R Analysis Example Replication C12 # Chapter 12 Multiple Imputation 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 =</pre> ",", 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))</pre> show(ex12_3b <- svymean(~bpxdi1_1, nhanessvy, se=T, na.rm=T, ci=T))</pre> show(ex12 3c <- svymean(~indfmpir, nhanessvy, se=T, na.rm=T, ci=T))</pre> # 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))</pre> 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"))</pre>
impm1$predictorMatrix
summary(impm1)
# add a predictor matrix to control imputation model predictors for each imputed variable
pred <- impm1$predictorMatrix</pre>
pred[, "sdmvpsu"] <- 0</pre>
pred[, "sdmvstra"] <- 0</pre>
pred[, "seqn"] <- 0</pre>
pred[, "age18p"] <- 0</pre>
pred[, "descode"] <- 1</pre>
impm1$predictorMatrix
impm1 pred <- mice(nhanesc12 subm1, pred=pred, n.imp=5, seed=2016, defaultMethod=c("norm","logreg","polyreg"))</pre>
summary(impm1 pred)
# create new high diastolic blood pressure base on imputed bpxdi1_1, prepare long data set and then back to mids
after computation
longm1 <- complete(impm1_pred, action='long', include=TRUE)</pre>
longm1$high_diastolic <- ifelse(longm1$bpxdi1_1 >=90,1,0)
summary(longm1)
#use as.mids() to convert back to mids object
impm1a <- as.mids(longm1)</pre>
# convert mids to data useable for work in mitools
library(mitools)
mydatam1 <- imputationList(lapply(1:5, complete, x=impm1a))</pre>
summary(mydatam1)
# set survey design
library(survey)
desm1 <- svydesign(id=~sdmvstra, strat=~sdmvpsu, weight=~wtmec2yr, data=(mydatam1), nest=TRUE)</pre>
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+bpxdi1_1+indfmpir), se=T, na.rm=T, ci=T )
fitm1_ex12_3</pre>
```

```
# 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"))</pre>
impm2$predictorMatrix
summary(impm2)
# add a predictor matrix to control imputation model predictors for each imputed variable
pred <- impm2$predictorMatrix</pre>
pred[,"sdmvpsu"] <- 0</pre>
pred[, "sdmvstra"] <- 0</pre>
pred[, "seqn"] <- 0</pre>
pred[, "age18p"] <- 0</pre>
pred[, "descode"] <- 0</pre>
pred[,"wtmec2yr"] <- 0</pre>
impm2$predictorMatrix
pred
impm2 pred <- mice(nhanesc12 subm2, pred=pred, n.imp=5, seed=2016, defaultMethod=c("norm","logreg","polyreg"))</pre>
summary(impm2 pred)
# create new high diastolic blood pressure base on imputed bpxdi1 1, prepare long data set and then back to mids
after computation
longm2 <- complete(impm2_pred, action='long', include=TRUE)</pre>
longm2$high diastolic <- ifelse(longm2$bpxdi1 1 >=90,1,0)
summary(longm2)
#use as.mids() to convert back to mids object
impm2a <- as.mids(longm2)</pre>
# convert mids to data useable for work in mitools
library(mitools)
mydatam2 <- imputationList(lapply(1:5, complete, x=impm2a))</pre>
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, Taable 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 ))</pre>
```

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.

Output R Analysis Example Replication C12

