library(survey)
library(mice)

# Read in Nhanes C11 data set, set up for missing data imputation and analysis 2
nhanesc12 <- read.table(file = "P:/ASDA 2/Data sets/nhanes 2011_2012/c12_impute_subset_nhanes1112.csv", sep = ",", header = T, as.is=T)
nhanesc12$marcat=factor(nhanesc12$marcat)

# subset to just records used in analysis
nhanesc12_sub <- nhanesc12[ which(nhanesc12$age18p==1 & nhanesc12$wtmec2yr >0),]
summary(nhanesc12_sub)

# Missing data pattern
md.pattern(nhanesc12_sub)

# create an indicator of high blood pressure
nhanesc12_sub$high_diastolic <- ifelse(nhanesc12_sub$bpxdi1_1 >=90, 1,0)
summary(nhanesc12_sub$high_diastolic)

# survey design
nhanessvy <- svydesign(strata=~sdmvstra, id=~sdmvpsu, weights=~wtmec2yr, data=nhanesc12_sub, nest=T)

# Complete Case Analysis
# Obtain means for 3 continuous variables imputed using method 1 as well, Table 12.3
show(ex12_3a <- svymean(~bmxbmi, nhanessvy, se=T, na.rm=T, ci=T))
show(ex12_3b <- svymean(~bpxdi1_1, nhanessvy, se=T, na.rm=T, ci=T))
show(ex12_3c <- svymean(~indfmpir, nhanessvy, se=T, na.rm=T, ci=T))

# High Blood Pressure Mean, Complete Case, Table 12.4
(ex12_4 <- svymean(~factor(high_diastolic),nhanessvy, se=T, na.rm=T, deff=T, ci=T, keep.vars=T))
confint(ex12_4)

# Logistic Regression Complete Case Analysis with Design Correction, Table 12.5
mod12_5 <- svyglm(high_diastolic ~ factor(ridreth1) + factor(riagendr)+ agec + agecsq,family=quasibinomial, design=nhanessvy)
summary(mod12_5)
# Method 1 with Design Variables in Model

nhanesc12_subm1 <- nhanesc12[ which(nhanesc12$age18p==1 & nhanesc12$wtmec2yr >0),]

#nhanesc12_subm1$descode=factor(nhanesc12_subm1$descode)

summary(nhanesc12_subm1)

# use mice to impute and specify type of default method for imputation models

# run without custom predictor matrix first

impm1 <- mice(nhanesc12_subm1, n.imp=5, seed=2016, defaultMethod=c("norm","logreg","polyreg"))

impm1$predictorMatrix

summary(impm1)

# add a predictor matrix to control imputation model predictors for each imputed variable

pred <- impm1$predictorMatrix

pred[, "sdmvpsu"] <- 0

pred[, "sdmvstra"] <- 0

pred[, "seqn"] <- 0

pred[, "age18p"] <- 0

pred[, "descode"] <- 1

impm1$predictorMatrix

pred

impm1_pred <- mice(nhanesc12_subm1, pred=pred, n.imp=5, seed=2016, defaultMethod=c("norm","logreg","polyreg"))

summary(impm1_pred)

# create new high diastolic blood pressure base on imputed bpxdi1_1, prepare long data set and then back to mids after computation

longm1 <- complete(impm1_pred, action='long', include=TRUE)

longm1$high_diastolic <- ifelse(longm1$bpxdi1_1 >=90,1,0)

summary(longm1)

#use as.mids() to convert back to mids object

impm1a <- as.mids(longm1)

# convert mids to data useable for work in mitools

library(mitools)

mydatam1 <- imputationList(lapply(1:5, complete, x=impm1a))

summary(mydatam1)

# set survey design

library(survey)

desm1 <- svydesign(id=~sdmvstra, strat=~sdmvpsu, weight=~wtmec2yr, data=(mydatam1), nest=TRUE)

summary(desm1)

# run design based logistic model with svyglm using 5 imputed data sets contained in desm1, Taable 12.5

fitm1 <- with(desm1, svyglm (high_diastolic ~ factor(ridreth1) + factor(riagendr) + agec + agecsq,
family=quasibinomial))

summary(MIcombine(fitm1))

# combined mean high blood pressure with design adjustment, Table 12.4

fitm1_mean <- with(desm1, svymean(~factor(high_diastolic), se=T, na.rm=T, ci=T ))

# mean high blood pressure for each imputed data set

fitm1_mean
# Use MIcombine for overall combined and design-adjusted mean/se
summary(MIcombine(fitm1_mean))
# Obtain means for 3 continuous variables imputed using method 1 as well, Table 12.3
fitm1_ex12_3 <- with(desm1, svymean(~bmxbmi+bpxd1_1+indfmpir), se=T, na.rm=T, ci=T)
fitm1_ex12_3
Method 2 WITHOUT Design Variables in Model

# return to original data without the CC high diastolic blood pressure
nhanesc12_subm2 <- nhanesc12[ which(nhanesc12$age18p==1 & nhanesc12$wtmec2yr >0),]

#nhanesc12_subm2$descode=factor(nhanesc12_subm2$descode)
summary(nhanesc12_subm2)

# use mice to impute and specify type of default method for imputation models

# run without custom predictor matrix first
impm2 <- mice(nhanesc12_subm2, n.imp=5, seed=2016, defaultMethod=c("norm","logreg","polyreg"))
impm2$predictorMatrix
summary(impm2)

# add a predictor matrix to control imputation model predictors for each imputed variable
pred <- impm2$predictorMatrix
pred[, "sdmvpsu"] <- 0
pred[, "sdmvstra"] <- 0
pred[, "seqn"] <- 0
pred[, "age18p"] <- 0
pred[, "descode"] <- 0
pred[, "wtmec2yr"] <- 0
impm2$predictorMatrix
pred

impm2_pred <- mice(nhanesc12_subm2, pred=pred, n.imp=5, seed=2016, defaultMethod=c("norm","logreg","polyreg"))
summary(impm2_pred)

# create new high diastolic blood pressure base on imputed bpxdi1_1, prepare long data set and then back to mids after computation
longm2 <- complete(impm2_pred, action='long', include=TRUE)
longm2$high_diastolic <- ifelse(longm2$bpxdi1_1 >=90,1,0)
summary(longm2)

#use as.mids() to convert back to mids object
impm2a <- as.mids(longm2)

# convert mids to data useable for work in mitools
library(mitools)
mydatam2 <- imputationList(lapply(1:5, complete, x=impm2a))
summary(mydatam2)

