

Analysis of Bone Fracture Data

Libraries

```
## PART 2

library(xgboost)
library(shapper)

## Warning: package 'shapper' was built under R version 4.3.3

library(ROCR)

## Warning: package 'ROCR' was built under R version 4.3.3

library(ROSE)

## Warning: package 'ROSE' was built under R version 4.3.3

library(DMwR2)

## Warning: package 'DMwR2' was built under R version 4.3.3

library(smotefamily)

## Warning: package 'smotefamily' was built under R version 4.3.3

library(randomForest)
library(readxl)
library(dplyr)
library(car)
library(caret)

## Warning: package 'ggplot2' was built under R version 4.3.3
## Warning: package 'lattice' was built under R version 4.3.3

library(car)
library(pROC)
library(dplyr)
library(glmnet)

## Warning: package 'glmnet' was built under R version 4.3.3

library(FactoMineR)

## Warning: package 'FactoMineR' was built under R version 4.3.3

library(rpart)
library(rpart)
library(rpart.plot)
```

```
## Warning: package 'rpart.plot' was built under R version 4.3.3
```

```
library(aplore3)
```

```
## Warning: package 'aplore3' was built under R version 4.3.3
```

```
# Load and summarize the dataset
```

```
data("glow_bonemed") # Corrected dataset name
```

```
summary(glow_bonemed)
```

```
##      sub_id      site_id      phy_id      priorfrac      age
##  Min.   : 1.0    Min.   :1.000    Min.   : 1.00    No :374    Min.   :55.00
## 1st Qu.:125.8    1st Qu.:2.000    1st Qu.: 57.75    Yes:126    1st Qu.:61.00
## Median :250.5    Median :3.000    Median :182.50                      Median :67.00
## Mean   :250.5    Mean   :3.436    Mean   :178.55                      Mean   :68.56
## 3rd Qu.:375.2    3rd Qu.:5.000    3rd Qu.:298.00                      3rd Qu.:76.00
## Max.   :500.0    Max.   :6.000    Max.   :325.00                      Max.   :90.00
##      weight      height      bmi      premeno      momfrac
## armassist
##  Min.   : 39.90    Min.   :134.0    Min.   :14.88    No :403    No :435    No
## :312
## 1st Qu.: 59.90    1st Qu.:157.0    1st Qu.:23.27    Yes: 97    Yes: 65
## Yes:188
## Median : 68.00    Median :161.5    Median :26.42
## Mean   : 71.82    Mean   :161.4    Mean   :27.55
## 3rd Qu.: 81.30    3rd Qu.:165.0    3rd Qu.:30.79
## Max.   :127.00    Max.   :199.0    Max.   :49.08
## smoke      raterisk      fracscore      fracture      bonemed      bonemed_fu
## No :465    Less :167    Min.   : 0.000    No :375    No :371    No :361
## Yes: 35    Same :186    1st Qu.: 2.000    Yes:125    Yes:129    Yes:139
##      Greater:147    Median : 3.000
##      Mean   : 3.698
##      3rd Qu.: 5.000
##      Max.   :11.000
## bonetreat
## No :382
## Yes:118
##
##
##
```

```
##
# Rename Columns and convert factors where needed
glow_bonemed_NEW <- glow_bonemed %>%
  rename(
    FRACTURE = fracture,
    AGE = age,
    HEIGHT = height,
    WEIGHT = weight,
    PREMENO = premeno,
    MOMFRAC = momfrac,
    RATERISK = raterisk,
    PRIORFRAC = priorfrac,
    ARMASSIST = armassist,
    SMOKE = smoke,
    BMI = bmi,
    SUB_ID = sub_id,
    SITE_ID = site_id,
    PHY_ID = phy_id,
    BONEMED = bonemed,
    FRACSCORE = fracscore,
    BONEMED_FU = bonemed_fu,
    BONETREAT = bonetreat
  ) %>%
  mutate(
    PRIORFRAC = as.numeric(PRIORFRAC == "Yes"),
    ARMASSIST = as.numeric(ARMASSIST == "Yes"),
    MOMFRAC = as.numeric(MOMFRAC == "Yes"),
    SMOKE = as.numeric(SMOKE == "Yes"),
    FRACTURE = as.numeric(FRACTURE == "Yes"),
    RATERISK_EQ_3 = as.numeric(RATERISK == "Greater"),
    RATERISK_num = as.numeric(factor(RATERISK))
  )
```

```

# INTERACTION AND STANDARDIZATION TERMS

# age
glow_bonemed_NEW <- glow_bonemed_NEW %>%
  mutate(AGE_STDZ = scale(AGE, center = TRUE, scale = TRUE))

# Standardize AGE and create interaction terms
glow_bonemed_NEW <- glow_bonemed_NEW %>%
  mutate(
    AGE_STDZ = scale(AGE, center = TRUE, scale = TRUE), # Standardize AGE
    AGExPRIORFRAC = AGE_STDZ * PRIORFRAC, # Interaction term: Standardized
    AGE * PRIORFRAC
    MOMFRACxARMASSIST = MOMFRAC * ARMASSIST, # Interaction term: MOMFRAC *
    ARMASSIST
    PRIORFRACxAGE_STDZ = PRIORFRAC * AGE_STDZ,
    NOPRIORFRACxAGE_STDZ = (1 - PRIORFRAC) * AGE_STDZ
    #AGE_STDZxNOPRIOR = (1 - PRIORFRAC) * AGE_STDZ #(same as above but used
    in code)

  )

# Create Interaction Terms
glow_bonemed_NEW <- glow_bonemed_NEW %>%
  mutate(
    PRIORFRACxAGE_STDZ = PRIORFRAC * AGE_STDZ,
    NOPRIORFRACxAGE_STDZ = (1 - PRIORFRAC) * AGE_STDZ
  )

# Save the new dataframe to a CSV file
#write.csv(glow_bonemed_NEW, "glow_bonemed_NEW.csv", row.names = FALSE)

# Drop Useless Columns

```

```
glow_bonemedNEW <- glow_bonemed_NEW[, !(names(glow_bonemed_NEW) %in%
c("SUB_ID", "SITE_ID", "PHY_ID"))]
```

```
# Rename Dataset to work with
```

```
GLOW_data <- glow_bonemed_NEW
```

```
glow <- GLOW_data
```

```
glows <- glow
```

```
colnames(GLOW_data)
```

```
## [1] "SUB_ID" "SITE_ID" "PHY_ID"
## [4] "PRIORFRAC" "AGE" "WEIGHT"
## [7] "HEIGHT" "BMI" "PREMENO"
## [10] "MOMFRAC" "ARMASSIST" "SMOKE"
## [13] "RATERISK" "FRACSCORE" "FRACTURE"
## [16] "BONEMED" "BONEMED_FU" "BONETREAT"
## [19] "RATERISK_EQ_3" "RATERISK_num" "AGE_STDZ"
## [22] "AGExPRIORFRAC" "MOMFRACxARMASSIST" "PRIORFRACxAGE_STDZ"
## [25] "NOPRIORFRACxAGE_STDZ"
```

```
colnames(glow)
```

```
## [1] "SUB_ID" "SITE_ID" "PHY_ID"
## [4] "PRIORFRAC" "AGE" "WEIGHT"
## [7] "HEIGHT" "BMI" "PREMENO"
## [10] "MOMFRAC" "ARMASSIST" "SMOKE"
## [13] "RATERISK" "FRACSCORE" "FRACTURE"
## [16] "BONEMED" "BONEMED_FU" "BONETREAT"
## [19] "RATERISK_EQ_3" "RATERISK_num" "AGE_STDZ"
## [22] "AGExPRIORFRAC" "MOMFRACxARMASSIST" "PRIORFRACxAGE_STDZ"
## [25] "NOPRIORFRACxAGE_STDZ"
```

```
colnames(glows)
```

```
## [1] "SUB_ID" "SITE_ID" "PHY_ID"
## [4] "PRIORFRAC" "AGE" "WEIGHT"
## [7] "HEIGHT" "BMI" "PREMENO"
## [10] "MOMFRAC" "ARMASSIST" "SMOKE"
## [13] "RATERISK" "FRACSCORE" "FRACTURE"
```

```
## [16] "BONEMED"          "BONEMED_FU"          "BONETREAT"
## [19] "RATERISK_EQ_3"     "RATERISK_num"        "AGE_STDZ"
## [22] "AGExPRIORFRAC"     "MOMFRACxARMASSIST"   "PRIORFRACxAGE_STDZ"
## [25] "NOPRIORFRACxAGE_STDZ"
```

Model Building

GLM

Prepare the Logistic Regression Model

```
modell1 <- glm(FRACTURE ~ AGE_STDZ + HEIGHT + PRIORFRAC + MOMFRAC + ARMASSIST
+ RATERISK_EQ_3 + PRIORFRACxAGE_STDZ + NOPRIORFRACxAGE_STDZ, data =
GLOW_data, family = binomial())

# Check Model Sumary & Diagnostics
summary(modell1)

##
## Call:
## glm(formula = FRACTURE ~ AGE_STDZ + HEIGHT + PRIORFRAC + MOMFRAC +
##      ARMASSIST + RATERISK_EQ_3 + PRIORFRACxAGE_STDZ + NOPRIORFRACxAGE_STDZ,
##      family = binomial(), data = GLOW_data)
##
## Coefficients: (1 not defined because of singularities)
##
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)      5.18600    2.90210   1.787 0.073941 .
## AGE_STDZ          0.49416    0.14671   3.368 0.000756 ***
## HEIGHT          -0.04329    0.01813  -2.388 0.016951 *
## PRIORFRAC         0.85315    0.25473   3.349 0.000811 ***
## MOMFRAC          0.71225    0.30707   2.319 0.020368 *
## ARMASSIST        0.44757    0.23238   1.926 0.054106 .
## RATERISK_EQ_3     0.46265    0.23961   1.931 0.053495 .
## PRIORFRACxAGE_STDZ -0.51953    0.23153  -2.244 0.024839 *
## NOPRIORFRACxAGE_STDZ      NA         NA      NA      NA
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##      Null deviance: 562.34  on 499  degrees of freedom
## Residual deviance: 504.78  on 492  degrees of freedom
## AIC: 520.78
##
## Number of Fisher Scoring iterations: 4

#car::vif(model)

# Refit the model without the problematic interaction term
model_refit <- glm(FRACTURE ~ AGE_STDZ + HEIGHT + PRIORFRAC + MOMFRAC +
  ARMASSIST + RATERISK_EQ_3 + PRIORFRACxAGE_STDZ, data = GLOW_data, family =
  binomial())

# Check the new model summary
summary(model_refit)

##
## Call:
## glm(formula = FRACTURE ~ AGE_STDZ + HEIGHT + PRIORFRAC + MOMFRAC +
##      ARMASSIST + RATERISK_EQ_3 + PRIORFRACxAGE_STDZ, family = binomial(),
##      data = GLOW_data)
##
## Coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)      5.18600      2.90210   1.787 0.073941 .
## AGE_STDZ          0.49416      0.14671   3.368 0.000756 ***
## HEIGHT          -0.04329      0.01813  -2.388 0.016951 *
## PRIORFRAC         0.85315      0.25473   3.349 0.000811 ***
## MOMFRAC          0.71225      0.30707   2.319 0.020368 *
## ARMASSIST         0.44757      0.23238   1.926 0.054106 .
## RATERISK_EQ_3     0.46265      0.23961   1.931 0.053495 .
## PRIORFRACxAGE_STDZ -0.51953      0.23153  -2.244 0.024839 *
## ---
```

```
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##      Null deviance: 562.34  on 499  degrees of freedom
## Residual deviance: 504.78  on 492  degrees of freedom
## AIC: 520.78
##
## Number of Fisher Scoring iterations: 4
# Attempt VIF calculation again
vif(model_refit)
##           AGE_STDZ           HEIGHT           PRIORFRAC
MOMFRAC
##           1.804248           1.069318           1.218999
1.029081
##           ARMASSIST          RATERISK_EQ_3 PRIORFRACxAGE_STDZ
##           1.106067           1.069982           1.881434
# Original Model
# Fit the original logistic regression model
original_model <- glm(FRACTURE ~ AGE + HEIGHT + PRIORFRAC + MOMFRAC +
  ARMASSIST + RATERISK_EQ_3 + AGExPRIORFRAC,
                      family = binomial(link = "logit"),
                      data = GLOW_data)

summary(original_model)
##
## Call:
## glm(formula = FRACTURE ~ AGE + HEIGHT + PRIORFRAC + MOMFRAC +
##      ARMASSIST + RATERISK_EQ_3 + AGExPRIORFRAC, family = binomial(link =
"logit"),
##      data = GLOW_data)
##
## Coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)    1.41714    3.29734   0.430 0.667353
## AGE            0.05497    0.01632   3.368 0.000756 ***
```



```
## HEIGHT          -0.04329      0.01813   -2.388 0.016951 *
## PRIORFRAC       0.85315      0.25473    3.349 0.000811 ***
## MOMFRAC         0.71225      0.30707    2.319 0.020368 *
## ARMASSIST       0.44757      0.23238    1.926 0.054106 .
## RATERISK_EQ_3   0.46265      0.23961    1.931 0.053495 .
## AGExPRIORFRAC  -0.51953      0.23153   -2.244 0.024839 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##      Null deviance: 562.34  on 499  degrees of freedom
## Residual deviance: 504.78  on 492  degrees of freedom
## AIC: 520.78
##
## Number of Fisher Scoring iterations: 4
```

```
car::vif(original_model)
```

```
##           AGE           HEIGHT      PRIORFRAC      MOMFRAC      ARMASSIST
##      1.804248      1.069318      1.218999      1.029081      1.106067
## RATERISK_EQ_3 AGExPRIORFRAC
##      1.069982      1.881434
```

Logistic Regression Model

```
model2 <- glm(FRACTURE ~ AGE_STDZ + HEIGHT + PRIORFRAC + MOMFRAC + ARMASSIST,
data = GLOW_data, family = binomial())
```

```
summary(model2)
```

```
##
## Call:
## glm(formula = FRACTURE ~ AGE_STDZ + HEIGHT + PRIORFRAC + MOMFRAC +
##      ARMASSIST, family = binomial(), data = GLOW_data)
##
## Coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)   5.78083    2.90433   1.990  0.04654 *
## AGE_STDZ      0.26748    0.11464   2.333  0.01964 *
```

```
## HEIGHT      -0.04635      0.01816  -2.552   0.01070  *
## PRIORFRAC    0.75259      0.23959   3.141   0.00168  **
## MOMFRAC      0.72263      0.30235   2.390   0.01684  *
## ARMASSIST    0.52372      0.22829   2.294   0.02179  *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##      Null deviance: 562.34  on 499  degrees of freedom
## Residual deviance: 513.46  on 494  degrees of freedom
## AIC: 525.46
##
## Number of Fisher Scoring iterations: 4
```

Check Model Summary and Diagnostics

```
car::vif(model2)

## AGE_STDZ      HEIGHT PRIORFRAC      MOMFRAC ARMASSIST
##  1.140680   1.066260   1.080805   1.012421   1.085556
```

Validation Split Data and Validate Model

```
set.seed(123)

trainIndex <- createDataPartition(GLOW_data$FRACTURE, p = 0.8, list = FALSE,
times = 1)

trainData <- GLOW_data[trainIndex, ]
validationData <- GLOW_data[-trainIndex, ]

fitModel <- glm(FRACTURE ~ AGE_STDZ + HEIGHT + PRIORFRAC, data = trainData,
family = binomial())

validationData$predicted_probs <- predict(fitModel, newdata = validationData,
type = "response")

validationData$predicted_class <- ifelse(validationData$predicted_probs >
0.5, 1, 0)

conf_matrix <-
caret::confusionMatrix(as.factor(validationData$predicted_class),
as.factor(validationData$FRACTURE))
```

```

print(conf_matrix)

## Confusion Matrix and Statistics
##
##           Reference
## Prediction  0   1
##           0 65 22
##           1 10  3
##
##           Accuracy : 0.68
##           95% CI : (0.5792, 0.7698)
##           No Information Rate : 0.75
##           P-Value [Acc > NIR] : 0.95540
##
##           Kappa : -0.0159
##
##           Mcnemar's Test P-Value : 0.05183
##
##           Sensitivity : 0.8667
##           Specificity : 0.1200
##           Pos Pred Value : 0.7471
##           Neg Pred Value : 0.2308
##           Prevalence : 0.7500
##           Detection Rate : 0.6500
##           Detection Prevalence : 0.8700
##           Balanced Accuracy : 0.4933
##
##           'Positive' Class : 0
##

```

ROC Curve & AUC

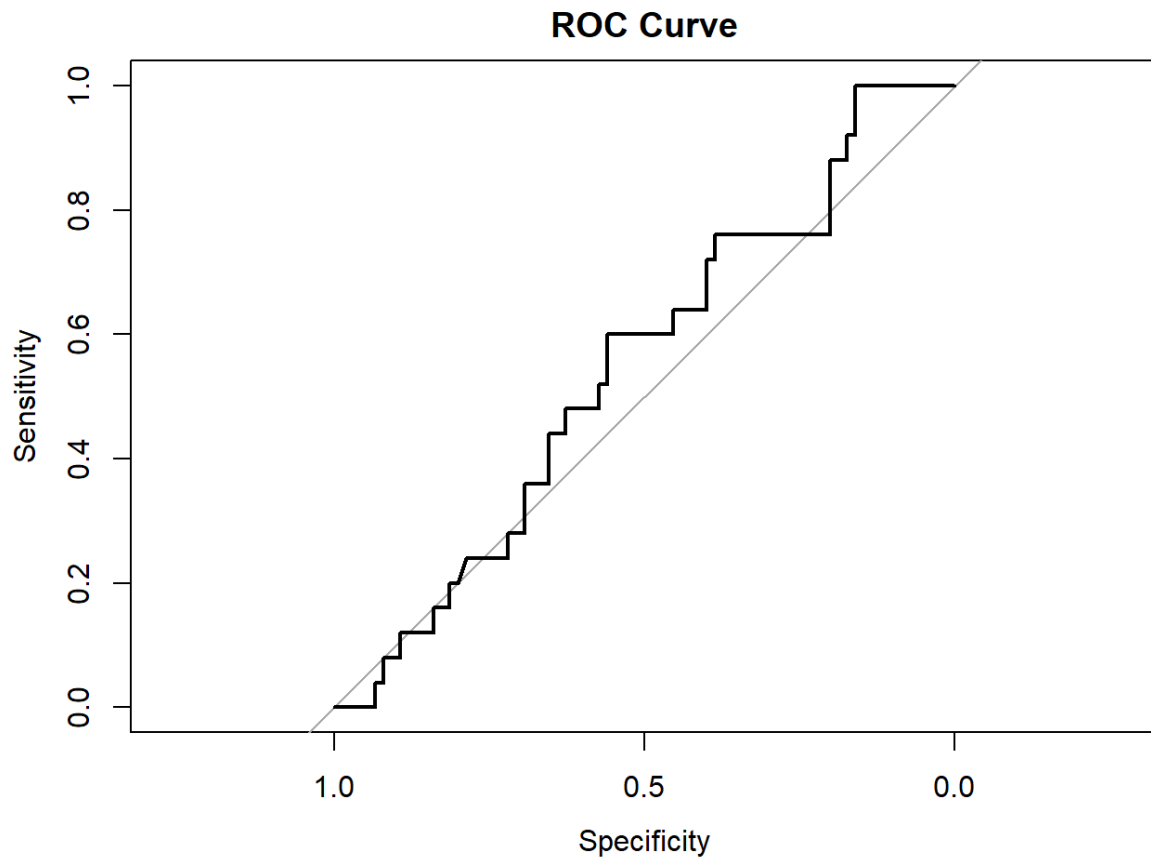
```

roc_result <- roc(response = validationData$FRACTURE, predictor =
validationData$predicted_probs)

## Setting levels: control = 0, case = 1
## Setting direction: controls < cases

```

```
plot(roc_result, main="ROC Curve")
```



```
auc(roc_result)

## Area under the curve: 0.5464

# Improved Model:
# Standardize AGE and create new interaction terms
GLOW_data <- GLOW_data %>%
  mutate(
    AGE_STDZ = scale(AGE, center = TRUE, scale = TRUE), # Standardize AGE
    PRIORFRACxAGE_STDZ = PRIORFRAC * AGE_STDZ, # Interaction term: PRIORFRAC
    * Standardized AGE
    NOPRIORFRACxAGE_STDZ = (1 - PRIORFRAC) * AGE_STDZ # Interaction term: (1
    - PRIORFRAC) * Standardized AGE
  )

# Fit the improved logistic regression model
improved_model <- glm(FRACTURE ~ AGE_STDZ + HEIGHT + PRIORFRAC + MOMFRAC +
  ARMASIST + RATERISK_EQ_3 + PRIORFRACxAGE_STDZ + NOPRIORFRACxAGE_STDZ,
```

```

        family = binomial(link = "logit"),
        data = GLOW_data)

# car::vif(improved_model) # Too Much Multicollinearity
summary(improved_model)

##
## Call:
## glm(formula = FRACTURE ~ AGE_STDZ + HEIGHT + PRIORFRAC + MOMFRAC +
##      ARMASSIST + RATERISK_EQ_3 + PRIORFRACxAGE_STDZ + NOPRIORFRACxAGE_STDZ,
##      family = binomial(link = "logit"), data = GLOW_data)
##
## Coefficients: (1 not defined because of singularities)
##
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)      5.18600    2.90210   1.787 0.073941 .
## AGE_STDZ          0.49416    0.14671   3.368 0.000756 ***
## HEIGHT          -0.04329    0.01813  -2.388 0.016951 *
## PRIORFRAC         0.85315    0.25473   3.349 0.000811 ***
## MOMFRAC           0.71225    0.30707   2.319 0.020368 *
## ARMASSIST         0.44757    0.23238   1.926 0.054106 .
## RATERISK_EQ_3     0.46265    0.23961   1.931 0.053495 .
## PRIORFRACxAGE_STDZ -0.51953    0.23153  -2.244 0.024839 *
## NOPRIORFRACxAGE_STDZ      NA          NA      NA      NA
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##      Null deviance: 562.34  on 499  degrees of freedom
## Residual deviance: 504.78  on 492  degrees of freedom
## AIC: 520.78
##
## Number of Fisher Scoring iterations: 4

# Fit the improved logistic regression model without the problematic term
improved_model2 <- glm(FRACTURE ~ AGE_STDZ + HEIGHT + PRIORFRAC + MOMFRAC +
ARMASSIST + RATERISK_EQ_3 + PRIORFRACxAGE_STDZ,