```
> # 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 =</pre>
",", 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)
                                       ridreth1
                                                                          sdmvpsu
      segn
                     riagendr
                                                        wtmec2yr
                                                                                            sdmystra
 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.:1.000
                                   1st Qu.:3.000
                                                                                        1st Qu.: 92.00
                                                     1st Qu.: 16174
 Median :67109
                  Median :2.000
                                   Median :3.000
                                                     Median : 24567
                                                                       Median:2.000
                                                                                        Median : 96.00
                                                            : 41318
        :67076
                         :1.506
                                   Mean
                                           :3.301
                                                                       Mean
                                                                               :1.638
                                                                                        Mean
                                                                                                : 95.87
 Mean
                  Mean
                                                     Mean
                  3rd Qu.:2.000
                                                                                        3rd Qu.: 99.00
 3rd Qu.:69533
                                   3rd Qu.:4.000
                                                     3rd Qu.: 45238
                                                                       3rd Qu.:2.000
        :71915
                  Max.
                          :2.000
                                   Max.
                                           :5.000
                                                     Max.
                                                            :222580
                                                                       Max.
                                                                               :3.000
                                                                                        Max.
                                                                                                :103.00
    indfmpir
                      bmxbmi
                                        age18p
                                                      age
                                                                   marcat
                                                                                  descode
                                                                                                    bpxdi1 1
        :0.000
 Min.
                  Min.
                          :13.40
                                   Min.
                                           :1
                                                Min.
                                                        :18.00
                                                                      :2991
                                                                               Min.
                                                                                      : 901.0
                                                                                                 Min.
                                                                                                         : 10.00
                  1st Qu.:23.80
                                                                                                 1st Qu.: 64.00
 1st Qu.:0.950
                                   1st Qu.:1
                                                1st Qu.:31.00
                                                                  2
                                                                      :1183
                                                                               1st Qu.: 922.0
 Median :1.840
                  Median :27.40
                                   Median :1
                                                                               Median : 961.0
                                                                                                 Median : 72.00
                                                Median :47.00
                                                                  3
                                                                      :1141
 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
        :5.000
                          :82.10
                                                        :80.00
                                                                                      :1032.0
 Max.
                  Max.
                                   Max.
                                           :1
                                                Max.
                                                                               Max.
                                                                                                 Max.
                                                                                                         :120.00
 NA's
        :487
                  NA's
                          :90
                                                                                                 NA's
                                                                                                         :503
                                              age4cat
      agec
                          agecsq
 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
        : 0.8099
                             : 345.0635
                     Mean
                                           Mean
                                                   :2.594
 Mean
 3rd Qu.: 15.6448
                     3rd Qu.: 559.0785
                                           3rd Qu.:3.000
        : 33.6448
                             :1131.9752
 Max.
                     Max.
                                           Max.
                                                   :4.000
> # Missing data pattern
> md.pattern(nhanesc12 sub)
     seqn riagendr ridreth1 wtmec2yr sdmvpsu sdmvstra age18p age descode agec agecsq age4cat bmxbmi marcat
                  1
                                                                                                          1
4416
        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
  48
        1
                  1
                            1
                                      1
                                              1
                                                        1
                                                                1
                                                                    1
                                                                                          1
                                                                                                  1
                                                                                                                 1
                                                                            1
 230
        1
                  1
                            1
                                      1
                                              1
                                                        1
                                                                1
                                                                    1
                                                                            1
                                                                                         1
                                                                                                  1
                                                                                                          1
                                                                                                                 0
                  1
                                      1
 386
        1
                                              1
                                                                                                                 1
  12
                  1
                            1
                                      1
                                              1
                                                        1
                                                                    1
                                                                            1
                                                                                  1
                                                                                          1
                                                                                                  1
                                                                                                          0
                                      1
                                                                    1
  31
        1
                  1
                            1
                                              1
                                                        1
                                                                1
                                                                            1
                                                                                         1
                                                                                                  1
                                                                                                          1
                                                                                                                 0
   6
        1
                  1
                            1
                                      1
                                              1
                                                        1
                                                                1
                                                                    1
                                                                            1
                                                                                  1
                                                                                          1
                                                                                                  1
                                                                                                          n
                                                                                                                 n
        1
                  1
                            1
                                      1
                                                        1
                                                                1
                                                                    1
                                                                                         1
  62
                                              1
                                                                            1
                                                                                  1
                                                                                                  1
                                                                                                          1
                                                                                                                 1
                  1
                                                                                                          0
                                                                                                                 1
  18
                                      1
                                              1
                                                                    1
                                                                            1
                                                                                          1
                                                                                                  1
```

```
22
                  1
                                     1
                                                       1
                                                                                        1
                                                                                                        1
                                              1
                                                               1
                                                                            1
                                                                                                 1
   4
        1
                  1
                            1
                                     1
                                              1
                                                       1
                                                               1
                                                                   1
                                                                            1
                                                                                 1
                                                                                         1
                                                                                                 1
                                                                                                        0
   9
        1
                  1
                            1
                                     1
                                              1
                                                       1
                                                                   1
                                                                            1
                                                                                 1
                                                                                         1
                                                                                                 1
                                                                                                        1
   2
        1
                  1
                           1
                                     1
                                              1
                                                       1
                                                               1
                                                                   1
                                                                            1
                                                                                 1
                                                                                        1
                                                                                                 1
                                                                                                        0
        0
                  0
                                              0
                                                                                         0
                                                                                                 0
                                                                                                        90
                                                                                                              300
     indfmpir bpxdi1_1
4416
             1
 369
             0
                      1
                            1
             1
  48
                      1
                            1
 230
             1
                      1
                            1
 386
             1
                      0
                            1
             0
  12
                      1
                           2
             0
                            2
  31
                      1
   6
             1
                            2
  62
             0
                      0
                            2
             1
                      0
                            2
  18
  22
             1
                      0
                            2
             0
                      0
                           3
   4
   9
             0
                      0
                           3
   2
             1
                      0
                            3
                    503 1380
          487
> # create an indicator of high blood pressure
> nhanesc12 sub$high diastolic <- ifelse(nhanesc12 sub$bpxdi1 1 >=90, 1,0)
> summary(nhanesc12_sub$high_diastolic)
   Min. 1st Qu. Median
                            Mean 3rd Qu.
                                                      NA's
                                              Max.
  0.000
          0.000
                  0.000
                           0.062 0.000
                                            1.000
                                                       503
> # 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))</pre>
         mean
                  SE
bmxbmi 28.623 0.214
> show(ex12_3b <- svymean(~bpxdi1_1, nhanessvy, se=T, na.rm=T, ci=T))</pre>
           mean
bpxdi1 1 71.609 0.5047
> show(ex12_3c <- svymean(~indfmpir, nhanessvy, se=T, na.rm=T, ci=T))</pre>
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))</pre>
                                            SE
                               mean
                                                 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
```

