03_07_3chem_cpg_obesity

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Contents

```
## set up workspace
rm(list = ls())
library(data.table)
library(knitr)
library(tidyverse)
library(magrittr)
library(stats)
library(tibble)
library(grid)  # low-level grid functions are required
options(stringsAsFactors = F)
options(dplyr.width = Inf)
getwd()
```

```
## [1] "/home/guanshim/Documents/gitlab/ECCHO_github/DataProcessed/for_obesity"
```

```
## not in function
"%nin%" <- Negate("%in%")

# ######## clean memory ###################### rm(list =
# ls()) gc() ls() slotNames(x) getSlots(x)
```

```
################################### No maternal_age ############

c("Need:", "outcome_f", "CpGdata_f", "Xs_f")
```

```
## [1] "Need:"     "outcome_f" "CpGdata_f" "Xs_f"
```

```
## equal length of outcomes and covariates
cpg_FunRegSim <- function(outcome, CpGdata, Xs, Outcome_name,
    Topn, chemname) {
    ## get the gender
    gender1 = unlist(strsplit(deparse(substitute(Xs)), "_", fixed = T))[2]
    gender2 = unlist(strsplit(deparse(substitute(CpGdata)), "_",
        fixed = T))[2]
    if (gender1 != gender2)
        stop("should use the same gender data")
    Gender = ifelse(gender1 == "m", "male", "female")
    ## number of CpG to test, also the number of multiple test
    n_cpg = ncol(CpGdata)
    ## outcome lm
    outcome_lm = lapply(1:n_cpg, function(i) {
        lm = lm(outcome ~ CpGdata[, i] + Race + Bcell + CD4T +
            CD8T + Gran + Mono + NK + nRBC, data = Xs)
        coef = summary(lm)$coefficients[2, ]
        return(coef)
    })
```

```
    outcome_lm = data.frame(matrix(unlist(outcome_lm), ncol = 4,
        byrow = TRUE, dimnames = list(c(colnames(CpGdata)), c("Estimate",
            "Std.Error", "t.statistic", "p.value"))))

    # adjusted p-value
    outcome_lm = outcome_lm %>% mutate(FDR = p.adjust(p.value,
        "BH", n_cpg), names = colnames(CpGdata)) %>% mutate(Estimate = round(Estimate,
        4), Std.Error = round(Std.Error, 4), t.statistic = round(t.statistic,
        4)) %>% select(names, everything())
    # sort by p.value
    outcome_lm = outcome_lm[order(outcome_lm$p.value), ]
    outcome_lm = data.frame(outcome_lm)

    ## sample size
    size = length(outcome) - sum(is.na(outcome))
    ## save results per outcome
    fwrite(outcome_lm, row.names = F, paste("~/Documents/gitlab/ECCHO_github/DataProcessed/for_obesity/
        Sys.Date(), "_", Gender, "_", Outcome_name, "_", chemname,
        "_", ".csv", sep = ""))
    ## summary table
    kable(head(outcome_lm, Topn), caption = paste("Top CpGs from ",
        n_cpg, " CpGs", " for Outcome: ", Outcome_name, " of ",
        Gender, " (Sample Size = ", size, ") ", sep = "", collapse = ""))
}

## read in data
pfas_cell_583 <- read.csv("~/Documents/gitlab/ECCHO_github/DataProcessed/for_obesity/11_05_pfas_cell_583
Outcomes <- colnames(pfas_cell_583)[5:13]
Outcomes
```

```
## [1] "birth_weight"          "ipv3_pp_fm_pct"        "Chol_IPV3"
## [4] "FFA_IPV3"              "Gluc_IPV3"             "HDL_IPV3"
## [7] "Insu_IPV3"             "Trig_IPV3"             "Leptin_actual__ng_ml_"
```

```
## gender top cpgs
f_pfoa_DMR_top1 <- read.csv("~/Documents/gitlab/ECCHO_github/DataProcessed/dmr/2019-03-07_f_pfoa_DMR_to
f_pfhxs_DMR_top1 <- read.csv("~/Documents/gitlab/ECCHO_github/DataProcessed/dmr/2019-03-07_f_pfhxs_DMR_
f_pfos_DMR_top1 <- read.csv("~/Documents/gitlab/ECCHO_github/DataProcessed/dmr/2019-03-07_f_pfos_DMR_to

# all clinical data, chemical conc, obesity outcomes
clinchem_f <- read.csv("/home/guanshim/Documents/gitlab/ECCHO_github/DataProcessed/clin_chem_f.csv")
dim(clinchem_f)
```

```
## [1] 278  26
```

```
# mval
dtall_f <- fread("~/Documents/gitlab/ECCHO_github/DataProcessed/for_obesity/dt_all_f.csv",
    header = T)
dim(dtall_f)
```

```
## [1]    278 433386
```

```
sum(dtall_f$pid != clinchem_f$pid)
```

```
## [1] 0
```

```
## cpgs <- colnames(dtall_f)[-c(1:26)]
sum(colnames(dtall_f) %in% f_pfoa_DMR_top1$ID)
```

```
## [1] 71
```

```
dtall_f <- data.frame(dtall_f)
# CpGdata
CpGdatapfoa_f <- dtall_f[, colnames(dtall_f) %in% f_pfoa_DMR_top1$ID]
CpGdatapfhxs_f <- dtall_f[, colnames(dtall_f) %in% f_pfhxs_DMR_top1$ID]
CpGdatapfos_f <- dtall_f[, colnames(dtall_f) %in% f_pfos_DMR_top1$ID]
# all outcome, covariate
colnames(clinchem_f)
```

```
##  [1] "pid"                   "infant_sex"
##  [3] "maternal_age"          "Race"
##  [5] "birth_weight"          "ipv3_pp_fm_pct"
##  [7] "Chol_IPV3"             "FFA_IPV3"
##  [9] "Gluc_IPV3"             "HDL_IPV3"
## [11] "Insu_IPV3"             "Trig_IPV3"
## [13] "Leptin_actual__ng_ml_" "Bcell"
## [15] "CD4T"                  "CD8T"
## [17] "Gran"                  "Mono"
## [19] "NK"                    "nRBC"
## [21] "PFHXS_ng_ml"           "PFOA_ng_ml"
## [23] "PFOS_ng_ml"            "lnpfhxs"
## [25] "lnpfoa"                "lnpfos"
```

```
#

## # the regression summary table for log10 outcomes
lapply(Outcomes, function(x) {
    cpg_FunRegSim(log10(clinchem_f[, x]), CpGdatapfoa_f, clinchem_f,
        x, 10, "pfoa")
})
```

```
## [[1]]
##
##
## Table: Top CpGs from 71 CpGs for Outcome: birth_weight of female (Sample Size = 278)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 44   cg27066989     -0.0418      0.0127       -3.3011   0.0010937   0.0399381
## 21   cg04706597      0.0315      0.0099        3.1899   0.0015922   0.0399381
## 6    cg01044662     -0.0589      0.0186       -3.1583   0.0017684   0.0399381
## 35   cg23135908      0.0602      0.0195        3.0848   0.0022500   0.0399381
## 19   cg14645861      0.0439      0.0152        2.8811   0.0042841   0.0608338
## 31   cg11061422      0.0330      0.0120        2.7486   0.0063913   0.0756302
## 56   cg05156120      0.0327      0.0155        2.1018   0.0365017   0.3242954
## 61   cg10377245     -0.0331      0.0158       -2.1014   0.0365403   0.3242954
## 7    cg05194362      0.0473      0.0232        2.0373   0.0426009   0.3360740
## 70   cg05756954      0.0133      0.0079        1.6771   0.0946890   0.5735656
##
## [[2]]
##
```

##
Table: Top CpGs from 71 CpGs for Outcome: ipv3_pp_fm_pct of female (Sample Size = 271)
##
names   Estimate   Std.Error   t.statistic   p.value   FDR
--- ----------- --------- ---------- ------------ ---------- ----------
35   cg23135908   0.2427   0.0750   3.2378   0.0013603   0.0965845
43   cg26524067   0.1784   0.0625   2.8573   0.0046172   0.1639093
55   cg07670516   -0.0970   0.0382   -2.5384   0.0117187   0.2773417
15   cg18110333   0.0209   0.0093   2.2530   0.0250905   0.4453572
8   cg06117855   0.1047   0.0540   1.9378   0.0537262   0.7629124
51   cg03749207   -0.0218   0.0129   -1.6927   0.0917037   0.8770771
38   cg12553554   0.1201   0.0710   1.6902   0.0921877   0.8770771
18   cg09735274   0.0496   0.0338   1.4668   0.1436344   0.8770771
27   cg25483741   -0.0620   0.0425   -1.4598   0.1455445   0.8770771
56   cg05156120   0.0877   0.0603   1.4541   0.1471182   0.8770771
##
[[3]]
##
##
Table: Top CpGs from 71 CpGs for Outcome: Chol_IPV3 of female (Sample Size = 257)
##
names   Estimate   Std.Error   t.statistic   p.value   FDR
--- ----------- --------- ---------- ------------ ---------- ----------
24   cg04205943   0.1156   0.0346   3.3447   0.0009517   0.0651404
36   cg25739366   -0.1498   0.0476   -3.1498   0.0018349   0.0651404
59   cg06586046   0.1180   0.0466   2.5306   0.0120091   0.2196921