# set survey design
library(survey)
desm2 <- svydesign(id=~sdmvstra, strat=~sdmvpsu, weight=~wtmec2yr, data=(mydatam2), nest=TRUE)
summary(desm2)

# run design based logistic model with svyglm using 5 imputed data sets contained in desm1, Table 12.5
fitm2 <- with(desm2, svyglm (high_diastolic ~ factor(ridreth1) + factor(riagendr) + agec + agecsq,
family=quasibinomial))
summary(MIcombine(fitm2))

# combined mean high blood pressure with design adjustment, Table 12.4
fitm2_mean <- with(desm2, svymean(~factor(high_diastolic), se=T, na.rm=T, ci=T))
# mean high blood pressure for each imputed data set

fitm2_mean

# Use MIcombine for overall combined and design-adjusted mean/se

summary(MIcombine(fitm2_mean))

# Note: FEFI method available in R as of early June 2017, see
https://sites.google.com/view/jaekwangkim/software for more information, this will be included on ASDA website in the near future.
> # Chapter 12 Multiple Imputation
> # stata code as guide
> library(survey)
> library(mice)
>
> # Read in Nhanes C11 data set, set up for missing data imputation and analysis 2
> nhanesc12 <- read.table(file = "P:/ASDA 2/Data sets/nhanes 2011_2012/c12_impute_subset_nhanes1112.csv", sep = ",", header = T, as.is=T)
> nhanesc12$marcat=factor(nhanesc12$marcat)
>
> # subset to just records used in analysis
> nhanesc12_sub <- nhanesc12[ which(nhanesc12$age18p==1 & nhanesc12$wtmec2yr >0),]
> summary(nhanesc12_sub)

```
seqn    riagendr    ridreth1  wtmec2yr  sdmvpsu  sdmvstra
Min.   :62161  Min.   :1.000  Min.   :1.000  Min.   : 4413  Min.   :1.000  Min.   : 90.00
1st Qu.:64611  1st Qu.:1.000  1st Qu.:3.000  1st Qu.: 16174  1st Qu.:1.000  1st Qu.: 92.00
Median :67109  Median :2.000  Median :3.000  Median : 24567  Median :2.000  Median : 96.00
Mean   :67076  Mean   :1.506  Mean   :3.301  Mean   : 41318  Mean   :1.638  Mean   : 95.87
3rd Qu.:69533  3rd Qu.:2.000  3rd Qu.:4.000  3rd Qu.: 45238  3rd Qu.:2.000  3rd Qu.: 99.00
Max.   :71915  Max.   :2.000  Max.   :5.000  Max.   :222580  Max.   :3.000  Max.   :103.00

indmpir    bmxbmi      age18p  age  marcat     descode  bpxdi1_1
Min.   :0.000  Min.   :13.40  Min.   :18.00  1   :2991  Min.   : 901.0  Min.   : 10.00
1st Qu.:0.950  1st Qu.:23.80  1st Qu.:31.00  2   :1183  1st Qu.: 922.0  1st Qu.: 64.00
Median :1.840  Median :27.40  Median :47.00  3   :1141  Median : 961.0  Median : 72.00
Mean   :2.374  Mean   :28.62  Mean   :47.17  NA's: 300  Mean   : 960.3  Mean   : 71.02
3rd Qu.:3.933  3rd Qu.:32.00  3rd Qu.:62.00  3rd Qu.: 992.0  3rd Qu.: 99.00  3rd Qu.: 78.00
Max.   :5.000  Max.   :559.0785  Max.   :80.00  Max.   :1032.0  Max.   :120.00  Max.   :120.00
NA's   :487     NA's   :90

agemc  agecsq  age4cat
Min.   : -28.3552  Min.   : 0.1261  Min.   :1.000
1st Qu.: -15.3552  1st Qu.:  58.4436  1st Qu.:2.000
Median :   0.6448  Median : 244.7610  Median :3.000
Mean   :   0.8099  Mean   : 345.0635  Mean   :2.594
3rd Qu.:  15.6448  3rd Qu.: 559.0785  3rd Qu.:3.000
Max.   :  33.6448  Max.   :1131.9752  Max.   :4.000
```
```
> # Missing data pattern
> md.pattern(nhanesc12_sub)

```
  seqn  riagendr  ridreth1  wtmec2yr  sdmvpsu  sdmvstra  age18p  age  descode  indmpir  bmxbmi  age18p  age  marcat  descode  bpxdi1_1
4416    1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1
369     1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1
48      1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       0
230     1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       0
386     1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1
12      1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1
31      1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       0
6       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       0
62      1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       1
18      1       1       1       1       1       1       1       1       1       1       1       1       1       1       1       0
```
> # create an indicator of high blood pressure
> nhanesc12_sub$high_diastolic <- ifelse(nhanesc12_sub$bpxdi1_1 >= 90, 1, 0)
> summary(nhanesc12_sub$high_diastolic)

> # survey design
> nhanessvy <- svydesign(strata=~sdmvstra, id=~sdmvpsu, weights=~wtmec2yr, data=nhanesc12_sub, nest=T)

> # Complete Case Analysis
> # Obtain means for 3 continuous variables imputed using method 1 as well, Table 12.3
> show(ex12_3a <- svymean(~bmxbmi, nhanessvy, se=T, na.rm=T, ci=T))

mean SE
bmxbmi 28.623 0.214

> show(ex12_3b <- svymean(~bpxdi1_1, nhanessvy, se=T, na.rm=T, ci=T))

mean SE
bpxdi1_1 71.609 0.5047

> show(ex12_3c <- svymean(~indfmpir, nhanessvy, se=T, na.rm=T, ci=T))

mean SE
indfmpir 2.8592 0.1064

> # High Blood Pressure Mean, Complete Case, Table 12.4
> (ex12_4 <- svymean(~factor(high_diastolic), nhanessvy, se=T, na.rm=T, deff=T, ci=T, keep.vars=T))

mean SE  DEff
factor(high_diastolic)0 0.9391787 0.0079624 5.6729
factor(high_diastolic)1 0.0608213 0.0079624 5.6729

> confint(ex12_4)

2.5 %  97.5 %
factor(high_diastolic)0 0.92357258 0.95478473
factor(high_diastolic)1 0.04521527 0.07642742
Call:
svyglm(formula = high_diastolic ~ factor(ridreth1) + factor(riagendr) +
        agec + agecsq, family = quasibinomial, design = nhanessvy)

Survey design:
svydesign(strata = ~sdmvstra, id = ~sdmvpsu, weights = ~wtmec2yr,
        data = nhanesc12_sub, nest = T)

Coefficients:

|                | Estimate  | Std. Error | t value | Pr(>|t|) |
|----------------|-----------|------------|---------|----------|
| (Intercept)    | -2.2498852| 0.1985021  | -11.334 | 4.99e-07 *** |
| factor(ridreth1)2 | -0.7256815| 0.2449515  | -2.963  | 0.014226 *   |
| factor(ridreth1)3 | 0.1312534 | 0.2245498  | 0.585   | 0.571822    |
| factor(ridreth1)4 | 0.6582416 | 0.2463534  | 2.672   | 0.023414 *   |
| factor(ridreth1)5 | 0.0498803 | 0.2447868  | 0.204   | 0.842620    |
| factor(riagendr)2 | -0.5467630| 0.2077358  | -2.632  | 0.025075 *   |
| agec           | 0.0084599 | 0.0069603  | 1.215   | 0.252108    |
| agecsq         | -0.0016157| 0.0002767  | -5.838  | 0.000164 *** |

---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

(Dispersion parameter for quasibinomial family taken to be 1.019763)

Number of Fisher Scoring iterations: 6
> # Method 1 with Design Variables in Model
> # return to original data without the CC high diastolic blood pressure
> nhanesc12_subm1 <- nhanesc12[ which(nhanesc12$age18p==1 & nhanesc12$wtmec2yr >0),]
> nhanesc12_subm1$descode=factor(nhanesc12_subm1$descode)
>
> summary(nhanesc12_subm1)