```
> # 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)
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|)
             -2.2498852 0.1985021 -11.334 4.99e-07 ***
(Intercept)
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 *
                0.0084599 0.0069603 1.215 0.252108
agec
                agecsq
- - -
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)
                    riagendr
                                     ridreth1
                                                      wtmec2yr
                                                                       sdmvpsu
                                                                                        sdmvstra
                                                          : 4413
                                                                                            : 90.00
 Min.
        :62161
                 Min.
                        :1.000
                                  Min.
                                         :1.000
                                                  Min.
                                                                    Min.
                                                                           :1.000
                                                                                     Min.
                 1st Qu.:1.000
                                  1st Qu.:3.000
 1st Qu.:64611
                                                  1st Qu.: 16174
                                                                    1st Qu.:1.000
                                                                                     1st Qu.: 92.00
                                                  Median : 24567
 Median :67109
                 Median :2.000
                                  Median :3.000
                                                                    Median :2.000
                                                                                     Median : 96.00
        :67076
                        :1.506
                                  Mean
                                         :3.301
                                                  Mean
                                                          : 41318
                                                                    Mean
                                                                           :1.638
                                                                                     Mean
                                                                                            : 95.87
 Mean
                 Mean
 3rd Qu.:69533
                 3rd Qu.:2.000
                                  3rd Qu.:4.000
                                                  3rd Qu.: 45238
                                                                    3rd Qu.:2.000
                                                                                     3rd Qu.: 99.00
        :71915
                                         :5.000
                                                          :222580
                                                                                            :103.00
 Max.
                 Max.
                         :2.000
                                  Max.
                                                  Max.
                                                                    Max.
                                                                           :3.000
                                                                                     Max.
    indfmpir
                     bmxbmi
                                      age18p
                                                                              descode
                                                                                                bpxdi1 1
                                                   age
                                                                marcat
        :0.000
                         :13.40
 Min.
                 Min.
                                  Min.
                                         :1
                                              Min.
                                                      :18.00
                                                               1
                                                                   :2991
                                                                           Min.
                                                                                   : 901.0
                                                                                             Min.
                                                                                                    : 10.00
                 1st Qu.:23.80
                                                                           1st Qu.: 922.0
 1st Qu.:0.950
                                  1st Qu.:1
                                              1st Qu.:31.00
                                                               2
                                                                   :1183
                                                                                             1st Qu.: 64.00
 Median :1.840
                 Median :27.40
                                  Median :1
                                              Median :47.00
                                                                           Median : 961.0
                                                                                             Median : 72.00
                                                               3
                                                                   :1141
 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
                                            age4cat
      agec
                         agecsq
 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
       : 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"))</pre>
 iter imp variable
  1
      1 indfmpir
                   bmxbmi
                           marcat
                                    bpxdi1_1
  1
      2 indfmpir
                   bmxbmi
                           marcat
                                    bpxdi1 1
  1
      3
         indfmpir
                   bmxbmi
                            marcat
                                    bpxdi1 1
```

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                                       bpxdi1_1
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> impm1$predictorMatrix
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age4cat
> summary(impm1)
Multiply imputed data set
mice(data = nhanesc12_subm1, defaultMethod = c("norm", "logreg",
    "polyreg"), seed = 2016, n.imp = 5)
Number of multiple imputations: 5
Missing cells per column:
```