```

```

        family = binomial(link = "logit"),
        data = GLOW_data)

summary(improved_model2)

##
## Call:
## glm(formula = FRACTURE ~ AGE_STDZ + HEIGHT + PRIORFRAC + MOMFRAC +
##      ARMASSIST + RATERISK_EQ_3 + PRIORFRACxAGE_STDZ, family = binomial(link
##      = "logit"),
##      data = GLOW_data)
##
## Coefficients:
##              Estimate Std. Error z value Pr(>|z|)
## (Intercept)      5.18600    2.90210   1.787 0.073941 .
## AGE_STDZ          0.49416    0.14671   3.368 0.000756 ***
## HEIGHT          -0.04329    0.01813  -2.388 0.016951 *
## PRIORFRAC         0.85315    0.25473   3.349 0.000811 ***
## MOMFRAC          0.71225    0.30707   2.319 0.020368 *
## ARMASSIST         0.44757    0.23238   1.926 0.054106 .
## RATERISK_EQ_3     0.46265    0.23961   1.931 0.053495 .
## PRIORFRACxAGE_STDZ -0.51953    0.23153  -2.244 0.024839 *
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## (Dispersion parameter for binomial family taken to be 1)
##
##      Null deviance: 562.34  on 499  degrees of freedom
## Residual deviance: 504.78  on 492  degrees of freedom
## AIC: 520.78
##
## Number of Fisher Scoring iterations: 4
# check the VIF for the improved model again
car::vif(improved_model2)
##              AGE_STDZ              HEIGHT              PRIORFRAC
MOMFRAC

```

```
##          1.804248          1.069318          1.218999
1.029081

##          ARMASSIST          RATERISK_EQ_3 PRIORFRACxAGE_STDZ
##          1.106067          1.069982          1.881434
```

```
# Test Model
```

```
# Split into training and validation
```

```
set.seed(123) # for reproducibility
```

```
trainIndex <- createDataPartition(GLOW_data$FRACTURE, p = 0.8,
                                   list = FALSE,
                                   times = 1)
```

```
trainData <- GLOW_data[trainIndex, ]
```

```
validationData <- GLOW_data[-trainIndex, ]
```

```
# Fit Model on Training Data
```

```
improved_model <- glm(FRACTURE ~ AGE_STDZ + HEIGHT + PRIORFRAC + MOMFRAC +
  ARMASSIST + RATERISK_EQ_3 + PRIORFRACxAGE_STDZ,
                     family = binomial(link = "logit"),
                     data = trainData)
```

```
# Make Predictions on Validation Data
```

```
# Predicting probabilities
```

```
validationData$predicted_probs <- predict(improved_model, newdata =
  validationData, type = "response")
```

```
# Convert probabilities to a binary outcome (0 or 1) based on a threshold of 0.5
```

```
validationData$predicted_class <- ifelse(validationData$predicted_probs >
  0.5, 1, 0)
```

```
# Evaluate Model Performance
```

```
# Creating a confusion matrix to compare actual and predicted classifications
```

```
conf_matrix <- confusionMatrix(as.factor(validationData$predicted_class),
  as.factor(validationData$FRACTURE))
```

```
print(conf_matrix)
```

```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  0   1
##           0 67 21
##           1   8   4
##
##           Accuracy : 0.71
##           95% CI : (0.6107, 0.7964)
##           No Information Rate : 0.75
##           P-Value [Acc > NIR] : 0.85046
##
##           Kappa : 0.0645
##
##           McNemar's Test P-Value : 0.02586
##
##           Sensitivity : 0.8933
##           Specificity : 0.1600
##           Pos Pred Value : 0.7614
##           Neg Pred Value : 0.3333
##           Prevalence : 0.7500
##           Detection Rate : 0.6700
##           Detection Prevalence : 0.8800
##           Balanced Accuracy : 0.5267
##
##           'Positive' Class : 0
##
```

```
# ROC Curve & AUC
```

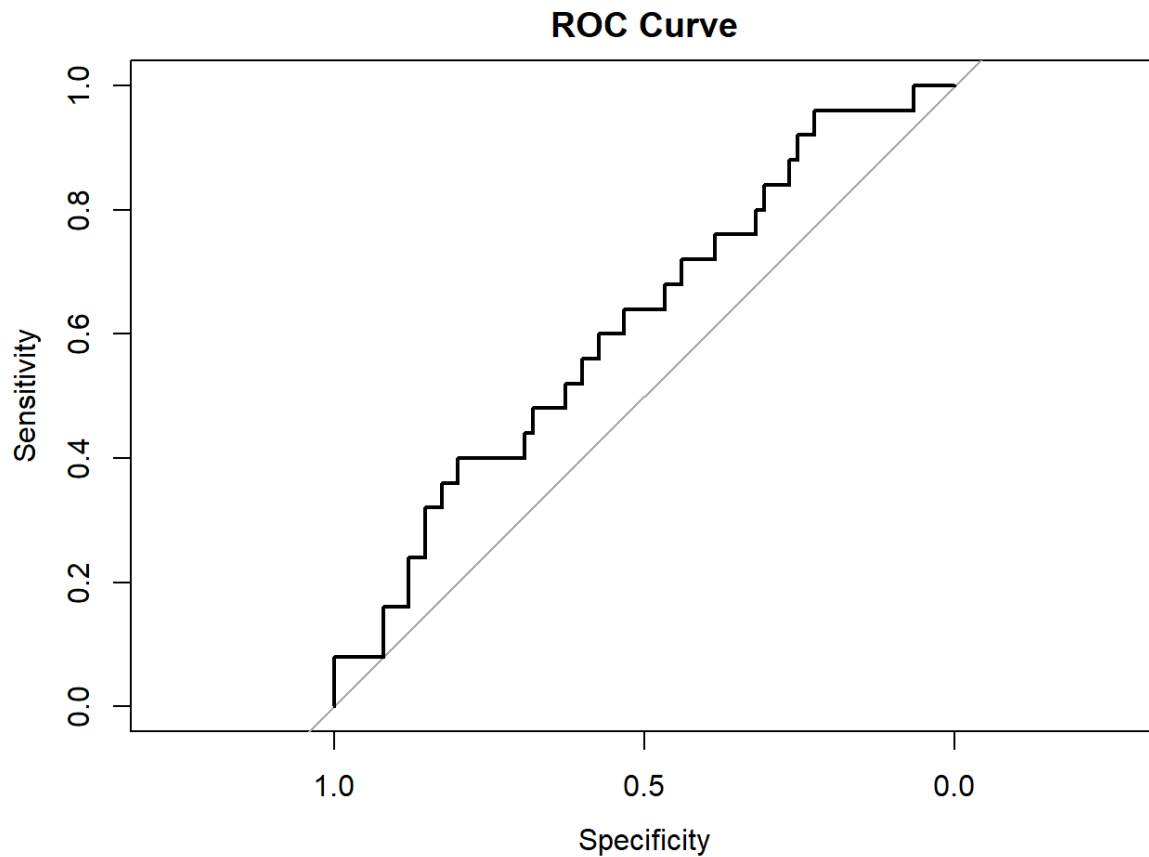
```
# ROC curve
```

```
roc_result <- roc(response = validationData$FRACTURE, predictor =
validationData$predicted_probs)
```

```
## Setting levels: control = 0, case = 1
```

```
## Setting direction: controls < cases
```

```
plot(roc_result, main="ROC Curve")
```

```
auc(roc_result)
## Area under the curve: 0.6149

# REFINING FURTHER

# Pairwise
pairwise_interactions <- GLOW_data %>%
  mutate(
    AGExWEIGHT = AGE * WEIGHT,
    AGExHEIGHT = AGE * HEIGHT,
    WEIGHTxHEIGHT = WEIGHT * HEIGHT
  )

# Total Pairwise
selected_vars <- c("AGE", "WEIGHT", "HEIGHT", "PRIORFRAC", "AGExPRIORFRAC",
  "AGE_STDZ", "AGE_STDZxPRIOR", "AGE_STDZxNOPRIOR", "BMI", "PREMENO",
  "MOMFRAC", "ARMASSIST", "MOMFRACxARMASSIST", "SMOKE", "RATERISK",
  "RATERISK_EQ_1", "RATERISK_EQ_2", "RATERISK_EQ_3", "FRACSCORE",
  "PRIORFRACxAGE_STDZ", "NOPRIORFRACxAGE_STDZ") # List the variables to
combine
```

```

# Ensure to use the correct variable names as they exist in your dataframe
combinations <- combn(selected_vars, 2, simplify = FALSE) # Get all
combinations of these variables

# Iterate over the combinations and create interaction terms
for(comb in combinations) {
  if(all(comb %in% names(GLOW_data))) {
    var_name <- paste(comb, collapse = "TOTAL_PAIRWISE") # Create a name for
the new variable

    pairwise_interactions[[var_name]] <- GLOW_data[[comb[1]]] *
GLOW_data[[comb[2]]]
  } else {
    warning("Variable combination does not exist in the dataset: ",
paste(comb, collapse = " and "))
  }
}

## Warning: Variable combination does not exist in the dataset: AGE and
## AGE_STDZxPRIOR
## Warning: Variable combination does not exist in the dataset: AGE and
## AGE_STDZxNOPRIOR
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning: Variable combination does not exist in the dataset: AGE and
## RATERISK_EQ_1
## Warning: Variable combination does not exist in the dataset: AGE and
## RATERISK_EQ_2
## Warning: Variable combination does not exist in the dataset: WEIGHT and
## AGE_STDZxPRIOR
## Warning: Variable combination does not exist in the dataset: WEIGHT and
## AGE_STDZxNOPRIOR
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not

```

```
## meaningful for factors
## Warning: Variable combination does not exist in the dataset: WEIGHT and
## RATERISK_EQ_1
## Warning: Variable combination does not exist in the dataset: WEIGHT and
## RATERISK_EQ_2
## Warning: Variable combination does not exist in the dataset: HEIGHT and
## AGE_STDZxPRIOR
## Warning: Variable combination does not exist in the dataset: HEIGHT and
## AGE_STDZxNOPRIOR
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning: Variable combination does not exist in the dataset: HEIGHT and
## RATERISK_EQ_1
## Warning: Variable combination does not exist in the dataset: HEIGHT and
## RATERISK_EQ_2
## Warning: Variable combination does not exist in the dataset: PRIORFRAC and
## AGE_STDZxPRIOR
## Warning: Variable combination does not exist in the dataset: PRIORFRAC and
## AGE_STDZxNOPRIOR
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning: Variable combination does not exist in the dataset: PRIORFRAC and
## RATERISK_EQ_1
## Warning: Variable combination does not exist in the dataset: PRIORFRAC and
## RATERISK_EQ_2
## Warning: Variable combination does not exist in the dataset: AGExPRIORFRAC
and
## AGE_STDZxPRIOR
## Warning: Variable combination does not exist in the dataset: AGExPRIORFRAC
and
## AGE_STDZxNOPRIOR
```

```
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning: Variable combination does not exist in the dataset: AGExPRIORFRAC
and
## RATERISK_EQ_1
## Warning: Variable combination does not exist in the dataset: AGExPRIORFRAC
and
## RATERISK_EQ_2
## Warning: Variable combination does not exist in the dataset: AGE_STDZ and
## AGE_STDZxPRIOR
## Warning: Variable combination does not exist in the dataset: AGE_STDZ and
## AGE_STDZxNOPRIOR
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning: Variable combination does not exist in the dataset: AGE_STDZ and
## RATERISK_EQ_1
## Warning: Variable combination does not exist in the dataset: AGE_STDZ and
## RATERISK_EQ_2
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## AGE_STDZxNOPRIOR
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## BMI
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## PREMENO
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## MOMFRAC
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## ARMASSIST
```

```
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## MOMFRACxARMASSIST
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## SMOKE
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## RATERISK
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## RATERISK_EQ_1
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## RATERISK_EQ_2
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## RATERISK_EQ_3
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## FRACSCORE
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## PRIORFRACxAGE_STDZ
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxPRIOR and
## NOPRIORFRACxAGE_STDZ
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxNOPRIOR
## and BMI
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxNOPRIOR
## and PREMENO
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxNOPRIOR
## and MOMFRAC
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxNOPRIOR
## and ARMASSIST
```

```
## Warning: Variable combination does not exist in the dataset:
AGE_STDZxNOPRIOR

## and MOMFRACxARMASIST

## Warning: Variable combination does not exist in the dataset:
AGE_STDZxNOPRIOR

## and SMOKE

## Warning: Variable combination does not exist in the dataset:
AGE_STDZxNOPRIOR

## and RATERISK

## Warning: Variable combination does not exist in the dataset:
AGE_STDZxNOPRIOR

## and RATERISK_EQ_1

## Warning: Variable combination does not exist in the dataset:
AGE_STDZxNOPRIOR

## and RATERISK_EQ_2

## Warning: Variable combination does not exist in the dataset:
AGE_STDZxNOPRIOR

## and RATERISK_EQ_3

## Warning: Variable combination does not exist in the dataset:
AGE_STDZxNOPRIOR

## and FRACSCORE

## Warning: Variable combination does not exist in the dataset:
AGE_STDZxNOPRIOR

## and PRIORFRACxAGE_STDZ

## Warning: Variable combination does not exist in the dataset:
AGE_STDZxNOPRIOR

## and NOPRIORFRACxAGE_STDZ

## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors

## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors

## Warning: Variable combination does not exist in the dataset: BMI and
## RATERISK_EQ_1

## Warning: Variable combination does not exist in the dataset: BMI and
## RATERISK_EQ_2

## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors

## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
```

```
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning: Variable combination does not exist in the dataset: PREMENO and
## RATERISK_EQ_1
## Warning: Variable combination does not exist in the dataset: PREMENO and
## RATERISK_EQ_2
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning: Variable combination does not exist in the dataset: MOMFRAC and
## RATERISK_EQ_1
## Warning: Variable combination does not exist in the dataset: MOMFRAC and
## RATERISK_EQ_2
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning: Variable combination does not exist in the dataset: ARMASSIST and
## RATERISK_EQ_1
## Warning: Variable combination does not exist in the dataset: ARMASSIST and
## RATERISK_EQ_2
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning: Variable combination does not exist in the dataset:
MOMFRACxARMASSIST
```

```
## and RATERISK_EQ_1
## Warning: Variable combination does not exist in the dataset:
MOMFRACxARMASSIST
## and RATERISK_EQ_2
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning: Variable combination does not exist in the dataset: SMOKE and
## RATERISK_EQ_1
## Warning: Variable combination does not exist in the dataset: SMOKE and
## RATERISK_EQ_2
## Warning: Variable combination does not exist in the dataset: RATERISK and
## RATERISK_EQ_1
## Warning: Variable combination does not exist in the dataset: RATERISK and
## RATERISK_EQ_2
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning in Ops.factor(GLOW_data[[comb[1]]], GLOW_data[[comb[2]]]): '*' not
## meaningful for factors
## Warning: Variable combination does not exist in the dataset: RATERISK_EQ_1
and
## RATERISK_EQ_2
## Warning: Variable combination does not exist in the dataset: RATERISK_EQ_1
and
## RATERISK_EQ_3
## Warning: Variable combination does not exist in the dataset: RATERISK_EQ_1
and
## FRACSCORE
## Warning: Variable combination does not exist in the dataset: RATERISK_EQ_1
and
## PRIORFRACxAGE_STDZ
## Warning: Variable combination does not exist in the dataset: RATERISK_EQ_1
and
## NOPRIORFRACxAGE_STDZ
```



```

## Warning: Variable combination does not exist in the dataset: RATERISK_EQ_2
and
## RATERISK_EQ_3
## Warning: Variable combination does not exist in the dataset: RATERISK_EQ_2
and
## FRACSCORE
## Warning: Variable combination does not exist in the dataset: RATERISK_EQ_2
and
## PRIORFRACxAGE_STDZ
## Warning: Variable combination does not exist in the dataset: RATERISK_EQ_2
and
## NOPRIORFRACxAGE_STDZ

## MORE ADVANCED MODELING
# Refining Further
# Pairwise
pairwise_interactions <- GLOW_data %>%
  mutate(
    AGExWEIGHT = AGE * WEIGHT,
    AGExHEIGHT = AGE * HEIGHT,
    WEIGHTxHEIGHT = WEIGHT * HEIGHT
  )

# Total Pairwise
selected_vars <- c("AGE", "WEIGHT", "HEIGHT")
combinations <- combn(selected_vars, 2, simplify = FALSE) # Get all
combinations of these variables

# Check the structure of the new dataframe with interaction terms
str(pairwise_interactions)

## 'data.frame':    500 obs. of  28 variables:
##  $ SUB_ID          : int  1 2 3 4 5 6 7 8 9 10 ...
##  $ SITE_ID         : int  1 4 6 6 1 5 5 1 1 4 ...
##  $ PHY_ID          : int  14 284 305 309 37 299 302 36 8 282 ...
##  $ PRIORFRAC       : num  0 0 1 0 0 1 0 1 1 0 ...
##  $ AGE             : int  62 65 88 82 61 67 84 82 86 58 ...
##  $ WEIGHT          : num  70.3 87.1 50.8 62.1 68 68 50.8 40.8 62.6
63.5 ...

```

```

## $ HEIGHT : int 158 160 157 160 152 161 150 153 156 166 ...
## $ BMI : num 28.2 34 20.6 24.3 29.4 ...
## $ PREMENO : Factor w/ 2 levels "No","Yes": 1 1 1 1 1 1 1 1 1 1
1 ...
## $ MOMFRAC : num 0 0 1 0 0 0 0 0 0 0 ...
## $ ARMASSIST : num 0 0 1 0 0 0 0 0 0 0 ...
## $ SMOKE : num 0 0 0 0 0 1 0 0 0 0 ...
## $ RATERISK : Factor w/ 3 levels "Less","Same",...: 2 2 1 1 2 2
1 2 2 1 ...
## $ FRACSCORE : int 1 2 11 5 1 4 6 7 7 0 ...
## $ FRACTURE : num 0 0 0 0 0 0 0 0 0 0 ...
## $ BONEMED : Factor w/ 2 levels "No","Yes": 1 1 1 1 1 1 1 2 1
1 ...
## $ BONEMED_FU : Factor w/ 2 levels "No","Yes": 1 1 1 1 1 1 1 2 1
1 ...
## $ BONETREAT : Factor w/ 2 levels "No","Yes": 1 1 1 1 1 1 1 2 1
1 ...
## $ RATERISK_EQ_3 : num 0 0 0 0 0 0 0 0 0 0 ...
## $ RATERISK_num : num 2 2 1 1 2 2 1 2 2 1 ...
## $ AGE_STDZ : num [1:500, 1] -0.73 -0.396 2.162 1.495 -0.841
...
## ..- attr(*, "scaled:center")= num 68.6
## ..- attr(*, "scaled:scale")= num 8.99
## $ AGExPRIORFRAC : num [1:500, 1] 0 0 2.16 0 0 ...
## ..- attr(*, "scaled:center")= num 68.6
## ..- attr(*, "scaled:scale")= num 8.99
## $ MOMFRACxARMASSIST : num 0 0 1 0 0 0 0 0 0 0 ...
## $ PRIORFRACxAGE_STDZ : num [1:500, 1] 0 0 2.16 0 0 ...
## ..- attr(*, "scaled:center")= num 68.6
## ..- attr(*, "scaled:scale")= num 8.99
## $ NOPRIORFRACxAGE_STDZ: num [1:500, 1] -0.73 -0.396 0 1.495 -0.841 ...
## ..- attr(*, "scaled:center")= num 68.6
## ..- attr(*, "scaled:scale")= num 8.99
## $ AGExWEIGHT : num 4359 5662 4470 5092 4148 ...
## $ AGExHEIGHT : int 9796 10400 13816 13120 9272 10787 12600
12546 13416 9628 ...
## $ WEIGHTxHEIGHT : num 11107 13936 7976 9936 10336 ...

