.08 | 3.21 | 5.23 | 5.88 | 6.70 | 11.69 | ▂▇▃▁▁ |
| e3\_asmokcigd\_p\_None | 0 | 1 | 0.49 | 1.76 | 0.00 | 0.00 | 0.00 | 0.00 | 15.24 | ▇▁▁▁▁ |
| h\_distinvnear1\_preg\_Log | 0 | 1 | -3.15 | 1.61 | -10.02 | -3.98 | -3.00 | -2.26 | 2.79 | ▁▁▇▃▁ |
| h\_trafload\_preg\_pow1over3 | 0 | 1 | 75.54 | 60.16 | 0.35 | 33.65 | 66.61 | 113.08 | 294.27 | ▇▆▃▁▁ |
| h\_trafnear\_preg\_pow1over3 | 0 | 1 | 14.99 | 8.23 | 0.00 | 7.94 | 12.12 | 21.40 | 39.32 | ▁▇▃▂▁ |
| h\_bro\_preg\_Log | 0 | 1 | 1.26 | 2.30 | -2.98 | -0.50 | 1.87 | 2.75 | 4.90 | ▃▆▁▇▃ |
| h\_clf\_preg\_Log | 0 | 1 | 0.96 | 2.94 | -6.91 | -0.50 | 2.08 | 3.18 | 3.83 | ▁▁▂▃▇ |
| h\_thm\_preg\_Log | 0 | 1 | 2.71 | 1.59 | -1.60 | 1.85 | 2.91 | 3.84 | 5.03 | ▁▂▃▅▇ |
| h\_mbmi\_None | 0 | 1 | 25.03 | 5.18 | 15.88 | 21.26 | 24.02 | 27.34 | 51.42 | ▇▇▂▁▁ |
| hs\_wgtgain\_None | 0 | 1 | 13.50 | 6.24 | 0.00 | 9.00 | 12.00 | 18.00 | 55.00 | ▇▇▁▁▁ |
| e3\_gac\_None | 0 | 1 | 39.63 | 1.71 | 28.00 | 38.71 | 40.00 | 40.71 | 44.14 | ▁▁▁▇▂ |
| h\_age\_None | 0 | 1 | 30.80 | 4.86 | 16.00 | 27.64 | 31.00 | 34.06 | 43.51 | ▁▃▇▆▁ |
| e3\_bw | 0 | 1 | 3389.30 | 509.99 | 1100.00 | 3080.00 | 3398.00 | 3720.00 | 5260.00 | ▁▁▇▅▁ |

* There’s 6 phenotype in ‘phenotype’ dataset, 13 covariates in ‘covariates’ dataset and 88 prenatal exposures in ‘pre\_exp’ dataset, which I would focus on. According to my research question, I would keep only one phenotype *e3\_bw*(birthweight) as my outcome. Also, since this study don’t focus on postnatal period, I would remove *hs\_c\_height\_None*(Height of the child at 6-11 years old (m)), *hs\_c\_weight\_None*(Weight of the child at 6-11 years old (kg)),*hs\_child\_age\_None*(Child age at examination (years)) from my covariates list that I would control for. They were the only three variables in ‘covariates’ dataset that are highly correlated with each other. **In a nutshell, the final dataset ‘studydata’ had 1 identifier *ID*, 1 outcome *e3bw*, 10 covariates and 88 prenatal exposures.** There’s no missing and duplicate in this dataset. All variables were correctly classified as numeric or factor.
* Some covariates and exposores are different across cohorts(I didn’t do hypothesis testing, I just used visual inspection). We should assess the heterogenitity before we could pool the data from 6 cohots. But due to limited time, I just assumed that we can pool them together.

# Implement Elastic Net Algorithm

#Partition data for use in demonstration  
set.seed(123)  
train.indices<-createDataPartition(y=studydata$e3\_bw,p=0.7,list=FALSE)  
train.data<-studydata[train.indices, ]  
test.data<-studydata[-train.indices, ]

set.seed(123)  
control = trainControl(method = "repeatedcv",   
 number = 10,  
 repeats = 5,  
 selectionFunction = "best")  
  
  
# Model building  
en.model<- train(  
 e3\_bw ~.,   
 data = train.data,   
 method = "glmnet",  
 trControl = control,   
 preProc = c("center", "scale"),  
 tuneGrid = expand.grid(alpha = seq(0, 1, length = 20),   
 lambda = exp(seq(3, -3, length = 100)))  
 )  
# I chose tuneGrid here, because this command can be used for different scenarios,but using TuneLength, I have to look at all results and see which k is the best.   
  
#Print the values of alpha and lambda that gave best prediction  
en.model$bestTune

## alpha lambda  
## 1993 1 13.14127

# Model coefficients  
coef(en.model$finalModel, en.model$bestTune$lambda)

## 123 x 1 sparse Matrix of class "dgCMatrix"  
## s1  
## (Intercept) 3386.7960526  
## h\_abs\_ratio\_preg\_Log .   
## h\_no2\_ratio\_preg\_Log .   
## h\_pm10\_ratio\_preg\_None -15.8184671  
## h\_pm25\_ratio\_preg\_None .   
## h\_accesslines300\_preg\_dic0 .   
## h\_accesspoints300\_preg\_Log .   
## h\_builtdens300\_preg\_Sqrt .   
## h\_connind300\_preg\_Sqrt .   
## h\_fdensity300\_preg\_Log .   
## h\_frichness300\_preg\_None .   
## h\_landuseshan300\_preg\_None .   
## h\_popdens\_preg\_Sqrt .   
## h\_walkability\_mean\_preg\_None .   
## e3\_alcpreg\_yn\_None1 .   
## h\_cereal\_preg\_Ter(9,27.3] .   
## h\_cereal\_preg\_Ter(27.3,Inf] .   
## h\_dairy\_preg\_Ter(17.1,27.1] 7.9710319  
## h\_dairy\_preg\_Ter(27.1,Inf] .   
## h\_fastfood\_preg\_Ter(0.25,0.83] .   
## h\_fastfood\_preg\_Ter(0.83,Inf] -1.5167790  
## h\_fish\_preg\_Ter(1.9,4.1] .   
## h\_fish\_preg\_Ter(4.1,Inf] .   
## h\_folic\_t1\_None1 -13.5643674  
## h\_fruit\_preg\_Ter(0.6,18.2] .   
## h\_fruit\_preg\_Ter(18.2,Inf] .   
## h\_legume\_preg\_Ter(0.5,2] .   
## h\_legume\_preg\_Ter(2,Inf] .   
## h\_meat\_preg\_Ter(6.5,10] .   
## h\_meat\_preg\_Ter(10,Inf] .   
## h\_pamod\_t3\_NoneOften 3.9781030  
## h\_pamod\_t3\_NoneSometimes -0.1056258  
## h\_pamod\_t3\_NoneVery Often .   
## h\_pavig\_t3\_NoneLow -5.8999337  
## h\_pavig\_t3\_NoneMedium .   
## h\_veg\_preg\_Ter(8.8,16.5] .   
## h\_veg\_preg\_Ter(16.5,Inf] -3.8750667  
## hs\_as\_m\_Log2 -8.8144787  
## hs\_cd\_m\_Log2 -4.6852357  
## hs\_co\_m\_Log2 .   
## hs\_cs\_m\_Log2 -1.3928696  
## hs\_cu\_m\_Log2 11.8108218  
## hs\_hg\_m\_Log2 .   
## hs\_mn\_m\_Log2 .   
## hs\_mo\_m\_Log2 .   
## hs\_pb\_m\_Log2 .   
## hs\_tl\_mdich\_NoneUndetected 5.2662545  
## h\_humidity\_preg\_None .   
## h\_pressure\_preg\_None .   
## h\_temperature\_preg\_None .   
## h\_blueyn300\_preg\_None1 .   
## h\_greenyn300\_preg\_None1 .   
## h\_ndvi100\_preg\_None 14.3946448  
## h\_lden\_cat\_preg\_None .   
## hs\_dde\_madj\_Log2 .   
## hs\_ddt\_madj\_Log2 .   
## hs\_hcb\_madj\_Log2 .   
## hs\_pcb118\_madj\_Log2 .   
## hs\_pcb138\_madj\_Log2 .   
## hs\_pcb153\_madj\_Log2 .   
## hs\_pcb170\_madj\_Log2 .   
## hs\_pcb180\_madj\_Log2 .   
## hs\_sumPCBs5\_madj\_Log2 .   
## hs\_dep\_madj\_Log2 -8.7728556  
## hs\_detp\_madj\_Log2 .   
## hs\_dmp\_madj\_Log2 .   
## hs\_dmtp\_madj\_Log2 17.6705884  
## hs\_pbde153\_madj\_Log2 .   
## hs\_pbde47\_madj\_Log2 11.3946652  
## hs\_pfhxs\_m\_Log2 .   
## hs\_pfna\_m\_Log2 -10.4312255  
## hs\_pfoa\_m\_Log2 -7.6724629  
## hs\_pfos\_m\_Log2 .   
## hs\_pfunda\_m\_Log2 .   
## hs\_bpa\_madj\_Log2 .   
## hs\_bupa\_madj\_Log2 .   
## hs\_etpa\_madj\_Log2 18.0331278  
## hs\_mepa\_madj\_Log2 -10.8937394  
## hs\_oxbe\_madj\_Log2 6.7639741  
## hs\_prpa\_madj\_Log2 .   
## hs\_trcs\_madj\_Log2 .   
## hs\_mbzp\_madj\_Log2 .   
## hs\_mecpp\_madj\_Log2 .   
## hs\_mehhp\_madj\_Log2 .   
## hs\_mehp\_madj\_Log2 .   
## hs\_meohp\_madj\_Log2 .   
## hs\_mep\_madj\_Log2 .   
## hs\_mibp\_madj\_Log2 8.6389188  
## hs\_mnbp\_madj\_Log2 .   
## hs\_ohminp\_madj\_Log2 .   
## hs\_oxominp\_madj\_Log2 .   
## hs\_sumDEHP\_madj\_Log2 .   
## e3\_asmokcigd\_p\_None -12.9413098  
## hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_cotinine\_mcat\_NoneSmokers -1.1695623  
## h\_distinvnear1\_preg\_Log .   
## h\_trafload\_preg\_pow1over3 .   
## h\_trafnear\_preg\_pow1over3 -2.4134593  
## h\_bro\_preg\_Log -42.9311999  
## h\_clf\_preg\_Log .   
## h\_thm\_preg\_Log .   
## h\_cohort2 .   
## h\_cohort3 -6.5180591  
## h\_cohort4 .   
## h\_cohort5 10.4907085  
## h\_cohort6 .   
## e3\_sex\_Nonemale 73.3793752  
## e3\_yearbir\_None2004 .   
## e3\_yearbir\_None2005 .   
## e3\_yearbir\_None2006 .   
## e3\_yearbir\_None2007 .   
## e3\_yearbir\_None2008 .   
## e3\_yearbir\_None2009 .   
## h\_mbmi\_None 41.8537906  
## hs\_wgtgain\_None 43.7369604  
## e3\_gac\_None 233.4141577  
## h\_age\_None .   
## h\_edumc\_None2 .   
## h\_edumc\_None3 13.9204259  
## h\_native\_None1 .   
## h\_native\_None2 17.5434887  
## h\_parity\_None1 28.2029278  
## h\_parity\_None2 14.0549894

resamp = en.model$resample  
  
  
# Predictions for models  
prediction = predict(en.model, test.data)  
  
# Evaluation  
RMSE(prediction, test.data$e3\_bw)

## [1] 411.9273

R2(prediction, test.data$e3\_bw)