5   cg20260610   -0.0487   0.0193   -2.5197   0.0123770   0.2196921
57   cg05504117   -0.0595   0.0255   -2.3303   0.0205974   0.2562947
35   cg23135908   -0.1039   0.0449   -2.3110   0.0216587   0.2562947
39   cg14911689   0.0174   0.0083   2.0838   0.0382097   0.3875556
41   cg25198599   -0.0263   0.0147   -1.7957   0.0737707   0.4861052
45   cg18997137   -0.1158   0.0646   -1.7921   0.0743462   0.4861052
21   cg04706597   0.0424   0.0237   1.7911   0.0745043   0.4861052
##
[[4]]
##
##
Table: Top CpGs from 71 CpGs for Outcome: FFA_IPV3 of female (Sample Size = 237)
##
names   Estimate   Std.Error   t.statistic   p.value   FDR
--- ----------- --------- ---------- ------------ ---------- ----------
48   cg10489428   0.3694   0.1397   2.6442   0.0087594   0.4043285
68   cg22442730   -0.2059   0.0807   -2.5513   0.0113895   0.4043285
3   cg17862152   0.0473   0.0227   2.0811   0.0385508   0.8712252
45   cg18997137   -0.2157   0.1195   -1.8055   0.0723245   0.8712252
34   cg10742801   -0.1452   0.0824   -1.7611   0.0795608   0.8712252
52   cg00220102   0.1095   0.0634   1.7256   0.0857746   0.8712252
35   cg23135908   0.1367   0.0825   1.6578   0.0987438   0.8712252
6   cg01044662   -0.1266   0.0795   -1.5917   0.1128530   0.8712252
12   cg18710053   0.0593   0.0398   1.4919   0.1371071   0.8712252
54   cg13476078   -0.0529   0.0358   -1.4782   0.1407351   0.8712252
##
[[5]]
##

##
Table: Top CpGs from 71 CpGs for Outcome: Gluc_IPV3 of female (Sample Size = 263)
##
names   Estimate   Std.Error   t.statistic   p.value   FDR
--- ----------- --------- ---------- ------------ ---------- ----------
44   cg27066989   -0.0734   0.0210   -3.4889   0.0005718   0.0405996
12   cg18710053   -0.0359   0.0147   -2.4382   0.0154487   0.5484274
3   cg17862152   0.0165   0.0087   1.9018   0.0583367   0.9829644
5   cg20260610   0.0255   0.0140   1.8237   0.0693711   0.9829644
65   cg01718065   -0.0372   0.0220   -1.6890   0.0924528   0.9829644
62   cg05836043   0.0295   0.0180   1.6431   0.1016049   0.9829644
42   cg11839682   0.0301   0.0184   1.6360   0.1030885   0.9829644
48   cg10489428   -0.0853   0.0568   -1.5015   0.1344648   0.9829644
52   cg00220102   0.0371   0.0256   1.4501   0.1482687   0.9829644
38   cg12553554   -0.0450   0.0321   -1.4016   0.1622722   0.9829644
##
[[6]]
##
##
Table: Top CpGs from 71 CpGs for Outcome: HDL_IPV3 of female (Sample Size = 242)
##
names   Estimate   Std.Error   t.statistic   p.value   FDR
--- ----------- --------- ---------- ------------ ---------- ----------
5   cg20260610   -0.0646   0.0190   -3.4033   0.0007843   0.0556844
35   cg23135908   -0.1092   0.0438   -2.4932   0.0133576   0.4364555
62   cg05836043   -0.0568   0.0249   -2.2845   0.0232446   0.4364555
9   cg23730617   -0.0735   0.0336   -2.1852   0.0298782   0.4364555
36   cg25739366   -0.1040   0.0478   -2.1737   0.0307363   0.4364555
27   cg25483741   -0.0487   0.0255   -1.9083   0.0575818   0.5877882
6   cg01044662   -0.0770   0.0424   -1.8159   0.0706826   0.5877882
48   cg10489428   -0.1290   0.0753   -1.7129   0.0880600   0.5877882
71   cg13741802   0.0330   0.0203   1.6243   0.1056801   0.5877882
24   cg04205943   0.0567   0.0352   1.6090   0.1089707   0.5877882
##
[[7]]
##
##
Table: Top CpGs from 71 CpGs for Outcome: Insu_IPV3 of female (Sample Size = 255)
##
names   Estimate   Std.Error   t.statistic   p.value   FDR
--- ----------- --------- ---------- ------------ ---------- ----------
24   cg04205943   0.1957   0.0675   2.8999   0.0040715   0.2443219
59   cg06586046   -0.2355   0.0917   -2.5676   0.0108335   0.2443219
5   cg20260610   0.0911   0.0374   2.4375   0.0155017   0.2443219
62   cg05836043   -0.1155   0.0479   -2.4130   0.0165586   0.2443219
12   cg18710053   -0.0947   0.0395   -2.3986   0.0172058   0.2443219
8   cg06117855   0.1398   0.0647   2.1618   0.0316051   0.3151137
6   cg01044662   0.1785   0.0856   2.0861   0.0380044   0.3151137
68   cg22442730   0.1732   0.0836   2.0713   0.0393748   0.3151137
15   cg18110333   0.0229   0.0111   2.0653   0.0399440   0.3151137
42   cg11839682   -0.0945   0.0495   -1.9100   0.0572983   0.4068183
##
[[8]]
##

```
##
## Table: Top CpGs from 71 CpGs for Outcome: Trig_IPV3 of female (Sample Size = 252)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 43   cg26524067     -0.1843      0.0601       -3.0678   0.0024014   0.1530061
## 15   cg18110333     -0.0264      0.0092       -2.8817   0.0043100   0.1530061
## 8    cg06117855     -0.1380      0.0530       -2.6053   0.0097483   0.1910342
## 58   cg08195512     -0.1817      0.0753       -2.4123   0.0165951   0.1910342
## 44   cg27066989     -0.1102      0.0474       -2.3266   0.0208133   0.1910342
## 22   cg19708055      0.1205      0.0518        2.3263   0.0208296   0.1910342
## 1    cg19370715      0.1220      0.0530        2.3014   0.0222210   0.1910342
## 6    cg01044662     -0.1598      0.0702       -2.2760   0.0237179   0.1910342
## 57   cg05504117     -0.0925      0.0413       -2.2401   0.0259928   0.1910342
## 59   cg06586046      0.1684      0.0761        2.2123   0.0278824   0.1910342
##
## [[9]]
##
##
## Table: Top CpGs from 71 CpGs for Outcome: Leptin_actual__ng_ml_ of female (Sample Size = 226)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 60   cg19729649      0.3250      0.1196        2.7175   0.0071104   0.2854698
## 37   cg06039161     -0.2134      0.0798       -2.6752   0.0080414   0.2854698
## 24   cg04205943      0.2019      0.1022        1.9761   0.0494125   0.7475332
## 67   cg22943498      0.3134      0.1668        1.8790   0.0615931   0.7475332
## 54   cg13476078     -0.1089      0.0598       -1.8208   0.0700204   0.7475332
## 5    cg20260610      0.1065      0.0587        1.8127   0.0712652   0.7475332
## 35   cg23135908      0.2459      0.1446        1.7009   0.0904004   0.7475332
## 51   cg03749207     -0.0380      0.0232       -1.6379   0.1029021   0.7475332
## 32   cg06103397     -0.1265      0.0774       -1.6345   0.1036014   0.7475332
## 8    cg06117855     -0.1649      0.1014       -1.6266   0.1052864   0.7475332
```

```
lapply(Outcomes, function(x) {
    cpg_FunRegSim(log10(clinchem_f[, x]), CpGdatapfhxs_f, clinchem_f,
        x, 10, "pfhxs")
})
```

```
## [[1]]
##
##
## Table: Top CpGs from 25 CpGs for Outcome: birth_weight of female (Sample Size = 278)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 21   cg14999189     -0.1206      0.0310       -3.8908   0.0001261   0.0031532
## 2    cg03540175     -0.0204      0.0072       -2.8248   0.0050861   0.0635763
## 12   cg12982322     -0.0435      0.0189       -2.2996   0.0222378   0.1753603
## 17   cg01098955     -0.0298      0.0135       -2.1970   0.0288782   0.1753603
## 23   cg23601416      0.0349      0.0165        2.1183   0.0350721   0.1753603
## 7    cg01383911      0.0227      0.0174        1.2993   0.1949525   0.6768921
## 11   cg04585209      0.0158      0.0123        1.2881   0.1988078   0.6768921
## 3    cg02930239      0.0101      0.0086        1.1759   0.2406838   0.6768921
## 22   cg13403724      0.0093      0.0087        1.0692   0.2859630   0.6768921
```

```