bmxbmi

age18p

age

marcat

seqn riagendr ridreth1 wtmec2yr sdmvpsu sdmvstra indfmpir

0	0	0	0	0	0 4	187 9	90 () 0	300
descode b	pxdi1 1	agec a	gecsq age	4cat					
0	503	0	0	0					
Imputation									
seqn	riagendr	ridreth1	wtmec2yr	sdmvpsu	sdmvstra	indfmpir	bmxbmi	age18p	age
		н н	""	' ""	11 11	"norm"	"norm"	J	" "
marcat	descode	bpxdi1_1	agec	agecsq	age4cat				
"polyreg"	11 11	. — "norm"	""	""					
VisitSeque	nce:								
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. 7	8	11	_ 13						
PredictorN	latrix:								
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seqn	0		0 0		0	. 0	0 (0 0
riagendr	0	0	0 0	0	0	0	0 (0	0 0
ridreth1	0	0	0 0	0	0	0	0 (0	0 0
wtmec2yr	0	0	0 0	0	0	0	0 (0	0 0
sdmvpsu	0	0	0 0	0	0	0	0 (0	0 0
sdmvstra	0	0	0 0	0	0	0	0 (0	0 0
indfmpir	1	1	1 1	1	1	0	1 () 1	1 0
bmxbmi	1	1	1 1	1	1	1	0 () 1	1 0
age18p	0	0	0 0	0	0	0	0 (0	0 0
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marcat	1		1 1	1	1	1	1 (0 0
descode	0	0	0 0	0	0	0	0 (0	0 0
bpxdi1_1	1		1 1		1	1	1 (1 0
agec	0		0 0		0	0	0 (0	0 0
agecsq	0	0	0 0	0	0	0	0 (0	0 0
age4cat	0	0	0 0	0	0	0	0 (0	0 0
	pxdi1 1 ag	gec agecsq	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						
bmxbmi	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						
agecsq	0	0 0	0						
age4cat	0	0 0	0						
Dandan san			0016						

Random generator seed value: 2016

- > # add a predictor matrix to control imputation model predictors for each imputed variable
- > pred <- impm1\$predictorMatrix</pre>
- > pred[,"sdmvpsu"] <- 0</pre>
- > pred[,"sdmvstra"] <- 0</pre>
- > pred[,"seqn"] <- 0
- > pred[,"age18p"] <- 0</pre>
- > pred[,"descode"] <- 1</pre>
- > impm1\$predictorMatrix

	seqn	riagendr	ridreth1	wtmec2yr	sdmvpsu	sdmvstra	indfmpir	bmxbmi	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	0	1	1	0
bmxbmi	1	1	1	1	1	1	1	0	0	1	1	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	1	1	0	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	0	1	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

bpxdi1_1 agec agecsq 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
bmxbmi	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
agecsq	0	0	0	0
age4cat	0	0	0	0

> pred

	seqn	riagendr	ridreth1	wtmec2yr	sdmvpsu	sdmvstra	$\verb"indfmpir"$	${\tt bmxbmi}$	age18p	age	marcat	descode
seqn	0	0	0	0	0	0	0	0	0	0	0	1
riagendr	0	0	0	0	0	0	0	0	0	0	0	1
ridreth1	0	0	0	0	0	0	0	0	0	0	0	1
wtmec2yr	0	0	0	0	0	0	0	0	0	0	0	1
sdmvpsu	0	0	0	0	0	0	0	0	0	0	0	1
sdmvstra	0	0	0	0	0	0	0	0	0	0	0	1
indfmpir	0	1	1	1	0	0	0	1	0	1	1	1
bmxbmi	0	1	1	1	0	0	1	0	0	1	1	1
age18p	0	0	0	0	0	0	0	0	0	0	0	1

age	0	0	0	0	0	0	0	0	0	0	0 1
marcat	0	1	1	1	0	0	1	1	0	1	0 1
descode	0	0	0	0	0	0	0	0	0	0	0 1
bpxdi1_1	0	1	1	1	0	0	1	1	0	1	1 1
agec	0	0	0	0	0	0	0	0	0	0	0 1
agecsq	0	0	0	0	0	0	0	0	0	0	0 1
age4cat	0	0	0	0	0	0	0	0	0	0	0 1