## [1] 0.4216801

* Elastic Net Algorithm were applied to training dataset, with the best hyperparameter of = 1, 13.14. This is a lasso model and can select features. Finally, only 34 variables are kept in the model. testing RMSE is 411.9273048 and testing R2 is 0.4216801.

# Optional: Interaction

I used to try PCA to reduce the dimensionality, but it takes a long time to figure it out. I would rather pick 5 features from exposome that were kept in my EN.model and 1 feature I think might be a efect modifier based on my knowlege to explore the two-way interaction.

set.seed(123)  
  
model\_interaction <- train(  
 e3\_bw ~ (h\_pm10\_ratio\_preg\_None+h\_dairy\_preg\_Ter+h\_fastfood\_preg\_Ter+h\_folic\_t1\_None+h\_pamod\_t3\_None+h\_pavig\_t3\_None+h\_veg\_preg\_Ter+hs\_as\_m\_Log2+hs\_cd\_m\_Log2+hs\_cs\_m\_Log2+hs\_cu\_m\_Log2+hs\_tl\_mdich\_None+h\_ndvi100\_preg\_None+hs\_dep\_madj\_Log2+hs\_dmtp\_madj\_Log2+hs\_pbde47\_madj\_Log2+hs\_pfna\_m\_Log2+hs\_pfoa\_m\_Log2+hs\_etpa\_madj\_Log2+hs\_oxbe\_madj\_Log2+hs\_oxbe\_madj\_Log2+hs\_mibp\_madj\_Log2+e3\_asmokcigd\_p\_None+hs\_cotinine\_mcat\_None+h\_trafnear\_preg\_pow1over3+h\_bro\_preg\_Log+e3\_sex\_None+h\_mbmi\_None+hs\_wgtgain\_None+e3\_gac\_None+h\_edumc\_None+h\_native\_None+h\_parity\_None)^2,   
 data = train.data, preProcess=c("center", "scale"),   
 method = "glmnet",  
 trControl = control,  
 expandLength=10  
 )  
  
  
  
#Print the values of alpha and lambda that gave best prediction  
model\_interaction$bestTune

## alpha lambda  
## 6 0.55 50.99261

#Examine model coefficients for variable importance  
coef(model\_interaction$finalModel, model\_interaction$bestTune$lambda)