## 4    cg14177328     -0.0101      0.0103       -0.9740   0.3309306   0.6768921
##
## [[2]]
##
##
## Table: Top CpGs from 25 CpGs for Outcome: ipv3_pp_fm_pct of female (Sample Size = 271)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 23   cg23601416      0.1229      0.0636        1.9321   0.0544248   0.6202627
## 18   cg03749207     -0.0218      0.0129       -1.6927   0.0917037   0.6202627
## 13   cg18852692      0.0903      0.0556        1.6225   0.1058993   0.6202627
## 7    cg01383911      0.1041      0.0675        1.5429   0.1240643   0.6202627
## 21   cg14999189     -0.1659      0.1218       -1.3618   0.1744445   0.6202627
## 4    cg14177328     -0.0520      0.0394       -1.3214   0.1875207   0.6202627
## 11   cg04585209      0.0620      0.0474        1.3082   0.1919656   0.6202627
## 22   cg13403724      0.0430      0.0334        1.2892   0.1984841   0.6202627
## 16   cg23101649     -0.0909      0.0791       -1.1492   0.2515132   0.6466547
## 2    cg03540175     -0.0320      0.0283       -1.1320   0.2586619   0.6466547
##
## [[3]]
##
##
## Table: Top CpGs from 25 CpGs for Outcome: Chol_IPV3 of female (Sample Size = 257)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 21   cg14999189      0.1584      0.0741        2.1377   0.0335215   0.8380383
## 14   cg01906695      0.0781      0.0476        1.6394   0.1024021   0.9450349
## 17   cg01098955      0.0493      0.0310        1.5887   0.1134042   0.9450349
## 25   cg10521948     -0.0316      0.0230       -1.3742   0.1706100   0.9461642
## 2    cg03540175      0.0191      0.0171        1.1168   0.2651814   0.9461642
## 6    cg23435118     -0.0523      0.0484       -1.0815   0.2805469   0.9461642
## 24   cg05546784      0.0592      0.0572        1.0354   0.3015071   0.9461642
## 10   cg06691343     -0.0274      0.0342       -0.8005   0.4241855   0.9461642
## 3    cg02930239     -0.0158      0.0203       -0.7802   0.4360364   0.9461642
## 8    cg03668078     -0.0468      0.0636       -0.7348   0.4631322   0.9461642
##
## [[4]]
##
##
## Table: Top CpGs from 25 CpGs for Outcome: FFA_IPV3 of female (Sample Size = 237)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 11   cg04585209      0.1030      0.0546        1.8856   0.0606281   0.7151351
## 17   cg01098955     -0.0947      0.0581       -1.6297   0.1045446   0.7151351
## 21   cg14999189     -0.2091      0.1312       -1.5933   0.1124929   0.7151351
## 15   cg16096766     -0.1443      0.0974       -1.4817   0.1398197   0.7151351
## 24   cg05546784      0.1350      0.1030        1.3105   0.1913594   0.7151351
## 10   cg06691343      0.0798      0.0629        1.2671   0.2064265   0.7151351
## 6    cg23435118     -0.1121      0.0889       -1.2605   0.2087678   0.7151351
## 3    cg02930239      0.0422      0.0367        1.1514   0.2507921   0.7151351
## 13   cg18852692     -0.0684      0.0617       -1.1097   0.2683210   0.7151351
```

```
## 22   cg13403724     -0.0391      0.0366       -1.0676   0.2868488   0.7151351
##
## [[5]]
##
##
## Table: Top CpGs from 25 CpGs for Outcome: Gluc_IPV3 of female (Sample Size = 263)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 2    cg03540175     -0.0330      0.0122       -2.7078   0.0072356   0.1632449
## 21   cg14999189     -0.1341      0.0536       -2.4998   0.0130596   0.1632449
## 17   cg01098955     -0.0371      0.0227       -1.6354   0.1032155   0.8601295
## 5    cg09893305     -0.0270      0.0225       -1.2002   0.2311652   0.8732565
## 20   cg06988897     -0.0126      0.0115       -1.0947   0.2746983   0.8732565
## 22   cg13403724      0.0157      0.0145        1.0815   0.2804868   0.8732565
## 8    cg03668078      0.0462      0.0464        0.9959   0.3202277   0.8732565
## 4    cg14177328     -0.0175      0.0178       -0.9861   0.3250224   0.8732565
## 7    cg01383911      0.0261      0.0295        0.8865   0.3761974   0.8732565
## 14   cg01906695     -0.0302      0.0349       -0.8661   0.3872471   0.8732565
##
## [[6]]
##
##
## Table: Top CpGs from 25 CpGs for Outcome: HDL_IPV3 of female (Sample Size = 242)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 21   cg14999189      0.1052      0.0729        1.4427   0.1504435   0.8878887
## 11   cg04585209     -0.0392      0.0282       -1.3919   0.1652720   0.8878887
## 14   cg01906695      0.0652      0.0473        1.3785   0.1693750   0.8878887
## 23   cg23601416     -0.0438      0.0376       -1.1653   0.2450907   0.8878887
## 6    cg23435118     -0.0491      0.0479       -1.0264   0.3057781   0.8878887
## 5    cg09893305      0.0293      0.0306        0.9572   0.3394446   0.8878887
## 3    cg02930239     -0.0178      0.0200       -0.8923   0.3731499   0.8878887
## 18   cg03749207     -0.0063      0.0078       -0.8086   0.4195463   0.8878887
## 25   cg10521948     -0.0172      0.0229       -0.7513   0.4532345   0.8878887
## 1    cg25251562     -0.0073      0.0097       -0.7488   0.4547485   0.8878887
##
## [[7]]
##
##
## Table: Top CpGs from 25 CpGs for Outcome: Insu_IPV3 of female (Sample Size = 255)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 17   cg01098955      0.1400      0.0609        2.2985   0.0223776   0.5594402
## 13   cg18852692      0.1116      0.0666        1.6750   0.0952182   0.9466027
## 3    cg02930239      0.0500      0.0390        1.2801   0.2017089   0.9466027
## 23   cg23601416     -0.0917      0.0751       -1.2211   0.2232034   0.9466027
## 4    cg14177328     -0.0565      0.0474       -1.1925   0.2342165   0.9466027
## 12   cg12982322      0.0928      0.0845        1.0979   0.2733185   0.9466027
## 6    cg23435118      0.0927      0.0936        0.9901   0.3230971   0.9466027
## 16   cg23101649     -0.0841      0.0930       -0.9043   0.3667304   0.9466027
## 11   cg04585209      0.0502      0.0558        0.9003   0.3688353   0.9466027
```

```
## 1    cg25251562     -0.0144      0.0194       -0.7401   0.4599202   0.9466027
##
## [[8]]
##
##
## Table: Top CpGs from 25 CpGs for Outcome: Trig_IPV3 of female (Sample Size = 252)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 15   cg16096766     -0.2033      0.0844       -2.4072   0.0168263   0.2466403
## 24   cg05546784      0.2087      0.0916        2.2782   0.0235863   0.2466403
## 18   cg03749207      0.0278      0.0127        2.1884   0.0295968   0.2466403
## 9    cg15175005      0.0944      0.0490        1.9293   0.0548621   0.3364626
## 2    cg03540175      0.0505      0.0275        1.8380   0.0672925   0.3364626
## 20   cg06988897      0.0448      0.0256        1.7482   0.0816921   0.3403839
## 8    cg03668078     -0.1288      0.1047       -1.2307   0.2196340   0.6561019
## 22   cg13403724      0.0388      0.0320        1.2115   0.2268836   0.6561019
## 21   cg14999189     -0.1373      0.1203       -1.1411   0.2549655   0.6561019
## 5    cg09893305     -0.0568      0.0506       -1.1233   0.2624408   0.6561019
##
## [[9]]
##
##
## Table: Top CpGs from 25 CpGs for Outcome: Leptin_actual__ng_ml_ of female (Sample Size = 226)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 23   cg23601416      0.2514      0.1141        2.2025   0.0286909   0.5612759
## 12   cg12982322     -0.2636      0.1327       -1.9863   0.0482639   0.5612759
## 18   cg03749207     -0.0380      0.0232       -1.6379   0.1029021   0.5612759
## 1    cg25251562     -0.0471      0.0302       -1.5605   0.1200976   0.5612759
## 22   cg13403724      0.0919      0.0593        1.5496   0.1227111   0.5612759
## 14   cg01906695      0.2132      0.1420        1.5014   0.1347062   0.5612759
## 21   cg14999189     -0.2832      0.2250       -1.2585   0.2095518   0.6280014
## 7    cg01383911      0.1440      0.1231        1.1691   0.2436397   0.6280014
## 25   cg10521948      0.0804      0.0703        1.1437   0.2540335   0.6280014
## 5    cg09893305     -0.1015      0.0941       -1.0792   0.2816938   0.6280014
```