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

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iter imp variable
       indfmpir
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                                   bpxdi1_1
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        indfmpir
                  bmxbmi
                          marcat
                                   bpxdi1_1
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        indfmpir
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                                   bpxdi1_1
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4 indfmpir bmxbmi marcat bpxdi1_1
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      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:
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"polyreg"
                          "norm"
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PredictorMatrix:
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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
> longm1 <- complete(impm1_pred, action='long', include=TRUE)</pre>
> longm1$high_diastolic <- ifelse(longm1$bpxdi1_1 >=90,1,0)
> summary(longm1)
                .id
                                                                ridreth1
 .imp
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                                 sean
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                       6
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                                                    :1.000
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                                                                                     : 4413
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          1000
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                                            1st Qu.:1.000
                                                             1st Qu.:3.000
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 2:5615
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                                   :67076
                                            Mean
                                                    :1.506
                                                             Mean
                                                                    :3.301
                                                                              Mean
                                                                                     : 41318
                                                                                                Mean
                                                                                                       :1.638
          1003
                           3rd Qu.:69533
                                            3rd Qu.:2.000
                                                             3rd Qu.:4.000
                                                                              3rd Qu.: 45331
                                                                                                3rd Qu.:2.000
 4:5615
                       6
 5:5615
          1004
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                       6
                           Max.
                                   :71915
                                            Max.
                                                    :2.000
                                                             Max.
                                                                    :5.000
                                                                              Max.
                                                                                      :222580
                                                                                                Max.
                                                                                                       :3.000
          (Other):33654
    sdmvstra
                      indfmpir
                                         hmxhmi
                                                           age18p
                                                                                     marcat
                                                                        age
        : 90.00
                          :-3.691
                                            : 8.257
                                                                           :18.00
 Min.
                  Min.
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                                                                   Min.
                                                                                         :18312
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 1st Qu.: 92.00
                  1st Qu.: 0.960
                                     1st Qu.:23.800
                                                       1st Qu.:1
                                                                   1st Qu.:31.00
                                                                                    2
                                                                                         : 7134
                                                                                         : 7944
 Median : 96.00
                  Median : 1.883
                                    Median :27.400
                                                       Median :1
                                                                   Median :47.00
       : 95.87
                         : 2.367
                                    Mean
                                            :28.625
                                                       Mean
                                                                   Mean
                                                                           :47.17
                                                                                    NA's: 300
 3rd Qu.: 99.00
                  3rd Qu.: 3.890
                                    3rd Qu.:32.100
                                                       3rd Qu.:1
                                                                   3rd Qu.:62.00
                                                                           :80.00
 Max.
        :103.00
                  Max.
                          : 8.608
                                    Max.
                                            :82.100
                                                       Max.
                                                              : 1
                                                                   Max.
                   NA's
                          :487
                                     NA's
                                            :90
    descode
                      bpxdi1_1
                                                                                               high_diastolic
                                          agec
                                                             agecsq
                                                                                 age4cat
 Min.
        : 901.0
                  Min.
                          : 10.00
                                    Min.
                                            :-28.3552
                                                         Min.
                                                                :
                                                                    0.1261
                                                                              Min.
                                                                                      :1.000
                                                                                               Min.
                                                                                                      :0.0000
 1st Qu.: 922.0
                  1st Qu.: 64.00
                                     1st Qu.:-15.3552
                                                         1st Qu.: 58.4436
                                                                              1st Qu.:2.000
                                                                                               1st Qu.:0.0000
 Median : 961.0
                  Median : 72.00
                                     Median: 0.6448
                                                         Median: 244.7610
                                                                              Median :3.000
                                                                                               Median :0.0000
 Mean
        : 960.3
                  Mean
                          : 70.97
                                     Mean
                                            : 0.8099
                                                         Mean
                                                                : 345.0635
                                                                                      :2.594
                                                                                               Mean
                                                                                                       :0.0612
                                                                              Mean
 3rd Qu.: 992.0
                  3rd Qu.: 78.00
                                     3rd Qu.: 15.6448
                                                         3rd Qu.: 559.0785
                                                                              3rd Qu.:3.000
                                                                                               3rd Qu.:0.0000
 Max.
        :1032.0
                  Max.
                          :120.00
                                     Max.
                                           : 33.6448
                                                         Max.
                                                                :1131.9752
                                                                              Max.
                                                                                      :4.000
                                                                                               Max.
                                                                                                       :1.0000
                   NA's
                          :503
                                                                                               NA's
                                                                                                       :503
> #use as.mids() to convert back to mids object
> impm1a <- as.mids(longm1)</pre>
> # convert mids to data useable for work in mitools
> library(mitools)
> mydatam1 <- imputationList(lapply(1:5, complete, x=impm1a))</pre>
> summary(mydatam1)
            Length Class Mode
imputations 5
                    -none- list
                    -none- call
call
            2
> # set survey design
> library(survey)
> desm1 <- svydesign(id=~sdmvstra, strat=~sdmvpsu, weight=~wtmec2yr, data=(mydatam1), nest=TRUE)</pre>
> summary(desm1)
        Length Class Mode
designs 5
                -none- list
                -none- call
call
        6
```