```
seqn          riagendr        ridreth1        wtmec2yr         sdmvpsu         sdmvstra
Min.   :62161   Min.   :1.000   Min.   :1.000   Min.   :  4413   Min.   :1.000   Min.   : 90.00
1st Qu.:64611   1st Qu.:1.000   1st Qu.:3.000   1st Qu.: 16174   1st Qu.:1.000   1st Qu.: 92.00
Median :67109   Median :2.000   Median :3.000   Median : 24567   Median :2.000   Median : 96.00
Mean   :67076   Mean   :1.506   Mean   :3.301   Mean   : 41318   Mean   :1.638   Mean   : 95.87
3rd Qu.:69533   3rd Qu.:2.000   3rd Qu.:4.000   3rd Qu.: 45238   3rd Qu.:2.000   3rd Qu.: 99.00
Max.   :71915   Max.   :2.000   Max.   :5.000   Max.   :222580   Max.   :3.000   Max.   :103.00
indfmpir         bmxbmi          age18p       age         marcat        descode          bpxdi1_1
Min.   :0.000   Min.   :13.40   Min.   :1   Min.   :18.00   1   :2991   Min.   : 901.0   Min.   : 10.00
1st Qu.:0.950   1st Qu.:23.80   1st Qu.:1   1st Qu.:31.00   2   :1183   1st Qu.: 922.0   1st Qu.: 64.00
Median :1.840   Median :27.40   Median :1   Median :47.00   3   :1141   Median : 961.0   Median : 72.00
Mean   :2.374   Mean   :28.62   Mean   :1   Mean   :47.17 NA's: 300 Mean   : 960.3 Mean   : 71.02
3rd Qu.:3.933   3rd Qu.:32.00   3rd Qu.:1   3rd Qu.:62.00               3rd Qu.: 992.0   3rd Qu.: 78.00
Max.   :5.000   Max.   :82.10   Max.   :1   Max.   :80.00               Max.   :1032.0   Max.   :120.00
NA's :487      NA's :90                                                               NA's :503
agec              agecsq             age4cat
Min.   : 28.3552   Min.   : 0.1261   Min.   :1.000
1st Qu.: 15.3552   1st Qu.:  58.4436   1st Qu.:2.000
Median :  0.6448   Median : 244.7610   Median :3.000
Mean   :  0.8099   Mean   : 345.0635   Mean   :2.594
3rd Qu.: 15.6448   3rd Qu.: 559.0785   3rd Qu.:3.000
Max.   : 33.6448   Max.   :1131.9752   Max.   :4.000
```

> # use mice to impute and specify type of default method for imputation models

> # run without custom predictor matrix first
> impm1 <- mice(nhanesc12_subm1, n.imp=5, seed=2016, defaultMethod=c("norm","logreg","polyreg"))