```
lapply(Outcomes, function(x) {
    cpg_FunRegSim(log10(clinchem_f[, x]), CpGdatapfos_f, clinchem_f,
        x, 10, "pfos")
})
```

```
## [[1]]
##
##
## Table: Top CpGs from 45 CpGs for Outcome: birth_weight of female (Sample Size = 278)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 42   cg18568930      0.0353      0.0132        2.6842   0.0077222   0.2295938
## 22   cg21136371      0.0389      0.0159        2.4540   0.0147640   0.2295938
## 37   cg05372963      0.0251      0.0103        2.4407   0.0153063   0.2295938
## 34   cg01098955     -0.0298      0.0135       -2.1970   0.0288782   0.3016727
## 2    cg16328007      0.0329      0.0154        2.1368   0.0335192   0.3016727
```

```
## 41   cg26464626      0.0297      0.0155        1.9101   0.0571857   0.4288926
## 9    cg07857469      0.0248      0.0149        1.6689   0.0963007   0.6190757
## 28   cg17709804     -0.0134      0.0101       -1.3209   0.1876697   0.7676145
## 32   cg11108474      0.0157      0.0119        1.3202   0.1878967   0.7676145
## 23   cg24079038     -0.0342      0.0282       -1.2110   0.2269620   0.7676145
##
## [[2]]
##
##
## Table: Top CpGs from 45 CpGs for Outcome: ipv3_pp_fm_pct of female (Sample Size = 271)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 23   cg24079038     -0.2006      0.1091       -1.8377   0.0672441   0.8238111
## 35   cg08172552     -0.1289      0.0729       -1.7690   0.0780698   0.8238111
## 36   cg03749207     -0.0218      0.0129       -1.6927   0.0917037   0.8238111
## 22   cg21136371      0.1015      0.0621        1.6355   0.1031487   0.8238111
## 26   cg18852692      0.0903      0.0556        1.6225   0.1058993   0.8238111
## 12   cg03122674     -0.0558      0.0359       -1.5551   0.1211345   0.8238111
## 37   cg05372963     -0.0607      0.0398       -1.5263   0.1281484   0.8238111
## 40   cg25418852     -0.1008      0.0743       -1.3570   0.1759455   0.9452668
## 21   cg01458105      0.0212      0.0168        1.2651   0.2069515   0.9452668
## 20   cg06937617     -0.0517      0.0411       -1.2565   0.2100593   0.9452668
##
## [[3]]
##
##
## Table: Top CpGs from 45 CpGs for Outcome: Chol_IPV3 of female (Sample Size = 257)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 25   cg25739366     -0.1498      0.0476       -3.1498   0.0018349   0.0825724
## 42   cg18568930     -0.0688      0.0301       -2.2852   0.0231512   0.3081645
## 35   cg08172552     -0.0940      0.0436       -2.1530   0.0322885   0.3081645
## 14   cg15927196     -0.0899      0.0429       -2.0943   0.0372556   0.3081645
## 29   cg14911689      0.0174      0.0083        2.0838   0.0382097   0.3081645
## 28   cg17709804      0.0475      0.0233        2.0336   0.0430589   0.3081645
## 7    cg01565777     -0.0847      0.0430       -1.9686   0.0501194   0.3081645
## 45   cg13666323     -0.0395      0.0205       -1.9297   0.0547848   0.3081645
## 9    cg07857469      0.0635      0.0353        1.8024   0.0726973   0.3634863
## 34   cg01098955      0.0493      0.0310        1.5887   0.1134042   0.4424861
##
## [[4]]
##
##
## Table: Top CpGs from 45 CpGs for Outcome: FFA_IPV3 of female (Sample Size = 237)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 37   cg05372963      0.1002      0.0433        2.3109   0.0217373   0.6368572
## 44   cg17022362     -0.1033      0.0468       -2.2072   0.0283048   0.6368572
## 17   cg14306956      0.1170      0.0648        1.8062   0.0722178   0.7270091
## 34   cg01098955     -0.0947      0.0581       -1.6297   0.1045446   0.7270091
## 20   cg06937617     -0.0718      0.0448       -1.6023   0.1104804   0.7270091
```

```
## 33   cg16096766     -0.1443      0.0974       -1.4817   0.1398197   0.7270091
## 6    cg01919208      0.0915      0.0641        1.4282   0.1546077   0.7270091
## 21   cg01458105     -0.0245      0.0181       -1.3532   0.1773365   0.7270091
## 12   cg03122674     -0.0543      0.0407       -1.3341   0.1835061   0.7270091
## 39   cg11568697     -0.0340      0.0255       -1.3320   0.1841832   0.7270091
##
## [[5]]
##
##
## Table: Top CpGs from 45 CpGs for Outcome: Gluc_IPV3 of female (Sample Size = 263)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 6    cg01919208      0.0560      0.0254        2.2003   0.0286910   0.7588638
## 10   cg26924408      0.0450      0.0220        2.0440   0.0419902   0.7588638
## 9    cg07857469      0.0492      0.0251        1.9643   0.0505909   0.7588638
## 31   cg02072400     -0.0194      0.0108       -1.7951   0.0738363   0.7988666
## 34   cg01098955     -0.0371      0.0227       -1.6354   0.1032155   0.7988666
## 43   cg18055623     -0.0678      0.0427       -1.5879   0.1135661   0.7988666
## 4    cg18592026      0.0379      0.0269        1.4113   0.1593915   0.7988666
## 2    cg16328007      0.0369      0.0263        1.4049   0.1612783   0.7988666
## 17   cg14306956     -0.0358      0.0257       -1.3960   0.1639393   0.7988666
## 13   cg01760756     -0.0215      0.0160       -1.3424   0.1806585   0.7988666
##
## [[6]]
##
##
## Table: Top CpGs from 45 CpGs for Outcome: HDL_IPV3 of female (Sample Size = 242)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 9    cg07857469      0.1022      0.0344        2.9703   0.0032875   0.1479390
## 3    cg23729443     -0.1027      0.0449       -2.2845   0.0232488   0.3457834
## 22   cg21136371     -0.0800      0.0358       -2.2331   0.0264983   0.3457834
## 25   cg25739366     -0.1040      0.0478       -2.1737   0.0307363   0.3457834
## 35   cg08172552     -0.0824      0.0431       -1.9102   0.0573360   0.4799852
## 23   cg24079038      0.1228      0.0660        1.8611   0.0639980   0.4799852
## 42   cg18568930     -0.0527      0.0298       -1.7707   0.0779188   0.5009068
## 28   cg17709804      0.0317      0.0235        1.3496   0.1784558   0.8674709
## 32   cg11108474     -0.0315      0.0261       -1.2080   0.2282624   0.8674709
## 45   cg13666323     -0.0239      0.0207       -1.1591   0.2475883   0.8674709
##
## [[7]]
##
##
## Table: Top CpGs from 45 CpGs for Outcome: Insu_IPV3 of female (Sample Size = 255)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 17   cg14306956     -0.1725      0.0674       -2.5584   0.0111189   0.4370685
## 34   cg01098955      0.1400      0.0609        2.2985   0.0223776   0.4370685
## 6    cg01919208      0.1517      0.0691        2.1945   0.0291379   0.4370685
## 23   cg24079038     -0.2246      0.1288       -1.7432   0.0825605   0.8569637
## 26   cg18852692      0.1116      0.0666        1.6750   0.0952182   0.8569637
```

```