```

```
# View the first few rows to confirm the new columns were added
```

```
head(pairwise_interactions)
```

##	SUB_ID	SITE_ID	PHY_ID	PRIORFRAC	AGE	WEIGHT	HEIGHT	BMI	PREMENO
## 1	1	1	14	0	62	70.3	158	28.16055	No
0									
## 2	2	4	284	0	65	87.1	160	34.02344	No
0									
## 3	3	6	305	1	88	50.8	157	20.60936	No
1									
## 4	4	6	309	0	82	62.1	160	24.25781	No
0									
## 5	5	1	37	0	61	68.0	152	29.43213	No
0									
## 6	6	5	299	1	67	68.0	161	26.23356	No
0									

##	ARMASSIST	SMOKE	RATERISK	FRACSCORE	FRACTURE	BONEMED	BONEMED_FU	BONETREAT
## 1	0	0	Same	1	0	No	No	No
## 2	0	0	Same	2	0	No	No	No
## 3	1	0	Less	11	0	No	No	No
## 4	0	0	Less	5	0	No	No	No
## 5	0	0	Same	1	0	No	No	No
## 6	0	1	Same	4	0	No	No	No

##	RATERISK_EQ_3	RATERISK_num	AGE_STDZ	AGExPRIORFRAC	MOMFRACxARMASSIST
## 1	0	2	-0.7299597	0.0000000	0
## 2	0	2	-0.3962384	0.0000000	0
## 3	0	1	2.1622915	2.1622915	1
## 4	0	1	1.4948489	0.0000000	0
## 5	0	2	-0.8412001	0.0000000	0
## 6	0	2	-0.1737576	-0.1737576	0

##	PRIORFRACxAGE_STDZ	NOPRIORFRACxAGE_STDZ	AGExWEIGHT	AGExHEIGHT
## 1	0.0000000	-0.7299597	4358.6	9796
11107.4				
## 2	0.0000000	-0.3962384	5661.5	10400
13936.0				
## 3	2.1622915	0.0000000	4470.4	13816
7975.6				

```
## 4          0.0000000          1.4948489          5092.2          13120
9936.0

## 5          0.0000000          -0.8412001          4148.0          9272
10336.0

## 6          -0.1737576          0.0000000          4556.0          10787
10948.0
```

```
# Find Target Column "FRACTURE"
```

```
# Print all column names in the dataset
```

```
print(names(GLOW_data))
```

```
## [1] "SUB_ID"          "SITE_ID"          "PHY_ID"
## [4] "PRIORFRAC"       "AGE"              "WEIGHT"
## [7] "HEIGHT"          "BMI"              "PREMENO"
## [10] "MOMFRAC"         "ARMASSIST"        "SMOKE"
## [13] "RATERISK"        "FRACSCORE"        "FRACTURE"
## [16] "BONEMED"         "BONEMED_FU"       "BONETREAT"
## [19] "RATERISK_EQ_3"   "RATERISK_num"     "AGE_STDZ"
## [22] "AGExPRIORFRAC"   "MOMFRACxARMASSIST" "PRIORFRACxAGE_STDZ"
## [25] "NOPRIORFRACxAGE_STDZ"
```

```
# Or use the which function to find the index of the 'FRACTURE' column
```

```
fracture_column_index <- which(names(GLOW_data) == "FRACTURE")
```

```
print(paste("The 'FRACTURE' column is at index:", fracture_column_index))
```

```
## [1] "The 'FRACTURE' column is at index: 15"
```

```
# *****
```

```
# ADD FRACTURE COLLMN BACK IN
```

```
# GLOW_data <- GLOW_data %>%
```

```
# mutate(
```

```
#   FRACTURE = as.numeric(FRACTURE == "Yes")
```

```
# )
```

```
# *****
```

```
# Ensure y is just the FRACTURE column as a factor if it's categorical
```

```
y <- as.factor(GLOW_data$FRACTURE)
```

```
# Ensure x excludes the FRACTURE column
```

```
x <- GLOW_data[, -which(names(GLOW_data) == "FRACTURE")]
```

```
# Setup RFE control
```

```
control <- rfeControl(functions=rfFuncs, method="repeatedcv", number=10,
repeats=3)
```

```
# Run RFE
```

```
results <- rfe(x, y, sizes=c(1:5), rfeControl=control)
```

```
# Print results
```

```
print(results)
```

```
##
```

```
## Recursive feature selection
```

```
##
```

```
## Outer resampling method: Cross-Validated (10 fold, repeated 3 times)
```

```
##
```

```
## Resampling performance over subset size:
```

```
##
```

```
## Variables Accuracy Kappa AccuracySD KappaSD Selected
```

```
##          1    0.9987 0.9964    0.005074 0.013524
```

```
##          2    0.9993 0.9982    0.003651 0.009732      *
```

```
##          3    0.9987 0.9964    0.005074 0.013524
```

```
##          4    0.9987 0.9964    0.005074 0.013524
```

```
##          5    0.9987 0.9964    0.005074 0.013524
```

```
##         24    0.9987 0.9964    0.005074 0.013524
```

```
##
```

```
## The top 2 variables (out of 2):
```

```
##      SUB_ID, FRACSCORE
```

```
# Print the results
```

```
print(results)
```

```
##
```

```
## Recursive feature selection
```

```
##
```

```
## Outer resampling method: Cross-Validated (10 fold, repeated 3 times)
```

```
##
```

```
## Resampling performance over subset size:
```

```
##
```

```
## Variables Accuracy Kappa AccuracySD KappaSD Selected
```

```
##          1    0.9987 0.9964    0.005074 0.013524
##          2    0.9993 0.9982    0.003651 0.009732      *
##          3    0.9987 0.9964    0.005074 0.013524
##          4    0.9987 0.9964    0.005074 0.013524
##          5    0.9987 0.9964    0.005074 0.013524
##         24    0.9987 0.9964    0.005074 0.013524
##
## The top 2 variables (out of 2):
##      SUB_ID, FRACSCORE
```

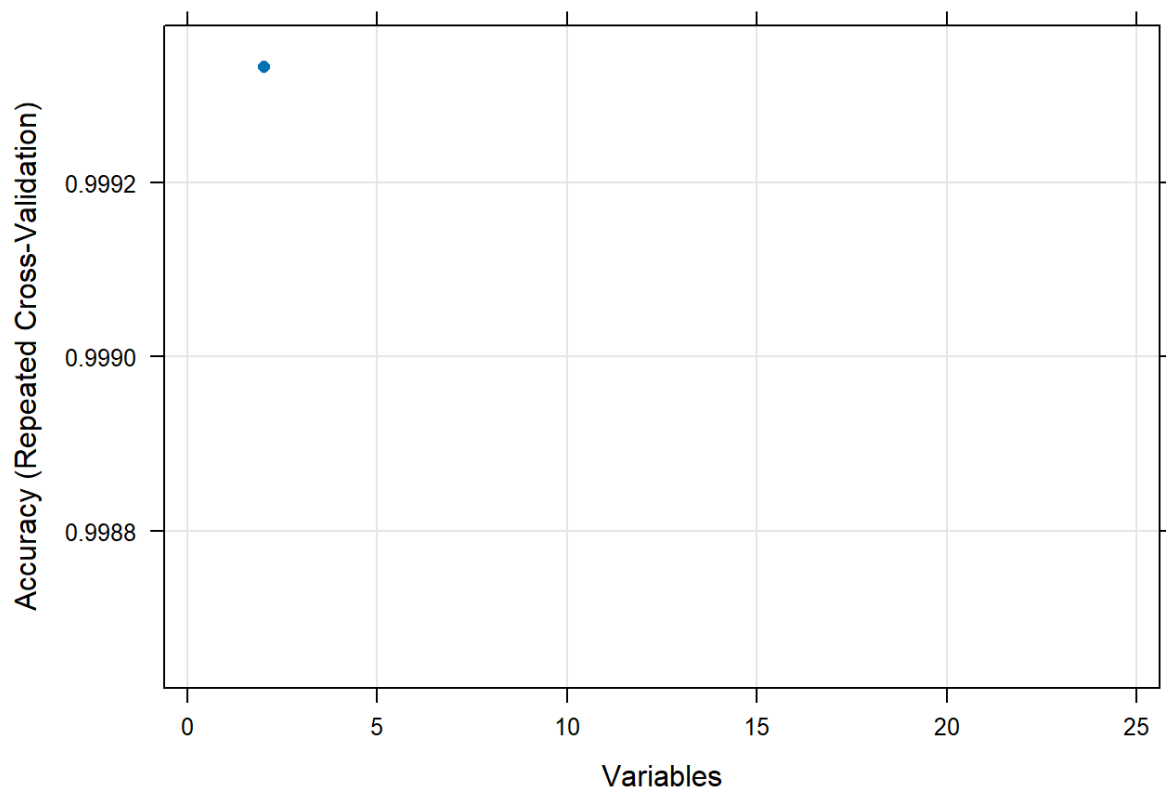
```
# Summary RFE
```

```
summary(results)
```

##	Length	Class	Mode
## pred	0	-none-	NULL
## variables	6	data.frame	list
## results	5	data.frame	list
## bestSubset	1	-none-	numeric
## fit	18	randomForest	list
## optVariables	2	-none-	character
## optsize	1	-none-	numeric
## call	5	-none-	call
## control	14	-none-	list
## resample	8	data.frame	list
## metric	1	-none-	character
## maximize	1	-none-	logical
## perfNames	2	-none-	character
## times	3	-none-	list
## resampledCM	0	-none-	NULL
## obsLevels	2	-none-	character
## dots	0	-none-	list

```
# Plotting RFE
```

```
plot(results, type = c("g", "c"))
```



```
# Review Selected Features
```

```
print(results$optsize) # Prints the optimal size of features
```

```
## [1] 2
```

```
print(results$variables) # Prints the names of the selected variables at the optimal size
```

##	0	1	Overall	var	Variables
## 1	57.560077217	57.560077217	57.560077217	SUB_ID	24
## 2	4.876131282	4.876131282	4.876131282	FRACSCORE	24
## 3	4.428949742	4.428949742	4.428949742	NOPRIORFRACxAGE_STDZ	24
## 4	3.959130250	3.959130250	3.959130250	BONEMED_FU	24
## 5	3.196624973	3.196624973	3.196624973	HEIGHT	24
## 6	2.847696121	2.847696121	2.847696121	BMI	24
## 7	1.905056279	1.905056279	1.905056279	BONETREAT	24
## 8	1.753818085	1.753818085	1.753818085	AGE	24
## 9	1.657072125	1.657072125	1.657072125	BONEMED	24
## 10	1.472733126	1.472733126	1.472733126	WEIGHT	24

## 11	1.202020666	1.202020666	1.202020666	AGE_STDZ	24
## 12	1.002721061	1.002721061	1.002721061	MOMFRACxARMASSIST	24
## 13	0.671048244	0.671048244	0.671048244	PRIORFRAC	24
## 14	0.618954678	0.618954678	0.618954678	RATERISK	24
## 15	0.238286534	0.238286534	0.238286534	ARMASSIST	24
## 16	0.128223582	0.128223582	0.128223582	PRIORFRACxAGE_STDZ	24
## 17	-0.128383570	-0.128383570	-0.128383570	MOMFRAC	24
## 18	-0.162165219	-0.162165219	-0.162165219	RATERISK_num	24
## 19	-0.175339388	-0.175339388	-0.175339388	RATERISK_EQ_3	24
## 20	-0.274453245	-0.274453245	-0.274453245	SMOKE	24
## 21	-0.283265976	-0.283265976	-0.283265976	AGExPRIORFRAC	24
## 22	-0.470113074	-0.470113074	-0.470113074	SITE_ID	24
## 23	-0.513873770	-0.513873770	-0.513873770	PHY_ID	24
## 24	-0.555358191	-0.555358191	-0.555358191	PREMENO	24
## 25	57.560077217	57.560077217	57.560077217	SUB_ID	5
## 26	4.876131282	4.876131282	4.876131282	FRACSCORE	5
## 27	4.428949742	4.428949742	4.428949742	NOPRIORFRACxAGE_STDZ	5
## 28	3.959130250	3.959130250	3.959130250	BONEMED_FU	5
## 29	3.196624973	3.196624973	3.196624973	HEIGHT	5
## 30	57.560077217	57.560077217	57.560077217	SUB_ID	4
## 31	4.876131282	4.876131282	4.876131282	FRACSCORE	4
## 32	4.428949742	4.428949742	4.428949742	NOPRIORFRACxAGE_STDZ	4
## 33	3.959130250	3.959130250	3.959130250	BONEMED_FU	4
## 34	57.560077217	57.560077217	57.560077217	SUB_ID	3
## 35	4.876131282	4.876131282	4.876131282	FRACSCORE	3
## 36	4.428949742	4.428949742	4.428949742	NOPRIORFRACxAGE_STDZ	3
## 37	57.560077217	57.560077217	57.560077217	SUB_ID	2
## 38	4.876131282	4.876131282	4.876131282	FRACSCORE	2
## 39	57.560077217	57.560077217	57.560077217	SUB_ID	1
## 40	60.106351341	60.106351341	60.106351341	SUB_ID	24
## 41	4.394348434	4.394348434	4.394348434	FRACSCORE	24
## 42	4.333670621	4.333670621	4.333670621	BMI	24
## 43	3.295910892	3.295910892	3.295910892	AGE_STDZ	24
## 44	3.224382679	3.224382679	3.224382679	BONEMED	24

## 45	2.861585754	2.861585754	2.861585754	NOPRIORFRACxAGE_STDZ	24
## 46	2.569018933	2.569018933	2.569018933	BONEMED_FU	24
## 47	2.141929242	2.141929242	2.141929242	WEIGHT	24
## 48	2.121453690	2.121453690	2.121453690	RATERISK_EQ_3	24
## 49	2.110967585	2.110967585	2.110967585	AGE	24
## 50	1.916234714	1.916234714	1.916234714	PRIORFRACxAGE_STDZ	24
## 51	1.817747514	1.817747514	1.817747514	BONETREAT	24
## 52	1.702698691	1.702698691	1.702698691	AGExPRIORFRAC	24
## 53	1.566460698	1.566460698	1.566460698	RATERISK	24
## 54	1.283613735	1.283613735	1.283613735	PRIORFRAC	24
## 55	1.276637664	1.276637664	1.276637664	SITE_ID	24
## 56	0.974081302	0.974081302	0.974081302	PHY_ID	24
## 57	0.812423130	0.812423130	0.812423130	ARMASSIST	24
## 58	0.688750195	0.688750195	0.688750195	PREMENO	24
## 59	0.381986178	0.381986178	0.381986178	MOMFRAC	24
## 60	0.252838045	0.252838045	0.252838045	HEIGHT	24
## 61	-0.010617450	-0.010617450	-0.010617450	RATERISK_num	24
## 62	-0.491919399	-0.491919399	-0.491919399	SMOKE	24
## 63	-0.824362228	-0.824362228	-0.824362228	MOMFRACxARMASSIST	24
## 64	60.106351341	60.106351341	60.106351341	SUB_ID	5
## 65	4.394348434	4.394348434	4.394348434	FRACSCORE	5
## 66	4.333670621	4.333670621	4.333670621	BMI	5
## 67	3.295910892	3.295910892	3.295910892	AGE_STDZ	5
## 68	3.224382679	3.224382679	3.224382679	BONEMED	5
## 69	60.106351341	60.106351341	60.106351341	SUB_ID	4
## 70	4.394348434	4.394348434	4.394348434	FRACSCORE	4
## 71	4.333670621	4.333670621	4.333670621	BMI	4
## 72	3.295910892	3.295910892	3.295910892	AGE_STDZ	4
## 73	60.106351341	60.106351341	60.106351341	SUB_ID	3
## 74	4.394348434	4.394348434	4.394348434	FRACSCORE	3
## 75	4.333670621	4.333670621	4.333670621	BMI	3
## 76	60.106351341	60.106351341	60.106351341	SUB_ID	2
## 77	4.394348434	4.394348434	4.394348434	FRACSCORE	2
## 78	60.106351341	60.106351341	60.106351341	SUB_ID	1

## 79	64.868561700	64.868561700	64.868561700	SUB_ID	24
## 80	4.457698990	4.457698990	4.457698990	BONEMED_FU	24
## 81	3.836167641	3.836167641	3.836167641	FRACSCORE	24
## 82	3.822764109	3.822764109	3.822764109	NOPRIORFRACxAGE_STDZ	24
## 83	3.015866736	3.015866736	3.015866736	HEIGHT	24
## 84	2.948353992	2.948353992	2.948353992	AGE_STDZ	24
## 85	2.740958413	2.740958413	2.740958413	BMI	24
## 86	2.610613180	2.610613180	2.610613180	BONEMED	24
## 87	1.971584877	1.971584877	1.971584877	SITE_ID	24
## 88	1.968832279	1.968832279	1.968832279	PRIORFRAC	24
## 89	1.790337952	1.790337952	1.790337952	AGE	24
## 90	1.740583277	1.740583277	1.740583277	BONETREAT	24
## 91	1.729591717	1.729591717	1.729591717	PHY_ID	24
## 92	1.285970165	1.285970165	1.285970165	WEIGHT	24
## 93	1.265369909	1.265369909	1.265369909	SMOKE	24
## 94	0.980164947	0.980164947	0.980164947	RATERISK	24
## 95	0.824808905	0.824808905	0.824808905	ARMASSIST	24
## 96	0.612806180	0.612806180	0.612806180	PRIORFRACxAGE_STDZ	24
## 97	0.417727377	0.417727377	0.417727377	MOMFRAC	24
## 98	0.158625964	0.158625964	0.158625964	RATERISK_num	24
## 99	-0.078589030	-0.078589030	-0.078589030	RATERISK_EQ_3	24
## 100	-0.350030865	-0.350030865	-0.350030865	AGExPRIORFRAC	24
## 101	-0.732221030	-0.732221030	-0.732221030	MOMFRACxARMASSIST	24
## 102	-1.754783487	-1.754783487	-1.754783487	PREMENO	24
## 103	64.868561700	64.868561700	64.868561700	SUB_ID	5
## 104	4.457698990	4.457698990	4.457698990	BONEMED_FU	5
## 105	3.836167641	3.836167641	3.836167641	FRACSCORE	5
## 106	3.822764109	3.822764109	3.822764109	NOPRIORFRACxAGE_STDZ	5
## 107	3.015866736	3.015866736	3.015866736	HEIGHT	5
## 108	64.868561700	64.868561700	64.868561700	SUB_ID	4
## 109	4.457698990	4.457698990	4.457698990	BONEMED_FU	4
## 110	3.836167641	3.836167641	3.836167641	FRACSCORE	4
## 111	3.822764109	3.822764109	3.822764109	NOPRIORFRACxAGE_STDZ	4
## 112	64.868561700	64.868561700	64.868561700	SUB_ID	3

## 113	4.457698990	4.457698990	4.457698990	BONEMED_FU	3
## 114	3.836167641	3.836167641	3.836167641	FRACSCORE	3
## 115	64.868561700	64.868561700	64.868561700	SUB_ID	2
## 116	4.457698990	4.457698990	4.457698990	BONEMED_FU	2
## 117	64.868561700	64.868561700	64.868561700	SUB_ID	1
## 118	60.704082205	60.704082205	60.704082205	SUB_ID	24
## 119	4.170806311	4.170806311	4.170806311	BMI	24
## 120	3.445115607	3.445115607	3.445115607	FRACSCORE	24
## 121	3.146389278	3.146389278	3.146389278	NOPRIORFRACxAGE_STDZ	24
## 122	2.908817688	2.908817688	2.908817688	HEIGHT	24
## 123	2.703114015	2.703114015	2.703114015	AGE_STDZ	24
## 124	2.627908309	2.627908309	2.627908309	AGE	24
## 125	2.462877867	2.462877867	2.462877867	BONEMED	24
## 126	2.420006316	2.420006316	2.420006316	BONEMED_FU	24
## 127	1.973434853	1.973434853	1.973434853	RATERISK	24
## 128	1.908790777	1.908790777	1.908790777	WEIGHT	24
## 129	1.725237196	1.725237196	1.725237196	RATERISK_num	24
## 130	1.655126622	1.655126622	1.655126622	BONETREAT	24
## 131	1.219990546	1.219990546	1.219990546	RATERISK_EQ_3	24
## 132	1.035955898	1.035955898	1.035955898	PRIORFRACxAGE_STDZ	24
## 133	0.970049394	0.970049394	0.970049394	MOMFRAC	24
## 134	0.768288423	0.768288423	0.768288423	PRIORFRAC	24
## 135	0.628509324	0.628509324	0.628509324	ARMASSIST	24
## 136	0.413762484	0.413762484	0.413762484	SITE_ID	24
## 137	0.321212093	0.321212093	0.321212093	PHY_ID	24
## 138	-0.094692778	-0.094692778	-0.094692778	SMOKE	24
## 139	-0.359087484	-0.359087484	-0.359087484	AGExPRIORFRAC	24
## 140	-0.571232166	-0.571232166	-0.571232166	MOMFRACxARMASSIST	24
## 141	-0.636349282	-0.636349282	-0.636349282	PREMENO	24
## 142	60.704082205	60.704082205	60.704082205	SUB_ID	5
## 143	4.170806311	4.170806311	4.170806311	BMI	5
## 144	3.445115607	3.445115607	3.445115607	FRACSCORE	5
## 145	3.146389278	3.146389278	3.146389278	NOPRIORFRACxAGE_STDZ	5
## 146	2.908817688	2.908817688	2.908817688	HEIGHT	5