```
iter imp variable
 1 1 indfmpir bmxbmi marcat bpxdi1_1
 1 2 indfmpir bmxbmi marcat bpxdi1_1
 1 3 indfmpir bmxbmi marcat bpxdi1_1
 1 4 indfmpir bmxbmi marcat bpxdi1_1
 1 5 indfmpir bmxbmi marcat bpxdi1_1
 2 1 indfmpir bmxbmi marcat bpxdi1_1
 2 2 indfmpir bmxbmi marcat bpxdi1_1
 2 3 indfmpir bmxbmi marcat bpxdi1_1
 2 4 indfmpir bmxbmi marcat bpxdi1_1
 2 5 indfmpir bmxbmi marcat bpxdi1_1
 3 1 indfmpir bmxbmi marcat bpxdi1_1
 3 2 indfmpir bmxbmi marcat bpxdi1_1
 3 3 indfmpir bmxbmi marcat bpxdi1_1
 3 4 indfmpir bmxbmi marcat bpxdi1_1
 3 5 indfmpir bmxbmi marcat bpxdi1_1
 4 1 indfmpir bmxbmi marcat bpxdi1_1
 4 2 indfmpir bmxbmi marcat bpxdi1_1
 4 3 indfmpir bmxbmi marcat bpxdi1_1
 4 4 indfmpir bmxbmi marcat bpxdi1_1
 4 5 indfmpir bmxbmi marcat bpxdi1_1
 5 1 indfmpir bmxbmi marcat bpxdi1_1
 5 2 indfmpir bmxbmi marcat bpxdi1_1
 5 3 indfmpir bmxbmi marcat bpxdi1_1
 5 4 indfmpir bmxbmi marcat bpxdi1_1
 5 5 indfmpir bmxbmi marcat bpxdi1_1
```
> impm1$predictorMatrix

<table>
<thead>
<tr>
<th>seqn</th>
<th>riagendr</th>
<th>ridreth1</th>
<th>wtmec2yr</th>
<th>sdmvpsu</th>
<th>sdmvstra</th>
<th>indfmpir</th>
<th>bmxbmi</th>
<th>age18p</th>
<th>age</th>
<th>marcat</th>
<th>descode</th>
<th>bpxdi1_1</th>
<th>agec</th>
<th>agecsq</th>
<th>age4cat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>seqn</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>riagendr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ridreth1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>wtmec2yr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>sdmvpsu</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>sdmvstra</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>indfmpir</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>bmxbmi</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>age18p</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>age</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>marcat</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>descode</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>bpxdi1_1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>agec</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>agecsq</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>age4cat</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

> summary(impm1)

Multiply imputed data set
Call:
mice(data = nhanesc12_subm1, defaultMethod = c("norm", "logreg", "polyreg"), seed = 2016, n.imp = 5)
Number of multiple imputations: 5
Missing cells per column:

<table>
<thead>
<tr>
<th>seqn</th>
<th>riagendr</th>
<th>ridreth1</th>
<th>wtmec2yr</th>
<th>sdmvpsu</th>
<th>sdmvstra</th>
<th>indfmpir</th>
<th>bmxbmi</th>
<th>age18p</th>
<th>age</th>
<th>marcat</th>
<th>descode</th>
<th>bpxdi1_1</th>
<th>agec</th>
<th>agecsq</th>
<th>age4cat</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>seqn</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>riagendr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ridreth1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>wtmec2yr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>sdmvpsu</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>sdmvstra</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>indfmpir</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>bmxbmi</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>age18p</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>age</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>marcat</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>descode</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>bpxdi1_1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>agec</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>agecsq</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>age4cat</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

>
Imputation methods:

<table>
<thead>
<tr>
<th>seqn</th>
<th>riagendr</th>
<th>ridreth1</th>
<th>wtmec2yr</th>
<th>sdmvpsu</th>
<th>sdmvstra</th>
<th>indfmpir</th>
<th>bmxbmi</th>
<th>age18p</th>
<th>age</th>
<th>marcat</th>
<th>descode</th>
<th>bpxdi1_1</th>
<th>agec</th>
<th>agecsq</th>
<th>age4cat</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;norm&quot;</td>
<td>&quot;norm&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;polyreg&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
</tr>
</tbody>
</table>

VisitSequence:

indfmpir bmxbmi marcat bpxdi1_1

7 8 11 13

PredictorMatrix:

<table>
<thead>
<tr>
<th>seqn</th>
<th>riagendr</th>
<th>ridreth1</th>
<th>wtmec2yr</th>
<th>sdmvpsu</th>
<th>sdmvstra</th>
<th>indfmpir</th>
<th>bmxbmi</th>
<th>age18p</th>
<th>age</th>
<th>marcat</th>
<th>descode</th>
<th>bpxdi1_1</th>
<th>agec</th>
<th>agecsq</th>
<th>age4cat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Random generator seed value: 2016
> # add a predictor matrix to control imputation model predictors for each imputed variable
> pred <- impm1$predictorMatrix
> pred[, "sdmvpsu"] <- 0
> pred[, "sdmvstra"] <- 0
> pred[, "seqn"] <- 0
> pred[, "age18p"] <- 0
> pred[, "descode"] <- 1
> impm1$predictorMatrix

<table>
<thead>
<tr>
<th>seqn</th>
<th>riagendr</th>
<th>ridreth1</th>
<th>wtmec2yr</th>
<th>sdmvpsu</th>
<th>sdmvstra</th>
<th>indfmpir</th>
<th>bmixbmi</th>
<th>age18p</th>
<th>age</th>
<th>marcat</th>
<th>descode</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

> pred

<table>
<thead>
<tr>
<th>seqn</th>
<th>riagendr</th>
<th>ridreth1</th>
<th>wtmec2yr</th>
<th>sdmvpsu</th>
<th>sdmvstra</th>
<th>indfmpir</th>
<th>bmixbmi</th>
<th>age18p</th>
<th>age</th>
<th>marcat</th>
<th>descode</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
imp1 pred <- mice(nhanesc12_subm1, pred=pred, n.imp=5, seed=2016, defaultMethod=c("norm","logreg","polyreg"))

iter imp variable
    1   1  indfmpir bmi bmi marcat bpxdi1_1
    1   2  indfmpir bmi bmi marcat bpxdi1_1
    1   3  indfmpir bmi bmi marcat bpxdi1_1
    1   4  indfmpir bmi bmi marcat bpxdi1_1
    1   5  indfmpir bmi bmi marcat bpxdi1_1
    2   1  indfmpir bmi bmi marcat bpxdi1_1
    2   2  indfmpir bmi bmi marcat bpxdi1_1
    2   3  indfmpir bmi bmi marcat bpxdi1_1
    2   4  indfmpir bmi bmi marcat bpxdi1_1
    2   5  indfmpir bmi bmi marcat bpxdi1_1
    3   1  indfmpir bmi bmi marcat bpxdi1_1
    3   2  indfmpir bmi bmi marcat bpxdi1_1
    3   3  indfmpir bmi bmi marcat bpxdi1_1
    3   4  indfmpir bmi bmi marcat bpxdi1_1
    3   5  indfmpir bmi bmi marcat bpxdi1_1
    4   1  indfmpir bmi bmi marcat bpxdi1_1
    4   2  indfmpir bmi bmi marcat bpxdi1_1
    4   3  indfmpir bmi bmi marcat bpxdi1_1
    4   4  indfmpir bmi bmi marcat bpxdi1_1
    4   5  indfmpir bmi bmi marcat bpxdi1_1
    5   1  indfmpir bmi bmi marcat bpxdi1_1
    5   2  indfmpir bmi bmi marcat bpxdi1_1
    5   3  indfmpir bmi bmi marcat bpxdi1_1
```
5 4 indfmpir bmxbmi marcat bpxdi1_1
5 5 indfmpir bmxbmi marcat bpxdi1_1

> summary(impm1_pred)

Multiply imputed data set

Call:
mice(data = nhanesc12_subm1, predictorMatrix = pred, defaultMethod = c("norm",
"logreg", "polyreg"), seed = 2016, n.imp = 5)

Number of multiple imputations: 5

Missing cells per column:

<table>
<thead>
<tr>
<th>seqn</th>
<th>riagendr</th>
<th>ridreth1</th>
<th>wtmec2yr</th>
<th>sdmvpsu</th>
<th>sdmvstra</th>
<th>indfmpir</th>
<th>bmxbmi</th>
<th>age18p</th>
<th>age</th>
<th>marcat</th>
<th>descode</th>
<th>bpxdi1_1</th>
<th>agec</th>
<th>agecsq</th>
<th>age4cat</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>487</td>
<td>90</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>300</td>
<td>0</td>
<td>503</td>
<td>0</td>
</tr>
</tbody>
</table>

Imputation methods:

<table>
<thead>
<tr>
<th>seqn</th>
<th>riagendr</th>
<th>ridreth1</th>
<th>wtmec2yr</th>
<th>sdmvpsu</th>
<th>sdmvstra</th>
<th>indfmpir</th>
<th>bmxbmi</th>
<th>age18p</th>
<th>age</th>
<th>marcat</th>
<th>descode</th>
<th>bpxdi1_1</th>
<th>agec</th>
<th>agecsq</th>
<th>age4cat</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;norm&quot;</td>
<td>&quot;norm&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;polyreg&quot;</td>
<td>&quot;norm&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td></td>
</tr>
</tbody>
</table>

VisitSequence:

<table>
<thead>
<tr>
<th>indfmpir</th>
<th>bmxbmi</th>
<th>marcat</th>
<th>bpxdi1_1</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>8</td>
<td>11</td>
<td>13</td>
</tr>
</tbody>
</table>

PredictorMatrix:

<table>
<thead>
<tr>
<th>seqn</th>
<th>riagendr</th>
<th>ridreth1</th>
<th>wtmec2yr</th>
<th>sdmvpsu</th>
<th>sdmvstra</th>
<th>indfmpir</th>
<th>bmxbmi</th>
<th>age18p</th>
<th>age</th>
<th>marcat</th>
<th>descode</th>
<th>bpxdi1_1</th>
<th>agec</th>
<th>agecsq</th>
<th>age4cat</th>
</tr>
</thead>
<tbody>
<tr>
<td>seqn</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>riagendr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ridreth1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>wtmec2yr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>sdmvpsu</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>sdmvstra</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>indfmpir</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>bmxbmi</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>age18p</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>age</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>marcat</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>descode</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>bpxdi1_1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>agec</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>agecsq</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>age4cat</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>bpxdi1_1</td>
<td>agec</td>
<td>agecsq</td>
<td>age4cat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>seqn</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>riagendr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ridreth1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>wtmec2yr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>sdmvpsu</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>sdmvstra</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>indfmpir</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>bmxbmi</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>age18p</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>age</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>marcat</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>descode</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>bpxdi1_1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
```

> # create new high diastolic blood pressure base on imputed bpxdi1_1, prepare long data set and then back to mids after computation
> longm1 <- complete(impm1_pred, action='long', include=TRUE)
> longm1$high_diastolic <- ifelse(longm1$bpxdi1_1 >= 90, 1, 0)
> summary(longm1)

> # use as.mids() to convert back to mids object
> impm1a <- as.mids(longm1)

> # set survey design
> library(survey)
> desm1 <- svydesign(id=~sdmvstra, strat=~sdmvpsu, weight=~wtmec2yr, data=(mydatam1), nest=TRUE)
> summary(desm1)
> # run design based logistic model with svyglm using 5 imputed data sets contained in desm1, Table 12.5
> fitm1 <- with(desm1, svyglm(high_diastolic ~ factor(ridreth1) + factor(riagendr) + agec + agecsq,
> family=quasibinomial))
> summary(MIcombine(fitm1))

Multiple imputation results:
with(desm1, svyglm(high_diastolic ~ factor(ridreth1) + factor(riagendr) +
agec + agecsq, family = quasibinomial))
MIcombine.default(fitm1)

results se (lower upper) missInfo
(Intercept) -2.21225529 0.2363615980 -2.67555595 -1.748954637 2 %
factor(ridreth1)2 -0.65726291 0.272186781 -1.19131231 -0.123213501 7 %
factor(ridreth1)3 0.14335568 0.2227878149 -0.29346488 0.580176235 4 %
factor(ridreth1)4 0.61474724 0.2373021838 0.14958714 1.079907345 2 %
factor(ridreth1)5 0.08433028 0.2932258468 -0.49178742 0.660447983 9 %
factor(riagendr)2 -0.55414764 0.1769625809 -1.00219639 -0.10698883 11 %
agec 0.01025488 0.0069408411 -0.00335723 0.023866981 5 %
agecsq -0.00177005 0.0002429929 -0.00224678 -0.001293319 6 %
>
> # combined mean high blood pressure with design adjustment, Table 12.4
> fitm1_mean <- with(desm1, svymean(~factor(high_diastolic), se = T, na.rm = T, ci = T))
> # mean high blood pressure for each imputed data set
> fitm1_mean

[[1]]
mean SE
factor(high_diastolic)0 0.939158 0.0065
factor(high_diastolic)1 0.060842 0.0065

[[2]]
mean SE
factor(high_diastolic)0 0.937171 0.0061
factor(high_diastolic)1 0.062829 0.0061

[[3]]
mean SE
factor(high_diastolic)0 0.937128 0.0072
factor(high_diastolic)1 0.062872 0.0072

[[4]]
mean SE
factor(high_diastolic)0 0.94144 0.0065
factor(high_diastolic)1 0.05856 0.0065

[[5]]
mean SE
factor(high_diastolic)0 0.939831 0.0064
factor(high_diastolic)1 0.060169 0.0064

attr(, 'call')
with(desm1, svymean(~factor(high_diastolic), se = T, na.rm = T,
ci = T))
> # Use MIcombine for overall combined and design-adjusted mean/se
> summary(MIcombine(fitm1_mean))
Multiple imputation results:
with(desm1, svymean(~factor(high_diastolic), se = T, na.rm = T, 
    ci = T))
WICombine.default(fitm1_mean)

results                      se     (lower    upper) missInfo
factor(high_diastolic)0 0.93894542 0.006851186 0.92548700 0.9524038      9%
factor(high_diastolic)1 0.06105458 0.006851186 0.04759615 0.0745130      9%

> # Obtain means for 3 continuous variables imputed using method 1 as well, Table 12.3
> fitm1_ex12_3 <- with(desm1, svymean(~bmxbmi+bpxdi1_1+indfmpir), se=T, na.rm=T, ci=T)
> fitm1_ex12_3

[[1]]
  mean     SE
bmxbmi    28.634 0.2356
bpxdi1_1  71.518 0.4253
indfmpir  2.855 0.1118

[[2]]
  mean     SE
bmxbmi    28.6275 0.2262
bpxdi1_1  71.6151 0.4422
indfmpir   2.8398 0.1126

[[3]]
  mean     SE
bmxbmi    28.6419 0.2314
bpxdi1_1  71.5659 0.4521
indfmpir   2.8425 0.1110

[[4]]
  mean     SE
bmxbmi    28.641 0.2315
bpxdi1_1  71.460  0.4305
indfmpir   2.852  0.1103

[[5]]
  mean     SE
bmxbmi    28.6236 0.2296
bpxdi1_1  71.5747 0.4392
indfmpir   2.8507 0.1122

dh(["call"]
with(desm1, svymean(~bmxbmi + bpxdi1_1+indfmpir), se = T, na.rm = T, 
    ci = T)
# Method 2 WITHOUT Design Variables in Model

> # return to original data without the CC high diastolic blood pressure
> nhanesc12_subm2 <- nhanesc12[ which(nhanesc12$age18p==1 & nhanesc12$wtmec2yr > 0), ]

> #nhanesc12_subm2$descodex=factor(nhanesc12_subm2$descodex)
> summary(nhanesc12_subm2)