## 22   cg21136371      0.1099      0.0721        1.5239   0.1288351   0.8729624
## 35   cg08172552      0.1229      0.0855        1.4373   0.1519121   0.8729624
## 11   cg26929925     -0.0595      0.0417       -1.4255   0.1552907   0.8729624
## 37   cg05372963     -0.0650      0.0478       -1.3615   0.1745925   0.8729624
## 7    cg01565777      0.1087      0.0863        1.2602   0.2087928   0.9002587
##
## [[8]]
##
##
## Table: Top CpGs from 45 CpGs for Outcome: Trig_IPV3 of female (Sample Size = 252)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 35   cg08172552      0.1725      0.0702        2.4572   0.0147050   0.2663716
## 33   cg16096766     -0.2033      0.0844       -2.4072   0.0168263   0.2663716
## 24   cg22961513     -0.0736      0.0324       -2.2677   0.0242295   0.2663716
## 37   cg05372963      0.0863      0.0395        2.1885   0.0295864   0.2663716
## 36   cg03749207      0.0278      0.0127        2.1884   0.0295968   0.2663716
## 43   cg18055623      0.1585      0.0960        1.6512   0.0999898   0.7499237
## 6    cg01919208     -0.0802      0.0573       -1.4014   0.1623814   0.9791506
## 1    cg05337761      0.0419      0.0318        1.3181   0.1887041   0.9791506
## 18   cg13911959     -0.0366      0.0312       -1.1722   0.2422746   0.9791506
## 25   cg25739366     -0.0866      0.0780       -1.1110   0.2676898   0.9791506
##
## [[9]]
##
##
## Table: Top CpGs from 45 CpGs for Outcome: Leptin_actual__ng_ml_ of female (Sample Size = 226)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 22   cg21136371      0.2840      0.1139        2.4935   0.0133977   0.3291404
## 31   cg02072400      0.1112      0.0452        2.4613   0.0146285   0.3291404
## 20   cg06937617     -0.1569      0.0744       -2.1085   0.0361437   0.4762331
## 3    cg23729443      0.2430      0.1306        1.8608   0.0641280   0.4762331
## 45   cg13666323      0.1147      0.0619        1.8532   0.0652154   0.4762331
## 32   cg11108474      0.1468      0.0817        1.7980   0.0735800   0.4762331
## 7    cg01565777      0.2367      0.1319        1.7948   0.0740807   0.4762331
## 36   cg03749207     -0.0380      0.0232       -1.6379   0.1029021   0.5788245
## 11   cg26929925      0.0868      0.0642        1.3516   0.1779187   0.7673465
## 18   cg13911959     -0.0745      0.0617       -1.2082   0.2282742   0.7673465
```

```
## gender top cpgs
m_pfoa_DMR_top1 <- read.csv("~/Documents/gitlab/ECCHO_github/DataProcessed/dmr/2019-03-07_m_pfoa_DMR_top
m_pfhxs_DMR_top1 <- read.csv("~/Documents/gitlab/ECCHO_github/DataProcessed/dmr/2019-03-07_m_pfhxs_DMR_
m_pfos_DMR_top1 <- read.csv("~/Documents/gitlab/ECCHO_github/DataProcessed/dmr/2019-03-07_m_pfos_DMR_top

# all clinical data, chemical conc, obesity outcomes
clinchem_m <- read.csv("/home/guanshim/Documents/gitlab/ECCHO_github/DataProcessed/clin_chem_m.csv")
dim(clinchem_m)
```

```
## [1] 305  26
```

```
# # all clinchem
clinchem <- read.csv("/home/guanshim/Documents/gitlab/ECCHO_github/DataProcessed/clin_chem.csv",
```

```
    header = T)
clinchem_m <- read.csv("/home/guanshim/Documents/gitlab/ECCHO_github/DataProcessed/clin_chem_m.csv")
dim(clinchem_m)
```

```
## [1] 305  26
```

```
t_mval <- fread("~/Documents/gitlab/ECCHO_github/DataProcessed/for_obesity/t_mval.csv",
    header = T)
dt_all <- merge(clinchem, t_mval, by = "pid")

dim(dt_all)
```

```
## [1]    583 433386
```

```
dt_all <- data.table(dt_all)
dtall_m <- dt_all[infant_sex == "Male"]

sum(dtall_m$pid != clinchem_m$pid)
```

```
## [1] 0
```

```
## cpgs <- colnames(dtall_f)[-c(1:26)]
sum(colnames(dtall_m) %in% m_pfoa_DMR_top1$ID)
```

```
## [1] 63
```

```
dtall_m <- data.frame(dtall_m)
## CpGdata
CpGdatapfoa_m <- dtall_m[, colnames(dtall_m) %in% m_pfoa_DMR_top1$ID]
CpGdatapfhxs_m <- dtall_m[, colnames(dtall_m) %in% m_pfhxs_DMR_top1$ID]
CpGdatapfos_m <- dtall_m[, colnames(dtall_m) %in% m_pfos_DMR_top1$ID]
# all outcome, covariate

## # the regression summary table for log10 outcomes
lapply(Outcomes, function(x) {
    cpg_FunRegSim(log10(clinchem_m[, x]), CpGdatapfoa_m, clinchem_m,
        x, 10, "pfoa")
})
```

```
## [[1]]
##
##
## Table: Top CpGs from 63 CpGs for Outcome: birth_weight of male (Sample Size = 305)
##
##       names          Estimate   Std.Error   t.statistic     p.value          FDR
## ---   ------------  ---------  ----------  ------------  ----------  ----------
## 33    cg16703135      -0.0514      0.0203       -2.5339   0.0117985   0.3941503
## 18    cg06941635       0.0320      0.0131        2.4513   0.0148132   0.3941503
## 55    cg09713758       0.0486      0.0207        2.3470   0.0195842   0.3941503
## 5     cg25138412      -0.0195      0.0086       -2.2525   0.0250254   0.3941503
## 39    cg08541962      -0.0229      0.0118       -1.9379   0.0535883   0.5067952
## 58    cg00963654      -0.0190      0.0099       -1.9121   0.0568273   0.5067952
## 40    cg04850999       0.0250      0.0133        1.8715   0.0622652   0.5067952
## 44    cg09188980       0.0269      0.0145        1.8567   0.0643549   0.5067952
## 4     cg16904639       0.0293      0.0170        1.7254   0.0855054   0.5799501
## 41    cg24440658      -0.0124      0.0074       -1.6902   0.0920556   0.5799501
##
```

[[2]]
##
##
Table: Top CpGs from 63 CpGs for Outcome: ipv3_pp_fm_pct of male (Sample Size = 292)
##
names   Estimate   Std.Error   t.statistic   p.value   FDR
--- ----------- --------- ---------- ------------ ---------- ----------
16   cg25399309   0.0954   0.0438   2.1806   0.0300364   0.6268178
51   cg14859324   -0.1766   0.0811   -2.1770   0.0303124   0.6268178
40   cg04850999   0.1152   0.0532   2.1632   0.0313664   0.6268178
32   cg26800883   0.0698   0.0354   1.9719   0.0496007   0.6268178
18   cg06941635   0.1035   0.0532   1.9476   0.0524520   0.6268178
21   cg26922678   0.0486   0.0257   1.8906   0.0596969   0.6268178
50   cg10671180   0.1730   0.0990   1.7466   0.0817983   0.6999269
63   cg22822140   -0.0676   0.0396   -1.7072   0.0888796   0.6999269
17   cg26232870   0.1108   0.0698   1.5884   0.1133227   0.7932588
44   cg09188980   0.0834   0.0590   1.4136   0.1585706   0.8130985
##
[[3]]
##
##
Table: Top CpGs from 63 CpGs for Outcome: Chol_IPV3 of male (Sample Size = 287)
##
names   Estimate   Std.Error   t.statistic   p.value   FDR
--- ----------- --------- ---------- ------------ ---------- ----------
31   cg08623515   -0.1253   0.0431   -2.9083   0.0039281   0.2474726
19   cg20249327   -0.0161   0.0068   -2.3627   0.0188343   0.5932802
18   cg06941635   0.0581   0.0275   2.1165   0.0351963   0.7391228
32   cg26800883   0.0348   0.0187   1.8594   0.0640297   0.7849801
62   cg07226201   -0.0469   0.0259   -1.8117   0.0711140   0.7849801
58   cg00963654   0.0360   0.0208   1.7366   0.0835738   0.7849801
16   cg25399309   0.0396   0.0240   1.6516   0.0997412   0.7849801
42   cg23374834   0.0415   0.0257   1.6174   0.1069207   0.7849801
11   cg13919821   0.0894   0.0581   1.5390   0.1249540   0.7849801
59   cg05006231   0.0159   0.0106   1.5061   0.1331713   0.7849801
##
[[4]]
##
##
Table: Top CpGs from 63 CpGs for Outcome: FFA_IPV3 of male (Sample Size = 265)
##
names   Estimate   Std.Error   t.statistic   p.value   FDR
--- ----------- --------- ---------- ------------ ---------- ----------
8   cg02713669   0.1810   0.0551   3.2846   0.0011645   0.0733620
57   cg24870966   0.1541   0.0634   2.4316   0.0157229   0.4032195
28   cg13353717   -0.0394   0.0173   -2.2742   0.0237864   0.4032195
63   cg22822140   0.0926   0.0413   2.2454   0.0256012   0.4032195
46   cg04024827   -0.1275   0.0626   -2.0378   0.0426064   0.4171802
12   cg00347798   0.1356   0.0674   2.0125   0.0452158   0.4171802
32   cg26800883   -0.0723   0.0366   -1.9769   0.0491328   0.4171802
11   cg13919821   0.2155   0.1108   1.9442   0.0529753   0.4171802
13   cg21386373   -0.2648   0.1480   -1.7889   0.0748249   0.4993691
15   cg23110957   -0.1472   0.0894   -1.6457   0.1010592   0.4993691
##

[[5]]
##
##
Table: Top CpGs from 63 CpGs for Outcome: Gluc_IPV3 of male (Sample Size = 295)
##
names   Estimate   Std.Error   t.statistic   p.value   FDR
--- ----------- --------- ---------- ------------ ---------- ----------
43   cg01263624   -0.0426   0.0183   -2.3238   0.0208396   0.5045503