## 147	60.704082205	60.704082205	60.704082205	SUB_ID	4
## 148	4.170806311	4.170806311	4.170806311	BMI	4
## 149	3.445115607	3.445115607	3.445115607	FRACSCORE	4
## 150	3.146389278	3.146389278	3.146389278	NOPRIORFRACxAGE_STDZ	4
## 151	60.704082205	60.704082205	60.704082205	SUB_ID	3
## 152	4.170806311	4.170806311	4.170806311	BMI	3
## 153	3.445115607	3.445115607	3.445115607	FRACSCORE	3
## 154	60.704082205	60.704082205	60.704082205	SUB_ID	2
## 155	4.170806311	4.170806311	4.170806311	BMI	2
## 156	60.704082205	60.704082205	60.704082205	SUB_ID	1
## 157	62.014254305	62.014254305	62.014254305	SUB_ID	24
## 158	4.804068429	4.804068429	4.804068429	NOPRIORFRACxAGE_STDZ	24
## 159	3.587218592	3.587218592	3.587218592	FRACSCORE	24
## 160	2.969459221	2.969459221	2.969459221	BONEMED_FU	24
## 161	2.817837711	2.817837711	2.817837711	AGE	24
## 162	2.810708593	2.810708593	2.810708593	BMI	24
## 163	2.799589536	2.799589536	2.799589536	HEIGHT	24
## 164	2.265486066	2.265486066	2.265486066	AGE_STDZ	24
## 165	2.099997773	2.099997773	2.099997773	WEIGHT	24
## 166	1.899656303	1.899656303	1.899656303	BONEMED	24
## 167	1.868095343	1.868095343	1.868095343	BONETREAT	24
## 168	1.823136136	1.823136136	1.823136136	PRIORFRAC	24
## 169	1.487352232	1.487352232	1.487352232	RATERISK_num	24
## 170	1.176126814	1.176126814	1.176126814	PREMENO	24
## 171	1.092240152	1.092240152	1.092240152	RATERISK_EQ_3	24
## 172	0.490931515	0.490931515	0.490931515	PHY_ID	24
## 173	0.384846780	0.384846780	0.384846780	ARMASSIST	24
## 174	0.375829077	0.375829077	0.375829077	SITE_ID	24
## 175	0.166564255	0.166564255	0.166564255	MOMFRACxARMASSIST	24
## 176	-0.041467135	-0.041467135	-0.041467135	MOMFRAC	24
## 177	-0.152673285	-0.152673285	-0.152673285	SMOKE	24
## 178	-0.323175397	-0.323175397	-0.323175397	AGExPRIORFRAC	24
## 179	-0.375226290	-0.375226290	-0.375226290	RATERISK	24
## 180	-0.951728460	-0.951728460	-0.951728460	PRIORFRACxAGE_STDZ	24

## 181	62.014254305	62.014254305	62.014254305	SUB_ID	5
## 182	4.804068429	4.804068429	4.804068429	NOPRIORFRACxAGE_STDZ	5
## 183	3.587218592	3.587218592	3.587218592	FRACSCORE	5
## 184	2.969459221	2.969459221	2.969459221	BONEMED_FU	5
## 185	2.817837711	2.817837711	2.817837711	AGE	5
## 186	62.014254305	62.014254305	62.014254305	SUB_ID	4
## 187	4.804068429	4.804068429	4.804068429	NOPRIORFRACxAGE_STDZ	4
## 188	3.587218592	3.587218592	3.587218592	FRACSCORE	4
## 189	2.969459221	2.969459221	2.969459221	BONEMED_FU	4
## 190	62.014254305	62.014254305	62.014254305	SUB_ID	3
## 191	4.804068429	4.804068429	4.804068429	NOPRIORFRACxAGE_STDZ	3
## 192	3.587218592	3.587218592	3.587218592	FRACSCORE	3
## 193	62.014254305	62.014254305	62.014254305	SUB_ID	2
## 194	4.804068429	4.804068429	4.804068429	NOPRIORFRACxAGE_STDZ	2
## 195	62.014254305	62.014254305	62.014254305	SUB_ID	1
## 196	64.428242331	64.428242331	64.428242331	SUB_ID	24
## 197	4.605380189	4.605380189	4.605380189	BONEMED_FU	24
## 198	4.392259548	4.392259548	4.392259548	NOPRIORFRACxAGE_STDZ	24
## 199	4.120443751	4.120443751	4.120443751	WEIGHT	24
## 200	3.786738358	3.786738358	3.786738358	BMI	24
## 201	3.750144768	3.750144768	3.750144768	FRACSCORE	24
## 202	3.212990536	3.212990536	3.212990536	AGE_STDZ	24
## 203	3.100047228	3.100047228	3.100047228	BONEMED	24
## 204	2.781647440	2.781647440	2.781647440	BONETREAT	24
## 205	2.739360886	2.739360886	2.739360886	AGE	24
## 206	2.614621042	2.614621042	2.614621042	HEIGHT	24
## 207	1.469451773	1.469451773	1.469451773	MOMFRAC	24
## 208	1.081573482	1.081573482	1.081573482	ARMASSIST	24
## 209	0.778039950	0.778039950	0.778039950	AGExPRIORFRAC	24
## 210	0.683891129	0.683891129	0.683891129	PHY_ID	24
## 211	0.599734795	0.599734795	0.599734795	SMOKE	24
## 212	0.517938843	0.517938843	0.517938843	SITE_ID	24
## 213	0.504746517	0.504746517	0.504746517	MOMFRACxARMASSIST	24
## 214	0.498870765	0.498870765	0.498870765	PRIORFRACxAGE_STDZ	24

## 215	0.397244050	0.397244050	0.397244050	PRIORFRAC	24
## 216	0.204675708	0.204675708	0.204675708	RATERISK_EQ_3	24
## 217	0.128004383	0.128004383	0.128004383	RATERISK_num	24
## 218	-0.285668174	-0.285668174	-0.285668174	PREMENO	24
## 219	-0.698585608	-0.698585608	-0.698585608	RATERISK	24
## 220	64.428242331	64.428242331	64.428242331	SUB_ID	5
## 221	4.605380189	4.605380189	4.605380189	BONEMED_FU	5
## 222	4.392259548	4.392259548	4.392259548	NOPRIORFRACxAGE_STDZ	5
## 223	4.120443751	4.120443751	4.120443751	WEIGHT	5
## 224	3.786738358	3.786738358	3.786738358	BMI	5
## 225	64.428242331	64.428242331	64.428242331	SUB_ID	4
## 226	4.605380189	4.605380189	4.605380189	BONEMED_FU	4
## 227	4.392259548	4.392259548	4.392259548	NOPRIORFRACxAGE_STDZ	4
## 228	4.120443751	4.120443751	4.120443751	WEIGHT	4
## 229	64.428242331	64.428242331	64.428242331	SUB_ID	3
## 230	4.605380189	4.605380189	4.605380189	BONEMED_FU	3
## 231	4.392259548	4.392259548	4.392259548	NOPRIORFRACxAGE_STDZ	3
## 232	64.428242331	64.428242331	64.428242331	SUB_ID	2
## 233	4.605380189	4.605380189	4.605380189	BONEMED_FU	2
## 234	64.428242331	64.428242331	64.428242331	SUB_ID	1
## 235	66.133764401	66.133764401	66.133764401	SUB_ID	24
## 236	4.109521189	4.109521189	4.109521189	HEIGHT	24
## 237	3.684737228	3.684737228	3.684737228	FRACSCORE	24
## 238	3.402606780	3.402606780	3.402606780	BONEMED_FU	24
## 239	3.097924170	3.097924170	3.097924170	NOPRIORFRACxAGE_STDZ	24
## 240	3.016479718	3.016479718	3.016479718	BMI	24
## 241	2.808045339	2.808045339	2.808045339	AGE	24
## 242	2.672651597	2.672651597	2.672651597	AGE_STDZ	24
## 243	2.462908621	2.462908621	2.462908621	WEIGHT	24
## 244	2.427683610	2.427683610	2.427683610	BONETREAT	24
## 245	1.802728967	1.802728967	1.802728967	RATERISK_num	24
## 246	1.643977745	1.643977745	1.643977745	PRIORFRAC	24
## 247	1.280948105	1.280948105	1.280948105	RATERISK_EQ_3	24
## 248	1.136330917	1.136330917	1.136330917	PRIORFRACxAGE_STDZ	24

## 249	1.092603513	1.092603513	1.092603513	RATERISK	24
## 250	0.780742057	0.780742057	0.780742057	AGExPRIORFRAC	24
## 251	0.745339333	0.745339333	0.745339333	BONEMED	24
## 252	0.706376428	0.706376428	0.706376428	SITE_ID	24
## 253	0.627412079	0.627412079	0.627412079	PHY_ID	24
## 254	0.287197998	0.287197998	0.287197998	ARMASSIST	24
## 255	-0.273806919	-0.273806919	-0.273806919	PREMENO	24
## 256	-0.306308387	-0.306308387	-0.306308387	MOMFRAC	24
## 257	-0.339268774	-0.339268774	-0.339268774	SMOKE	24
## 258	-0.674896595	-0.674896595	-0.674896595	MOMFRACxARMASSIST	24
## 259	66.133764401	66.133764401	66.133764401	SUB_ID	5
## 260	4.109521189	4.109521189	4.109521189	HEIGHT	5
## 261	3.684737228	3.684737228	3.684737228	FRACSCORE	5
## 262	3.402606780	3.402606780	3.402606780	BONEMED_FU	5
## 263	3.097924170	3.097924170	3.097924170	NOPRIORFRACxAGE_STDZ	5
## 264	66.133764401	66.133764401	66.133764401	SUB_ID	4
## 265	4.109521189	4.109521189	4.109521189	HEIGHT	4
## 266	3.684737228	3.684737228	3.684737228	FRACSCORE	4
## 267	3.402606780	3.402606780	3.402606780	BONEMED_FU	4
## 268	66.133764401	66.133764401	66.133764401	SUB_ID	3
## 269	4.109521189	4.109521189	4.109521189	HEIGHT	3
## 270	3.684737228	3.684737228	3.684737228	FRACSCORE	3
## 271	66.133764401	66.133764401	66.133764401	SUB_ID	2
## 272	4.109521189	4.109521189	4.109521189	HEIGHT	2
## 273	66.133764401	66.133764401	66.133764401	SUB_ID	1
## 274	64.370936726	64.370936726	64.370936726	SUB_ID	24
## 275	4.121667641	4.121667641	4.121667641	FRACSCORE	24
## 276	3.818725825	3.818725825	3.818725825	NOPRIORFRACxAGE_STDZ	24
## 277	3.480570530	3.480570530	3.480570530	AGE	24
## 278	3.383970860	3.383970860	3.383970860	BMI	24
## 279	3.310161138	3.310161138	3.310161138	HEIGHT	24
## 280	2.913399316	2.913399316	2.913399316	WEIGHT	24
## 281	2.255453542	2.255453542	2.255453542	AGE_STDZ	24
## 282	1.899419886	1.899419886	1.899419886	BONEMED	24

## 283	1.760231260	1.760231260	1.760231260	RATERISK_num	24
## 284	1.350814663	1.350814663	1.350814663	BONEMED_FU	24
## 285	1.081309545	1.081309545	1.081309545	AGExPRIORFRAC	24
## 286	1.013353736	1.013353736	1.013353736	RATERISK	24
## 287	0.919453189	0.919453189	0.919453189	PRIORFRAC	24
## 288	0.912058796	0.912058796	0.912058796	ARMASSIST	24
## 289	0.816017904	0.816017904	0.816017904	SMOKE	24
## 290	0.649528436	0.649528436	0.649528436	PRIORFRACxAGE_STDZ	24
## 291	0.507917688	0.507917688	0.507917688	BONETREAT	24
## 292	0.503544482	0.503544482	0.503544482	SITE_ID	24
## 293	0.483162579	0.483162579	0.483162579	MOMFRAC	24
## 294	0.448468261	0.448468261	0.448468261	PHY_ID	24
## 295	0.414413565	0.414413565	0.414413565	MOMFRACxARMASSIST	24
## 296	-0.692811985	-0.692811985	-0.692811985	RATERISK_EQ_3	24
## 297	-0.780074633	-0.780074633	-0.780074633	PREMENO	24
## 298	64.370936726	64.370936726	64.370936726	SUB_ID	5
## 299	4.121667641	4.121667641	4.121667641	FRACSCORE	5
## 300	3.818725825	3.818725825	3.818725825	NOPRIORFRACxAGE_STDZ	5
## 301	3.480570530	3.480570530	3.480570530	AGE	5
## 302	3.383970860	3.383970860	3.383970860	BMI	5
## 303	64.370936726	64.370936726	64.370936726	SUB_ID	4
## 304	4.121667641	4.121667641	4.121667641	FRACSCORE	4
## 305	3.818725825	3.818725825	3.818725825	NOPRIORFRACxAGE_STDZ	4
## 306	3.480570530	3.480570530	3.480570530	AGE	4
## 307	64.370936726	64.370936726	64.370936726	SUB_ID	3
## 308	4.121667641	4.121667641	4.121667641	FRACSCORE	3
## 309	3.818725825	3.818725825	3.818725825	NOPRIORFRACxAGE_STDZ	3
## 310	64.370936726	64.370936726	64.370936726	SUB_ID	2
## 311	4.121667641	4.121667641	4.121667641	FRACSCORE	2
## 312	64.370936726	64.370936726	64.370936726	SUB_ID	1
## 313	63.125141920	63.125141920	63.125141920	SUB_ID	24
## 314	3.942219489	3.942219489	3.942219489	FRACSCORE	24
## 315	3.807479234	3.807479234	3.807479234	NOPRIORFRACxAGE_STDZ	24
## 316	3.508663495	3.508663495	3.508663495	AGE_STDZ	24

## 317	3.367260987	3.367260987	3.367260987	BMI	24
## 318	2.964456424	2.964456424	2.964456424	AGE	24
## 319	2.428819652	2.428819652	2.428819652	WEIGHT	24
## 320	2.382388047	2.382388047	2.382388047	PRIORFRAC	24
## 321	2.291639095	2.291639095	2.291639095	HEIGHT	24
## 322	1.940033035	1.940033035	1.940033035	BONEMED	24
## 323	1.561873520	1.561873520	1.561873520	BONEMED_FU	24
## 324	1.176172249	1.176172249	1.176172249	PHY_ID	24
## 325	0.996851154	0.996851154	0.996851154	SITE_ID	24
## 326	0.983529079	0.983529079	0.983529079	BONETREAT	24
## 327	0.814637047	0.814637047	0.814637047	ARMASSIST	24
## 328	0.604491879	0.604491879	0.604491879	RATERISK_num	24
## 329	0.567120091	0.567120091	0.567120091	RATERISK_EQ_3	24
## 330	0.391048636	0.391048636	0.391048636	PRIORFRACxAGE_STDZ	24
## 331	0.259463666	0.259463666	0.259463666	AGExPRIORFRAC	24
## 332	0.212670305	0.212670305	0.212670305	MOMFRAC	24
## 333	-0.040304679	-0.040304679	-0.040304679	SMOKE	24
## 334	-0.317433285	-0.317433285	-0.317433285	RATERISK	24
## 335	-0.727185660	-0.727185660	-0.727185660	MOMFRACxARMASSIST	24
## 336	-0.875799121	-0.875799121	-0.875799121	PREMENO	24
## 337	63.125141920	63.125141920	63.125141920	SUB_ID	5
## 338	3.942219489	3.942219489	3.942219489	FRACSCORE	5
## 339	3.807479234	3.807479234	3.807479234	NOPRIORFRACxAGE_STDZ	5
## 340	3.508663495	3.508663495	3.508663495	AGE_STDZ	5
## 341	3.367260987	3.367260987	3.367260987	BMI	5
## 342	63.125141920	63.125141920	63.125141920	SUB_ID	4
## 343	3.942219489	3.942219489	3.942219489	FRACSCORE	4
## 344	3.807479234	3.807479234	3.807479234	NOPRIORFRACxAGE_STDZ	4
## 345	3.508663495	3.508663495	3.508663495	AGE_STDZ	4
## 346	63.125141920	63.125141920	63.125141920	SUB_ID	3
## 347	3.942219489	3.942219489	3.942219489	FRACSCORE	3
## 348	3.807479234	3.807479234	3.807479234	NOPRIORFRACxAGE_STDZ	3
## 349	63.125141920	63.125141920	63.125141920	SUB_ID	2
## 350	3.942219489	3.942219489	3.942219489	FRACSCORE	2

##	351	63.125141920	63.125141920	63.125141920	SUB_ID	1
##	352	58.898982804	58.898982804	58.898982804	SUB_ID	24
##	353	4.832957850	4.832957850	4.832957850	FRACSCORE	24
##	354	3.473173018	3.473173018	3.473173018	NOPRIORFRACxAGE_STDZ	24
##	355	3.387269022	3.387269022	3.387269022	HEIGHT	24
##	356	3.184519271	3.184519271	3.184519271	BONEMED_FU	24
##	357	3.045256285	3.045256285	3.045256285	AGE_STDZ	24
##	358	2.789952906	2.789952906	2.789952906	WEIGHT	24
##	359	2.701867873	2.701867873	2.701867873	BMI	24
##	360	2.488195410	2.488195410	2.488195410	BONEMED	24
##	361	2.350417472	2.350417472	2.350417472	AGE	24
##	362	1.984149714	1.984149714	1.984149714	PHY_ID	24
##	363	1.767882598	1.767882598	1.767882598	BONETREAT	24
##	364	1.544718359	1.544718359	1.544718359	MOMFRAC	24
##	365	1.400388634	1.400388634	1.400388634	SITE_ID	24
##	366	1.164366806	1.164366806	1.164366806	PRIORFRAC	24
##	367	1.151190069	1.151190069	1.151190069	RATERISK_EQ_3	24
##	368	0.414599555	0.414599555	0.414599555	ARMASSIST	24
##	369	0.347032796	0.347032796	0.347032796	RATERISK	24
##	370	0.082316698	0.082316698	0.082316698	PRIORFRACxAGE_STDZ	24
##	371	-0.220317387	-0.220317387	-0.220317387	MOMFRACxARMASSIST	24
##	372	-0.235868235	-0.235868235	-0.235868235	RATERISK_num	24
##	373	-0.312752754	-0.312752754	-0.312752754	AGExPRIORFRAC	24
##	374	-0.382476684	-0.382476684	-0.382476684	PREMENO	24
##	375	-0.484148255	-0.484148255	-0.484148255	SMOKE	24
##	376	58.898982804	58.898982804	58.898982804	SUB_ID	5
##	377	4.832957850	4.832957850	4.832957850	FRACSCORE	5
##	378	3.473173018	3.473173018	3.473173018	NOPRIORFRACxAGE_STDZ	5
##	379	3.387269022	3.387269022	3.387269022	HEIGHT	5
##	380	3.184519271	3.184519271	3.184519271	BONEMED_FU	5
##	381	58.898982804	58.898982804	58.898982804	SUB_ID	4
##	382	4.832957850	4.832957850	4.832957850	FRACSCORE	4
##	383	3.473173018	3.473173018	3.473173018	NOPRIORFRACxAGE_STDZ	4
##	384	3.387269022	3.387269022	3.387269022	HEIGHT	4

## 385	58.898982804	58.898982804	58.898982804	SUB_ID	3
## 386	4.832957850	4.832957850	4.832957850	FRACSCORE	3
## 387	3.473173018	3.473173018	3.473173018	NOPRIORFRACxAGE_STDZ	3
## 388	58.898982804	58.898982804	58.898982804	SUB_ID	2
## 389	4.832957850	4.832957850	4.832957850	FRACSCORE	2
## 390	58.898982804	58.898982804	58.898982804	SUB_ID	1
## 391	61.592153876	61.592153876	61.592153876	SUB_ID	24
## 392	4.102182921	4.102182921	4.102182921	FRACSCORE	24
## 393	3.129707151	3.129707151	3.129707151	HEIGHT	24
## 394	2.847378757	2.847378757	2.847378757	NOPRIORFRACxAGE_STDZ	24
## 395	2.805512621	2.805512621	2.805512621	AGE	24
## 396	2.666626521	2.666626521	2.666626521	BONEMED	24
## 397	2.345887709	2.345887709	2.345887709	BMI	24
## 398	2.233838392	2.233838392	2.233838392	BONEMED_FU	24
## 399	2.201681255	2.201681255	2.201681255	WEIGHT	24
## 400	2.029842755	2.029842755	2.029842755	ARMASSIST	24
## 401	1.487991968	1.487991968	1.487991968	BONETREAT	24
## 402	1.094267713	1.094267713	1.094267713	RATERISK_EQ_3	24
## 403	1.058188072	1.058188072	1.058188072	PREMENO	24
## 404	0.970782814	0.970782814	0.970782814	AGE_STDZ	24
## 405	0.678008079	0.678008079	0.678008079	PRIORFRAC	24
## 406	0.590266341	0.590266341	0.590266341	SITE_ID	24
## 407	0.448088814	0.448088814	0.448088814	PHY_ID	24
## 408	0.365112245	0.365112245	0.365112245	AGExPRIORFRAC	24
## 409	0.332208697	0.332208697	0.332208697	RATERISK	24
## 410	-0.128796592	-0.128796592	-0.128796592	RATERISK_num	24
## 411	-0.259330290	-0.259330290	-0.259330290	MOMFRACxARMASSIST	24
## 412	-0.420008807	-0.420008807	-0.420008807	SMOKE	24
## 413	-0.636000940	-0.636000940	-0.636000940	PRIORFRACxAGE_STDZ	24
## 414	-0.921437030	-0.921437030	-0.921437030	MOMFRAC	24
## 415	61.592153876	61.592153876	61.592153876	SUB_ID	5
## 416	4.102182921	4.102182921	4.102182921	FRACSCORE	5
## 417	3.129707151	3.129707151	3.129707151	HEIGHT	5
## 418	2.847378757	2.847378757	2.847378757	NOPRIORFRACxAGE_STDZ	5