```
> # 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))
Multiple imputation results:
      with(desm1, svyglm(high_diastolic ~ factor(ridreth1) + factor(riagendr) +
    agec + agecsq, family = quasibinomial))
      MIcombine.default(fitm1)
                     results
                                               (lower
                                                            upper) missInfo
(Intercept)
                  -2.21225529 0.2363615980 -2.67555595 -1.748954637
                                                                        2 %
factor(ridreth1)2 -0.65726291 0.2721286781 -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 %
9 %
factor(riagendr)2 -0.55414764 0.1769625808 -0.90219639 -0.206098883
                                                                       11 %
                  0.01025488 0.0069408411 -0.00335723 0.023866981
agec
                                                                        5 %
                  -0.00177005 0.0002429929 -0.00224678 -0.001293319
agecsq
                                                                        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 ))</pre>
> # 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
factor(high diastolic)0 0.937171 0.0061
factor(high_diastolic)1 0.062829 0.0061
[[3]]
                            mean
                                    SF
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]]
                                    SE
                           mean
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,
> # 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))
      MIcombine.default(fitm1_mean)
                                                    (lower
                           results
                                                              upper) missInfo
                                            se
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 )</pre>
> fitm1_ex12_3
[[1]]
                    SE
           mean
bmxbmi 28.634 0.2356
bpxdi1 1 71.518 0.4253
indfmpir 2.855 0.1118
[[2]]
                     SE
            mean
bmxbmi 28.6275 0.2262
bpxdi1_1 71.6151 0.4422
indfmpir 2.8398 0.1126
[[3]]
                     SE
            mean
        28.6419 0.2314
bmxbmi
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]]
                     SE
            mean
bmxbmi 28.6236 0.2296
bpxdi1_1 71.5747 0.4392
indfmpir 2.8507 0.1122
attr(, "call")
with(desm1, svymean(~bmxbmi + bpxdi1_1 + indfmpir), se = T, na.rm = T,
    ci = T)
```

- > # 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)

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
- > impm2 <- mice(nhanesc12_subm2, n.imp=5, seed=2016, defaultMethod=c("norm","logreg","polyreg"))</pre>

iter imp variable

	T 1111	p 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

```
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      2
         indfmpir
                     bmxbmi marcat bpxdi1_1
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                                       bpxdi1_1
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          indfmpir
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          indfmpir
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                                       bpxdi1_1
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          indfmpir
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          indfmpir
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                              marcat bpxdi1_1
> impm2$predictorMatrix
          seqn riagendr ridreth1 wtmec2yr sdmvpsu sdmvstra indfmpir bmxbmi age18p age marcat descode
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age4cat
> 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:
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sdmvpsu sdmvstra indfmpir

bmxbmi

age18p

marcat

age

seqn riagendr ridreth1 wtmec2yr

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descode bpxdi1_1
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"polyreg"
                           "norm"
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                       marcat bpxdi1_1
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PredictorMatrix:
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                                 0
                                          0
wtmec2yr
                                 0
sdmvpsu
                   0
                        0
                                          0
                   0
                        0
                                 0
                                          0
sdmvstra
indfmpir
                   1
                        0
                                 1
                                          1
bmxbmi
                   1
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                                          1
age18p
                   0
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                         0
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                                          0
age
marcat
                   1
                        0
                                 1
                                           1
                   0
                         0
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                                          0
descode
bpxdi1_1
                   0
                        0
                                 1
                                          1
agec
                   0
                        0
                                 0
                                          0
                                 0
                   0
                         0
                                          0
agecsq
age4cat
                   0
                         0
                                 0
                                          0
Random generator seed value:
                                   2016
> # add a predictor matrix to control imputation model predictors for each imputed variable
> pred <- impm2$predictorMatrix</pre>
> pred[,"sdmvpsu"] <- 0</pre>
> pred[,"sdmvstra"] <- 0</pre>
> pred[,"seqn"] <- 0</pre>
> pred[, "age18p"] <- 0</pre>
```

- > pred[,"descode"] <- 0</pre>
- > pred[,"wtmec2yr"] <- 0</pre>
- > impm2\$predictorMatrix

	seqn	riagendr	ridreth1	wtmec2yr	sdmvpsu	sdmvstra	indfmpir	bmxbmi	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	0	1	1	0
bmxbmi	1	1	1	1	1	1	1	0	0	1	1	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	1	1	0	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	0	1	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

bpxdi1_1 agec agecsq age4cat seqn riagendr ridreth1 wtmec2yr sdmvpsu sdmvstra indfmpir bmxbmi age18p age marcat

age4cat > pred

agecsq

descode

bpxdi1_1

agec

seqn riagendr ridreth1 wtmec2yr sdmvpsu sdmvstra indfmpir bmxbmi age18p age marcat descode seqn riagendr ridreth1 wtmec2yr sdmvpsu sdmvstra indfmpir bmxbmi age18p age marcat descode bpxdi1_1 agec

```
0
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agecsq
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age4cat
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          bpxdi1_1 agec agecsq age4cat
                  0
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                                0
seqn
riagendr
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                        0
                                0
                                          0
                  0
                        0
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                                          0
ridreth1
                  0
                        0
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                                          0
wtmec2yr
sdmvpsu
                  0
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                        0
                                 0
                                          0
sdmvstra
indfmpir
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                                 1
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bmxbmi
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age18p
                  0
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age
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descode
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agec
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agecsq
age4cat
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                                          0
```

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