35   cg04451175   -0.0620   0.0276   -2.2506   0.0251710   0.5045503
42   cg23374834   0.0455   0.0222   2.0517   0.0411116   0.5045503
59   cg05006231   0.0182   0.0090   2.0182   0.0445088   0.5045503
18   cg06941635   -0.0480   0.0239   -2.0107   0.0452986   0.5045503
24   cg25107000   0.0242   0.0123   1.9707   0.0497282   0.5045503
58   cg00963654   0.0337   0.0181   1.8682   0.0627582   0.5045503
39   cg08541962   0.0402   0.0218   1.8488   0.0655269   0.5045503
15   cg23110957   0.0716   0.0398   1.8000   0.0729242   0.5045503
5   cg25138412   -0.0286   0.0163   -1.7564   0.0800873   0.5045503
##
[[6]]
##
##
Table: Top CpGs from 63 CpGs for Outcome: HDL_IPV3 of male (Sample Size = 261)
##
names   Estimate   Std.Error   t.statistic   p.value   FDR
--- ----------- --------- ---------- ------------ ---------- ----------
22   cg13502540   0.0784   0.0246   3.1805   0.0016553   0.1042855
46   cg04024827   0.0886   0.0306   2.8993   0.0040709   0.1282331
21   cg26922678   0.0319   0.0133   2.3951   0.0173517   0.2348350
17   cg26232870   0.0828   0.0360   2.3019   0.0221623   0.2348350
8   cg02713669   0.0652   0.0284   2.2928   0.0226868   0.2348350
14   cg24549659   0.0275   0.0121   2.2803   0.0234312   0.2348350
45   cg06230206   -0.0644   0.0288   -2.2381   0.0260928   0.2348350
16   cg25399309   0.0483   0.0237   2.0350   0.0429033   0.3098487
24   cg25107000   0.0288   0.0143   2.0217   0.0442641   0.3098487
62   cg07226201   -0.0493   0.0261   -1.8896   0.0599670   0.3500018
##
[[7]]
##
##
Table: Top CpGs from 63 CpGs for Outcome: Insu_IPV3 of male (Sample Size = 282)
##
names   Estimate   Std.Error   t.statistic   p.value   FDR
--- ----------- --------- ---------- ------------ ---------- ----------
42   cg23374834   0.1686   0.0586   2.8765   0.0043391   0.2733604
27   cg09312897   0.0393   0.0155   2.5347   0.0118167   0.2854912
5   cg25138412   -0.1088   0.0438   -2.4840   0.0135948   0.2854912
25   cg02002586   0.2004   0.0856   2.3415   0.0199308   0.3139107
24   cg25107000   0.0622   0.0331   1.8798   0.0611997   0.6919812
54   cg04050728   0.1964   0.1104   1.7790   0.0763624   0.6919812
17   cg26232870   0.1398   0.0841   1.6618   0.0977107   0.6919812
35   cg04451175   -0.1212   0.0743   -1.6315   0.1039439   0.6919812
57   cg24870966   -0.1240   0.0780   -1.5901   0.1129710   0.6919812
19   cg20249327   -0.0244   0.0159   -1.5346   0.1260567   0.6919812
##

```
## [[8]]
##
##
## Table: Top CpGs from 63 CpGs for Outcome: Trig_IPV3 of male (Sample Size = 284)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 25   cg02002586     -0.2134      0.0655       -3.2588   0.0012600   0.0468312
## 30   cg11074783     -0.1476      0.0477       -3.0957   0.0021669   0.0468312
## 46   cg04024827     -0.1731      0.0561       -3.0869   0.0022301   0.0468312
## 57   cg24870966      0.1758      0.0605        2.9081   0.0039342   0.0619640
## 17   cg26232870     -0.1774      0.0657       -2.6991   0.0073845   0.0930450
## 44   cg09188980      0.1310      0.0554        2.3640   0.0187762   0.1971500
## 61   cg09555818     -0.0647      0.0292       -2.2190   0.0273030   0.2457272
## 20   cg27313566     -0.0747      0.0355       -2.1048   0.0362201   0.2852331
## 62   cg07226201      0.0922      0.0469        1.9670   0.0501873   0.3186603
## 22   cg13502540     -0.0880      0.0448       -1.9637   0.0505810   0.3186603
##
## [[9]]
##
##
## Table: Top CpGs from 63 CpGs for Outcome: Leptin_actual__ng_ml_ of male (Sample Size = 252)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 40   cg04850999      0.3745      0.1025        3.6548   0.0003157   0.0198889
## 44   cg09188980      0.3368      0.1103        3.0539   0.0025113   0.0791051
## 8    cg02713669     -0.3136      0.1139       -2.7534   0.0063448   0.1332417
## 55   cg09713758     -0.3912      0.1598       -2.4480   0.0150780   0.2374782
## 16   cg25399309      0.1866      0.0884        2.1120   0.0357105   0.4499521
## 15   cg23110957     -0.3150      0.1614       -1.9514   0.0521639   0.5477210
## 20   cg27313566     -0.1196      0.0713       -1.6773   0.0947724   0.6674954
## 38   cg09642378      0.1537      0.0920        1.6698   0.0962464   0.6674954
## 12   cg00347798      0.1948      0.1199        1.6241   0.1056562   0.6674954
## 10   cg25810938     -0.0716      0.0450       -1.5893   0.1132885   0.6674954
```

```r
lapply(Outcomes, function(x) {
    cpg_FunRegSim(log10(clinchem_m[, x]), CpGdatapfhxs_m, clinchem_m,
        x, 10, "pfhxs")
})
```

```
## [[1]]
##
##
## Table: Top CpGs from 33 CpGs for Outcome: birth_weight of male (Sample Size = 305)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 31   cg00300969      0.0593      0.0237        2.5076   0.0126934   0.4188825
## 11   cg05540047      0.0317      0.0185        1.7148   0.0874404   0.7952057
## 32   cg08440266      0.0217      0.0129        1.6868   0.0926948   0.7952057
## 5    cg06102419      0.0155      0.0098        1.5802   0.1151279   0.7952057
## 14   cg10978585     -0.0169      0.0116       -1.4555   0.1465824   0.7952057
## 1    cg11391637     -0.0177      0.0129       -1.3639   0.1736296   0.7952057
## 33   cg15194925     -0.0239      0.0201       -1.1883   0.2356516   0.7952057
```

```
## 12   cg01362455     -0.0127      0.0116       -1.0988   0.2727571   0.7952057
## 13   cg10930308     -0.0025      0.0024       -1.0217   0.3077562   0.7952057
## 4    cg03776087     -0.0133      0.0133       -0.9985   0.3188535   0.7952057
##
## [[2]]
##
##
## Table: Top CpGs from 33 CpGs for Outcome: ipv3_pp_fm_pct of male (Sample Size = 292)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 20   cg08146609      0.2059      0.1043        1.9738   0.0493772   0.5381358
## 8    cg04490945     -0.0970      0.0506       -1.9159   0.0563837   0.5381358
## 33   cg15194925     -0.1519      0.0820       -1.8516   0.0651336   0.5381358
## 30   cg08381537     -0.0468      0.0272       -1.7195   0.0866264   0.5381358
## 15   cg00686197     -0.1476      0.0868       -1.7010   0.0900517   0.5381358
## 6    cg18005693      0.0409      0.0247        1.6609   0.0978429   0.5381358
## 29   cg10696199     -0.0849      0.0562       -1.5101   0.1321344   0.6103976
## 21   cg07673020     -0.0380      0.0270       -1.4073   0.1604474   0.6103976
## 27   cg12390516     -0.0357      0.0258       -1.3872   0.1664721   0.6103976
## 17   cg06814287     -0.0924      0.0769       -1.2021   0.2303208   0.6426143
##
## [[3]]
##
##
## Table: Top CpGs from 33 CpGs for Outcome: Chol_IPV3 of male (Sample Size = 287)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 33   cg15194925     -0.1113      0.0423       -2.6291   0.0090385   0.1549032
## 28   cg11647108      0.0552      0.0211        2.6159   0.0093881   0.1549032
## 13   cg10930308     -0.0121      0.0051       -2.3678   0.0185791   0.2043703
## 8    cg04490945      0.0563      0.0264        2.1304   0.0340157   0.2806295
## 11   cg05540047     -0.0687      0.0394       -1.7452   0.0820560   0.5415694
## 1    cg11391637      0.0399      0.0277        1.4405   0.1508680   0.8297742
## 18   cg13840445      0.0569      0.0440        1.2910   0.1977973   0.8767404
## 12   cg01362455      0.0248      0.0251        0.9879   0.3240635   0.8767404
## 22   cg04155289      0.0161      0.0171        0.9423   0.3468770   0.8767404
## 20   cg08146609      0.0487      0.0539        0.9036   0.3669886   0.8767404
##
## [[4]]
##
##
## Table: Top CpGs from 33 CpGs for Outcome: FFA_IPV3 of male (Sample Size = 265)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 26   cg07862768      0.1671      0.0684        2.4431   0.0152402   0.3098008
## 11   cg05540047     -0.1669      0.0774       -2.1556   0.0320523   0.3098008
## 25   cg09323728      0.0934      0.0450        2.0764   0.0388544   0.3098008
## 13   cg10930308     -0.0196      0.0101       -1.9454   0.0528317   0.3098008
## 28   cg11647108      0.0794      0.0411        1.9353   0.0540631   0.3098008
## 31   cg00300969      0.1899      0.0991        1.9172   0.0563274   0.3098008
## 10   cg16031250      0.1517      0.0945        1.6048   0.1097677   0.4329549
```