## 893 x 1 sparse Matrix of class "dgCMatrix"  
## s1  
## (Intercept) 3386.7960526  
## h\_pm10\_ratio\_preg\_None .   
## h\_dairy\_preg\_Ter(17.1,27.1] .   
## h\_dairy\_preg\_Ter(27.1,Inf] .   
## h\_fastfood\_preg\_Ter(0.25,0.83] .   
## h\_fastfood\_preg\_Ter(0.83,Inf] .   
## h\_folic\_t1\_None1 .   
## h\_pamod\_t3\_NoneOften .   
## h\_pamod\_t3\_NoneSometimes .   
## h\_pamod\_t3\_NoneVery Often .   
## h\_pavig\_t3\_NoneLow .   
## h\_pavig\_t3\_NoneMedium .   
## h\_veg\_preg\_Ter(8.8,16.5] .   
## h\_veg\_preg\_Ter(16.5,Inf] .   
## hs\_as\_m\_Log2 .   
## hs\_cd\_m\_Log2 .   
## hs\_cs\_m\_Log2 .   
## hs\_cu\_m\_Log2 .   
## hs\_tl\_mdich\_NoneUndetected .   
## h\_ndvi100\_preg\_None .   
## hs\_dep\_madj\_Log2 .   
## hs\_dmtp\_madj\_Log2 .   
## hs\_pbde47\_madj\_Log2 .   
## hs\_pfna\_m\_Log2 .   
## hs\_pfoa\_m\_Log2 .   
## hs\_etpa\_madj\_Log2 .   
## hs\_oxbe\_madj\_Log2 .   
## hs\_mibp\_madj\_Log2 .   
## e3\_asmokcigd\_p\_None .   
## hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_cotinine\_mcat\_NoneSmokers .   
## h\_trafnear\_preg\_pow1over3 .   
## h\_bro\_preg\_Log .   
## e3\_sex\_Nonemale .   
## h\_mbmi\_None .   
## hs\_wgtgain\_None .   
## e3\_gac\_None 160.6385546  
## h\_edumc\_None2 .   
## h\_edumc\_None3 .   
## h\_native\_None1 .   
## h\_native\_None2 .   
## h\_parity\_None1 .   
## h\_parity\_None2 .   
## h\_pm10\_ratio\_preg\_None:h\_dairy\_preg\_Ter(17.1,27.1] .   
## h\_pm10\_ratio\_preg\_None:h\_dairy\_preg\_Ter(27.1,Inf] .   
## h\_pm10\_ratio\_preg\_None:h\_fastfood\_preg\_Ter(0.25,0.83] .   
## h\_pm10\_ratio\_preg\_None:h\_fastfood\_preg\_Ter(0.83,Inf] .   
## h\_pm10\_ratio\_preg\_None:h\_folic\_t1\_None1 .   
## h\_pm10\_ratio\_preg\_None:h\_pamod\_t3\_NoneOften .   
## h\_pm10\_ratio\_preg\_None:h\_pamod\_t3\_NoneSometimes .   
## h\_pm10\_ratio\_preg\_None:h\_pamod\_t3\_NoneVery Often .   
## h\_pm10\_ratio\_preg\_None:h\_pavig\_t3\_NoneLow .   
## h\_pm10\_ratio\_preg\_None:h\_pavig\_t3\_NoneMedium .   
## h\_pm10\_ratio\_preg\_None:h\_veg\_preg\_Ter(8.8,16.5] .   
## h\_pm10\_ratio\_preg\_None:h\_veg\_preg\_Ter(16.5,Inf] .   
## h\_pm10\_ratio\_preg\_None:hs\_as\_m\_Log2 .   
## h\_pm10\_ratio\_preg\_None:hs\_cd\_m\_Log2 .   
## h\_pm10\_ratio\_preg\_None:hs\_cs\_m\_Log2 .   
## h\_pm10\_ratio\_preg\_None:hs\_cu\_m\_Log2 .   
## h\_pm10\_ratio\_preg\_None:hs\_tl\_mdich\_NoneUndetected .   
## h\_pm10\_ratio\_preg\_None:h\_ndvi100\_preg\_None .   
## h\_pm10\_ratio\_preg\_None:hs\_dep\_madj\_Log2 .   
## h\_pm10\_ratio\_preg\_None:hs\_dmtp\_madj\_Log2 .   
## h\_pm10\_ratio\_preg\_None:hs\_pbde47\_madj\_Log2 .   
## h\_pm10\_ratio\_preg\_None:hs\_pfna\_m\_Log2 .   
## h\_pm10\_ratio\_preg\_None:hs\_pfoa\_m\_Log2 .   
## h\_pm10\_ratio\_preg\_None:hs\_etpa\_madj\_Log2 .   
## h\_pm10\_ratio\_preg\_None:hs\_oxbe\_madj\_Log2 .   
## h\_pm10\_ratio\_preg\_None:hs\_mibp\_madj\_Log2 .   
## h\_pm10\_ratio\_preg\_None:e3\_asmokcigd\_p\_None .   
## h\_pm10\_ratio\_preg\_None:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_pm10\_ratio\_preg\_None:hs\_cotinine\_mcat\_NoneSmokers .   
## h\_pm10\_ratio\_preg\_None:h\_trafnear\_preg\_pow1over3 .   
## h\_pm10\_ratio\_preg\_None:h\_bro\_preg\_Log .   
## h\_pm10\_ratio\_preg\_None:e3\_sex\_Nonemale .   
## h\_pm10\_ratio\_preg\_None:h\_mbmi\_None .   
## h\_pm10\_ratio\_preg\_None:hs\_wgtgain\_None .   
## h\_pm10\_ratio\_preg\_None:e3\_gac\_None .   
## h\_pm10\_ratio\_preg\_None:h\_edumc\_None2 .   
## h\_pm10\_ratio\_preg\_None:h\_edumc\_None3 .   
## h\_pm10\_ratio\_preg\_None:h\_native\_None1 .   
## h\_pm10\_ratio\_preg\_None:h\_native\_None2 .   
## h\_pm10\_ratio\_preg\_None:h\_parity\_None1 .   
## h\_pm10\_ratio\_preg\_None:h\_parity\_None2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_fastfood\_preg\_Ter(0.25,0.83] .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_fastfood\_preg\_Ter(0.25,0.83] .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_fastfood\_preg\_Ter(0.83,Inf] .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_fastfood\_preg\_Ter(0.83,Inf] .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_folic\_t1\_None1 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_folic\_t1\_None1 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_pamod\_t3\_NoneOften .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_pamod\_t3\_NoneOften .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_pamod\_t3\_NoneSometimes .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_pamod\_t3\_NoneSometimes .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_pamod\_t3\_NoneVery Often .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_pamod\_t3\_NoneVery Often .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_pavig\_t3\_NoneLow .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_pavig\_t3\_NoneLow .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_pavig\_t3\_NoneMedium 4.0981651  
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_pavig\_t3\_NoneMedium .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_veg\_preg\_Ter(8.8,16.5] .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_veg\_preg\_Ter(8.8,16.5] .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_veg\_preg\_Ter(16.5,Inf] .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_veg\_preg\_Ter(16.5,Inf] .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_as\_m\_Log2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_as\_m\_Log2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_cd\_m\_Log2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_cd\_m\_Log2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_cs\_m\_Log2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_cs\_m\_Log2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_cu\_m\_Log2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_cu\_m\_Log2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_tl\_mdich\_NoneUndetected .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_tl\_mdich\_NoneUndetected .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_ndvi100\_preg\_None 0.4598823  
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_ndvi100\_preg\_None .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_dep\_madj\_Log2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_dep\_madj\_Log2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_dmtp\_madj\_Log2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_dmtp\_madj\_Log2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_pbde47\_madj\_Log2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_pbde47\_madj\_Log2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_pfna\_m\_Log2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_pfna\_m\_Log2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_pfoa\_m\_Log2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_pfoa\_m\_Log2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_etpa\_madj\_Log2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_etpa\_madj\_Log2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_oxbe\_madj\_Log2 3.5810429  
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_oxbe\_madj\_Log2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_mibp\_madj\_Log2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_mibp\_madj\_Log2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:e3\_asmokcigd\_p\_None .   