## 419	2.805512621	2.805512621	2.805512621	AGE	5
## 420	61.592153876	61.592153876	61.592153876	SUB_ID	4
## 421	4.102182921	4.102182921	4.102182921	FRACSCORE	4
## 422	3.129707151	3.129707151	3.129707151	HEIGHT	4
## 423	2.847378757	2.847378757	2.847378757	NOPRIORFRACxAGE_STDZ	4
## 424	61.592153876	61.592153876	61.592153876	SUB_ID	3
## 425	4.102182921	4.102182921	4.102182921	FRACSCORE	3
## 426	3.129707151	3.129707151	3.129707151	HEIGHT	3
## 427	61.592153876	61.592153876	61.592153876	SUB_ID	2
## 428	4.102182921	4.102182921	4.102182921	FRACSCORE	2
## 429	61.592153876	61.592153876	61.592153876	SUB_ID	1
## 430	58.420184251	58.420184251	58.420184251	SUB_ID	24
## 431	4.437892003	4.437892003	4.437892003	BONEMED_FU	24
## 432	3.939081478	3.939081478	3.939081478	NOPRIORFRACxAGE_STDZ	24
## 433	3.891240009	3.891240009	3.891240009	WEIGHT	24
## 434	3.875607521	3.875607521	3.875607521	BMI	24
## 435	3.749497481	3.749497481	3.749497481	AGE_STDZ	24
## 436	3.036473975	3.036473975	3.036473975	BONETREAT	24
## 437	2.677378533	2.677378533	2.677378533	FRACSCORE	24
## 438	2.270759118	2.270759118	2.270759118	AGE	24
## 439	1.912648176	1.912648176	1.912648176	PRIORFRAC	24
## 440	1.781586039	1.781586039	1.781586039	BONEMED	24
## 441	1.735775746	1.735775746	1.735775746	SMOKE	24
## 442	1.584261276	1.584261276	1.584261276	HEIGHT	24
## 443	1.570200128	1.570200128	1.570200128	SITE_ID	24
## 444	1.453981635	1.453981635	1.453981635	PRIORFRACxAGE_STDZ	24
## 445	1.211136661	1.211136661	1.211136661	RATERISK	24
## 446	0.917834464	0.917834464	0.917834464	ARMASSIST	24
## 447	0.686661902	0.686661902	0.686661902	RATERISK_EQ_3	24
## 448	0.472347799	0.472347799	0.472347799	RATERISK_num	24
## 449	0.275766056	0.275766056	0.275766056	PHY_ID	24
## 450	-0.059729430	-0.059729430	-0.059729430	AGExPRIORFRAC	24
## 451	-0.372313995	-0.372313995	-0.372313995	PREMENO	24
## 452	-0.527113930	-0.527113930	-0.527113930	MOMFRACxARMASSIST	24

## 453	-1.552054799	-1.552054799	-1.552054799	MOMFRAC	24
## 454	58.420184251	58.420184251	58.420184251	SUB_ID	5
## 455	4.437892003	4.437892003	4.437892003	BONEMED_FU	5
## 456	3.939081478	3.939081478	3.939081478	NOPRIORFRACxAGE_STDZ	5
## 457	3.891240009	3.891240009	3.891240009	WEIGHT	5
## 458	3.875607521	3.875607521	3.875607521	BMI	5
## 459	58.420184251	58.420184251	58.420184251	SUB_ID	4
## 460	4.437892003	4.437892003	4.437892003	BONEMED_FU	4
## 461	3.939081478	3.939081478	3.939081478	NOPRIORFRACxAGE_STDZ	4
## 462	3.891240009	3.891240009	3.891240009	WEIGHT	4
## 463	58.420184251	58.420184251	58.420184251	SUB_ID	3
## 464	4.437892003	4.437892003	4.437892003	BONEMED_FU	3
## 465	3.939081478	3.939081478	3.939081478	NOPRIORFRACxAGE_STDZ	3
## 466	58.420184251	58.420184251	58.420184251	SUB_ID	2
## 467	4.437892003	4.437892003	4.437892003	BONEMED_FU	2
## 468	58.420184251	58.420184251	58.420184251	SUB_ID	1
## 469	61.668546795	61.668546795	61.668546795	SUB_ID	24
## 470	4.784306790	4.784306790	4.784306790	FRACSCORE	24
## 471	4.041585024	4.041585024	4.041585024	NOPRIORFRACxAGE_STDZ	24
## 472	3.985860672	3.985860672	3.985860672	AGE	24
## 473	3.469612111	3.469612111	3.469612111	HEIGHT	24
## 474	2.860672368	2.860672368	2.860672368	BONEMED_FU	24
## 475	2.775784457	2.775784457	2.775784457	WEIGHT	24
## 476	2.692003541	2.692003541	2.692003541	AGE_STDZ	24
## 477	2.541397707	2.541397707	2.541397707	BMI	24
## 478	1.785356825	1.785356825	1.785356825	BONEMED	24
## 479	1.753387463	1.753387463	1.753387463	BONETREAT	24
## 480	1.487972671	1.487972671	1.487972671	PHY_ID	24
## 481	1.432751216	1.432751216	1.432751216	SITE_ID	24
## 482	1.340156442	1.340156442	1.340156442	PRIORFRACxAGE_STDZ	24
## 483	1.158435493	1.158435493	1.158435493	RATERISK_EQ_3	24
## 484	1.097618380	1.097618380	1.097618380	PRIORFRAC	24
## 485	1.026549111	1.026549111	1.026549111	MOMFRAC	24
## 486	0.552146508	0.552146508	0.552146508	RATERISK_num	24

## 487	0.483851917	0.483851917	0.483851917	SMOKE	24
## 488	0.388632218	0.388632218	0.388632218	ARMASSIST	24
## 489	0.268584845	0.268584845	0.268584845	RATERISK	24
## 490	0.264259572	0.264259572	0.264259572	PREMENO	24
## 491	-0.128534430	-0.128534430	-0.128534430	AGExPRIORFRAC	24
## 492	-0.429425688	-0.429425688	-0.429425688	MOMFRACxARMASSIST	24
## 493	61.668546795	61.668546795	61.668546795	SUB_ID	5
## 494	4.784306790	4.784306790	4.784306790	FRACSCORE	5
## 495	4.041585024	4.041585024	4.041585024	NOPRIORFRACxAGE_STDZ	5
## 496	3.985860672	3.985860672	3.985860672	AGE	5
## 497	3.469612111	3.469612111	3.469612111	HEIGHT	5
## 498	61.668546795	61.668546795	61.668546795	SUB_ID	4
## 499	4.784306790	4.784306790	4.784306790	FRACSCORE	4
## 500	4.041585024	4.041585024	4.041585024	NOPRIORFRACxAGE_STDZ	4
## 501	3.985860672	3.985860672	3.985860672	AGE	4
## 502	61.668546795	61.668546795	61.668546795	SUB_ID	3
## 503	4.784306790	4.784306790	4.784306790	FRACSCORE	3
## 504	4.041585024	4.041585024	4.041585024	NOPRIORFRACxAGE_STDZ	3
## 505	61.668546795	61.668546795	61.668546795	SUB_ID	2
## 506	4.784306790	4.784306790	4.784306790	FRACSCORE	2
## 507	61.668546795	61.668546795	61.668546795	SUB_ID	1
## 508	62.695852312	62.695852312	62.695852312	SUB_ID	24
## 509	3.669116716	3.669116716	3.669116716	NOPRIORFRACxAGE_STDZ	24
## 510	3.261061204	3.261061204	3.261061204	FRACSCORE	24
## 511	2.992964339	2.992964339	2.992964339	BONEMED_FU	24
## 512	2.558828839	2.558828839	2.558828839	HEIGHT	24
## 513	2.469205560	2.469205560	2.469205560	BMI	24
## 514	2.317561583	2.317561583	2.317561583	WEIGHT	24
## 515	2.230300331	2.230300331	2.230300331	AGE	24
## 516	2.052411350	2.052411350	2.052411350	AGE_STDZ	24
## 517	2.042411565	2.042411565	2.042411565	BONEMED	24
## 518	1.866638359	1.866638359	1.866638359	BONETREAT	24
## 519	0.917704819	0.917704819	0.917704819	ARMASSIST	24
## 520	0.875552517	0.875552517	0.875552517	SITE_ID	24

## 521	0.782697582	0.782697582	0.782697582	MOMFRAC	24
## 522	0.434098678	0.434098678	0.434098678	PRIORFRAC	24
## 523	0.390720467	0.390720467	0.390720467	RATERISK_num	24
## 524	-0.026208765	-0.026208765	-0.026208765	PHY_ID	24
## 525	-0.180958559	-0.180958559	-0.180958559	AGExPRIORFRAC	24
## 526	-0.201597232	-0.201597232	-0.201597232	RATERISK_EQ_3	24
## 527	-0.232520954	-0.232520954	-0.232520954	PREMENO	24
## 528	-0.243683594	-0.243683594	-0.243683594	RATERISK	24
## 529	-0.519554417	-0.519554417	-0.519554417	MOMFRACxARMASSIST	24
## 530	-0.640809723	-0.640809723	-0.640809723	SMOKE	24
## 531	-1.152241187	-1.152241187	-1.152241187	PRIORFRACxAGE_STDZ	24
## 532	62.695852312	62.695852312	62.695852312	SUB_ID	5
## 533	3.669116716	3.669116716	3.669116716	NOPRIORFRACxAGE_STDZ	5
## 534	3.261061204	3.261061204	3.261061204	FRACSCORE	5
## 535	2.992964339	2.992964339	2.992964339	BONEMED_FU	5
## 536	2.558828839	2.558828839	2.558828839	HEIGHT	5
## 537	62.695852312	62.695852312	62.695852312	SUB_ID	4
## 538	3.669116716	3.669116716	3.669116716	NOPRIORFRACxAGE_STDZ	4
## 539	3.261061204	3.261061204	3.261061204	FRACSCORE	4
## 540	2.992964339	2.992964339	2.992964339	BONEMED_FU	4
## 541	62.695852312	62.695852312	62.695852312	SUB_ID	3
## 542	3.669116716	3.669116716	3.669116716	NOPRIORFRACxAGE_STDZ	3
## 543	3.261061204	3.261061204	3.261061204	FRACSCORE	3
## 544	62.695852312	62.695852312	62.695852312	SUB_ID	2
## 545	3.669116716	3.669116716	3.669116716	NOPRIORFRACxAGE_STDZ	2
## 546	62.695852312	62.695852312	62.695852312	SUB_ID	1
## 547	57.447028118	57.447028118	57.447028118	SUB_ID	24
## 548	5.330440569	5.330440569	5.330440569	FRACSCORE	24
## 549	4.035837080	4.035837080	4.035837080	NOPRIORFRACxAGE_STDZ	24
## 550	3.238179235	3.238179235	3.238179235	BMI	24
## 551	2.728324178	2.728324178	2.728324178	AGE	24
## 552	2.429485368	2.429485368	2.429485368	HEIGHT	24
## 553	2.381492959	2.381492959	2.381492959	WEIGHT	24
## 554	2.286385150	2.286385150	2.286385150	BONEMED_FU	24

## 555	2.205912829	2.205912829	2.205912829	BONEMED	24
## 556	2.012309990	2.012309990	2.012309990	AGE_STDZ	24
## 557	1.381756194	1.381756194	1.381756194	SITE_ID	24
## 558	1.311096458	1.311096458	1.311096458	RATERISK_EQ_3	24
## 559	1.120646091	1.120646091	1.120646091	PRIORFRAC	24
## 560	1.036560399	1.036560399	1.036560399	MOMFRACxARMASSIST	24
## 561	0.769114156	0.769114156	0.769114156	BONETREAT	24
## 562	0.691033689	0.691033689	0.691033689	RATERISK_num	24
## 563	0.612164297	0.612164297	0.612164297	PRIORFRACxAGE_STDZ	24
## 564	0.563754671	0.563754671	0.563754671	AGExPRIORFRAC	24
## 565	0.519056767	0.519056767	0.519056767	PHY_ID	24
## 566	0.270015614	0.270015614	0.270015614	MOMFRAC	24
## 567	0.135791661	0.135791661	0.135791661	ARMASSIST	24
## 568	-0.894247161	-0.894247161	-0.894247161	RATERISK	24
## 569	-0.924677848	-0.924677848	-0.924677848	PREMENO	24
## 570	-1.389592717	-1.389592717	-1.389592717	SMOKE	24
## 571	57.447028118	57.447028118	57.447028118	SUB_ID	5
## 572	5.330440569	5.330440569	5.330440569	FRACSCORE	5
## 573	4.035837080	4.035837080	4.035837080	NOPRIORFRACxAGE_STDZ	5
## 574	3.238179235	3.238179235	3.238179235	BMI	5
## 575	2.728324178	2.728324178	2.728324178	AGE	5
## 576	57.447028118	57.447028118	57.447028118	SUB_ID	4
## 577	5.330440569	5.330440569	5.330440569	FRACSCORE	4
## 578	4.035837080	4.035837080	4.035837080	NOPRIORFRACxAGE_STDZ	4
## 579	3.238179235	3.238179235	3.238179235	BMI	4
## 580	57.447028118	57.447028118	57.447028118	SUB_ID	3
## 581	5.330440569	5.330440569	5.330440569	FRACSCORE	3
## 582	4.035837080	4.035837080	4.035837080	NOPRIORFRACxAGE_STDZ	3
## 583	57.447028118	57.447028118	57.447028118	SUB_ID	2
## 584	5.330440569	5.330440569	5.330440569	FRACSCORE	2
## 585	57.447028118	57.447028118	57.447028118	SUB_ID	1
## 586	61.836966268	61.836966268	61.836966268	SUB_ID	24
## 587	3.706788600	3.706788600	3.706788600	FRACSCORE	24
## 588	3.048427174	3.048427174	3.048427174	NOPRIORFRACxAGE_STDZ	24

## 589	2.734911834	2.734911834	2.734911834	BMI	24
## 590	2.292450122	2.292450122	2.292450122	WEIGHT	24
## 591	2.183844823	2.183844823	2.183844823	BONEMED_FU	24
## 592	1.843785218	1.843785218	1.843785218	AGE	24
## 593	1.815426709	1.815426709	1.815426709	SITE_ID	24
## 594	1.808915355	1.808915355	1.808915355	BONEMED	24
## 595	1.650590922	1.650590922	1.650590922	BONETREAT	24
## 596	1.646546782	1.646546782	1.646546782	HEIGHT	24
## 597	1.494713264	1.494713264	1.494713264	ARMASSIST	24
## 598	1.281369014	1.281369014	1.281369014	AGE_STDZ	24
## 599	1.263070798	1.263070798	1.263070798	PHY_ID	24
## 600	1.084503998	1.084503998	1.084503998	RATERISK_num	24
## 601	0.921920302	0.921920302	0.921920302	SMOKE	24
## 602	0.797415132	0.797415132	0.797415132	RATERISK	24
## 603	0.693147939	0.693147939	0.693147939	MOMFRACxARMASSIST	24
## 604	0.658427790	0.658427790	0.658427790	PREMENO	24
## 605	0.513453878	0.513453878	0.513453878	PRIORFRAC	24
## 606	0.513174353	0.513174353	0.513174353	AGExPRIORFRAC	24
## 607	0.477363193	0.477363193	0.477363193	RATERISK_EQ_3	24
## 608	-0.227726900	-0.227726900	-0.227726900	PRIORFRACxAGE_STDZ	24
## 609	-0.687182515	-0.687182515	-0.687182515	MOMFRAC	24
## 610	61.836966268	61.836966268	61.836966268	SUB_ID	5
## 611	3.706788600	3.706788600	3.706788600	FRACSCORE	5
## 612	3.048427174	3.048427174	3.048427174	NOPRIORFRACxAGE_STDZ	5
## 613	2.734911834	2.734911834	2.734911834	BMI	5
## 614	2.292450122	2.292450122	2.292450122	WEIGHT	5
## 615	61.836966268	61.836966268	61.836966268	SUB_ID	4
## 616	3.706788600	3.706788600	3.706788600	FRACSCORE	4
## 617	3.048427174	3.048427174	3.048427174	NOPRIORFRACxAGE_STDZ	4
## 618	2.734911834	2.734911834	2.734911834	BMI	4
## 619	61.836966268	61.836966268	61.836966268	SUB_ID	3
## 620	3.706788600	3.706788600	3.706788600	FRACSCORE	3
## 621	3.048427174	3.048427174	3.048427174	NOPRIORFRACxAGE_STDZ	3
## 622	61.836966268	61.836966268	61.836966268	SUB_ID	2

## 623	3.706788600	3.706788600	3.706788600	FRACSCORE	2
## 624	61.836966268	61.836966268	61.836966268	SUB_ID	1
## 625	62.768087353	62.768087353	62.768087353	SUB_ID	24
## 626	4.392033633	4.392033633	4.392033633	FRACSCORE	24
## 627	2.969376347	2.969376347	2.969376347	NOPRIORFRACxAGE_STDZ	24
## 628	2.873720793	2.873720793	2.873720793	BONEMED_FU	24
## 629	2.714712111	2.714712111	2.714712111	WEIGHT	24
## 630	2.074876786	2.074876786	2.074876786	HEIGHT	24
## 631	1.977399772	1.977399772	1.977399772	BMI	24
## 632	1.790136357	1.790136357	1.790136357	AGE_STDZ	24
## 633	1.610943511	1.610943511	1.610943511	PRIORFRAC	24
## 634	1.595901584	1.595901584	1.595901584	BONETREAT	24
## 635	1.497184676	1.497184676	1.497184676	AGE	24
## 636	1.399781958	1.399781958	1.399781958	BONEMED	24
## 637	1.376657247	1.376657247	1.376657247	ARMASSIST	24
## 638	0.922449006	0.922449006	0.922449006	SITE_ID	24
## 639	0.607839131	0.607839131	0.607839131	RATERISK_num	24
## 640	0.599062199	0.599062199	0.599062199	PRIORFRACxAGE_STDZ	24
## 641	0.491198405	0.491198405	0.491198405	RATERISK	24
## 642	0.489936179	0.489936179	0.489936179	PHY_ID	24
## 643	0.038547897	0.038547897	0.038547897	MOMFRAC	24
## 644	-0.358162020	-0.358162020	-0.358162020	SMOKE	24
## 645	-0.773815768	-0.773815768	-0.773815768	RATERISK_EQ_3	24
## 646	-0.908691878	-0.908691878	-0.908691878	AGExPRIORFRAC	24
## 647	-1.034619993	-1.034619993	-1.034619993	MOMFRACxARMASSIST	24
## 648	-1.569112051	-1.569112051	-1.569112051	PREMENO	24
## 649	62.768087353	62.768087353	62.768087353	SUB_ID	5
## 650	4.392033633	4.392033633	4.392033633	FRACSCORE	5
## 651	2.969376347	2.969376347	2.969376347	NOPRIORFRACxAGE_STDZ	5
## 652	2.873720793	2.873720793	2.873720793	BONEMED_FU	5
## 653	2.714712111	2.714712111	2.714712111	WEIGHT	5
## 654	62.768087353	62.768087353	62.768087353	SUB_ID	4
## 655	4.392033633	4.392033633	4.392033633	FRACSCORE	4
## 656	2.969376347	2.969376347	2.969376347	NOPRIORFRACxAGE_STDZ	4

## 657	2.873720793	2.873720793	2.873720793	BONEMED_FU	4
## 658	62.768087353	62.768087353	62.768087353	SUB_ID	3
## 659	4.392033633	4.392033633	4.392033633	FRACSCORE	3
## 660	2.969376347	2.969376347	2.969376347	NOPRIORFRACxAGE_STDZ	3
## 661	62.768087353	62.768087353	62.768087353	SUB_ID	2
## 662	4.392033633	4.392033633	4.392033633	FRACSCORE	2
## 663	62.768087353	62.768087353	62.768087353	SUB_ID	1
## 664	61.637041973	61.637041973	61.637041973	SUB_ID	24
## 665	4.289607000	4.289607000	4.289607000	BONEMED_FU	24
## 666	3.955910779	3.955910779	3.955910779	FRACSCORE	24
## 667	3.929465585	3.929465585	3.929465585	BONETREAT	24
## 668	3.801161947	3.801161947	3.801161947	BMI	24
## 669	3.236188743	3.236188743	3.236188743	NOPRIORFRACxAGE_STDZ	24
## 670	2.815793695	2.815793695	2.815793695	AGE_STDZ	24
## 671	2.812823325	2.812823325	2.812823325	HEIGHT	24
## 672	2.750229651	2.750229651	2.750229651	WEIGHT	24
## 673	2.736029009	2.736029009	2.736029009	AGE	24
## 674	2.149736278	2.149736278	2.149736278	BONEMED	24
## 675	1.471576006	1.471576006	1.471576006	SITE_ID	24
## 676	1.393906637	1.393906637	1.393906637	SMOKE	24
## 677	1.366210669	1.366210669	1.366210669	PRIORFRAC	24
## 678	0.991084953	0.991084953	0.991084953	PRIORFRACxAGE_STDZ	24
## 679	0.738197707	0.738197707	0.738197707	RATERISK	24
## 680	0.642944667	0.642944667	0.642944667	AGExPRIORFRAC	24
## 681	0.502848710	0.502848710	0.502848710	RATERISK_EQ_3	24
## 682	0.459690974	0.459690974	0.459690974	ARMASSIST	24
## 683	0.409536618	0.409536618	0.409536618	MOMFRAC	24
## 684	0.095538930	0.095538930	0.095538930	RATERISK_num	24
## 685	0.057898195	0.057898195	0.057898195	PREMENO	24
## 686	-0.584921076	-0.584921076	-0.584921076	MOMFRACxARMASSIST	24
## 687	-0.621150310	-0.621150310	-0.621150310	PHY_ID	24
## 688	61.637041973	61.637041973	61.637041973	SUB_ID	5
## 689	4.289607000	4.289607000	4.289607000	BONEMED_FU	5
## 690	3.955910779	3.955910779	3.955910779	FRACSCORE	5