```
## 23   cg14009688      0.1262      0.0798        1.5812   0.1150690   0.4329549
## 7    cg01382474      0.1281      0.0817        1.5673   0.1182827   0.4329549
## 19   cg03942932     -0.1026      0.0683       -1.5033   0.1340007   0.4329549
##
## [[5]]
##
##
## Table: Top CpGs from 33 CpGs for Outcome: Gluc_IPV3 of male (Sample Size = 295)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 11   cg05540047      0.0664      0.0339        1.9577   0.0512406   0.6107543
## 5    cg06102419     -0.0340      0.0182       -1.8711   0.0623528   0.6107543
## 10   cg16031250      0.0733      0.0413        1.7747   0.0770168   0.6107543
## 3    cg21550016      0.0128      0.0074        1.7207   0.0863948   0.6107543
## 15   cg00686197      0.0582      0.0390        1.4929   0.1365627   0.6107543
## 17   cg06814287      0.0517      0.0349        1.4801   0.1399634   0.6107543
## 19   cg03942932      0.0440      0.0305        1.4429   0.1501584   0.6107543
## 20   cg08146609      0.0659      0.0467        1.4128   0.1587914   0.6107543
## 14   cg10978585     -0.0300      0.0216       -1.3869   0.1665694   0.6107543
## 18   cg13840445      0.0477      0.0373        1.2792   0.2018780   0.6661976
##
## [[6]]
##
##
## Table: Top CpGs from 33 CpGs for Outcome: HDL_IPV3 of male (Sample Size = 261)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 33   cg15194925     -0.1157      0.0413       -2.8047   0.0054311   0.1792279
## 8    cg04490945      0.0495      0.0261        1.8942   0.0593543   0.6809230
## 32   cg08440266      0.0515      0.0275        1.8716   0.0624246   0.6809230
## 16   cg00875541      0.0974      0.0583        1.6702   0.0961273   0.6809230
## 28   cg11647108      0.0341      0.0209        1.6356   0.1031702   0.6809230
## 13   cg10930308     -0.0066      0.0051       -1.2845   0.2001550   0.9751269
## 26   cg07862768     -0.0385      0.0347       -1.1103   0.2679506   0.9751269
## 11   cg05540047     -0.0433      0.0402       -1.0774   0.2823270   0.9751269
## 15   cg00686197      0.0451      0.0456        0.9896   0.3233126   0.9751269
## 9    cg07350977     -0.0163      0.0180       -0.9088   0.3643113   0.9751269
##
## [[7]]
##
##
## Table: Top CpGs from 33 CpGs for Outcome: Insu_IPV3 of male (Sample Size = 282)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 20   cg08146609      0.4062      0.1225        3.3159   0.0010376   0.0342418
## 15   cg00686197      0.2250      0.1045        2.1525   0.0322392   0.4882917
## 22   cg04155289     -0.0788      0.0393       -2.0053   0.0459237   0.4882917
## 14   cg10978585     -0.1085      0.0573       -1.8947   0.0591869   0.4882917
## 29   cg10696199      0.1133      0.0708        1.5991   0.1109518   0.7322819
## 5    cg06102419     -0.0688      0.0484       -1.4217   0.1562550   0.7974443
## 17   cg06814287     -0.1174      0.0954       -1.2296   0.2198957   0.7974443
```

```
## 33   cg15194925     -0.1162      0.0976       -1.1898   0.2351447   0.7974443
## 26   cg07862768      0.0882      0.0827        1.0667   0.2870750   0.7974443
## 23   cg14009688      0.1001      0.0953        1.0507   0.2943513   0.7974443
##
## [[8]]
##
##
## Table: Top CpGs from 33 CpGs for Outcome: Trig_IPV3 of male (Sample Size = 284)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 14   cg10978585     -0.1183      0.0448       -2.6433   0.0086841   0.2146249
## 15   cg00686197     -0.2037      0.0815       -2.4999   0.0130076   0.2146249
## 13   cg10930308     -0.0213      0.0093       -2.2948   0.0225020   0.2475220
## 27   cg12390516     -0.0383      0.0243       -1.5756   0.1162676   0.7836122
## 28   cg11647108      0.0539      0.0383        1.4072   0.1605005   0.7836122
## 17   cg06814287      0.0973      0.0732        1.3289   0.1849821   0.7836122
## 1    cg11391637      0.0661      0.0501        1.3214   0.1874707   0.7836122
## 19   cg03942932     -0.0839      0.0639       -1.3139   0.1899666   0.7836122
## 22   cg04155289      0.0338      0.0307        1.1015   0.2716500   0.9433093
## 25   cg09323728      0.0462      0.0433        1.0668   0.2870187   0.9433093
##
## [[9]]
##
##
## Table: Top CpGs from 33 CpGs for Outcome: Leptin_actual__ng_ml_ of male (Sample Size = 252)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 20   cg08146609      0.5291      0.1971        2.6846   0.0077626   0.2427193
## 22   cg04155289     -0.1512      0.0616       -2.4571   0.0147103   0.2427193
## 12   cg01362455     -0.1715      0.0910       -1.8842   0.0607348   0.6680826
## 13   cg10930308     -0.0285      0.0185       -1.5429   0.1241683   0.6681865
## 6    cg18005693      0.0727      0.0487        1.4944   0.1363712   0.6681865
## 14   cg10978585     -0.1365      0.0915       -1.4925   0.1368648   0.6681865
## 25   cg09323728      0.1177      0.0860        1.3691   0.1722449   0.6681865
## 21   cg07673020      0.0664      0.0516        1.2861   0.1996543   0.6681865
## 8    cg04490945     -0.1126      0.0951       -1.1834   0.2378054   0.6681865
## 33   cg15194925     -0.1781      0.1554       -1.1459   0.2529660   0.6681865
```

```
lapply(Outcomes, function(x) {
    cpg_FunRegSim(log10(clinchem_m[, x]), CpGdatapfos_m, clinchem_m,
        x, 10, "pfos")
})
```

```
## [[1]]
##
##
## Table: Top CpGs from 52 CpGs for Outcome: birth_weight of male (Sample Size = 305)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 26   cg27110277      0.0378      0.0160        2.3674   0.0185572   0.7563043
## 33   cg18419977     -0.0148      0.0075       -1.9703   0.0497366   0.7563043
## 28   cg12630277     -0.0452      0.0249       -1.8140   0.0706915   0.7563043
```

```