```
sequi riagendr wtmec2yr sdmvpsu sdmvstra
Min.  :62161   Min.   :1.000   Min.  : 4413   Min.  :1.000   Min.  :90.00
1st Qu.:64611   1st Qu.:3.000   1st Qu.:16174  1st Qu.:1.000   1st Qu.:92.00
Median :67109    Median :3.000   Median :24567  Median :2.000   Median :96.00
Mean   :67076    Mean   :3.301   Mean   :41318  Mean   :1.638   Mean   :95.87
3rd Qu.:69533   3rd Qu.:4.000   3rd Qu.:45238  3rd Qu.:2.000   3rd Qu.:99.00
Max.   :71915   Max.   :5.000   Max.   :222580 Max.   :3.000   Max.   :103.00
```

```
indfmpir bmxbmi age18p age marcat decode bpxdi1_1
Min.   :0.000   Min.   :13.40   Min.   :18.00   1   :2991   Min.   : 901.0   Min.   : 10.00
1st Qu.:0.950   1st Qu.:23.80   1st Qu.:31.00   2   :1183   1st Qu.: 922.0   1st Qu.: 64.00
Median :1.840   Median :27.40   Median :47.00   3   :1141   Median : 961.0   Median : 72.00
Mean   :2.374   Mean   :28.62   Mean   :47.17   NA's: 300   Mean   : 960.3   Mean   : 71.02
3rd Qu.:3.933   3rd Qu.:32.00   3rd Qu.:62.00   3rd Qu.: 992.0   3rd Qu.: 78.00
Max.   :5.000   Max.   :82.10   Max.   :80.00   Max.   :1032.0   Max.   :120.00
```

```
agec agecsq age4cat
Min.   :28.3552   Min.   : 0.1261   Min.   :1.000
1st Qu.:15.3552   1st Qu.: 58.4436   1st Qu.:2.000
Median : 0.6448   Median : 244.7610   Median :3.000
Mean   : 0.8099   Mean   : 345.0635   Mean   :2.594
3rd Qu.: 15.6448   3rd Qu.: 559.0785   3rd Qu.:3.000
Max.   : 33.6448   Max.   :1131.9752   Max.   :4.000
```

> # use mice to impute and specify type of default method for imputation models
> # run without custom predictor matrix first
> impm2 <- mice(nhanesc12_subm2, n.imp=5, seed=2016, defaultMethod=c("norm","logreg","polyreg"))
> impm2$supportMatrix

> impm2$supportMatrix

> impm2$supportMatrix

> impm2$supportMatrix

> impm2$supportMatrix

> summary(impm2)

Multiply imputed data set

Call:
mice(data = nhanesc12_subm2, defaultMethod = c("norm", "logreg", "polyreg"), seed = 2016, n.imp = 5)

Number of multiple imputations: 5

Missing cells per column:

```
  seqn riagendr ridreth1 wtmec2yr sdmvpsu sdmvstra indfmpir bmx bmi age18p age marcat descod...
```

```
bpxdi1_1 agec agescsq age4cat
```

```
seqn riagendr ridreth1 wtmec2yr sdmvpsu sdmvstra indfmpir bmx bmi age18p age marcat descod...
seqn 0 0 0 0 0 0 0 0 0 0 0 0 0 0
riagendr 0 0 0 0 0 0 0 0 0 0 0 0 0 0
ridreth1 0 0 0 0 0 0 0 0 0 0 0 0 0 0
wtmec2yr 0 0 0 0 0 0 0 0 0 0 0 0 0 0
sdmvpsu 0 0 0 0 0 0 0 0 0 0 0 0 0 0
sdmvstra 0 0 0 0 0 0 0 0 0 0 0 0 0 0
indfmpir 1 1 1 1 1 1 1 1 0 1 1 1 0
bmx bmi 1 1 1 1 1 1 1 1 0 1 1 1 0
age18p 0 0 0 0 0 0 0 0 0 0 0 0 0 0
age 0 0 0 0 0 0 0 0 0 0 0 0 0 0
marcat 1 1 1 1 1 1 1 1 0 1 1 1 0
descode 0 0 0 0 0 0 0 0 0 0 0 0 0 0
bpxdi1_1 1 1 1 1 1 1 1 1 1 0 1 1 0
agec 0 0 0 0 0 0 0 0 0 0 0 0 0 0
agescsq 0 0 0 0 0 0 0 0 0 0 0 0 0 0
age4cat 0 0 0 0 0 0 0 0 0 0 0 0 0 0
bpxdi1_1 agec agescsq age4cat
seqn 0 0 0 0
riagendr 0 0 0 0
ridreth1 0 0 0 0
wtmec2yr 0 0 0 0
sdmvpsu 0 0 0 0
sdmvstra 0 0 0 0
indfmpir 1 0 1 1
bmx bmi 1 0 1 1
age18p 0 0 0 0
age 0 0 0 0
marcat 1 0 1 1
descode 0 0 0 0
bpxdi1_1 0 0 1 1
agec 0 0 0 0
agescsq 0 0 0 0
age4cat 0 0 0 0
```
Imputation methods:

```
seqn  riagendr  ridreth1  wtmec2yr  sdmvpsu  sdmvstra  indfmpir  bmxbmi  age18p  age
""   ""        ""        ""        ""        ""        ""      "norm"    "norm"    ""
```

VisitSequence:
```
indfmpir  bmxbmi  marcat  bpxdi1_1
7        8       11       13
```

Random generator seed value: 2016

```r
# add a predictor matrix to control imputation model predictors for each imputed variable
> pred <- impm2$predictorMatrix
> pred[,"sdmvpsu"] <- 0
> pred[,"sdmvstra"] <- 0
> pred[,"seqn"] <- 0
> pred[,"age18p"] <- 0
```
```r
> pred[, "descode"] <- 0
> pred[, "wtmec2yr"] <- 0
> impm2$predictorMatrix
```