## 691	3.929465585	3.929465585	3.929465585	BONETREAT	5
## 692	3.801161947	3.801161947	3.801161947	BMI	5
## 693	61.637041973	61.637041973	61.637041973	SUB_ID	4
## 694	4.289607000	4.289607000	4.289607000	BONEMED_FU	4
## 695	3.955910779	3.955910779	3.955910779	FRACSCORE	4
## 696	3.929465585	3.929465585	3.929465585	BONETREAT	4
## 697	61.637041973	61.637041973	61.637041973	SUB_ID	3
## 698	4.289607000	4.289607000	4.289607000	BONEMED_FU	3
## 699	3.955910779	3.955910779	3.955910779	FRACSCORE	3
## 700	61.637041973	61.637041973	61.637041973	SUB_ID	2
## 701	4.289607000	4.289607000	4.289607000	BONEMED_FU	2
## 702	61.637041973	61.637041973	61.637041973	SUB_ID	1
## 703	63.193650370	63.193650370	63.193650370	SUB_ID	24
## 704	4.938527912	4.938527912	4.938527912	FRACSCORE	24
## 705	3.648092153	3.648092153	3.648092153	BMI	24
## 706	3.183048385	3.183048385	3.183048385	WEIGHT	24
## 707	2.910138810	2.910138810	2.910138810	AGE	24
## 708	2.767198614	2.767198614	2.767198614	NOPRIORFRACxAGE_STDZ	24
## 709	2.653604848	2.653604848	2.653604848	BONEMED_FU	24
## 710	2.363347929	2.363347929	2.363347929	HEIGHT	24
## 711	2.078012481	2.078012481	2.078012481	AGE_STDZ	24
## 712	1.788684941	1.788684941	1.788684941	BONEMED	24
## 713	1.242430424	1.242430424	1.242430424	RATERISK_num	24
## 714	0.988857044	0.988857044	0.988857044	ARMASSIST	24
## 715	0.972544504	0.972544504	0.972544504	BONETREAT	24
## 716	0.895067383	0.895067383	0.895067383	PRIORFRAC	24
## 717	0.825504318	0.825504318	0.825504318	PHY_ID	24
## 718	0.825187784	0.825187784	0.825187784	SITE_ID	24
## 719	0.685401382	0.685401382	0.685401382	SMOKE	24
## 720	0.568172008	0.568172008	0.568172008	AGExPRIORFRAC	24
## 721	0.431120711	0.431120711	0.431120711	RATERISK_EQ_3	24
## 722	0.263615674	0.263615674	0.263615674	PRIORFRACxAGE_STDZ	24
## 723	-0.326791154	-0.326791154	-0.326791154	MOMFRAC	24
## 724	-0.384299820	-0.384299820	-0.384299820	RATERISK	24

## 725	-0.479556220	-0.479556220	-0.479556220	MOMFRACxARMASSIST	24
## 726	-0.724873688	-0.724873688	-0.724873688	PREMENO	24
## 727	63.193650370	63.193650370	63.193650370	SUB_ID	5
## 728	4.938527912	4.938527912	4.938527912	FRACSCORE	5
## 729	3.648092153	3.648092153	3.648092153	BMI	5
## 730	3.183048385	3.183048385	3.183048385	WEIGHT	5
## 731	2.910138810	2.910138810	2.910138810	AGE	5
## 732	63.193650370	63.193650370	63.193650370	SUB_ID	4
## 733	4.938527912	4.938527912	4.938527912	FRACSCORE	4
## 734	3.648092153	3.648092153	3.648092153	BMI	4
## 735	3.183048385	3.183048385	3.183048385	WEIGHT	4
## 736	63.193650370	63.193650370	63.193650370	SUB_ID	3
## 737	4.938527912	4.938527912	4.938527912	FRACSCORE	3
## 738	3.648092153	3.648092153	3.648092153	BMI	3
## 739	63.193650370	63.193650370	63.193650370	SUB_ID	2
## 740	4.938527912	4.938527912	4.938527912	FRACSCORE	2
## 741	63.193650370	63.193650370	63.193650370	SUB_ID	1
## 742	63.969346754	63.969346754	63.969346754	SUB_ID	24
## 743	3.827840745	3.827840745	3.827840745	NOPRIORFRACxAGE_STDZ	24
## 744	3.413200251	3.413200251	3.413200251	FRACSCORE	24
## 745	3.227579160	3.227579160	3.227579160	BONEMED_FU	24
## 746	3.052294702	3.052294702	3.052294702	WEIGHT	24
## 747	2.833825644	2.833825644	2.833825644	HEIGHT	24
## 748	2.570195661	2.570195661	2.570195661	BMI	24
## 749	2.222476634	2.222476634	2.222476634	AGE	24
## 750	2.082988214	2.082988214	2.082988214	AGE_STDZ	24
## 751	1.781788271	1.781788271	1.781788271	RATERISK_num	24
## 752	1.641499219	1.641499219	1.641499219	BONETREAT	24
## 753	0.971476226	0.971476226	0.971476226	BONEMED	24
## 754	0.807867761	0.807867761	0.807867761	PRIORFRAC	24
## 755	0.741410789	0.741410789	0.741410789	PHY_ID	24
## 756	0.693002130	0.693002130	0.693002130	RATERISK	24
## 757	0.354461115	0.354461115	0.354461115	ARMASSIST	24
## 758	0.063050432	0.063050432	0.063050432	RATERISK_EQ_3	24

## 759	-0.226073464	-0.226073464	-0.226073464	PRIORFRACxAGE_STDZ	24
## 760	-0.283965965	-0.283965965	-0.283965965	SMOKE	24
## 761	-0.584181889	-0.584181889	-0.584181889	AGExPRIORFRAC	24
## 762	-0.685094131	-0.685094131	-0.685094131	PREMENO	24
## 763	-0.729537953	-0.729537953	-0.729537953	SITE_ID	24
## 764	-0.761415878	-0.761415878	-0.761415878	MOMFRAC	24
## 765	-1.325545732	-1.325545732	-1.325545732	MOMFRACxARMASSIST	24
## 766	63.969346754	63.969346754	63.969346754	SUB_ID	5
## 767	3.827840745	3.827840745	3.827840745	NOPRIORFRACxAGE_STDZ	5
## 768	3.413200251	3.413200251	3.413200251	FRACSCORE	5
## 769	3.227579160	3.227579160	3.227579160	BONEMED_FU	5
## 770	3.052294702	3.052294702	3.052294702	WEIGHT	5
## 771	63.969346754	63.969346754	63.969346754	SUB_ID	4
## 772	3.827840745	3.827840745	3.827840745	NOPRIORFRACxAGE_STDZ	4
## 773	3.413200251	3.413200251	3.413200251	FRACSCORE	4
## 774	3.227579160	3.227579160	3.227579160	BONEMED_FU	4
## 775	63.969346754	63.969346754	63.969346754	SUB_ID	3
## 776	3.827840745	3.827840745	3.827840745	NOPRIORFRACxAGE_STDZ	3
## 777	3.413200251	3.413200251	3.413200251	FRACSCORE	3
## 778	63.969346754	63.969346754	63.969346754	SUB_ID	2
## 779	3.827840745	3.827840745	3.827840745	NOPRIORFRACxAGE_STDZ	2
## 780	63.969346754	63.969346754	63.969346754	SUB_ID	1
## 781	64.228225800	64.228225800	64.228225800	SUB_ID	24
## 782	5.525078425	5.525078425	5.525078425	FRACSCORE	24
## 783	3.938222750	3.938222750	3.938222750	BMI	24
## 784	3.001561844	3.001561844	3.001561844	NOPRIORFRACxAGE_STDZ	24
## 785	2.665556378	2.665556378	2.665556378	RATERISK_num	24
## 786	2.590263526	2.590263526	2.590263526	HEIGHT	24
## 787	2.553609504	2.553609504	2.553609504	PRIORFRAC	24
## 788	1.887558643	1.887558643	1.887558643	BONEMED_FU	24
## 789	1.771231063	1.771231063	1.771231063	BONEMED	24
## 790	1.667303288	1.667303288	1.667303288	AGE_STDZ	24
## 791	1.324229082	1.324229082	1.324229082	WEIGHT	24
## 792	1.146777409	1.146777409	1.146777409	PHY_ID	24

## 793	1.134635364	1.134635364	1.134635364	ARMASSIST	24
## 794	1.115537114	1.115537114	1.115537114	BONETREAT	24
## 795	0.732377135	0.732377135	0.732377135	AGE	24
## 796	0.675940754	0.675940754	0.675940754	MOMFRAC	24
## 797	0.611064020	0.611064020	0.611064020	PREMENO	24
## 798	0.494200853	0.494200853	0.494200853	SITE_ID	24
## 799	0.434065649	0.434065649	0.434065649	PRIORFRACxAGE_STDZ	24
## 800	0.418243893	0.418243893	0.418243893	AGExPRIORFRAC	24
## 801	-0.182317741	-0.182317741	-0.182317741	RATERISK_EQ_3	24
## 802	-0.240958537	-0.240958537	-0.240958537	RATERISK	24
## 803	-0.340789940	-0.340789940	-0.340789940	MOMFRACxARMASSIST	24
## 804	-0.386247303	-0.386247303	-0.386247303	SMOKE	24
## 805	64.228225800	64.228225800	64.228225800	SUB_ID	5
## 806	5.525078425	5.525078425	5.525078425	FRACSCORE	5
## 807	3.938222750	3.938222750	3.938222750	BMI	5
## 808	3.001561844	3.001561844	3.001561844	NOPRIORFRACxAGE_STDZ	5
## 809	2.665556378	2.665556378	2.665556378	RATERISK_num	5
## 810	64.228225800	64.228225800	64.228225800	SUB_ID	4
## 811	5.525078425	5.525078425	5.525078425	FRACSCORE	4
## 812	3.938222750	3.938222750	3.938222750	BMI	4
## 813	3.001561844	3.001561844	3.001561844	NOPRIORFRACxAGE_STDZ	4
## 814	64.228225800	64.228225800	64.228225800	SUB_ID	3
## 815	5.525078425	5.525078425	5.525078425	FRACSCORE	3
## 816	3.938222750	3.938222750	3.938222750	BMI	3
## 817	64.228225800	64.228225800	64.228225800	SUB_ID	2
## 818	5.525078425	5.525078425	5.525078425	FRACSCORE	2
## 819	64.228225800	64.228225800	64.228225800	SUB_ID	1
## 820	61.307427980	61.307427980	61.307427980	SUB_ID	24
## 821	3.642943357	3.642943357	3.642943357	FRACSCORE	24
## 822	3.126485013	3.126485013	3.126485013	BONEMED_FU	24
## 823	2.968825203	2.968825203	2.968825203	AGE_STDZ	24
## 824	2.874093586	2.874093586	2.874093586	HEIGHT	24
## 825	2.751623932	2.751623932	2.751623932	NOPRIORFRACxAGE_STDZ	24
## 826	2.541647021	2.541647021	2.541647021	AGE	24

## 827	2.412517368	2.412517368	2.412517368	BONEMED	24
## 828	2.382723668	2.382723668	2.382723668	BMI	24
## 829	1.501166318	1.501166318	1.501166318	WEIGHT	24
## 830	1.354938946	1.354938946	1.354938946	PRIORFRAC	24
## 831	1.034382768	1.034382768	1.034382768	BONETREAT	24
## 832	0.984719757	0.984719757	0.984719757	SMOKE	24
## 833	0.846379830	0.846379830	0.846379830	AGExPRIORFRAC	24
## 834	0.803589005	0.803589005	0.803589005	PHY_ID	24
## 835	0.567817494	0.567817494	0.567817494	PRIORFRACxAGE_STDZ	24
## 836	0.524666141	0.524666141	0.524666141	PREMENO	24
## 837	0.249961390	0.249961390	0.249961390	MOMFRAC	24
## 838	-0.132595519	-0.132595519	-0.132595519	RATERISK	24
## 839	-0.253184144	-0.253184144	-0.253184144	RATERISK_EQ_3	24
## 840	-0.351390760	-0.351390760	-0.351390760	RATERISK_num	24
## 841	-0.431431631	-0.431431631	-0.431431631	SITE_ID	24
## 842	-0.561764525	-0.561764525	-0.561764525	ARMASSIST	24
## 843	-0.835087793	-0.835087793	-0.835087793	MOMFRACxARMASSIST	24
## 844	61.307427980	61.307427980	61.307427980	SUB_ID	5
## 845	3.642943357	3.642943357	3.642943357	FRACSCORE	5
## 846	3.126485013	3.126485013	3.126485013	BONEMED_FU	5
## 847	2.968825203	2.968825203	2.968825203	AGE_STDZ	5
## 848	2.874093586	2.874093586	2.874093586	HEIGHT	5
## 849	61.307427980	61.307427980	61.307427980	SUB_ID	4
## 850	3.642943357	3.642943357	3.642943357	FRACSCORE	4
## 851	3.126485013	3.126485013	3.126485013	BONEMED_FU	4
## 852	2.968825203	2.968825203	2.968825203	AGE_STDZ	4
## 853	61.307427980	61.307427980	61.307427980	SUB_ID	3
## 854	3.642943357	3.642943357	3.642943357	FRACSCORE	3
## 855	3.126485013	3.126485013	3.126485013	BONEMED_FU	3
## 856	61.307427980	61.307427980	61.307427980	SUB_ID	2
## 857	3.642943357	3.642943357	3.642943357	FRACSCORE	2
## 858	61.307427980	61.307427980	61.307427980	SUB_ID	1
## 859	60.323847503	60.323847503	60.323847503	SUB_ID	24
## 860	3.466126238	3.466126238	3.466126238	BONEMED_FU	24

## 861	3.423574779	3.423574779	3.423574779	FRACSCORE	24
## 862	3.421472614	3.421472614	3.421472614	BMI	24
## 863	3.375888412	3.375888412	3.375888412	WEIGHT	24
## 864	3.256215572	3.256215572	3.256215572	NOPRIORFRACxAGE_STDZ	24
## 865	2.903038225	2.903038225	2.903038225	AGE_STDZ	24
## 866	2.376497255	2.376497255	2.376497255	BONETREAT	24
## 867	2.202838263	2.202838263	2.202838263	RATERISK_num	24
## 868	2.085185661	2.085185661	2.085185661	AGE	24
## 869	2.052636345	2.052636345	2.052636345	PRIORFRAC	24
## 870	1.905856711	1.905856711	1.905856711	HEIGHT	24
## 871	1.519571794	1.519571794	1.519571794	PHY_ID	24
## 872	1.433213031	1.433213031	1.433213031	BONEMED	24
## 873	0.987520108	0.987520108	0.987520108	PRIORFRACxAGE_STDZ	24
## 874	0.973546005	0.973546005	0.973546005	MOMFRAC	24
## 875	0.844255657	0.844255657	0.844255657	RATERISK_EQ_3	24
## 876	0.827735240	0.827735240	0.827735240	ARMASSIST	24
## 877	0.591095320	0.591095320	0.591095320	SMOKE	24
## 878	0.458263659	0.458263659	0.458263659	SITE_ID	24
## 879	0.307486130	0.307486130	0.307486130	PREMENO	24
## 880	0.204900091	0.204900091	0.204900091	RATERISK	24
## 881	0.122298557	0.122298557	0.122298557	AGExPRIORFRAC	24
## 882	-0.664210149	-0.664210149	-0.664210149	MOMFRACxARMASSIST	24
## 883	60.323847503	60.323847503	60.323847503	SUB_ID	5
## 884	3.466126238	3.466126238	3.466126238	BONEMED_FU	5
## 885	3.423574779	3.423574779	3.423574779	FRACSCORE	5
## 886	3.421472614	3.421472614	3.421472614	BMI	5
## 887	3.375888412	3.375888412	3.375888412	WEIGHT	5
## 888	60.323847503	60.323847503	60.323847503	SUB_ID	4
## 889	3.466126238	3.466126238	3.466126238	BONEMED_FU	4
## 890	3.423574779	3.423574779	3.423574779	FRACSCORE	4
## 891	3.421472614	3.421472614	3.421472614	BMI	4
## 892	60.323847503	60.323847503	60.323847503	SUB_ID	3
## 893	3.466126238	3.466126238	3.466126238	BONEMED_FU	3
## 894	3.423574779	3.423574779	3.423574779	FRACSCORE	3

## 895	60.323847503	60.323847503	60.323847503	SUB_ID	2
## 896	3.466126238	3.466126238	3.466126238	BONEMED_FU	2
## 897	60.323847503	60.323847503	60.323847503	SUB_ID	1
## 898	60.815726096	60.815726096	60.815726096	SUB_ID	24
## 899	4.287209684	4.287209684	4.287209684	FRACSCORE	24
## 900	3.887636328	3.887636328	3.887636328	NOPRIORFRACxAGE_STDZ	24
## 901	3.606033041	3.606033041	3.606033041	HEIGHT	24
## 902	3.335665160	3.335665160	3.335665160	BMI	24
## 903	2.862675215	2.862675215	2.862675215	AGE_STDZ	24
## 904	2.575494058	2.575494058	2.575494058	BONEMED_FU	24
## 905	1.868641134	1.868641134	1.868641134	AGE	24
## 906	1.841438340	1.841438340	1.841438340	BONETREAT	24
## 907	1.745937546	1.745937546	1.745937546	WEIGHT	24
## 908	1.704967598	1.704967598	1.704967598	BONEMED	24
## 909	1.229801652	1.229801652	1.229801652	MOMFRAC	24
## 910	1.190051921	1.190051921	1.190051921	PRIORFRACxAGE_STDZ	24
## 911	1.185570275	1.185570275	1.185570275	SITE_ID	24
## 912	1.006419143	1.006419143	1.006419143	PRIORFRAC	24
## 913	0.937148934	0.937148934	0.937148934	SMOKE	24
## 914	0.834648084	0.834648084	0.834648084	RATERISK_num	24
## 915	0.774439646	0.774439646	0.774439646	PHY_ID	24
## 916	0.614112358	0.614112358	0.614112358	ARMASSIST	24
## 917	0.588522057	0.588522057	0.588522057	RATERISK	24
## 918	0.023986647	0.023986647	0.023986647	RATERISK_EQ_3	24
## 919	-0.003766571	-0.003766571	-0.003766571	AGExPRIORFRAC	24
## 920	-0.090651820	-0.090651820	-0.090651820	MOMFRACxARMASSIST	24
## 921	-1.349552661	-1.349552661	-1.349552661	PREMENO	24
## 922	60.815726096	60.815726096	60.815726096	SUB_ID	5
## 923	4.287209684	4.287209684	4.287209684	FRACSCORE	5
## 924	3.887636328	3.887636328	3.887636328	NOPRIORFRACxAGE_STDZ	5
## 925	3.606033041	3.606033041	3.606033041	HEIGHT	5
## 926	3.335665160	3.335665160	3.335665160	BMI	5
## 927	60.815726096	60.815726096	60.815726096	SUB_ID	4
## 928	4.287209684	4.287209684	4.287209684	FRACSCORE	4

## 929	3.887636328	3.887636328	3.887636328	NOPRIORFRACxAGE_STDZ	4
## 930	3.606033041	3.606033041	3.606033041	HEIGHT	4
## 931	60.815726096	60.815726096	60.815726096	SUB_ID	3
## 932	4.287209684	4.287209684	4.287209684	FRACSCORE	3
## 933	3.887636328	3.887636328	3.887636328	NOPRIORFRACxAGE_STDZ	3
## 934	60.815726096	60.815726096	60.815726096	SUB_ID	2
## 935	4.287209684	4.287209684	4.287209684	FRACSCORE	2
## 936	60.815726096	60.815726096	60.815726096	SUB_ID	1
## 937	63.612120606	63.612120606	63.612120606	SUB_ID	24
## 938	4.743125553	4.743125553	4.743125553	FRACSCORE	24
## 939	3.388125136	3.388125136	3.388125136	NOPRIORFRACxAGE_STDZ	24
## 940	3.204744970	3.204744970	3.204744970	AGE	24
## 941	2.779856850	2.779856850	2.779856850	AGE_STDZ	24
## 942	2.771065412	2.771065412	2.771065412	BONEMED_FU	24
## 943	2.709942178	2.709942178	2.709942178	WEIGHT	24
## 944	2.404400250	2.404400250	2.404400250	BONEMED	24
## 945	2.078438539	2.078438539	2.078438539	HEIGHT	24
## 946	1.899811666	1.899811666	1.899811666	BMI	24
## 947	1.860686772	1.860686772	1.860686772	RATERISK_EQ_3	24
## 948	1.744652958	1.744652958	1.744652958	PHY_ID	24
## 949	1.724770478	1.724770478	1.724770478	BONETREAT	24
## 950	1.285613878	1.285613878	1.285613878	MOMFRAC	24
## 951	1.259197689	1.259197689	1.259197689	SITE_ID	24
## 952	1.121420427	1.121420427	1.121420427	ARMASSIST	24
## 953	0.986469565	0.986469565	0.986469565	PRIORFRAC	24
## 954	0.114619429	0.114619429	0.114619429	SMOKE	24
## 955	-0.324091283	-0.324091283	-0.324091283	RATERISK	24
## 956	-0.331681022	-0.331681022	-0.331681022	RATERISK_num	24
## 957	-0.392449127	-0.392449127	-0.392449127	AGExPRIORFRAC	24
## 958	-0.423207961	-0.423207961	-0.423207961	MOMFRACxARMASSIST	24
## 959	-0.551531048	-0.551531048	-0.551531048	PRIORFRACxAGE_STDZ	24
## 960	-0.764610467	-0.764610467	-0.764610467	PREMENO	24
## 961	63.612120606	63.612120606	63.612120606	SUB_ID	5
## 962	4.743125553	4.743125553	4.743125553	FRACSCORE	5