## 6    cg00805880     -0.0055      0.0030       -1.8039   0.0722632   0.7563043
## 50   cg14686919     -0.0402      0.0223       -1.8010   0.0727216   0.7563043
## 11   cg10144569      0.0213      0.0155        1.3732   0.1707241   0.8604757
## 23   cg06915202      0.0124      0.0092        1.3515   0.1775821   0.8604757
## 10   cg04220455     -0.0220      0.0169       -1.2996   0.1947469   0.8604757
## 31   cg00570518     -0.0349      0.0272       -1.2838   0.2002225   0.8604757
## 35   cg15212210      0.0092      0.0081        1.1320   0.2585387   0.8604757
##
## [[2]]
##
##
## Table: Top CpGs from 52 CpGs for Outcome: ipv3_pp_fm_pct of male (Sample Size = 292)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 24   cg11961845      0.3671      0.1119        3.2801   0.0011678   0.0607279
## 2    cg16091981      0.1887      0.0889        2.1230   0.0346276   0.6899519
## 52   cg12262698     -0.1091      0.0545       -2.0021   0.0462363   0.6899519
## 17   cg26922678      0.0486      0.0257        1.8906   0.0596969   0.6899519
## 20   cg13351249      0.1707      0.0926        1.8433   0.0663415   0.6899519
## 4    cg14667685     -0.0409      0.0300       -1.3660   0.1730220   0.9906424
## 31   cg00570518     -0.1435      0.1078       -1.3316   0.1840826   0.9906424
## 48   cg05006231      0.0261      0.0200        1.3081   0.1918991   0.9906424
## 26   cg27110277     -0.0825      0.0655       -1.2587   0.2091942   0.9906424
## 49   cg03908391     -0.1106      0.0953       -1.1612   0.2465314   0.9906424
##
## [[3]]
##
##
## Table: Top CpGs from 52 CpGs for Outcome: Chol_IPV3 of male (Sample Size = 287)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 20   cg13351249      0.1072      0.0480        2.2345   0.0262493   0.5761486
## 25   cg06840743     -0.0398      0.0189       -2.1028   0.0363816   0.5761486
## 49   cg03908391      0.0991      0.0490        2.0221   0.0441314   0.5761486
## 52   cg12262698      0.0584      0.0289        2.0203   0.0443191   0.5761486
## 21   cg19340455      0.0820      0.0436        1.8807   0.0610609   0.6119294
## 51   cg06748147      0.0944      0.0520        1.8150   0.0706072   0.6119294
## 40   cg01270593      0.0705      0.0413        1.7078   0.0887913   0.6510920
## 45   cg06803140      0.0804      0.0505        1.5933   0.1122248   0.6510920
## 36   cg18886147     -0.0786      0.0519       -1.5142   0.1311272   0.6510920
## 48   cg05006231      0.0159      0.0106        1.5061   0.1331713   0.6510920
##
## [[4]]
##
##
## Table: Top CpGs from 52 CpGs for Outcome: FFA_IPV3 of male (Sample Size = 265)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 46   cg04077795     -0.2245      0.0671       -3.3460   0.0009435   0.0490635
## 32   cg18899569      0.1287      0.0619        2.0776   0.0387427   0.5538829
## 21   cg19340455     -0.1708      0.0833       -2.0503   0.0413541   0.5538829
```

```
## 38   cg04024827     -0.1275      0.0626       -2.0378   0.0426064   0.5538829
## 29   cg19286437     -0.1420      0.0781       -1.8173   0.0703424   0.7315615
## 15   cg13927501      0.1888      0.1322        1.4288   0.1542972   0.8162738
## 28   cg12630277     -0.1469      0.1051       -1.3973   0.1635527   0.8162738
## 14   cg19025234     -0.1553      0.1164       -1.3338   0.1834615   0.8162738
## 49   cg03908391     -0.1194      0.0946       -1.2623   0.2079954   0.8162738
## 40   cg01270593      0.0973      0.0811        1.2002   0.2311574   0.8162738
##
## [[5]]
##
##
## Table: Top CpGs from 52 CpGs for Outcome: Gluc_IPV3 of male (Sample Size = 295)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 26   cg27110277     -0.0802      0.0294       -2.7284   0.0067602   0.3206880
## 6    cg00805880      0.0136      0.0057        2.3914   0.0174341   0.3206880
## 52   cg12262698     -0.0573      0.0249       -2.3005   0.0221427   0.3206880
## 37   cg27138204      0.0792      0.0351        2.2585   0.0246683   0.3206880
## 16   cg20795372     -0.0524      0.0259       -2.0239   0.0439101   0.3857433
## 48   cg05006231      0.0182      0.0090        2.0182   0.0445088   0.3857433
## 50   cg14686919     -0.0762      0.0419       -1.8192   0.0699292   0.4463205
## 45   cg06803140      0.0780      0.0432        1.8051   0.0721112   0.4463205
## 43   cg15484651      0.0746      0.0421        1.7733   0.0772478   0.4463205
## 15   cg13927501      0.0975      0.0590        1.6530   0.0994232   0.5009240
##
## [[6]]
##
##
## Table: Top CpGs from 52 CpGs for Outcome: HDL_IPV3 of male (Sample Size = 261)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 38   cg04024827      0.0886      0.0306        2.8993   0.0040709   0.1392609
## 28   cg12630277     -0.1436      0.0519       -2.7684   0.0060538   0.1392609
## 40   cg01270593      0.1081      0.0405        2.6720   0.0080343   0.1392609
## 17   cg26922678      0.0319      0.0133        2.3951   0.0173517   0.2255722
## 16   cg20795372      0.0616      0.0290        2.1222   0.0347995   0.3619153
## 21   cg19340455      0.0831      0.0420        1.9781   0.0490120   0.3652284
## 37   cg27138204      0.0793      0.0412        1.9235   0.0555531   0.3652284
## 18   cg08617970     -0.1713      0.0893       -1.9184   0.0561890   0.3652284
## 25   cg06840743     -0.0312      0.0191       -1.6396   0.1023383   0.4897548
## 36   cg18886147     -0.0821      0.0509       -1.6125   0.1081033   0.4897548
##
## [[7]]
##
##
## Table: Top CpGs from 52 CpGs for Outcome: Insu_IPV3 of male (Sample Size = 282)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 43   cg15484651      0.3061      0.1159        2.6405   0.0087567   0.3790235
## 13   cg20289913      0.0639      0.0260        2.4584   0.0145778   0.3790235
## 9    cg19988482      0.2238      0.1021        2.1919   0.0292310   0.5066699
```

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## 22   cg04155289     -0.0788      0.0393       -2.0053   0.0459237   0.5489159
## 26   cg27110277     -0.1543      0.0795       -1.9399   0.0534262   0.5489159
## 49   cg03908391     -0.2099      0.1126       -1.8644   0.0633365   0.5489159
## 8    cg13170076     -0.0964      0.0567       -1.6999   0.0902978   0.6388802
## 37   cg27138204      0.1534      0.0940        1.6311   0.1040351   0.6388802
## 52   cg12262698     -0.1080      0.0696       -1.5516   0.1219304   0.6388802
## 33   cg18419977      0.0533      0.0363        1.4704   0.1426072   0.6388802
##
## [[8]]
##
##
## Table: Top CpGs from 52 CpGs for Outcome: Trig_IPV3 of male (Sample Size = 284)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 38   cg04024827     -0.1731      0.0561       -3.0869   0.0022301   0.1159628
## 14   cg19025234     -0.3064      0.1093       -2.8034   0.0054175   0.1408560
## 24   cg11961845      0.2784      0.1074        2.5915   0.0100669   0.1648980
## 1    cg00078456     -0.1391      0.0557       -2.4957   0.0131609   0.1648980
## 41   cg09628216      0.1790      0.0738        2.4273   0.0158556   0.1648980
## 2    cg16091981      0.1612      0.0830        1.9416   0.0532049   0.4611095
## 18   cg08617970     -0.2923      0.1603       -1.8239   0.0692587   0.5144930
## 27   cg01073837     -0.0901      0.0529       -1.7041   0.0895020   0.5199171
## 50   cg14686919      0.1480      0.0885        1.6729   0.0954829   0.5199171
## 16   cg20795372     -0.0899      0.0544       -1.6505   0.0999841   0.5199171
##
## [[9]]
##
##
## Table: Top CpGs from 52 CpGs for Outcome: Leptin_actual__ng_ml_ of male (Sample Size = 252)
##
##      names         Estimate   Std.Error   t.statistic     p.value         FDR
## ---  -----------  ---------  ----------  ------------  ----------  ----------
## 24   cg11961845      0.6755      0.2098        3.2191   0.0014619   0.0760177
## 13   cg20289913      0.1161      0.0405        2.8632   0.0045611   0.1185895
## 7    cg00563566     -0.7192      0.2892       -2.4871   0.0135543   0.1912334
## 22   cg04155289     -0.1512      0.0616       -2.4571   0.0147103   0.1912334
## 34   cg25010124      0.2178      0.1022        2.1314   0.0340665   0.3542918
## 26   cg27110277      0.2403      0.1257        1.9122   0.0570278   0.4942413
## 41   cg09628216     -0.2888      0.1593       -1.8125   0.0711523   0.5285601
## 16   cg20795372      0.1710      0.1079        1.5846   0.1143716   0.6642857
## 47   cg19738980      0.1084      0.0732        1.4801   0.1401591   0.6642857
## 32   cg18899569      0.1695      0.1165        1.4549   0.1470061   0.6642857
```