## h\_dairy\_preg\_Ter(27.1,Inf]:e3\_asmokcigd\_p\_None .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_cotinine\_mcat\_NoneSmokers .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_cotinine\_mcat\_NoneSmokers .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_trafnear\_preg\_pow1over3 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_trafnear\_preg\_pow1over3 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_bro\_preg\_Log .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_bro\_preg\_Log .   
## h\_dairy\_preg\_Ter(17.1,27.1]:e3\_sex\_Nonemale .   
## h\_dairy\_preg\_Ter(27.1,Inf]:e3\_sex\_Nonemale .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_mbmi\_None .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_mbmi\_None .   
## h\_dairy\_preg\_Ter(17.1,27.1]:hs\_wgtgain\_None .   
## h\_dairy\_preg\_Ter(27.1,Inf]:hs\_wgtgain\_None .   
## h\_dairy\_preg\_Ter(17.1,27.1]:e3\_gac\_None .   
## h\_dairy\_preg\_Ter(27.1,Inf]:e3\_gac\_None .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_edumc\_None2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_edumc\_None2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_edumc\_None3 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_edumc\_None3 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_native\_None1 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_native\_None1 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_native\_None2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_native\_None2 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_parity\_None1 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_parity\_None1 .   
## h\_dairy\_preg\_Ter(17.1,27.1]:h\_parity\_None2 .   
## h\_dairy\_preg\_Ter(27.1,Inf]:h\_parity\_None2 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_folic\_t1\_None1 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_folic\_t1\_None1 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_pamod\_t3\_NoneOften .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_pamod\_t3\_NoneOften .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_pamod\_t3\_NoneSometimes .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_pamod\_t3\_NoneSometimes .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_pamod\_t3\_NoneVery Often .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_pamod\_t3\_NoneVery Often .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_pavig\_t3\_NoneLow .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_pavig\_t3\_NoneLow .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_pavig\_t3\_NoneMedium .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_pavig\_t3\_NoneMedium .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_veg\_preg\_Ter(8.8,16.5] .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_veg\_preg\_Ter(8.8,16.5] .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_veg\_preg\_Ter(16.5,Inf] .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_veg\_preg\_Ter(16.5,Inf] -0.3611757  
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_as\_m\_Log2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_as\_m\_Log2 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_cd\_m\_Log2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_cd\_m\_Log2 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_cs\_m\_Log2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_cs\_m\_Log2 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_cu\_m\_Log2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_cu\_m\_Log2 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_tl\_mdich\_NoneUndetected .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_tl\_mdich\_NoneUndetected .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_ndvi100\_preg\_None .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_ndvi100\_preg\_None .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_dep\_madj\_Log2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_dep\_madj\_Log2 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_dmtp\_madj\_Log2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_dmtp\_madj\_Log2 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_pbde47\_madj\_Log2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_pbde47\_madj\_Log2 4.8810669  
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_pfna\_m\_Log2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_pfna\_m\_Log2 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_pfoa\_m\_Log2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_pfoa\_m\_Log2 -0.3855678  
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_etpa\_madj\_Log2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_etpa\_madj\_Log2 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_oxbe\_madj\_Log2 2.5305948  
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_oxbe\_madj\_Log2 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_mibp\_madj\_Log2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_mibp\_madj\_Log2 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:e3\_asmokcigd\_p\_None .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:e3\_asmokcigd\_p\_None .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_cotinine\_mcat\_NoneSmokers .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_cotinine\_mcat\_NoneSmokers .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_trafnear\_preg\_pow1over3 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_trafnear\_preg\_pow1over3 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_bro\_preg\_Log .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_bro\_preg\_Log .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:e3\_sex\_Nonemale .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:e3\_sex\_Nonemale .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_mbmi\_None .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_mbmi\_None .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:hs\_wgtgain\_None .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:hs\_wgtgain\_None .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:e3\_gac\_None .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:e3\_gac\_None .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_edumc\_None2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_edumc\_None2 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_edumc\_None3 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_edumc\_None3 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_native\_None1 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_native\_None1 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_native\_None2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_native\_None2 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_parity\_None1 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_parity\_None1 .   
## h\_fastfood\_preg\_Ter(0.25,0.83]:h\_parity\_None2 .   
## h\_fastfood\_preg\_Ter(0.83,Inf]:h\_parity\_None2 .   
## h\_folic\_t1\_None1:h\_pamod\_t3\_NoneOften .   
## h\_folic\_t1\_None1:h\_pamod\_t3\_NoneSometimes -13.3072852  
## h\_folic\_t1\_None1:h\_pamod\_t3\_NoneVery Often .   
## h\_folic\_t1\_None1:h\_pavig\_t3\_NoneLow -10.6438311  
## h\_folic\_t1\_None1:h\_pavig\_t3\_NoneMedium .   
## h\_folic\_t1\_None1:h\_veg\_preg\_Ter(8.8,16.5] .   
## h\_folic\_t1\_None1:h\_veg\_preg\_Ter(16.5,Inf] .   
## h\_folic\_t1\_None1:hs\_as\_m\_Log2 .   
## h\_folic\_t1\_None1:hs\_cd\_m\_Log2 .   
## h\_folic\_t1\_None1:hs\_cs\_m\_Log2 .   
## h\_folic\_t1\_None1:hs\_cu\_m\_Log2 .   
## h\_folic\_t1\_None1:hs\_tl\_mdich\_NoneUndetected .   
## h\_folic\_t1\_None1:h\_ndvi100\_preg\_None .   
## h\_folic\_t1\_None1:hs\_dep\_madj\_Log2 .   
## h\_folic\_t1\_None1:hs\_dmtp\_madj\_Log2 .   
## h\_folic\_t1\_None1:hs\_pbde47\_madj\_Log2 .   
## h\_folic\_t1\_None1:hs\_pfna\_m\_Log2 .   
## h\_folic\_t1\_None1:hs\_pfoa\_m\_Log2 .   
## h\_folic\_t1\_None1:hs\_etpa\_madj\_Log2 .   
## h\_folic\_t1\_None1:hs\_oxbe\_madj\_Log2 .   
## h\_folic\_t1\_None1:hs\_mibp\_madj\_Log2 .   
## h\_folic\_t1\_None1:e3\_asmokcigd\_p\_None .   
## h\_folic\_t1\_None1:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_folic\_t1\_None1:hs\_cotinine\_mcat\_NoneSmokers .   
## h\_folic\_t1\_None1:h\_trafnear\_preg\_pow1over3 .   
## h\_folic\_t1\_None1:h\_bro\_preg\_Log .   
## h\_folic\_t1\_None1:e3\_sex\_Nonemale .   
## h\_folic\_t1\_None1:h\_mbmi\_None .   
## h\_folic\_t1\_None1:hs\_wgtgain\_None .   
## h\_folic\_t1\_None1:e3\_gac\_None .   
## h\_folic\_t1\_None1:h\_edumc\_None2 .   
## h\_folic\_t1\_None1:h\_edumc\_None3 .   
## h\_folic\_t1\_None1:h\_native\_None1 .   
## h\_folic\_t1\_None1:h\_native\_None2 .   
## h\_folic\_t1\_None1:h\_parity\_None1 .   
## h\_folic\_t1\_None1:h\_parity\_None2 .   
## h\_pamod\_t3\_NoneOften:h\_pavig\_t3\_NoneLow .   
## h\_pamod\_t3\_NoneSometimes:h\_pavig\_t3\_NoneLow .   