## 963	3.388125136	3.388125136	3.388125136	NOPRIORFRACxAGE_STDZ	5
## 964	3.204744970	3.204744970	3.204744970	AGE	5
## 965	2.779856850	2.779856850	2.779856850	AGE_STDZ	5
## 966	63.612120606	63.612120606	63.612120606	SUB_ID	4
## 967	4.743125553	4.743125553	4.743125553	FRACSCORE	4
## 968	3.388125136	3.388125136	3.388125136	NOPRIORFRACxAGE_STDZ	4
## 969	3.204744970	3.204744970	3.204744970	AGE	4
## 970	63.612120606	63.612120606	63.612120606	SUB_ID	3
## 971	4.743125553	4.743125553	4.743125553	FRACSCORE	3
## 972	3.388125136	3.388125136	3.388125136	NOPRIORFRACxAGE_STDZ	3
## 973	63.612120606	63.612120606	63.612120606	SUB_ID	2
## 974	4.743125553	4.743125553	4.743125553	FRACSCORE	2
## 975	63.612120606	63.612120606	63.612120606	SUB_ID	1
## 976	65.444909586	65.444909586	65.444909586	SUB_ID	24
## 977	4.695182795	4.695182795	4.695182795	FRACSCORE	24
## 978	3.698515375	3.698515375	3.698515375	BONEMED_FU	24
## 979	3.289307564	3.289307564	3.289307564	BMI	24
## 980	3.225766030	3.225766030	3.225766030	NOPRIORFRACxAGE_STDZ	24
## 981	3.041191268	3.041191268	3.041191268	AGE	24
## 982	2.855214593	2.855214593	2.855214593	WEIGHT	24
## 983	2.672899615	2.672899615	2.672899615	HEIGHT	24
## 984	2.507206098	2.507206098	2.507206098	BONETREAT	24
## 985	1.849269621	1.849269621	1.849269621	AGE_STDZ	24
## 986	1.703480889	1.703480889	1.703480889	BONEMED	24
## 987	1.693851555	1.693851555	1.693851555	RATERISK_num	24
## 988	1.323798647	1.323798647	1.323798647	SITE_ID	24
## 989	1.206719519	1.206719519	1.206719519	PHY_ID	24
## 990	1.080871138	1.080871138	1.080871138	RATERISK_EQ_3	24
## 991	0.602390158	0.602390158	0.602390158	ARMASSIST	24
## 992	0.428024000	0.428024000	0.428024000	RATERISK	24
## 993	0.361021197	0.361021197	0.361021197	SMOKE	24
## 994	0.357075571	0.357075571	0.357075571	PRIORFRAC	24
## 995	0.313944704	0.313944704	0.313944704	MOMFRAC	24
## 996	-0.103371749	-0.103371749	-0.103371749	PRIORFRACxAGE_STDZ	24

## 997	-0.198426307	-0.198426307	-0.198426307	AGExPRIORFRAC	24
## 998	-0.457117212	-0.457117212	-0.457117212	PREMENO	24
## 999	-0.655533958	-0.655533958	-0.655533958	MOMFRACxARMASSIST	24
## 1000	65.444909586	65.444909586	65.444909586	SUB_ID	5
## 1001	4.695182795	4.695182795	4.695182795	FRACSCORE	5
## 1002	3.698515375	3.698515375	3.698515375	BONEMED_FU	5
## 1003	3.289307564	3.289307564	3.289307564	BMI	5
## 1004	3.225766030	3.225766030	3.225766030	NOPRIORFRACxAGE_STDZ	5
## 1005	65.444909586	65.444909586	65.444909586	SUB_ID	4
## 1006	4.695182795	4.695182795	4.695182795	FRACSCORE	4
## 1007	3.698515375	3.698515375	3.698515375	BONEMED_FU	4
## 1008	3.289307564	3.289307564	3.289307564	BMI	4
## 1009	65.444909586	65.444909586	65.444909586	SUB_ID	3
## 1010	4.695182795	4.695182795	4.695182795	FRACSCORE	3
## 1011	3.698515375	3.698515375	3.698515375	BONEMED_FU	3
## 1012	65.444909586	65.444909586	65.444909586	SUB_ID	2
## 1013	4.695182795	4.695182795	4.695182795	FRACSCORE	2
## 1014	65.444909586	65.444909586	65.444909586	SUB_ID	1
## 1015	61.128452940	61.128452940	61.128452940	SUB_ID	24
## 1016	4.657541081	4.657541081	4.657541081	BONEMED_FU	24
## 1017	3.733984885	3.733984885	3.733984885	BMI	24
## 1018	3.361193979	3.361193979	3.361193979	NOPRIORFRACxAGE_STDZ	24
## 1019	3.107358397	3.107358397	3.107358397	AGE	24
## 1020	3.073149578	3.073149578	3.073149578	BONEMED	24
## 1021	2.995318466	2.995318466	2.995318466	FRACSCORE	24
## 1022	2.731954966	2.731954966	2.731954966	AGE_STDZ	24
## 1023	2.510869040	2.510869040	2.510869040	WEIGHT	24
## 1024	2.211497716	2.211497716	2.211497716	PRIORFRAC	24
## 1025	2.201886706	2.201886706	2.201886706	BONETREAT	24
## 1026	2.044044539	2.044044539	2.044044539	HEIGHT	24
## 1027	2.000006538	2.000006538	2.000006538	SMOKE	24
## 1028	1.372533339	1.372533339	1.372533339	SITE_ID	24
## 1029	0.931997714	0.931997714	0.931997714	PRIORFRACxAGE_STDZ	24
## 1030	0.819162351	0.819162351	0.819162351	RATERISK	24

##	1031	0.413672576	0.413672576	0.413672576	RATERISK_EQ_3	24
##	1032	0.234416314	0.234416314	0.234416314	RATERISK_num	24
##	1033	0.150925944	0.150925944	0.150925944	MOMFRACxARMASSIST	24
##	1034	0.133282338	0.133282338	0.133282338	PHY_ID	24
##	1035	0.129845490	0.129845490	0.129845490	ARMASSIST	24
##	1036	-0.106999292	-0.106999292	-0.106999292	PREMENO	24
##	1037	-0.364679547	-0.364679547	-0.364679547	AGExPRIORFRAC	24
##	1038	-0.486542739	-0.486542739	-0.486542739	MOMFRAC	24
##	1039	61.128452940	61.128452940	61.128452940	SUB_ID	5
##	1040	4.657541081	4.657541081	4.657541081	BONEMED_FU	5
##	1041	3.733984885	3.733984885	3.733984885	BMI	5
##	1042	3.361193979	3.361193979	3.361193979	NOPRIORFRACxAGE_STDZ	5
##	1043	3.107358397	3.107358397	3.107358397	AGE	5
##	1044	61.128452940	61.128452940	61.128452940	SUB_ID	4
##	1045	4.657541081	4.657541081	4.657541081	BONEMED_FU	4
##	1046	3.733984885	3.733984885	3.733984885	BMI	4
##	1047	3.361193979	3.361193979	3.361193979	NOPRIORFRACxAGE_STDZ	4
##	1048	61.128452940	61.128452940	61.128452940	SUB_ID	3
##	1049	4.657541081	4.657541081	4.657541081	BONEMED_FU	3
##	1050	3.733984885	3.733984885	3.733984885	BMI	3
##	1051	61.128452940	61.128452940	61.128452940	SUB_ID	2
##	1052	4.657541081	4.657541081	4.657541081	BONEMED_FU	2
##	1053	61.128452940	61.128452940	61.128452940	SUB_ID	1
##	1054	59.444222591	59.444222591	59.444222591	SUB_ID	24
##	1055	4.249751531	4.249751531	4.249751531	FRACSCORE	24
##	1056	3.525528568	3.525528568	3.525528568	BONEMED	24
##	1057	3.402935150	3.402935150	3.402935150	BONEMED_FU	24
##	1058	3.402663045	3.402663045	3.402663045	NOPRIORFRACxAGE_STDZ	24
##	1059	3.332105480	3.332105480	3.332105480	BMI	24
##	1060	3.176056236	3.176056236	3.176056236	AGE	24
##	1061	2.758103675	2.758103675	2.758103675	HEIGHT	24
##	1062	2.628452139	2.628452139	2.628452139	AGE_STDZ	24
##	1063	2.402132948	2.402132948	2.402132948	BONETREAT	24
##	1064	2.278345526	2.278345526	2.278345526	PRIORFRAC	24

## 1065	1.823281385	1.823281385	1.823281385	WEIGHT	24
## 1066	1.001404497	1.001404497	1.001404497	AGExPRIORFRAC	24
## 1067	0.966089080	0.966089080	0.966089080	RATERISK_EQ_3	24
## 1068	0.941571366	0.941571366	0.941571366	ARMASSIST	24
## 1069	0.661002400	0.661002400	0.661002400	SITE_ID	24
## 1070	0.392112090	0.392112090	0.392112090	RATERISK	24
## 1071	0.350081499	0.350081499	0.350081499	PRIORFRACxAGE_STDZ	24
## 1072	0.229847025	0.229847025	0.229847025	PHY_ID	24
## 1073	0.058253129	0.058253129	0.058253129	SMOKE	24
## 1074	0.043808557	0.043808557	0.043808557	RATERISK_num	24
## 1075	-0.841763969	-0.841763969	-0.841763969	PREMENO	24
## 1076	-1.024278474	-1.024278474	-1.024278474	MOMFRAC	24
## 1077	-1.543059954	-1.543059954	-1.543059954	MOMFRACxARMASSIST	24
## 1078	59.444222591	59.444222591	59.444222591	SUB_ID	5
## 1079	4.249751531	4.249751531	4.249751531	FRACSCORE	5
## 1080	3.525528568	3.525528568	3.525528568	BONEMED	5
## 1081	3.402935150	3.402935150	3.402935150	BONEMED_FU	5
## 1082	3.402663045	3.402663045	3.402663045	NOPRIORFRACxAGE_STDZ	5
## 1083	59.444222591	59.444222591	59.444222591	SUB_ID	4
## 1084	4.249751531	4.249751531	4.249751531	FRACSCORE	4
## 1085	3.525528568	3.525528568	3.525528568	BONEMED	4
## 1086	3.402935150	3.402935150	3.402935150	BONEMED_FU	4
## 1087	59.444222591	59.444222591	59.444222591	SUB_ID	3
## 1088	4.249751531	4.249751531	4.249751531	FRACSCORE	3
## 1089	3.525528568	3.525528568	3.525528568	BONEMED	3
## 1090	59.444222591	59.444222591	59.444222591	SUB_ID	2
## 1091	4.249751531	4.249751531	4.249751531	FRACSCORE	2
## 1092	59.444222591	59.444222591	59.444222591	SUB_ID	1
## 1093	61.823900913	61.823900913	61.823900913	SUB_ID	24
## 1094	5.478907606	5.478907606	5.478907606	FRACSCORE	24
## 1095	3.365366939	3.365366939	3.365366939	WEIGHT	24
## 1096	3.113341275	3.113341275	3.113341275	NOPRIORFRACxAGE_STDZ	24
## 1097	2.984500476	2.984500476	2.984500476	BONEMED_FU	24
## 1098	2.893269364	2.893269364	2.893269364	AGE	24

##	1099	2.812089372	2.812089372	2.812089372	AGE_STDZ	24
##	1100	2.739196890	2.739196890	2.739196890	HEIGHT	24
##	1101	2.331895438	2.331895438	2.331895438	BMI	24
##	1102	2.184042295	2.184042295	2.184042295	RATERISK_num	24
##	1103	1.614971730	1.614971730	1.614971730	BONETREAT	24
##	1104	1.215158670	1.215158670	1.215158670	PRIORFRACxAGE_STDZ	24
##	1105	1.146944800	1.146944800	1.146944800	ARMASSIST	24
##	1106	1.109098483	1.109098483	1.109098483	PRIORFRAC	24
##	1107	0.980975758	0.980975758	0.980975758	BONEMED	24
##	1108	0.931928845	0.931928845	0.931928845	RATERISK_EQ_3	24
##	1109	0.677311498	0.677311498	0.677311498	SITE_ID	24
##	1110	0.613941646	0.613941646	0.613941646	MOMFRAC	24
##	1111	0.550488497	0.550488497	0.550488497	AGExPRIORFRAC	24
##	1112	0.226381777	0.226381777	0.226381777	SMOKE	24
##	1113	0.052500964	0.052500964	0.052500964	PHY_ID	24
##	1114	-0.277765503	-0.277765503	-0.277765503	RATERISK	24
##	1115	-0.759543953	-0.759543953	-0.759543953	MOMFRACxARMASSIST	24
##	1116	-1.037830064	-1.037830064	-1.037830064	PREMENO	24
##	1117	61.823900913	61.823900913	61.823900913	SUB_ID	5
##	1118	5.478907606	5.478907606	5.478907606	FRACSCORE	5
##	1119	3.365366939	3.365366939	3.365366939	WEIGHT	5
##	1120	3.113341275	3.113341275	3.113341275	NOPRIORFRACxAGE_STDZ	5
##	1121	2.984500476	2.984500476	2.984500476	BONEMED_FU	5
##	1122	61.823900913	61.823900913	61.823900913	SUB_ID	4
##	1123	5.478907606	5.478907606	5.478907606	FRACSCORE	4
##	1124	3.365366939	3.365366939	3.365366939	WEIGHT	4
##	1125	3.113341275	3.113341275	3.113341275	NOPRIORFRACxAGE_STDZ	4
##	1126	61.823900913	61.823900913	61.823900913	SUB_ID	3
##	1127	5.478907606	5.478907606	5.478907606	FRACSCORE	3
##	1128	3.365366939	3.365366939	3.365366939	WEIGHT	3
##	1129	61.823900913	61.823900913	61.823900913	SUB_ID	2
##	1130	5.478907606	5.478907606	5.478907606	FRACSCORE	2
##	1131	61.823900913	61.823900913	61.823900913	SUB_ID	1
##	1132	63.206866483	63.206866483	63.206866483	SUB_ID	24

## 1133	4.964597696	4.964597696	4.964597696	FRACSCORE	24
## 1134	3.156174035	3.156174035	3.156174035	NOPRIORFRACxAGE_STDZ	24
## 1135	2.923339648	2.923339648	2.923339648	BMI	24
## 1136	2.692662870	2.692662870	2.692662870	HEIGHT	24
## 1137	2.439681013	2.439681013	2.439681013	WEIGHT	24
## 1138	2.000634195	2.000634195	2.000634195	PRIORFRAC	24
## 1139	1.863039261	1.863039261	1.863039261	AGE_STDZ	24
## 1140	1.794044357	1.794044357	1.794044357	BONEMED_FU	24
## 1141	1.744703245	1.744703245	1.744703245	AGE	24
## 1142	1.489460437	1.489460437	1.489460437	PHY_ID	24
## 1143	1.369558901	1.369558901	1.369558901	ARMASSIST	24
## 1144	1.346729234	1.346729234	1.346729234	RATERISK	24
## 1145	0.902750565	0.902750565	0.902750565	AGExPRIORFRAC	24
## 1146	0.754316457	0.754316457	0.754316457	MOMFRACxARMASSIST	24
## 1147	0.574618561	0.574618561	0.574618561	RATERISK_num	24
## 1148	0.496669510	0.496669510	0.496669510	BONEMED	24
## 1149	0.160832701	0.160832701	0.160832701	RATERISK_EQ_3	24
## 1150	0.132458052	0.132458052	0.132458052	SITE_ID	24
## 1151	0.020754632	0.020754632	0.020754632	BONETREAT	24
## 1152	0.014856577	0.014856577	0.014856577	PREMENO	24
## 1153	-0.052335350	-0.052335350	-0.052335350	PRIORFRACxAGE_STDZ	24
## 1154	-0.158227393	-0.158227393	-0.158227393	SMOKE	24
## 1155	-0.541631056	-0.541631056	-0.541631056	MOMFRAC	24
## 1156	63.206866483	63.206866483	63.206866483	SUB_ID	5
## 1157	4.964597696	4.964597696	4.964597696	FRACSCORE	5
## 1158	3.156174035	3.156174035	3.156174035	NOPRIORFRACxAGE_STDZ	5
## 1159	2.923339648	2.923339648	2.923339648	BMI	5
## 1160	2.692662870	2.692662870	2.692662870	HEIGHT	5
## 1161	63.206866483	63.206866483	63.206866483	SUB_ID	4
## 1162	4.964597696	4.964597696	4.964597696	FRACSCORE	4
## 1163	3.156174035	3.156174035	3.156174035	NOPRIORFRACxAGE_STDZ	4
## 1164	2.923339648	2.923339648	2.923339648	BMI	4
## 1165	63.206866483	63.206866483	63.206866483	SUB_ID	3
## 1166	4.964597696	4.964597696	4.964597696	FRACSCORE	3

##	1167	3.156174035	3.156174035	3.156174035	NOPRIORFRACxAGE_STDZ	3
##	1168	63.206866483	63.206866483	63.206866483	SUB_ID	2
##	1169	4.964597696	4.964597696	4.964597696	FRACSCORE	2
##	1170	63.206866483	63.206866483	63.206866483	SUB_ID	1
##		Resample				
##	1	Fold01.Rep1				
##	2	Fold01.Rep1				
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1148 Fold10.Rep3
1149 Fold10.Rep3
1150 Fold10.Rep3
1151 Fold10.Rep3

```
## 1152 Fold10.Rep3
## 1153 Fold10.Rep3
## 1154 Fold10.Rep3
## 1155 Fold10.Rep3
## 1156 Fold10.Rep3
## 1157 Fold10.Rep3
## 1158 Fold10.Rep3
## 1159 Fold10.Rep3
## 1160 Fold10.Rep3
## 1161 Fold10.Rep3
## 1162 Fold10.Rep3
## 1163 Fold10.Rep3
## 1164 Fold10.Rep3
## 1165 Fold10.Rep3
## 1166 Fold10.Rep3
## 1167 Fold10.Rep3
## 1168 Fold10.Rep3
## 1169 Fold10.Rep3
## 1170 Fold10.Rep3
```

```
# The optimal number of features determined by the RFE process is 5.
```

```
# The top 5 variables selected are FRACSCORE, WEIGHT, BMI, HEIGHT, and AGE_STDZxNOPRIOR
```

```
# RANDOM FOREST
```

```
# Ensure FRACTURE is a factor if it's categorical
```

```
GLOW_data$FRACTURE <- as.factor(GLOW_data$FRACTURE)
```

```
# Build the random forest model
```

```
rf_model <- randomForest(FRACTURE ~ ., data=GLOW_data, ntree=500,
importance=TRUE)
```

```
# Print the importance of each variable
```

```
print(importance(rf_model))
```

##		0	1	MeanDecreaseAccuracy
## SUB_ID		62.6121879	65.715482904	67.08370002
## SITE_ID		2.4985095	-0.212001626	2.38049773