```
> pred
```

```r
> impm2$predictorMatrix
```

```
seqn riagendr ridreth1 wtmec2yr sdmvpsu sdmvstra indfmpir bmbxbmi age18p age marcat descode
seqn 0 0 0 0 0 0 0 0 0 0 0 0
riagendr 0 0 0 0 0 0 0 0 0 0 0 0
ridreth1 0 0 0 0 0 0 0 0 0 0 0 0
wtmec2yr 0 0 0 0 0 0 0 0 0 0 0 0
sdmvpsu 0 0 0 0 0 0 0 0 0 0 0 0
sdmvstra 0 0 0 0 0 0 0 0 0 0 0 0
indfmpir 1 1 1 1 1 1 0 1 1 1 0 0
bmbxbmi 1 1 1 1 1 1 0 1 1 1 0 0
age18p 0 0 0 0 0 0 0 0 0 0 0 0
age 0 0 0 0 0 0 0 0 0 0 0 0
marcat 1 1 1 1 1 1 0 1 1 1 0 0
descode 0 0 0 0 0 0 0 0 0 0 0 0
bpxdi1_1 1 1 1 1 1 1 1 1 1 0 1 0
agec 0 0 0 0 0 0 0 0 0 0 0 0
agecsq 0 0 0 0 0 0 0 0 0 0 0 0
age4cat 0 0 0 0 0 0 0 0 0 0 0 0
```
```
> impm2_pred <- mice(nhanesc12_subm2, pred=pred, n.imp=5, seed=2016, defaultMethod=c("norm","logreg","polyreg"))
```