```
iter imp variable
1
        indfmpir
                                   bpxdi1 1
                  bmxbmi
                          marcat
1
                          marcat
        indfmpir
                  bmxbmi
                                   bpxdi1_1
1
     3
        indfmpir
                  bmxbmi
                          marcat
                                   bpxdi1_1
1
     4
        indfmpir
                  bmxbmi
                          marcat
                                   bpxdi1_1
1
     5
       indfmpir
                  bmxbmi
                          marcat
                                   bpxdi1_1
2
        indfmpir
                  bmxbmi
     1
                          marcat
                                   bpxdi1_1
2
        indfmpir
                  bmxbmi
                          marcat
                                   bpxdi1 1
2
     3
        indfmpir
                  bmxbmi
                          marcat
                                   bpxdi1_1
2
        indfmpir
                  bmxbmi
                          marcat
                                   bpxdi1_1
2
     5
        indfmpir
                  bmxbmi
                                   bpxdi1 1
                          marcat
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
        indfmpir
                  bmxbmi
                          marcat
                                   bpxdi1_1
4
     1
        indfmpir
                  bmxbmi
                          marcat
                                   bpxdi1 1
4
     2
        indfmpir
                  bmxbmi
                          marcat
                                   bpxdi1_1
4
     3
        indfmpir
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                                   bpxdi1_1
        indfmpir
4
                  bmxbmi
                          marcat
                                   bpxdi1_1
4
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        indfmpir
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                                   bpxdi1_1
                          marcat
5
     1
        indfmpir
                  bmxbmi
                                   bpxdi1_1
5
     2
        indfmpir
                  bmxbmi
                          marcat
                                   bpxdi1_1
5
        indfmpir
                  bmxbmi
                          marcat
                                   bpxdi1_1
5
     4
        indfmpir
                  bmxbmi
                          marcat
                                   bpxdi1 1
```

bmxbmi

marcat

bpxdi1_1

5

indfmpir

```
> 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:
    seqn riagendr ridreth1 wtmec2yr
                                         sdmvpsu sdmvstra indfmpir
                                                                          bmxbmi
                                                                                    age18p
                                                                                                         marcat
                                                                                                  age
        0
                            0
                                      0
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                                                           0
                                                                   487
                                                                              90
                                                                                          0
                                                                                                    0
                                                                                                            300
                                          age4cat
 descode bpxdi1 1
                         agec
                                 agecsq
        0
                503
                            0
                                       0
Imputation methods:
      segn
            riagendr
                        ridreth1
                                   wtmec2yr
                                                sdmvpsu
                                                          sdmvstra
                                                                     indfmpir
                                                                                   bmxbmi
                                                                                               age18p
                                                                                                              age
                                          11 11
                                                                        "norm"
                                                                                   "norm"
   marcat
             descode
                        bpxdi1 1
                                        agec
                                                 agecsq
                                                           age4cat
"polyreg"
                          "norm"
VisitSequence:
indfmpir
            bmxbmi
                      marcat bpxdi1 1
        7
                  8
                           11
                                     13
PredictorMatrix:
          segn riagendr ridreth1 wtmec2yr sdmvpsu sdmvstra indfmpir bmxbmi age18p age marcat descode
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age18p
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bpxdi1_1
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agecsq
age4cat
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segn
riagendr
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ridreth1
                                0
wtmec2yr
                  0
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sdmvpsu
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sdmvstra
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indfmpir
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bmxbmi
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descode
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                                         0
agec
```

agecsq