## h\_pamod\_t3\_NoneVery Often:h\_pavig\_t3\_NoneLow .   
## h\_pamod\_t3\_NoneOften:h\_pavig\_t3\_NoneMedium .   
## h\_pamod\_t3\_NoneSometimes:h\_pavig\_t3\_NoneMedium .   
## h\_pamod\_t3\_NoneVery Often:h\_pavig\_t3\_NoneMedium .   
## h\_pamod\_t3\_NoneOften:h\_veg\_preg\_Ter(8.8,16.5] .   
## h\_pamod\_t3\_NoneSometimes:h\_veg\_preg\_Ter(8.8,16.5] .   
## h\_pamod\_t3\_NoneVery Often:h\_veg\_preg\_Ter(8.8,16.5] .   
## h\_pamod\_t3\_NoneOften:h\_veg\_preg\_Ter(16.5,Inf] .   
## h\_pamod\_t3\_NoneSometimes:h\_veg\_preg\_Ter(16.5,Inf] -2.6399227  
## h\_pamod\_t3\_NoneVery Often:h\_veg\_preg\_Ter(16.5,Inf] .   
## h\_pamod\_t3\_NoneOften:hs\_as\_m\_Log2 .   
## h\_pamod\_t3\_NoneSometimes:hs\_as\_m\_Log2 .   
## h\_pamod\_t3\_NoneVery Often:hs\_as\_m\_Log2 .   
## h\_pamod\_t3\_NoneOften:hs\_cd\_m\_Log2 .   
## h\_pamod\_t3\_NoneSometimes:hs\_cd\_m\_Log2 .   
## h\_pamod\_t3\_NoneVery Often:hs\_cd\_m\_Log2 .   
## h\_pamod\_t3\_NoneOften:hs\_cs\_m\_Log2 .   
## h\_pamod\_t3\_NoneSometimes:hs\_cs\_m\_Log2 .   
## h\_pamod\_t3\_NoneVery Often:hs\_cs\_m\_Log2 .   
## h\_pamod\_t3\_NoneOften:hs\_cu\_m\_Log2 .   
## h\_pamod\_t3\_NoneSometimes:hs\_cu\_m\_Log2 .   
## h\_pamod\_t3\_NoneVery Often:hs\_cu\_m\_Log2 .   
## h\_pamod\_t3\_NoneOften:hs\_tl\_mdich\_NoneUndetected .   
## h\_pamod\_t3\_NoneSometimes:hs\_tl\_mdich\_NoneUndetected .   
## h\_pamod\_t3\_NoneVery Often:hs\_tl\_mdich\_NoneUndetected .   
## h\_pamod\_t3\_NoneOften:h\_ndvi100\_preg\_None .   
## h\_pamod\_t3\_NoneSometimes:h\_ndvi100\_preg\_None .   
## h\_pamod\_t3\_NoneVery Often:h\_ndvi100\_preg\_None .   
## h\_pamod\_t3\_NoneOften:hs\_dep\_madj\_Log2 .   
## h\_pamod\_t3\_NoneSometimes:hs\_dep\_madj\_Log2 .   
## h\_pamod\_t3\_NoneVery Often:hs\_dep\_madj\_Log2 .   
## h\_pamod\_t3\_NoneOften:hs\_dmtp\_madj\_Log2 3.7439636  
## h\_pamod\_t3\_NoneSometimes:hs\_dmtp\_madj\_Log2 .   
## h\_pamod\_t3\_NoneVery Often:hs\_dmtp\_madj\_Log2 .   
## h\_pamod\_t3\_NoneOften:hs\_pbde47\_madj\_Log2 .   
## h\_pamod\_t3\_NoneSometimes:hs\_pbde47\_madj\_Log2 .   
## h\_pamod\_t3\_NoneVery Often:hs\_pbde47\_madj\_Log2 1.0460578  
## h\_pamod\_t3\_NoneOften:hs\_pfna\_m\_Log2 .   
## h\_pamod\_t3\_NoneSometimes:hs\_pfna\_m\_Log2 .   
## h\_pamod\_t3\_NoneVery Often:hs\_pfna\_m\_Log2 .   
## h\_pamod\_t3\_NoneOften:hs\_pfoa\_m\_Log2 .   
## h\_pamod\_t3\_NoneSometimes:hs\_pfoa\_m\_Log2 .   
## h\_pamod\_t3\_NoneVery Often:hs\_pfoa\_m\_Log2 .   
## h\_pamod\_t3\_NoneOften:hs\_etpa\_madj\_Log2 .   
## h\_pamod\_t3\_NoneSometimes:hs\_etpa\_madj\_Log2 .   
## h\_pamod\_t3\_NoneVery Often:hs\_etpa\_madj\_Log2 .   
## h\_pamod\_t3\_NoneOften:hs\_oxbe\_madj\_Log2 .   
## h\_pamod\_t3\_NoneSometimes:hs\_oxbe\_madj\_Log2 .   
## h\_pamod\_t3\_NoneVery Often:hs\_oxbe\_madj\_Log2 .   
## h\_pamod\_t3\_NoneOften:hs\_mibp\_madj\_Log2 .   
## h\_pamod\_t3\_NoneSometimes:hs\_mibp\_madj\_Log2 .   
## h\_pamod\_t3\_NoneVery Often:hs\_mibp\_madj\_Log2 .   
## h\_pamod\_t3\_NoneOften:e3\_asmokcigd\_p\_None .   
## h\_pamod\_t3\_NoneSometimes:e3\_asmokcigd\_p\_None .   
## h\_pamod\_t3\_NoneVery Often:e3\_asmokcigd\_p\_None .   
## h\_pamod\_t3\_NoneOften:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_pamod\_t3\_NoneSometimes:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_pamod\_t3\_NoneVery Often:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_pamod\_t3\_NoneOften:hs\_cotinine\_mcat\_NoneSmokers .   
## h\_pamod\_t3\_NoneSometimes:hs\_cotinine\_mcat\_NoneSmokers .   
## h\_pamod\_t3\_NoneVery Often:hs\_cotinine\_mcat\_NoneSmokers .   
## h\_pamod\_t3\_NoneOften:h\_trafnear\_preg\_pow1over3 .   
## h\_pamod\_t3\_NoneSometimes:h\_trafnear\_preg\_pow1over3 .   
## h\_pamod\_t3\_NoneVery Often:h\_trafnear\_preg\_pow1over3 .   
## h\_pamod\_t3\_NoneOften:h\_bro\_preg\_Log .   
## h\_pamod\_t3\_NoneSometimes:h\_bro\_preg\_Log .   
## h\_pamod\_t3\_NoneVery Often:h\_bro\_preg\_Log .   
## h\_pamod\_t3\_NoneOften:e3\_sex\_Nonemale .   
## h\_pamod\_t3\_NoneSometimes:e3\_sex\_Nonemale .   
## h\_pamod\_t3\_NoneVery Often:e3\_sex\_Nonemale .   
## h\_pamod\_t3\_NoneOften:h\_mbmi\_None .   
## h\_pamod\_t3\_NoneSometimes:h\_mbmi\_None .   
## h\_pamod\_t3\_NoneVery Often:h\_mbmi\_None .   
## h\_pamod\_t3\_NoneOften:hs\_wgtgain\_None .   
## h\_pamod\_t3\_NoneSometimes:hs\_wgtgain\_None .   
## h\_pamod\_t3\_NoneVery Often:hs\_wgtgain\_None .   
## h\_pamod\_t3\_NoneOften:e3\_gac\_None .   
## h\_pamod\_t3\_NoneSometimes:e3\_gac\_None .   
## h\_pamod\_t3\_NoneVery Often:e3\_gac\_None .   
## h\_pamod\_t3\_NoneOften:h\_edumc\_None2 .   
## h\_pamod\_t3\_NoneSometimes:h\_edumc\_None2 .   
## h\_pamod\_t3\_NoneVery Often:h\_edumc\_None2 .   
## h\_pamod\_t3\_NoneOften:h\_edumc\_None3 .   
## h\_pamod\_t3\_NoneSometimes:h\_edumc\_None3 .   
## h\_pamod\_t3\_NoneVery Often:h\_edumc\_None3 .   
## h\_pamod\_t3\_NoneOften:h\_native\_None1 .   
## h\_pamod\_t3\_NoneSometimes:h\_native\_None1 .   
## h\_pamod\_t3\_NoneVery Often:h\_native\_None1 .   
## h\_pamod\_t3\_NoneOften:h\_native\_None2 .   
## h\_pamod\_t3\_NoneSometimes:h\_native\_None2 .   
## h\_pamod\_t3\_NoneVery Often:h\_native\_None2 .   
## h\_pamod\_t3\_NoneOften:h\_parity\_None1 .   
## h\_pamod\_t3\_NoneSometimes:h\_parity\_None1 .   
## h\_pamod\_t3\_NoneVery Often:h\_parity\_None1 .   
## h\_pamod\_t3\_NoneOften:h\_parity\_None2 .   
## h\_pamod\_t3\_NoneSometimes:h\_parity\_None2 .   
## h\_pamod\_t3\_NoneVery Often:h\_parity\_None2 .   
## h\_pavig\_t3\_NoneLow:h\_veg\_preg\_Ter(8.8,16.5] .   
## h\_pavig\_t3\_NoneMedium:h\_veg\_preg\_Ter(8.8,16.5] .   
## h\_pavig\_t3\_NoneLow:h\_veg\_preg\_Ter(16.5,Inf] .   
## h\_pavig\_t3\_NoneMedium:h\_veg\_preg\_Ter(16.5,Inf] .   
## h\_pavig\_t3\_NoneLow:hs\_as\_m\_Log2 .   
## h\_pavig\_t3\_NoneMedium:hs\_as\_m\_Log2 .   
## h\_pavig\_t3\_NoneLow:hs\_cd\_m\_Log2 .   
## h\_pavig\_t3\_NoneMedium:hs\_cd\_m\_Log2 .   
## h\_pavig\_t3\_NoneLow:hs\_cs\_m\_Log2 .   
## h\_pavig\_t3\_NoneMedium:hs\_cs\_m\_Log2 .   
## h\_pavig\_t3\_NoneLow:hs\_cu\_m\_Log2 .   
## h\_pavig\_t3\_NoneMedium:hs\_cu\_m\_Log2 .   
## h\_pavig\_t3\_NoneLow:hs\_tl\_mdich\_NoneUndetected .   
## h\_pavig\_t3\_NoneMedium:hs\_tl\_mdich\_NoneUndetected .   
## h\_pavig\_t3\_NoneLow:h\_ndvi100\_preg\_None .   
## h\_pavig\_t3\_NoneMedium:h\_ndvi100\_preg\_None .   
## h\_pavig\_t3\_NoneLow:hs\_dep\_madj\_Log2 -1.8504636  
## h\_pavig\_t3\_NoneMedium:hs\_dep\_madj\_Log2 .   
## h\_pavig\_t3\_NoneLow:hs\_dmtp\_madj\_Log2 .   
## h\_pavig\_t3\_NoneMedium:hs\_dmtp\_madj\_Log2 .   
## h\_pavig\_t3\_NoneLow:hs\_pbde47\_madj\_Log2 .   
## h\_pavig\_t3\_NoneMedium:hs\_pbde47\_madj\_Log2 .   
## h\_pavig\_t3\_NoneLow:hs\_pfna\_m\_Log2 .   
## h\_pavig\_t3\_NoneMedium:hs\_pfna\_m\_Log2 .   
## h\_pavig\_t3\_NoneLow:hs\_pfoa\_m\_Log2 .   
## h\_pavig\_t3\_NoneMedium:hs\_pfoa\_m\_Log2 .   
## h\_pavig\_t3\_NoneLow:hs\_etpa\_madj\_Log2 .   
## h\_pavig\_t3\_NoneMedium:hs\_etpa\_madj\_Log2 .   
## h\_pavig\_t3\_NoneLow:hs\_oxbe\_madj\_Log2 .   
## h\_pavig\_t3\_NoneMedium:hs\_oxbe\_madj\_Log2 .   
## h\_pavig\_t3\_NoneLow:hs\_mibp\_madj\_Log2 .   
## h\_pavig\_t3\_NoneMedium:hs\_mibp\_madj\_Log2 .   
## h\_pavig\_t3\_NoneLow:e3\_asmokcigd\_p\_None .   
## h\_pavig\_t3\_NoneMedium:e3\_asmokcigd\_p\_None .   
## h\_pavig\_t3\_NoneLow:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_pavig\_t3\_NoneMedium:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_pavig\_t3\_NoneLow:hs\_cotinine\_mcat\_NoneSmokers .   
## h\_pavig\_t3\_NoneMedium:hs\_cotinine\_mcat\_NoneSmokers .   
## h\_pavig\_t3\_NoneLow:h\_trafnear\_preg\_pow1over3 .   
## h\_pavig\_t3\_NoneMedium:h\_trafnear\_preg\_pow1over3 .   
## h\_pavig\_t3\_NoneLow:h\_bro\_preg\_Log .   
## h\_pavig\_t3\_NoneMedium:h\_bro\_preg\_Log .   
## h\_pavig\_t3\_NoneLow:e3\_sex\_Nonemale .   
## h\_pavig\_t3\_NoneMedium:e3\_sex\_Nonemale .   
## h\_pavig\_t3\_NoneLow:h\_mbmi\_None .   
## h\_pavig\_t3\_NoneMedium:h\_mbmi\_None .   
## h\_pavig\_t3\_NoneLow:hs\_wgtgain\_None .   
## h\_pavig\_t3\_NoneMedium:hs\_wgtgain\_None .   
## h\_pavig\_t3\_NoneLow:e3\_gac\_None .   
## h\_pavig\_t3\_NoneMedium:e3\_gac\_None .   
## h\_pavig\_t3\_NoneLow:h\_edumc\_None2 .   