```
iter imp variable
  1  1 indfmpir bmi marcat bpxdi1_1
  1  2 indfmpir bmi marcat bpxdi1_1
  1  3 indfmpir bmi marcat bpxdi1_1
  1  4 indfmpir bmi marcat bpxdi1_1
  1  5 indfmpir bmi marcat bpxdi1_1
  2  1 indfmpir bmi marcat bpxdi1_1
  2  2 indfmpir bmi marcat bpxdi1_1
  2  3 indfmpir bmi marcat bpxdi1_1
  2  4 indfmpir bmi marcat bpxdi1_1
  2  5 indfmpir bmi marcat bpxdi1_1
  3  1 indfmpir bmi marcat bpxdi1_1
  3  2 indfmpir bmi marcat bpxdi1_1
  3  3 indfmpir bmi marcat bpxdi1_1
  3  4 indfmpir bmi marcat bpxdi1_1
  3  5 indfmpir bmi marcat bpxdi1_1
  4  1 indfmpir bmi marcat bpxdi1_1
  4  2 indfmpir bmi marcat bpxdi1_1
  4  3 indfmpir bmi marcat bpxdi1_1
  4  4 indfmpir bmi marcat bpxdi1_1
  4  5 indfmpir bmi marcat bpxdi1_1
  5  1 indfmpir bmi marcat bpxdi1_1
  5  2 indfmpir bmi marcat bpxdi1_1
  5  3 indfmpir bmi marcat bpxdi1_1
  5  4 indfmpir bmi marcat bpxdi1_1
  5  5 indfmpir bmi marcat bpxdi1_1
```
> summary(impm2_pred)
Multiply imputed data set
Call:
mice(data = nhanesc12_subm2, predictorMatrix = pred, defaultMethod = c("norm",
"logreg", "polyreg"), seed = 2016, n.imp = 5)
Number of multiple imputations: 5
Missing cells per column:
<table>
<thead>
<tr>
<th>seqn</th>
<th>riagendr</th>
<th>ridreth1</th>
<th>wtmec2yr</th>
<th>sdmvpsu</th>
<th>sdmvstra</th>
<th>indfmpir</th>
<th>bmxbmi</th>
<th>age18p</th>
<th>age</th>
<th>marcat</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>487</td>
<td>90</td>
<td>0</td>
<td>0</td>
<td>300</td>
</tr>
<tr>
<td>decode</td>
<td>bpxdi1_1</td>
<td>agec</td>
<td>agecsq</td>
<td>age4cat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>503</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Imputation methods:
<table>
<thead>
<tr>
<th>seqn</th>
<th>riagendr</th>
<th>ridreth1</th>
<th>wtmec2yr</th>
<th>sdmvpsu</th>
<th>sdmvstra</th>
<th>indfmpir</th>
<th>bmxbmi</th>
<th>age18p</th>
<th>age</th>
<th>marcat</th>
</tr>
</thead>
<tbody>
<tr>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;norm&quot;</td>
<td>&quot;norm&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
</tr>
<tr>
<td>marcat</td>
<td>decode</td>
<td>bpxdi1_1</td>
<td>agec</td>
<td>agecsq</td>
<td>age4cat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&quot;polyreg&quot;</td>
<td>&quot;norm&quot;</td>
<td>&quot;norm&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td>&quot;&quot;</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

VisitSequence:
indfmpir | bmxbmi | marcat | bpxdi1_1 |
7       | 8      | 11      | 13      |

PredictorMatrix:
<table>
<thead>
<tr>
<th>seqn</th>
<th>riagendr</th>
<th>ridreth1</th>
<th>wtmec2yr</th>
<th>sdmvpsu</th>
<th>sdmvstra</th>
<th>indfmpir</th>
<th>bmxbmi</th>
<th>age18p</th>
<th>age</th>
<th>marcat</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>riagendr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>ridreth1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>wtmec2yr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>sdmvpsu</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>sdmvstra</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>indfmpir</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>bmxbmi</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>age18p</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>age</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>marcat</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>decode</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>bpxdi1_1</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>agec</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>agecsq</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>age4cat</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>bpxdi1_1</td>
<td>agec</td>
<td>agecsq</td>
<td>age4cat</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>seqn</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>riagendr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ridreth1</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>wtmec2yr</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sdmvpsu</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>sdmvstra</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>indfmpir</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bmxbmi</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>age18p</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>age</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>marcat</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>decode</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>bpxdi1_1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>agec</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>agecsq</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

23
age4cat 0 0 0 0

Random generator seed value: 2016

> # create new high diastolic blood pressure base on imputed bpxdi1_1, prepare long data set and then back to mids after computation
> longm2 <- complete(impm2_pred, action='long', include=TRUE)
> longm2$high_diastolic <- ifelse(longm2$bpxdi1_1 >=90,1,0)
> summary(longm2)

imp          .id
  .imp          .id seqn   riagendr   ridreth1   wtmec2yr      sdmvpsu
0:5615   1      :    6   Min.   :62161   Min.   :1.000   Min.   : 4413   Min.   :1.000
1:5615  1000   :    6   1st Qu.:64610   1st Qu.:1.000   1st Qu.: 16169   1st Qu.:1.000
2:5615  1001   :    6 Median :67109 Median :2.000 Median : 24567 Median :2.000
3:5615  1002   :    6 Mean   :67076 Mean   :1.506 Mean   : 41318 Mean   :1.638
4:5615  1003   :    6 3rd Qu.:69533 3rd Qu.:2.000 3rd Qu.: 45331 3rd Qu.:2.000
5:5615  1004   :    6 Max.   :71915 Max.   :2.000 Max.   :222580 Max.   :3.000
(Other):33654

sdmvstra     indfmpir   bmxbmi   age18p       age         marcat
Min.   : 90.00   Min.   : 3.839   Min.   : 4.303   Min.   :1   Min.   :18.00   1   :18277
1st Qu.: 92.00   1st Qu.: 0.960   1st Qu.:23.800   1st Qu.:1 1st Qu.:31.00   2   : 7129
Median : 96.00   Median : 1.890   Median :27.400   Median :1  Median :47.00   3   : 7984
Mean   : 95.87   Mean   : 2.378   Mean   :28.615   Mean   :1  Mean   :47.17 NA's:  300
3rd Qu.: 99.00   3rd Qu.: 3.900   3rd Qu.:32.100   3rd Qu.:1 3rd Qu.:62.00
Max.   :103.00   Max.   : 9.092   Max.   :82.100   Max.   :1  Max.   :80.00
NA's   :  503

descode    bpxdi1_1   agec           agesq    age4cat high_diastolic
Min.   : 901.0   Min.   : 10.00   Min.   : -28.3552   Min.   : 0.1261   Min.   :1.000   Min.   :0.000
1st Qu.: 922.0  1st Qu.: 64.00   1st Qu.: -15.3552   1st Qu.: 58.4436   1st Qu.:2.000   1st Qu.:0.000
Median : 961.0   Median : 72.00   Median :  0.6448   Median : 244.7610   Median :3.000   Median :0.000
Mean   : 960.3   Mean   : 70.97   Mean   :  0.8099   Mean   :345.0635   Mean   :2.594   Mean   :0.061
3rd Qu.: 992.0   3rd Qu.: 78.00   3rd Qu.: 15.6448   3rd Qu.: 559.0785   3rd Qu.:3.000   3rd Qu.:0.000
Max.   :1032.0   Max.   :120.00   Max.   : 33.6448   Max.   :1131.9752   Max.   :4.000   Max.   :1.000
NA's   :  503

> # use as.mids() to convert back to mids object
> impm2a  <- as.mids(longm2)

> # convert mids to data useable for work in mitools
> library(mitools)
> mydatam2 <- imputationList(lapply(1:5, complete, x=impm2a))
> summary(mydatam2)

  Length Class Mode
imputations 5 -none- list
call 2 -none- call

> # set survey design
> library(survey)
> desm2 <- svydesign(id=~sdmvstra, strat=~sdmvpsu, weight=~wtmec2yr, data=(mydatam2), nest=TRUE)
> summary(desm2)

  Length Class Mode
designs 5 -none- list
call 6 -none- call

> # run design based logistic model with svyglm using 5 imputed data sets contained in desm1, Table 12.5
> fitm2 <- with(desm2, svyglm (high_diatolic ~ factor(ridreth1) + factor(riagendr) + agec + agecsq, family=quasibinomial))
> summary(MIcombine(fitm2))

Multiple imputation results:

\[
\text{with(desm2, svyglm}(\text{high_diatolic} \sim \text{factor(ridreth1)} + \text{factor(riagendr)} + \text{agec} + \text{agecsq, family} = \text{quasibinomial}))
\]

\[
\text{MIcombine.default}(\text{fitm2})
\]

results se (lower upper) missInfo
(Intercept) -2.276264452 0.2340423016 -2.735019570 -1.817509333 2 %
factor(ridreth1)2 -0.658567994 0.2620548085 -1.174041445 -0.143094542 11 %
factor(ridreth1)3 0.153752272 0.2246763934 -0.286842571 0.594347114 4 %
factor(ridreth1)4 0.658261229 0.2387780360 0.190255632 1.126266826 1 %
factor(ridreth1)5 0.088040408 0.2988129120 -0.498033034 0.674113851 5 %
factor(riagendr)2 -0.501290427 0.1860284829 -0.868953631 -0.133627222 18 %
agec 0.008409436 0.0068413544 -0.004999598 0.021818470 1 %
agecsq -0.001708093 0.0002510349 -0.002208132 -0.001208054 25 %

> # combined mean high blood pressure with design adjustment, Table 12.4
> fitm2_mean <-
> with(desm2, svymean(~factor(high_diatolic), se=T, na.rm=T, ci=T ))
> # mean high blood pressure for each imputed data set
> fitm2_mean

[[1]]

mean SE
factor(high_diatolic)0 0.938486 0.0067
factor(high_diatolic)1 0.061514 0.0067

[[2]]

mean SE
factor(high_diatolic)0 0.939995 0.0066
factor(high_diatolic)1 0.060005 0.0066

[[3]]

mean SE
factor(high_diatolic)0 0.94009 0.0067
factor(high_diatolic)1 0.05991 0.0067

[[4]]

mean SE
factor(high_diatolic)0 0.94255 0.0065
factor(high_diatolic)1 0.05745 0.0065

[[5]]

mean SE
factor(high_diatolic)0 0.938556 0.0064
factor(high_diatolic)1 0.061444 0.0064

attr('call')
with(desm2, svymean(~factor(high_diatolic), se = T, na.rm = T, ci = T))
> # Use MIcombine for overall combined and design-adjusted mean/se
> summary(MIcombine(fitm2_mean))

Multiple imputation results:
  with(desm2, svymean(~factor(high_diastolic), se = T, na.rm = T,  
  ci = T))

MIcombine.default(fitm2_mean)

<table>
<thead>
<tr>
<th>results</th>
<th>se</th>
<th>(lower</th>
<th>upper</th>
<th>missInfo</th>
</tr>
</thead>
<tbody>
<tr>
<td>factor(high_diastolic)0</td>
<td>0.93993534</td>
<td>0.006816101</td>
<td>0.9265561</td>
<td>0.9533146</td>
</tr>
<tr>
<td>factor(high_diastolic)1</td>
<td>0.06006466</td>
<td>0.006816101</td>
<td>0.0466854</td>
<td>0.07344392</td>
</tr>
</tbody>
</table>

> # Note: FEFI method available in R as of early June 2017, see https://sites.google.com/view/jaekwangkim/software for more information, this will be included on ASDA website in the near future.