```
0
age4cat
                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)</pre>
> longm2$high diastolic <- ifelse(longm2$bpxdi1 1 >=90,1,0)
> summary(longm2)
                                                               ridreth1
                                                                                wtmec2yr
                                                                                                  sdmvpsu
 .imp
               .id
                                seqn
                                               riagendr
                 :
                           Min.
                                  :62161
                                                   :1.000
                                                                   :1.000
                                                                             Min.
                                                                                    : 4413
                                                                                               Min.
                                                                                                      :1.000
 0:5615
                      6
                                           Min.
                                                            Min.
 1:5615
          1000
                      6
                           1st Qu.:64610
                                           1st Qu.:1.000
                                                            1st Qu.:3.000
                                                                             1st Qu.: 16169
                                                                                               1st Qu.:1.000
                 :
                           Median :67109
 2:5615
          1001
                 :
                      6
                                           Median :2.000
                                                            Median :3.000
                                                                             Median : 24567
                                                                                               Median :2.000
          1002
                      6
                           Mean
                                  :67076
                                           Mean
 3:5615
                 :
                                                   :1.506
                                                            Mean
                                                                   :3.301
                                                                             Mean
                                                                                    : 41318
                                                                                               Mean
                                                                                                      :1.638
 4:5615
          1003
                      6
                           3rd Qu.:69533
                                           3rd Qu.:2.000
                                                            3rd Qu.:4.000
                                                                             3rd Qu.: 45331
                                                                                               3rd Qu.:2.000
 5:5615
          1004
                      6
                           Max.
                                  :71915
                                           Max.
                                                   :2.000
                                                            Max.
                                                                   :5.000
                                                                             Max.
                                                                                    :222580
                                                                                               Max.
                                                                                                      :3.000
          (Other):33654
                      indfmpir
                                        bmxbmi
                                                          age18p
                                                                                    marcat
    sdmvstra
                                                                        age
       : 90.00
                          :-3.839
                                            : 4.303
                                                                          :18.00
                  Min.
                                    Min.
                                                      Min.
                                                             : 1
                                                                  Min.
                                                                                       :18277
 Min.
                                                                                   1
 1st Qu.: 92.00
                  1st Qu.: 0.960
                                    1st Qu.:23.800
                                                      1st Qu.:1
                                                                  1st Qu.:31.00
                                                                                      : 7129
 Median : 96.00
                  Median : 1.890
                                    Median :27.400
                                                      Median :1
                                                                  Median :47.00
                                                                                       : 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
        :103.00
                  Max.
                         : 9.092
                                            :82.100
                                                      Max.
                                                                  Max.
                                                                          :80.00
                                    Max.
                                                             : 1
                  NA's
                          :487
                                    NA's
                                            :90
    descode
                     bpxdi1_1
                                         agec
                                                            agecsq
                                                                                age4cat
                                                                                              high_diastolic
 Min.
        : 901.0
                  Min.
                          : 10.00
                                            :-28.3552
                                                                : 0.1261
                                                                                    :1.000
                                                                                              Min.
                                                                                                     :0.000
                                    Min.
                                                        Min.
                                                                             Min.
 1st Qu.: 922.0
                  1st Qu.: 64.00
                                                                             1st Qu.:2.000
                                    1st Qu.:-15.3552
                                                        1st Qu.: 58.4436
                                                                                              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
        :1032.0
                  Max.
                          :120.00
                                    Max.
                                            : 33.6448
                                                                :1131.9752
                                                                                    :4.000
                                                                                              Max.
                                                                                                     :1.000
 Max.
                                                        Max.
                                                                             Max.
                          :503
                  NA's
                                                                                              NA's
                                                                                                     :503
> #use as.mids() to convert back to mids object
> impm2a <- as.mids(longm2)</pre>
>
> # convert mids to data useable for work in mitools
> library(mitools)
> mydatam2 <- imputationList(lapply(1:5, complete, x=impm2a))</pre>
> summary(mydatam2)
            Length Class Mode
                    -none- list
imputations 5
call
            2
                    -none- call
>
> # set survey design
> library(survey)
> desm2 <- svydesign(id=~sdmvstra, strat=~sdmvpsu, weight=~wtmec2yr, data=(mydatam2), nest=TRUE)</pre>
> summary(desm2)
        Length Class Mode
designs 5
               -none- list
call
               -none- call
> # run design based logistic model with svyglm using 5 imputed data sets contained in desm1, Taable 12.5
```

```
> fitm2 <- with(desm2, svyglm (high_diastolic ~ factor(ridreth1) + factor(riagendr) + agec + agecsq,
family=quasibinomial))
> summary(MIcombine(fitm2))
Multiple imputation results:
      with(desm2, svyglm(high_diastolic ~ factor(ridreth1) + factor(riagendr) +
    agec + agecsq, family = quasibinomial))
      MIcombine.default(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 %
                   0.008409436 0.0068413544 -0.004999598 0.021818470
                                                                             1 %
                  -0.001708093 0.0002510349 -0.002208132 -0.001208054
                                                                           25 %
agecsq
> # 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 ))</pre>
> # mean high blood pressure for each imputed data set
> fitm2 mean
[[1]]
                                      SE
                            mean
factor(high diastolic)0 0.938486 0.0067
factor(high_diastolic)1 0.061514 0.0067
[[2]]
                            mean
                                      SE
factor(high diastolic)0 0.939995 0.0066
factor(high diastolic)1 0.060005 0.0066
[[3]]
                           mean
                                     SE
factor(high diastolic)0 0.94009 0.0067
factor(high_diastolic)1 0.05991 0.0067
[[4]]
                                     SE
                           mean
factor(high diastolic)0 0.94255 0.0065
factor(high diastolic)1 0.05745 0.0065
[[5]]
                                      SE
                            mean
factor(high_diastolic)0 0.938556 0.0064
factor(high diastolic)1 0.061444 0.0064
attr(,"call")
with(desm2, svymean(~factor(high_diastolic), se = T, na.rm = T,
    ci = T)
```

> # 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.