## h\_pavig\_t3\_NoneMedium:h\_edumc\_None2 .   
## h\_pavig\_t3\_NoneLow:h\_edumc\_None3 .   
## h\_pavig\_t3\_NoneMedium:h\_edumc\_None3 .   
## h\_pavig\_t3\_NoneLow:h\_native\_None1 .   
## h\_pavig\_t3\_NoneMedium:h\_native\_None1 .   
## h\_pavig\_t3\_NoneLow:h\_native\_None2 .   
## h\_pavig\_t3\_NoneMedium:h\_native\_None2 .   
## h\_pavig\_t3\_NoneLow:h\_parity\_None1 .   
## h\_pavig\_t3\_NoneMedium:h\_parity\_None1 .   
## h\_pavig\_t3\_NoneLow:h\_parity\_None2 .   
## h\_pavig\_t3\_NoneMedium:h\_parity\_None2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_as\_m\_Log2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_as\_m\_Log2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_cd\_m\_Log2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_cd\_m\_Log2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_cs\_m\_Log2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_cs\_m\_Log2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_cu\_m\_Log2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_cu\_m\_Log2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_tl\_mdich\_NoneUndetected .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_tl\_mdich\_NoneUndetected .   
## h\_veg\_preg\_Ter(8.8,16.5]:h\_ndvi100\_preg\_None .   
## h\_veg\_preg\_Ter(16.5,Inf]:h\_ndvi100\_preg\_None .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_dep\_madj\_Log2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_dep\_madj\_Log2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_dmtp\_madj\_Log2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_dmtp\_madj\_Log2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_pbde47\_madj\_Log2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_pbde47\_madj\_Log2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_pfna\_m\_Log2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_pfna\_m\_Log2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_pfoa\_m\_Log2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_pfoa\_m\_Log2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_etpa\_madj\_Log2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_etpa\_madj\_Log2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_oxbe\_madj\_Log2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_oxbe\_madj\_Log2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_mibp\_madj\_Log2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_mibp\_madj\_Log2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:e3\_asmokcigd\_p\_None .   
## h\_veg\_preg\_Ter(16.5,Inf]:e3\_asmokcigd\_p\_None .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_cotinine\_mcat\_NoneSmokers .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_cotinine\_mcat\_NoneSmokers -8.7960723  
## h\_veg\_preg\_Ter(8.8,16.5]:h\_trafnear\_preg\_pow1over3 .   
## h\_veg\_preg\_Ter(16.5,Inf]:h\_trafnear\_preg\_pow1over3 -8.2561472  
## h\_veg\_preg\_Ter(8.8,16.5]:h\_bro\_preg\_Log .   
## h\_veg\_preg\_Ter(16.5,Inf]:h\_bro\_preg\_Log .   
## h\_veg\_preg\_Ter(8.8,16.5]:e3\_sex\_Nonemale .   
## h\_veg\_preg\_Ter(16.5,Inf]:e3\_sex\_Nonemale .   
## h\_veg\_preg\_Ter(8.8,16.5]:h\_mbmi\_None .   
## h\_veg\_preg\_Ter(16.5,Inf]:h\_mbmi\_None .   
## h\_veg\_preg\_Ter(8.8,16.5]:hs\_wgtgain\_None .   
## h\_veg\_preg\_Ter(16.5,Inf]:hs\_wgtgain\_None .   
## h\_veg\_preg\_Ter(8.8,16.5]:e3\_gac\_None .   
## h\_veg\_preg\_Ter(16.5,Inf]:e3\_gac\_None .   
## h\_veg\_preg\_Ter(8.8,16.5]:h\_edumc\_None2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:h\_edumc\_None2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:h\_edumc\_None3 .   
## h\_veg\_preg\_Ter(16.5,Inf]:h\_edumc\_None3 .   
## h\_veg\_preg\_Ter(8.8,16.5]:h\_native\_None1 .   
## h\_veg\_preg\_Ter(16.5,Inf]:h\_native\_None1 .   
## h\_veg\_preg\_Ter(8.8,16.5]:h\_native\_None2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:h\_native\_None2 .   
## h\_veg\_preg\_Ter(8.8,16.5]:h\_parity\_None1 .   
## h\_veg\_preg\_Ter(16.5,Inf]:h\_parity\_None1 .   
## h\_veg\_preg\_Ter(8.8,16.5]:h\_parity\_None2 .   
## h\_veg\_preg\_Ter(16.5,Inf]:h\_parity\_None2 .   
## hs\_as\_m\_Log2:hs\_cd\_m\_Log2 .   
## hs\_as\_m\_Log2:hs\_cs\_m\_Log2 .   
## hs\_as\_m\_Log2:hs\_cu\_m\_Log2 .   
## hs\_as\_m\_Log2:hs\_tl\_mdich\_NoneUndetected .   
## hs\_as\_m\_Log2:h\_ndvi100\_preg\_None .   
## hs\_as\_m\_Log2:hs\_dep\_madj\_Log2 .   
## hs\_as\_m\_Log2:hs\_dmtp\_madj\_Log2 .   
## hs\_as\_m\_Log2:hs\_pbde47\_madj\_Log2 .   
## hs\_as\_m\_Log2:hs\_pfna\_m\_Log2 .   
## hs\_as\_m\_Log2:hs\_pfoa\_m\_Log2 .   
## hs\_as\_m\_Log2:hs\_etpa\_madj\_Log2 .   
## hs\_as\_m\_Log2:hs\_oxbe\_madj\_Log2 .   
## hs\_as\_m\_Log2:hs\_mibp\_madj\_Log2 .   
## hs\_as\_m\_Log2:e3\_asmokcigd\_p\_None .   
## hs\_as\_m\_Log2:hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_as\_m\_Log2:hs\_cotinine\_mcat\_NoneSmokers .   
## hs\_as\_m\_Log2:h\_trafnear\_preg\_pow1over3 .   
## hs\_as\_m\_Log2:h\_bro\_preg\_Log .   
## hs\_as\_m\_Log2:e3\_sex\_Nonemale .   
## hs\_as\_m\_Log2:h\_mbmi\_None .   
## hs\_as\_m\_Log2:hs\_wgtgain\_None .   
## hs\_as\_m\_Log2:e3\_gac\_None .   
## hs\_as\_m\_Log2:h\_edumc\_None2 .   
## hs\_as\_m\_Log2:h\_edumc\_None3 .   
## hs\_as\_m\_Log2:h\_native\_None1 .   
## hs\_as\_m\_Log2:h\_native\_None2 .   
## hs\_as\_m\_Log2:h\_parity\_None1 .   
## hs\_as\_m\_Log2:h\_parity\_None2 .   
## hs\_cd\_m\_Log2:hs\_cs\_m\_Log2 .   
## hs\_cd\_m\_Log2:hs\_cu\_m\_Log2 .   
## hs\_cd\_m\_Log2:hs\_tl\_mdich\_NoneUndetected .   
## hs\_cd\_m\_Log2:h\_ndvi100\_preg\_None .   
## hs\_cd\_m\_Log2:hs\_dep\_madj\_Log2 .   
## hs\_cd\_m\_Log2:hs\_dmtp\_madj\_Log2 .   
## hs\_cd\_m\_Log2:hs\_pbde47\_madj\_Log2 .   
## hs\_cd\_m\_Log2:hs\_pfna\_m\_Log2 .   
## hs\_cd\_m\_Log2:hs\_pfoa\_m\_Log2 .   
## hs\_cd\_m\_Log2:hs\_etpa\_madj\_Log2 .   
## hs\_cd\_m\_Log2:hs\_oxbe\_madj\_Log2 .   
## hs\_cd\_m\_Log2:hs\_mibp\_madj\_Log2 .   
## hs\_cd\_m\_Log2:e3\_asmokcigd\_p\_None .   
## hs\_cd\_m\_Log2:hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_cd\_m\_Log2:hs\_cotinine\_mcat\_NoneSmokers .   
## hs\_cd\_m\_Log2:h\_trafnear\_preg\_pow1over3 .   
## hs\_cd\_m\_Log2:h\_bro\_preg\_Log 3.8152720  
## hs\_cd\_m\_Log2:e3\_sex\_Nonemale .   
## hs\_cd\_m\_Log2:h\_mbmi\_None .   
## hs\_cd\_m\_Log2:hs\_wgtgain\_None .   
## hs\_cd\_m\_Log2:e3\_gac\_None .   
## hs\_cd\_m\_Log2:h\_edumc\_None2 .   
## hs\_cd\_m\_Log2:h\_edumc\_None3 .   
## hs\_cd\_m\_Log2:h\_native\_None1 .   
## hs\_cd\_m\_Log2:h\_native\_None2 -4.9417896  
## hs\_cd\_m\_Log2:h\_parity\_None1 .   
## hs\_cd\_m\_Log2:h\_parity\_None2 .   
## hs\_cs\_m\_Log2:hs\_cu\_m\_Log2 .   
## hs\_cs\_m\_Log2:hs\_tl\_mdich\_NoneUndetected .   
## hs\_cs\_m\_Log2:h\_ndvi100\_preg\_None .   
## hs\_cs\_m\_Log2:hs\_dep\_madj\_Log2 .   
## hs\_cs\_m\_Log2:hs\_dmtp\_madj\_Log2 .   
## hs\_cs\_m\_Log2:hs\_pbde47\_madj\_Log2 .   
## hs\_cs\_m\_Log2:hs\_pfna\_m\_Log2 .   
## hs\_cs\_m\_Log2:hs\_pfoa\_m\_Log2 .   
## hs\_cs\_m\_Log2:hs\_etpa\_madj\_Log2 .   
## hs\_cs\_m\_Log2:hs\_oxbe\_madj\_Log2 .   
## hs\_cs\_m\_Log2:hs\_mibp\_madj\_Log2 .   
## hs\_cs\_m\_Log2:e3\_asmokcigd\_p\_None .   
## hs\_cs\_m\_Log2:hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_cs\_m\_Log2:hs\_cotinine\_mcat\_NoneSmokers .   
## hs\_cs\_m\_Log2:h\_trafnear\_preg\_pow1over3 .   
## hs\_cs\_m\_Log2:h\_bro\_preg\_Log -8.2074412  
## hs\_cs\_m\_Log2:e3\_sex\_Nonemale .   
## hs\_cs\_m\_Log2:h\_mbmi\_None .   
## hs\_cs\_m\_Log2:hs\_wgtgain\_None .   
## hs\_cs\_m\_Log2:e3\_gac\_None .   
## hs\_cs\_m\_Log2:h\_edumc\_None2 .   
## hs\_cs\_m\_Log2:h\_edumc\_None3 .   
## hs\_cs\_m\_Log2:h\_native\_None1 .   
## hs\_cs\_m\_Log2:h\_native\_None2 .   
## hs\_cs\_m\_Log2:h\_parity\_None1 .   
## hs\_cs\_m\_Log2:h\_parity\_None2 .   
## hs\_cu\_m\_Log2:hs\_tl\_mdich\_NoneUndetected .   
## hs\_cu\_m\_Log2:h\_ndvi100\_preg\_None .   
## hs\_cu\_m\_Log2:hs\_dep\_madj\_Log2 .   
## hs\_cu\_m\_Log2:hs\_dmtp\_madj\_Log2 .   
## hs\_cu\_m\_Log2:hs\_pbde47\_madj\_Log2 .   
## hs\_cu\_m\_Log2:hs\_pfna\_m\_Log2 .   
## hs\_cu\_m\_Log2:hs\_pfoa\_m\_Log2 .   
## hs\_cu\_m\_Log2:hs\_etpa\_madj\_Log2 .   
## hs\_cu\_m\_Log2:hs\_oxbe\_madj\_Log2 .   
## hs\_cu\_m\_Log2:hs\_mibp\_madj\_Log2 .   
## hs\_cu\_m\_Log2:e3\_asmokcigd\_p\_None .   
## hs\_cu\_m\_Log2:hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_cu\_m\_Log2:hs\_cotinine\_mcat\_NoneSmokers .   
## hs\_cu\_m\_Log2:h\_trafnear\_preg\_pow1over3 .   
## hs\_cu\_m\_Log2:h\_bro\_preg\_Log .   
## hs\_cu\_m\_Log2:e3\_sex\_Nonemale .   
## hs\_cu\_m\_Log2:h\_mbmi\_None .   
## hs\_cu\_m\_Log2:hs\_wgtgain\_None .   
## hs\_cu\_m\_Log2:e3\_gac\_None 55.7377360  
## hs\_cu\_m\_Log2:h\_edumc\_None2 .   
## hs\_cu\_m\_Log2:h\_edumc\_None3 .   
## hs\_cu\_m\_Log2:h\_native\_None1 .   
## hs\_cu\_m\_Log2:h\_native\_None2 .   
## hs\_cu\_m\_Log2:h\_parity\_None1 .   
## hs\_cu\_m\_Log2:h\_parity\_None2 .   
## hs\_tl\_mdich\_NoneUndetected:h\_ndvi100\_preg\_None .   
## hs\_tl\_mdich\_NoneUndetected:hs\_dep\_madj\_Log2 .   
## hs\_tl\_mdich\_NoneUndetected:hs\_dmtp\_madj\_Log2 .   
## hs\_tl\_mdich\_NoneUndetected:hs\_pbde47\_madj\_Log2 .   
## hs\_tl\_mdich\_NoneUndetected:hs\_pfna\_m\_Log2 .   
## hs\_tl\_mdich\_NoneUndetected:hs\_pfoa\_m\_Log2 .   
## hs\_tl\_mdich\_NoneUndetected:hs\_etpa\_madj\_Log2 .   
## hs\_tl\_mdich\_NoneUndetected:hs\_oxbe\_madj\_Log2 .   
## hs\_tl\_mdich\_NoneUndetected:hs\_mibp\_madj\_Log2 .   
## hs\_tl\_mdich\_NoneUndetected:e3\_asmokcigd\_p\_None .   
## hs\_tl\_mdich\_NoneUndetected:hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_tl\_mdich\_NoneUndetected:hs\_cotinine\_mcat\_NoneSmokers .   
## hs\_tl\_mdich\_NoneUndetected:h\_trafnear\_preg\_pow1over3 .   
## hs\_tl\_mdich\_NoneUndetected:h\_bro\_preg\_Log .   
## hs\_tl\_mdich\_NoneUndetected:e3\_sex\_Nonemale .   
## hs\_tl\_mdich\_NoneUndetected:h\_mbmi\_None 0.4697276  
## hs\_tl\_mdich\_NoneUndetected:hs\_wgtgain\_None .   
## hs\_tl\_mdich\_NoneUndetected:e3\_gac\_None .   
## hs\_tl\_mdich\_NoneUndetected:h\_edumc\_None2 .   
## hs\_tl\_mdich\_NoneUndetected:h\_edumc\_None3 .   
## hs\_tl\_mdich\_NoneUndetected:h\_native\_None1 .   
## hs\_tl\_mdich\_NoneUndetected:h\_native\_None2 .   
## hs\_tl\_mdich\_NoneUndetected:h\_parity\_None1 .   
## hs\_tl\_mdich\_NoneUndetected:h\_parity\_None2 .   
## h\_ndvi100\_preg\_None:hs\_dep\_madj\_Log2 .   
## h\_ndvi100\_preg\_None:hs\_dmtp\_madj\_Log2 .   
## h\_ndvi100\_preg\_None:hs\_pbde47\_madj\_Log2 .   
## h\_ndvi100\_preg\_None:hs\_pfna\_m\_Log2 .   
## h\_ndvi100\_preg\_None:hs\_pfoa\_m\_Log2 .   
## h\_ndvi100\_preg\_None:hs\_etpa\_madj\_Log2 .   
## h\_ndvi100\_preg\_None:hs\_oxbe\_madj\_Log2 .   
## h\_ndvi100\_preg\_None:hs\_mibp\_madj\_Log2 .   
## h\_ndvi100\_preg\_None:e3\_asmokcigd\_p\_None .   
## h\_ndvi100\_preg\_None:hs\_cotinine\_mcat\_NoneSHS smokers .   
## h\_ndvi100\_preg\_None:hs\_cotinine\_mcat\_NoneSmokers .   
## h\_ndvi100\_preg\_None:h\_trafnear\_preg\_pow1over3 .   
## h\_ndvi100\_preg\_None:h\_bro\_preg\_Log -6.0633753  
## h\_ndvi100\_preg\_None:e3\_sex\_Nonemale 5.4426771  
## h\_ndvi100\_preg\_None:h\_mbmi\_None 7.5808365  
## h\_ndvi100\_preg\_None:hs\_wgtgain\_None 20.7235442  
## h\_ndvi100\_preg\_None:e3\_gac\_None .   
## h\_ndvi100\_preg\_None:h\_edumc\_None2 .   
## h\_ndvi100\_preg\_None:h\_edumc\_None3 .   
## h\_ndvi100\_preg\_None:h\_native\_None1 .   
## h\_ndvi100\_preg\_None:h\_native\_None2 4.1305986  
## h\_ndvi100\_preg\_None:h\_parity\_None1 .   
## h\_ndvi100\_preg\_None:h\_parity\_None2 .   
## hs\_dep\_madj\_Log2:hs\_dmtp\_madj\_Log2 .   
## hs\_dep\_madj\_Log2:hs\_pbde47\_madj\_Log2 .   
## hs\_dep\_madj\_Log2:hs\_pfna\_m\_Log2 .   
## hs\_dep\_madj\_Log2:hs\_pfoa\_m\_Log2 .   
## hs\_dep\_madj\_Log2:hs\_etpa\_madj\_Log2 .   
## hs\_dep\_madj\_Log2:hs\_oxbe\_madj\_Log2 .   
## hs\_dep\_madj\_Log2:hs\_mibp\_madj\_Log2 .   
## hs\_dep\_madj\_Log2:e3\_asmokcigd\_p\_None .   
## hs\_dep\_madj\_Log2:hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_dep\_madj\_Log2:hs\_cotinine\_mcat\_NoneSmokers .   
## hs\_dep\_madj\_Log2:h\_trafnear\_preg\_pow1over3 .   
## hs\_dep\_madj\_Log2:h\_bro\_preg\_Log .   
## hs\_dep\_madj\_Log2:e3\_sex\_Nonemale .   
## hs\_dep\_madj\_Log2:h\_mbmi\_None .   
## hs\_dep\_madj\_Log2:hs\_wgtgain\_None .   
## hs\_dep\_madj\_Log2:e3\_gac\_None .   
## hs\_dep\_madj\_Log2:h\_edumc\_None2 .   
## hs\_dep\_madj\_Log2:h\_edumc\_None3 .   
## hs\_dep\_madj\_Log2:h\_native\_None1 .   
## hs\_dep\_madj\_Log2:h\_native\_None2 .   
## hs\_dep\_madj\_Log2:h\_parity\_None1 .   
## hs\_dep\_madj\_Log2:h\_parity\_None2 .   
## hs\_dmtp\_madj\_Log2:hs\_pbde47\_madj\_Log2 .   
## hs\_dmtp\_madj\_Log2:hs\_pfna\_m\_Log2 .   
## hs\_dmtp\_madj\_Log2:hs\_pfoa\_m\_Log2 .   
## hs\_dmtp\_madj\_Log2:hs\_etpa\_madj\_Log2 .   
## hs\_dmtp\_madj\_Log2:hs\_oxbe\_madj\_Log2 .   
## hs\_dmtp\_madj\_Log2:hs\_mibp\_madj\_Log2 .   
## hs\_dmtp\_madj\_Log2:e3\_asmokcigd\_p\_None .   
## hs\_dmtp\_madj\_Log2:hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_dmtp\_madj\_Log2:hs\_cotinine\_mcat\_NoneSmokers .   
## hs\_dmtp\_madj\_Log2:h\_trafnear\_preg\_pow1over3 .   
## hs\_dmtp\_madj\_Log2:h\_bro\_preg\_Log .   
## hs\_dmtp\_madj\_Log2:e3\_sex\_Nonemale 10.1517220  
## hs\_dmtp\_madj\_Log2:h\_mbmi\_None .   
## hs\_dmtp\_madj\_Log2:hs\_wgtgain\_None .   
## hs\_dmtp\_madj\_Log2:e3\_gac\_None .   
## hs\_dmtp\_madj\_Log2:h\_edumc\_None2 .   
## hs\_dmtp\_madj\_Log2:h\_edumc\_None3 .   
## hs\_dmtp\_madj\_Log2:h\_native\_None1 .   
## hs\_dmtp\_madj\_Log2:h\_native\_None2 .   
## hs\_dmtp\_madj\_Log2:h\_parity\_None1 .   
## hs\_dmtp\_madj\_Log2:h\_parity\_None2 0.6710689  
## hs\_pbde47\_madj\_Log2:hs\_pfna\_m\_Log2 .   
## hs\_pbde47\_madj\_Log2:hs\_pfoa\_m\_Log2 .   
## hs\_pbde47\_madj\_Log2:hs\_etpa\_madj\_Log2 .   
## hs\_pbde47\_madj\_Log2:hs\_oxbe\_madj\_Log2 .   
## hs\_pbde47\_madj\_Log2:hs\_mibp\_madj\_Log2 .   
## hs\_pbde47\_madj\_Log2:e3\_asmokcigd\_p\_None .   
## hs\_pbde47\_madj\_Log2:hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_pbde47\_madj\_Log2:hs\_cotinine\_mcat\_NoneSmokers .   
## hs\_pbde47\_madj\_Log2:h\_trafnear\_preg\_pow1over3 .   
## hs\_pbde47\_madj\_Log2:h\_bro\_preg\_Log .   
## hs\_pbde47\_madj\_Log2:e3\_sex\_Nonemale .   
## hs\_pbde47\_madj\_Log2:h\_mbmi\_None .   
## hs\_pbde47\_madj\_Log2:hs\_wgtgain\_None .   
## hs\_pbde47\_madj\_Log2:e3\_gac\_None .   
## hs\_pbde47\_madj\_Log2:h\_edumc\_None2 .   
## hs\_pbde47\_madj\_Log2:h\_edumc\_None3 .   
## hs\_pbde47\_madj\_Log2:h\_native\_None1 .   
## hs\_pbde47\_madj\_Log2:h\_native\_None2 .   
## hs\_pbde47\_madj\_Log2:h\_parity\_None1 .   
## hs\_pbde47\_madj\_Log2:h\_parity\_None2 .   
## hs\_pfna\_m\_Log2:hs\_pfoa\_m\_Log2 .   
## hs\_pfna\_m\_Log2:hs\_etpa\_madj\_Log2 .   
## hs\_pfna\_m\_Log2:hs\_oxbe\_madj\_Log2 -7.6543030  
## hs\_pfna\_m\_Log2:hs\_mibp\_madj\_Log2 .   
## hs\_pfna\_m\_Log2:e3\_asmokcigd\_p\_None .   
## hs\_pfna\_m\_Log2:hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_pfna\_m\_Log2:hs\_cotinine\_mcat\_NoneSmokers .   
## hs\_pfna\_m\_Log2:h\_trafnear\_preg\_pow1over3 .   
## hs\_pfna\_m\_Log2:h\_bro\_preg\_Log .   
## hs\_pfna\_m\_Log2:e3\_sex\_Nonemale .   
## hs\_pfna\_m\_Log2:h\_mbmi\_None .   
## hs\_pfna\_m\_Log2:hs\_wgtgain\_None .   
## hs\_pfna\_m\_Log2:e3\_gac\_None .   
## hs\_pfna\_m\_Log2:h\_edumc\_None2 .   
## hs\_pfna\_m\_Log2:h\_edumc\_None3 .   
## hs\_pfna\_m\_Log2:h\_native\_None1 .   
## hs\_pfna\_m\_Log2:h\_native\_None2 -11.7292894  
## hs\_pfna\_m\_Log2:h\_parity\_None1 -7.5304549  
## hs\_pfna\_m\_Log2:h\_parity\_None2 .   
## hs\_pfoa\_m\_Log2:hs\_etpa\_madj\_Log2 .   
## hs\_pfoa\_m\_Log2:hs\_oxbe\_madj\_Log2 .   
## hs\_pfoa\_m\_Log2:hs\_mibp\_madj\_Log2 .   
## hs\_pfoa\_m\_Log2:e3\_asmokcigd\_p\_None .   
## hs\_pfoa\_m\_Log2:hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_pfoa\_m\_Log2:hs\_cotinine\_mcat\_NoneSmokers -8.3728650  
## hs\_pfoa\_m\_Log2:h\_trafnear\_preg\_pow1over3 .   
## hs\_pfoa\_m\_Log2:h\_bro\_preg\_Log .   
## hs\_pfoa\_m\_Log2:e3\_sex\_Nonemale .   
## hs\_pfoa\_m\_Log2:h\_mbmi\_None .   
## hs\_pfoa\_m\_Log2:hs\_wgtgain\_None .   
## hs\_pfoa\_m\_Log2:e3\_gac\_None .   
## hs\_pfoa\_m\_Log2:h\_edumc\_None2 .   
## hs\_pfoa\_m\_Log2:h\_edumc\_None3 .   
## hs\_pfoa\_m\_Log2:h\_native\_None1 .   
## hs\_pfoa\_m\_Log2:h\_native\_None2 .   
## hs\_pfoa\_m\_Log2:h\_parity\_None1 .   
## hs\_pfoa\_m\_Log2:h\_parity\_None2 .   
## hs\_etpa\_madj\_Log2:hs\_oxbe\_madj\_Log2 .   
## hs\_etpa\_madj\_Log2:hs\_mibp\_madj\_Log2 .   
## hs\_etpa\_madj\_Log2:e3\_asmokcigd\_p\_None .   
## hs\_etpa\_madj\_Log2:hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_etpa\_madj\_Log2:hs\_cotinine\_mcat\_NoneSmokers .   
## hs\_etpa\_madj\_Log2:h\_trafnear\_preg\_pow1over3 .   
## hs\_etpa\_madj\_Log2:h\_bro\_preg\_Log .   
## hs\_etpa\_madj\_Log2:e3\_sex\_Nonemale 3.9238352  
## hs\_etpa\_madj\_Log2:h\_mbmi\_None .   
## hs\_etpa\_madj\_Log2:hs\_wgtgain\_None 8.0564777  
## hs\_etpa\_madj\_Log2:e3\_gac\_None .   
## hs\_etpa\_madj\_Log2:h\_edumc\_None2 .   
## hs\_etpa\_madj\_Log2:h\_edumc\_None3 .   
## hs\_etpa\_madj\_Log2:h\_native\_None1 .   
## hs\_etpa\_madj\_Log2:h\_native\_None2 .   
## hs\_etpa\_madj\_Log2:h\_parity\_None1 4.1655370  
## hs\_etpa\_madj\_Log2:h\_parity\_None2 .   
## hs\_oxbe\_madj\_Log2:hs\_mibp\_madj\_Log2 .   
## hs\_oxbe\_madj\_Log2:e3\_asmokcigd\_p\_None .   
## hs\_oxbe\_madj\_Log2:hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_oxbe\_madj\_Log2:hs\_cotinine\_mcat\_NoneSmokers .   
## hs\_oxbe\_madj\_Log2:h\_trafnear\_preg\_pow1over3 .   
## hs\_oxbe\_madj\_Log2:h\_bro\_preg\_Log .   
## hs\_oxbe\_madj\_Log2:e3\_sex\_Nonemale .   
## hs\_oxbe\_madj\_Log2:h\_mbmi\_None .   
## hs\_oxbe\_madj\_Log2:hs\_wgtgain\_None 1.3886409  
## hs\_oxbe\_madj\_Log2:e3\_gac\_None .   
## hs\_oxbe\_madj\_Log2:h\_edumc\_None2 .   
## hs\_oxbe\_madj\_Log2:h\_edumc\_None3 .   
## hs\_oxbe\_madj\_Log2:h\_native\_None1 .   
## hs\_oxbe\_madj\_Log2:h\_native\_None2 .   
## hs\_oxbe\_madj\_Log2:h\_parity\_None1 .   
## hs\_oxbe\_madj\_Log2:h\_parity\_None2 .   
## hs\_mibp\_madj\_Log2:e3\_asmokcigd\_p\_None .   
## hs\_mibp\_madj\_Log2:hs\_cotinine\_mcat\_NoneSHS smokers .   
## hs\_mibp\_madj\_Log2:hs\_cotinine\_mcat\_NoneSmokers .   
## hs\_mibp\_madj\_Log2:h\_trafnear\_preg\_pow1over3 .   
## hs\_mibp\_madj\_Log2:h\_bro\_preg\_Log .   
## hs\_mibp\_madj\_Log2:e3\_sex\_Nonemale .   
## hs\_mibp\_madj\_Log2:h\_mbmi\_None 1.3554259  
## hs\_mibp\_madj\_Log2:hs\_wgtgain\_None 3.6722376  
## hs\_mibp\_madj\_Log2:e3\_gac\_None .   
## hs\_mibp\_madj\_Log2:h\_edumc\_None2 .   
## hs\_mibp\_madj\_Log2:h\_edumc\_None3 .   
## hs\_mibp\_madj\_Log2:h\_native\_None1 .   
## hs\_mibp\_madj\_Log2:h\_native\_None2 .   
## hs\_mibp\_madj\_Log2:h\_parity\_None1 .   
## hs\_mibp\_madj\_Log2:h\_parity\_None2 .   
## e3\_asmokcigd\_p\_None:hs\_cotinine\_mcat\_NoneSHS smokers .   
## e3\_asmokcigd\_p\_None:hs\_cotinine\_mcat\_NoneSmokers .   
## e3\_asmokcigd\_p\_None:h\_trafnear\_preg\_pow1over3 -1.4993012  
## e3\_asmokcigd\_p\_None:h\_bro\_preg\_Log .   
## e3\_asmokcigd\_p\_None:e3\_sex\_Nonemale .   
## e3\_asmokcigd\_p\_None:h\_mbmi\_None .   
## e3\_asmokcigd\_p\_None:hs\_wgtgain\_None .   
## e3\_asmokcigd\_p\_None:e3\_gac\_None .   
## e3\_asmokcigd\_p\_None:h\_edumc\_None2 .   
## e3\_asmokcigd\_p\_None:h\_edumc\_None3 .   
## e3\_asmokcigd\_p\_None:h\_native\_None1 .   
## e3\_asmokcigd\_p\_None:h\_native\_None2 .   
## e3\_asmokcigd\_p\_None:h\_parity\_None1 .   
## e3\_asmokcigd\_p\_None:h\_parity\_None2 .   
## hs\_cotinine\_mcat\_NoneSHS smokers:h\_trafnear\_preg\_pow1over3 .   
## hs\_cotinine\_mcat\_NoneSmokers:h\_trafnear\_preg\_pow1over3 .   
## hs\_cotinine\_mcat\_NoneSHS smokers:h\_bro\_preg\_Log .   
## hs\_cotinine\_mcat\_NoneSmokers:h\_bro\_preg\_Log .   
## hs\_cotinine\_mcat\_NoneSHS smokers:e3\_sex\_Nonemale .   
## hs\_cotinine\_mcat\_NoneSmokers:e3\_sex\_Nonemale .   
## hs\_cotinine\_mcat\_NoneSHS smokers:h\_mbmi\_None .   
## hs\_cotinine\_mcat\_NoneSmokers:h\_mbmi\_None .   
## hs\_cotinine\_mcat\_NoneSHS smokers:hs\_wgtgain\_None .   
## hs\_cotinine\_mcat\_NoneSmokers:hs\_wgtgain\_None .   
## hs\_cotinine\_mcat\_NoneSHS smokers:e3\_gac\_None .   
## hs\_cotinine\_mcat\_NoneSmokers:e3\_gac\_None .   
## hs\_cotinine\_mcat\_NoneSHS smokers:h\_edumc\_None2 .   
## hs\_cotinine\_mcat\_NoneSmokers:h\_edumc\_None2 .   
## hs\_cotinine\_mcat\_NoneSHS smokers:h\_edumc\_None3 .   
## hs\_cotinine\_mcat\_NoneSmokers:h\_edumc\_None3 .   
## hs\_cotinine\_mcat\_NoneSHS smokers:h\_native\_None1 .   
## hs\_cotinine\_mcat\_NoneSmokers:h\_native\_None1 .   
## hs\_cotinine\_mcat\_NoneSHS smokers:h\_native\_None2 .   
## hs\_cotinine\_mcat\_NoneSmokers:h\_native\_None2 .   
## hs\_cotinine\_mcat\_NoneSHS smokers:h\_parity\_None1 .   
## hs\_cotinine\_mcat\_NoneSmokers:h\_parity\_None1 .   
## hs\_cotinine\_mcat\_NoneSHS smokers:h\_parity\_None2 .   
## hs\_cotinine\_mcat\_NoneSmokers:h\_parity\_None2 .   
## h\_trafnear\_preg\_pow1over3:h\_bro\_preg\_Log -21.5812801  
## h\_trafnear\_preg\_pow1over3:e3\_sex\_Nonemale .   
## h\_trafnear\_preg\_pow1over3:h\_mbmi\_None .   
## h\_trafnear\_preg\_pow1over3:hs\_wgtgain\_None .   
## h\_trafnear\_preg\_pow1over3:e3\_gac\_None .   
## h\_trafnear\_preg\_pow1over3:h\_edumc\_None2 .   
## h\_trafnear\_preg\_pow1over3:h\_edumc\_None3 .   
## h\_trafnear\_preg\_pow1over3:h\_native\_None1 .   
## h\_trafnear\_preg\_pow1over3:h\_native\_None2 .   
## h\_trafnear\_preg\_pow1over3:h\_parity\_None1 .   
## h\_trafnear\_preg\_pow1over3:h\_parity\_None2 .   
## h\_bro\_preg\_Log:e3\_sex\_Nonemale .   
## h\_bro\_preg\_Log:h\_mbmi\_None .   
## h\_bro\_preg\_Log:hs\_wgtgain\_None .   
## h\_bro\_preg\_Log:e3\_gac\_None .   
## h\_bro\_preg\_Log:h\_edumc\_None2 .   
## h\_bro\_preg\_Log:h\_edumc\_None3 .   
## h\_bro\_preg\_Log:h\_native\_None1 .   
## h\_bro\_preg\_Log:h\_native\_None2 .   
## h\_bro\_preg\_Log:h\_parity\_None1 .   
## h\_bro\_preg\_Log:h\_parity\_None2 .   
## e3\_sex\_Nonemale:h\_mbmi\_None 12.5999419  
## e3\_sex\_Nonemale:hs\_wgtgain\_None 41.6246653  
## e3\_sex\_Nonemale:e3\_gac\_None .   
## e3\_sex\_Nonemale:h\_edumc\_None2 .   
## e3\_sex\_Nonemale:h\_edumc\_None3 .   
## e3\_sex\_Nonemale:h\_native\_None1 .   
## e3\_sex\_Nonemale:h\_native\_None2 .   
## e3\_sex\_Nonemale:h\_parity\_None1 13.8745747  
## e3\_sex\_Nonemale:h\_parity\_None2 .   
## h\_mbmi\_None:hs\_wgtgain\_None .   
## h\_mbmi\_None:e3\_gac\_None 16.6206316  
## h\_mbmi\_None:h\_edumc\_None2 .   
## h\_mbmi\_None:h\_edumc\_None3 .   
## h\_mbmi\_None:h\_native\_None1 .   
## h\_mbmi\_None:h\_native\_None2 7.8949463  
## h\_mbmi\_None:h\_parity\_None1 .   
## h\_mbmi\_None:h\_parity\_None2 .   
## hs\_wgtgain\_None:e3\_gac\_None .   
## hs\_wgtgain\_None:h\_edumc\_None2 .   
## hs\_wgtgain\_None:h\_edumc\_None3 16.7210342  
## hs\_wgtgain\_None:h\_native\_None1 .   
## hs\_wgtgain\_None:h\_native\_None2 .   
## hs\_wgtgain\_None:h\_parity\_None1 .   
## hs\_wgtgain\_None:h\_parity\_None2 0.2588461  
## e3\_gac\_None:h\_edumc\_None2 .   
## e3\_gac\_None:h\_edumc\_None3 .   
## e3\_gac\_None:h\_native\_None1 .   
## e3\_gac\_None:h\_native\_None2 .   
## e3\_gac\_None:h\_parity\_None1 .   
## e3\_gac\_None:h\_parity\_None2 .   
## h\_edumc\_None2:h\_native\_None1 .   
## h\_edumc\_None3:h\_native\_None1 .   
## h\_edumc\_None2:h\_native\_None2 .   
## h\_edumc\_None3:h\_native\_None2 .   
## h\_edumc\_None2:h\_parity\_None1 .   
## h\_edumc\_None3:h\_parity\_None1 .   
## h\_edumc\_None2:h\_parity\_None2 .   
## h\_edumc\_None3:h\_parity\_None2 .   
## h\_native\_None1:h\_parity\_None1 .   
## h\_native\_None2:h\_parity\_None1 .   
## h\_native\_None1:h\_parity\_None2 .   
## h\_native\_None2:h\_parity\_None2 .

#Predict in test-set  
model\_interaction.pred <- model\_interaction %>%   
 predict(test.data)  
  
# Evaluation metrics and prediction performance  
data.frame(  
 RMSE = RMSE(model\_interaction.pred, test.data$e3\_bw),  
 Rsquare = R2(model\_interaction.pred, test.data$e3\_bw)  
 )

## RMSE Rsquare  
## 1 421.4676 0.4008985

* I don’t know why if I use expand.grid to tune and , there will be an error:Error in { : task 1 failed - “the condition has length > 1”. So, I just use expandLength=10.
* The RMSE and R2 for interaction model indicated that the model with automated interaction didn’t have a better performance compared with the one without interaction.