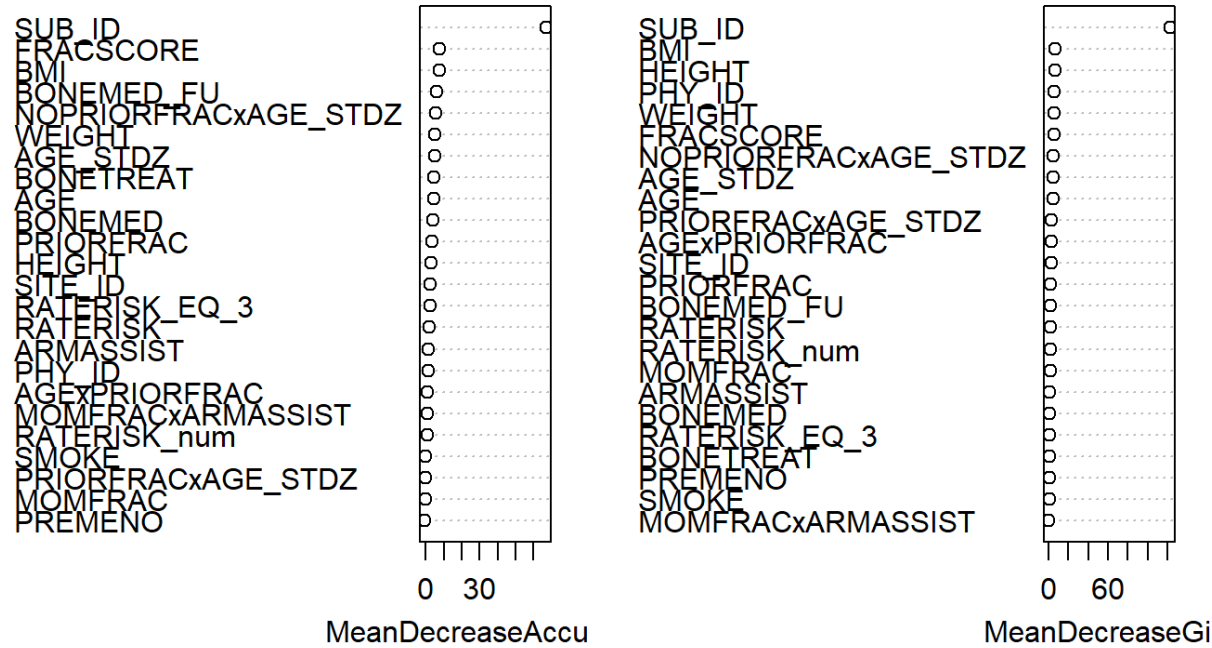
## PHY_ID	1.1306586	0.176230208	1.12326494
## PRIORFRAC	3.5586719	1.291933074	3.61322142
## AGE	4.5245942	0.341649995	4.31086931
## WEIGHT	5.9583739	-0.757895657	5.04256662
## HEIGHT	2.4831513	1.898654477	3.11310891
## BMI	8.4760980	-0.008161530	7.46166891
## PREMENO	-1.2633360	0.325914944	-0.67325726
## MOMFRAC	0.0380801	-0.916736366	-0.44918254
## ARMASSIST	1.8319557	-0.082007382	1.48800959
## SMOKE	0.5829811	-1.077956978	-0.02888994
## RATERISK	1.0425834	1.995687899	2.01243508
## FRACSCORE	6.8392742	3.494309715	7.46335355
## BONEMED	4.8554062	-2.010361346	4.13443523
## BONEMED_FU	6.0979212	0.273828229	5.97286350
## BONETREAT	4.8335809	-0.509607481	4.52005198
## RATERISK_EQ_3	2.4538964	0.137860152	2.20026871
## RATERISK_num	-0.8066306	2.090266963	0.69317951
## AGE_STDZ	5.6714141	-0.295374932	4.88828644
## AGExPRIORFRAC	0.6799395	0.962445643	1.06704087
## MOMFRACxARMASSIST	0.9806671	0.005158267	0.87793266
## PRIORFRACxAGE_STDZ	0.8544333	-1.799052771	-0.40288044
## NOPRIORFRACxAGE_STDZ	4.8100556	2.189911868	5.37778120
##	MeanDecreaseGini		
## SUB_ID	122.7330419		
## SITE_ID	2.4933762		
## PHY_ID	5.6309217		
## PRIORFRAC	1.7654977		
## AGE	4.5232876		
## WEIGHT	5.1066637		
## HEIGHT	6.0252334		
## BMI	6.4377834		
## PREMENO	0.7015662		
## MOMFRAC	1.2943913		
## ARMASSIST	1.2210545		

```
## SMOKE                                0.4642600
## RATERISK                             1.5981293
## FRACSCORE                            5.1039134
## BONEMED                              0.9710159
## BONEMED_FU                           1.6896958
## BONETREAT                            0.8693418
## RATERISK_EQ_3                        0.9241034
## RATERISK_num                         1.5116333
## AGE_STDZ                             4.6902943
## AGExPRIORFRAC                       2.6647241
## MOMFRACxARMASSIST                   0.3369723
## PRIORFRACxAGE_STDZ                 2.8592081
## NOPRIORFRACxAGE_STDZ               4.8683982
```

```
# Plot variable importance
```

```
varImpPlot(rf_model)
```

rf_model



```

# RANDOM FOREST

# Ensure FRACTURE is a factor if it's categorical
GLOW_data$FRACTURE <- as.factor(GLOW_data$FRACTURE)

# Build the random forest model
rf_model <- randomForest(FRACTURE ~ ., data=GLOW_data, ntree=500,
importance=TRUE)

# Print the importance of each variable
print(importance(rf_model))

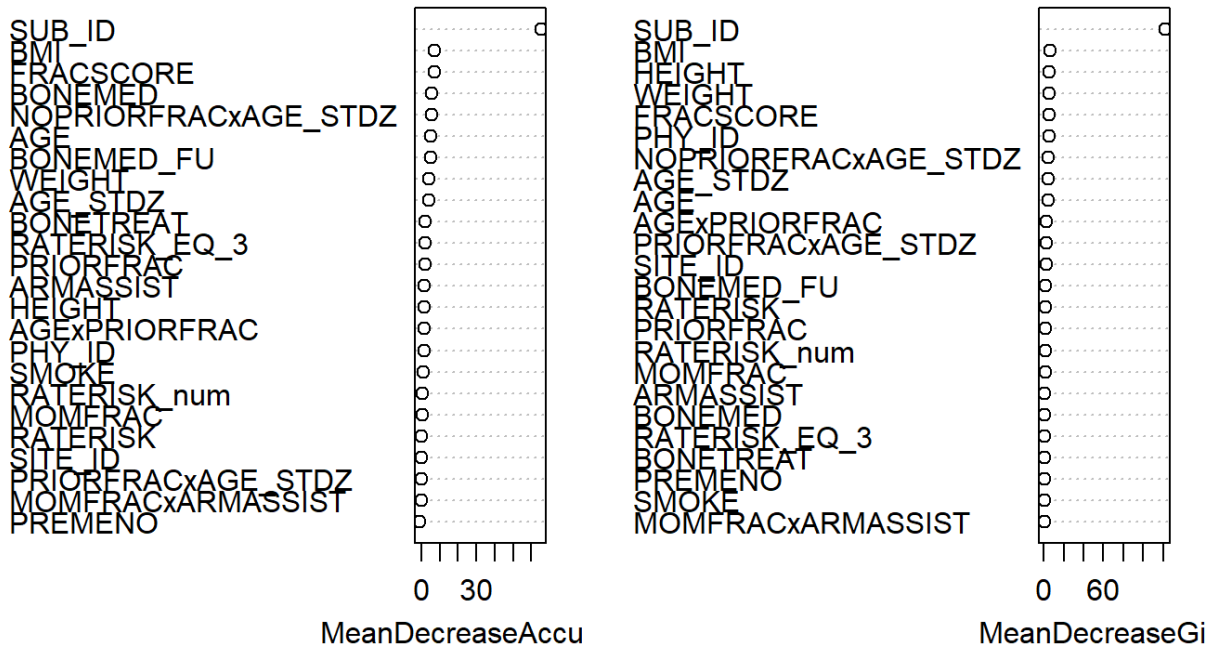
```

##		0	1	MeanDecreaseAccuracy
##	SUB_ID	60.16663720	67.4610174	65.34765401
##	SITE_ID	1.30569171	-1.6626086	0.11624490
##	PHY_ID	2.89723929	-1.8107504	1.56372457
##	PRIORFRAC	3.05775685	-0.8151036	2.04340106
##	AGE	6.10992332	0.1221043	5.43553008
##	WEIGHT	5.64673538	-1.5585010	4.36418179
##	HEIGHT	1.63782194	0.7700751	1.67873246
##	BMI	8.18352552	-0.7434904	7.34504388
##	PREMENO	-0.78279524	-0.3512526	-0.82418082
##	MOMFRAC	0.82064084	-0.4710652	0.44331323
##	ARMASSIST	2.65380873	-0.5908957	1.85284397
##	SMOKE	1.22911986	0.3556638	1.23176302
##	RATERISK	-0.08129908	0.7318728	0.29254444
##	FRACSCORE	5.38718149	4.0868331	7.00321557
##	BONEMED	6.10597708	0.3166537	5.46981026
##	BONEMED_FU	5.63340861	0.7353121	5.36272155
##	BONETREAT	3.06225394	-1.0757157	2.13524203
##	RATERISK_EQ_3	2.00763766	0.5269715	2.09121189
##	RATERISK_num	-0.92198682	1.7590908	0.52276713
##	AGE_STDZ	4.86638369	0.3492855	4.29208421
##	AGExPRIORFRAC	3.27763723	-1.7006615	1.67031301
##	MOMFRACxARMASSIST	-0.41999782	0.8433497	0.04198686
##	PRIORFRACxAGE_STDZ	1.63446093	-2.2570610	0.10056339

```
## NOPRIORFRACxAGE_STDZ  3.52678142  4.0267914          5.45518575
##
##                               MeanDecreaseGini
## SUB_ID                    122.1622138
## SITE_ID                    2.2593862
## PHY_ID                     5.2316616
## PRIORFRAC                  1.6909397
## AGE                        4.5117954
## WEIGHT                     5.4508460
## HEIGHT                     5.8765275
## BMI                        6.3249037
## PREMENO                    0.7445076
## MOMFRAC                    1.3813428
## ARMASSIST                  1.0533234
## SMOKE                      0.4489627
## RATERISK                   1.6999218
## FRACSCORE                  5.4248189
## BONEMED                    0.9983017
## BONEMED_FU                 1.7777501
## BONETREAT                  0.8504035
## RATERISK_EQ_3              0.9447167
## RATERISK_num               1.5866790
## AGE_STDZ                   4.5215574
## AGExPRIORFRAC              2.8864676
## MOMFRACxARMASSIST          0.4285930
## PRIORFRACxAGE_STDZ         2.8623326
## NOPRIORFRACxAGE_STDZ      4.5978523

# Plot variable importance
varImpPlot(rf_model)
```


rf_model



```
# Random Forest W SEED
```

```
GLOW_data$FRACTURE <- as.factor(GLOW_data$FRACTURE)
```

```
set.seed(123) # For reproducibility
```

```
rf_model <- randomForest(FRACTURE ~ ., data=GLOW_data, ntree=500,  
importance=TRUE)
```

```
importance(rf_model) # Shows importance score for each variable
```

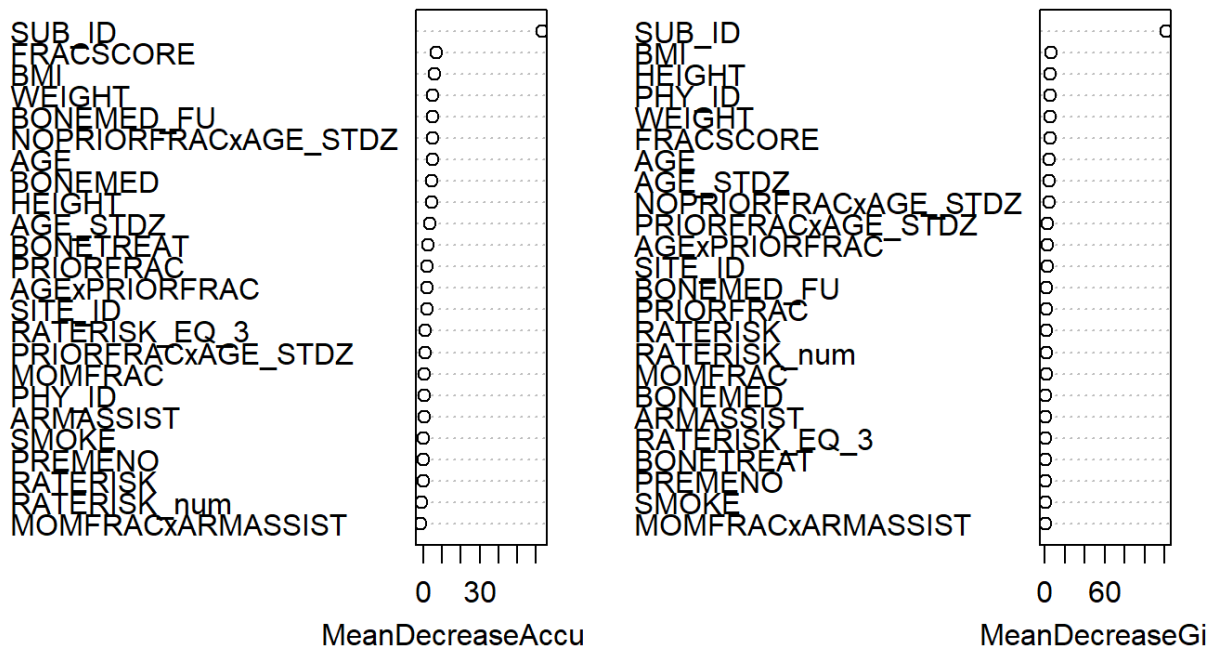
##	0	1	MeanDecreaseAccuracy
## SUB_ID	57.7788117	64.7201775	63.22439311
## SITE_ID	3.0265127	-1.2136723	2.13673684
## PHY_ID	1.5228799	-0.7425820	0.80350194
## PRIORFRAC	2.3205249	0.7059509	2.36535767
## AGE	5.1009957	0.5552545	4.89401905
## WEIGHT	6.2717122	-1.0568195	5.26060721
## HEIGHT	4.1288809	2.3824576	4.72345294
## BMI	7.2333438	-1.5298134	5.91426141
## PREMENO	-0.9159542	0.7758452	-0.02627726

## MOMFRAC	1.9913930	-1.3713291	0.85247675
## ARMASSIST	1.1244073	-0.1765833	0.74740612
## SMOKE	0.5666124	-0.4811641	0.26609402
## RATERISK	-1.2362910	1.4672427	-0.07975750
## FRACSCORE	6.1613400	2.0099281	6.82616729
## BONEMED	5.3839874	-0.9626865	4.82202599
## BONEMED_FU	5.0975261	1.8355321	5.11289900
## BONETREAT	2.6006868	1.2425631	2.81217249
## RATERISK_EQ_3	2.3659117	-1.5811427	1.07816317
## RATERISK_num	0.2026713	-1.4906767	-0.90332043
## AGE_STDZ	3.5561482	0.6940959	3.81292352
## AGExPRIORFRAC	3.1599722	-0.8063485	2.26311639
## MOMFRACxARMASSIST	-1.4565590	-0.2946979	-1.26243862
## PRIORFRACxAGE_STDZ	2.3032139	-1.7357001	1.07800326
## NOPRIORFRACxAGE_STDZ	4.7749760	1.2349391	5.08783678
##	MeanDecreaseGini		
## SUB_ID	121.6988191		
## SITE_ID	2.3330145		
## PHY_ID	5.6066219		
## PRIORFRAC	1.6651829		
## AGE	4.8114544		
## WEIGHT	5.5597058		
## HEIGHT	5.7925347		
## BMI	6.5129065		
## PREMENO	0.7395337		
## MOMFRAC	1.3454730		
## ARMASSIST	1.0115536		
## SMOKE	0.4689098		
## RATERISK	1.6297359		
## FRACSCORE	5.4296917		
## BONEMED	1.1499490		
## BONEMED_FU	1.8871480		
## BONETREAT	0.7417384		
## RATERISK_EQ_3	0.9478571		

```
## RATERISK_num          1.5842613
## AGE_STDZ              4.8099313
## AGExPRIORFRAC        2.8208520
## MOMFRACxARMASSIST     0.4396781
## PRIORFRACxAGE_STDZ   2.8700394
## NOPRIORFRACxAGE_STDZ 4.4753365

varImpPlot(rf_model) # Plots variable importance
```

rf_model



```
# PRINCIPAL COMPONENT ANALYSIS

library(FactoMineR)

# Select only numeric columns for PCA
numerical_data <- GLOW_data[sapply(GLOW_data, is.numeric)]

# Perform PCA
res.pca <- PCA(numerical_data, graph=FALSE)
```

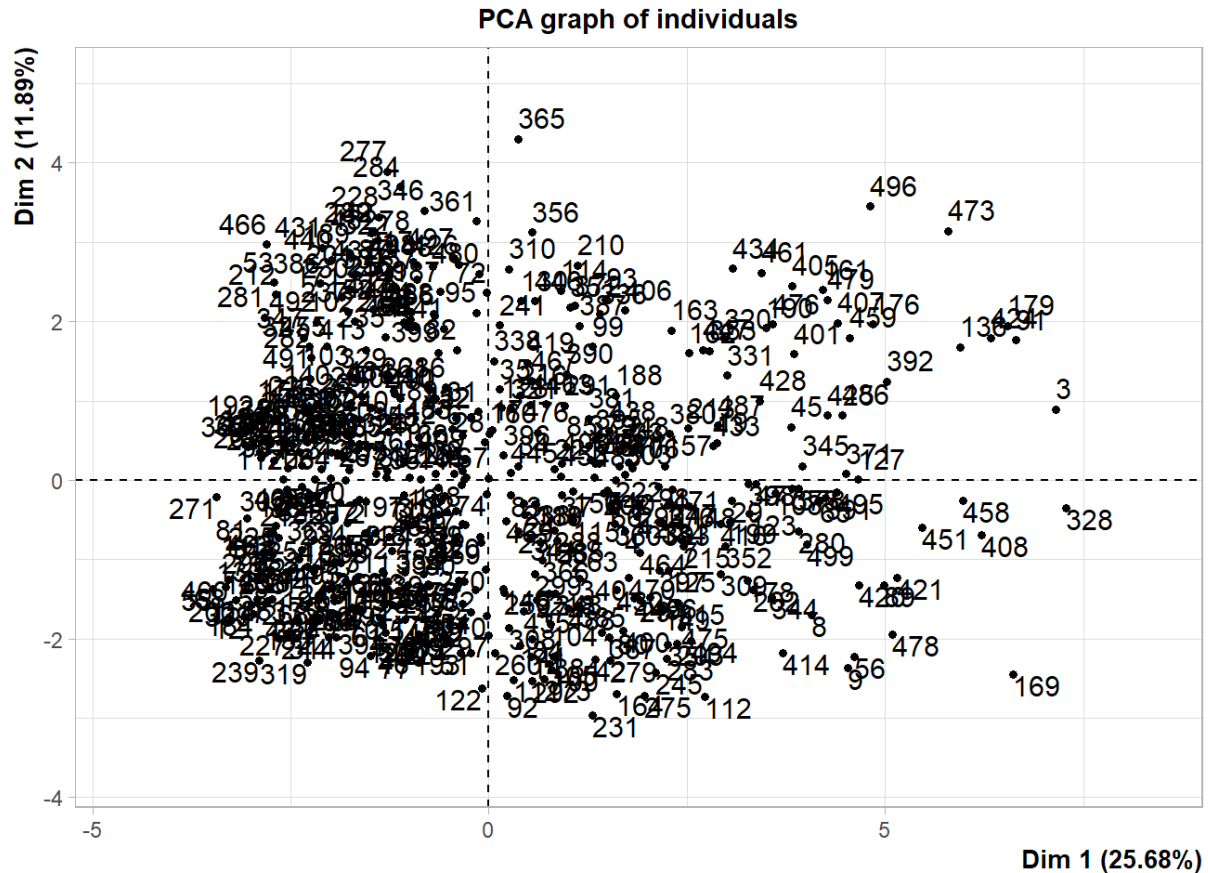
```

# Print PCA results
print(res.pca)

## **Results for the Principal Component Analysis (PCA)**
## The analysis was performed on 500 individuals, described by 19 variables
## *The results are available in the following objects:
##
##      name                description
## 1  "$eig"                "eigenvalues"
## 2  "$var"                "results for the variables"
## 3  "$var$coord"          "coord. for the variables"
## 4  "$var$cor"            "correlations variables - dimensions"
## 5  "$var$cos2"           "cos2 for the variables"
## 6  "$var$contrib"        "contributions of the variables"
## 7  "$ind"                "results for the individuals"
## 8  "$ind$coord"          "coord. for the individuals"
## 9  "$ind$cos2"           "cos2 for the individuals"
## 10 "$ind$contrib"        "contributions of the individuals"
## 11 "$call"               "summary statistics"
## 12 "$call$centre"        "mean of the variables"
## 13 "$call$ecart.type"    "standard error of the variables"
## 14 "$call$row.w"         "weights for the individuals"
## 15 "$call$col.w"         "weights for the variables"

# Optionally, plot the PCA
plot(res.pca, choix="var") # For variable contributions

```

```
# COMPUTING CORRELATION COEFFICIENTS

# Ensure FRACTURE is numeric for correlation computation
GLOW_data$FRACTURE <- as.numeric(as.factor(GLOW_data$FRACTURE)) - 1

# Re-run correlation with FRACTURE included if it's binary numeric
numerical_vars <- sapply(GLOW_data, is.numeric) # Re-check numerical
variables including FRACTURE

correlations <- cor(GLOW_data[, numerical_vars], use="pairwise.complete.obs")
# Compute the correlation matrix

fracture_correlations <- correlations[, "FRACTURE", drop = FALSE] # Extract
correlations with FRACTURE

print(fracture_correlations)
```

##	FRACTURE
## SUB_ID	0.75000150
## SITE_ID	0.06935643
## PHY_ID	0.06745920
## PRIORFRAC	0.21808819

```
## AGE 0.20765352
## WEIGHT -0.03625944
## HEIGHT -0.13640055
## BMI 0.01498506
## MOMFRAC 0.10643875
## ARMASSIST 0.15256788
## SMOKE -0.03167940
## FRACSCORE 0.26447951
## FRACTURE 1.00000000
## RATERISK_EQ_3 0.12419080
## RATERISK_num 0.15173188
## AGE_STDZ 0.20765352
## AGExPRIORFRAC 0.09727651
## MOMFRACxARMASSIST 0.05827942
## PRIORFRACxAGE_STDZ 0.09727651
## NOPRIORFRACxAGE_STDZ 0.18931686
```

```
# Computing Correlation Coefficients:
```

```
# GLOW_data is our dataset and FRACTURE is our binary target variable
```

```
numerical_vars <- sapply(GLOW_data, is.numeric) # Identify numerical variables
```

```
correlations <- cor(GLOW_data[, numerical_vars]) # Compute the correlation matrix
```

```
# Extract the correlations of all variables with FRACTURE
```

```
fracture_correlations <- correlations[, "FRACTURE", drop = FALSE] # Preserves the dataframe structure
```

```
sorted_correlations <- sort(fracture_correlations, decreasing = TRUE) # Sort by absolute value
```

```
print(sorted_correlations)
```

```
## [1] 1.00000000 0.75000150 0.26447951 0.21808819 0.20765352
0.20765352
## [7] 0.18931686 0.15256788 0.15173188 0.12419080 0.10643875
0.09727651
## [13] 0.09727651 0.06935643 0.06745920 0.05827942 0.01498506 -
0.03167940
## [19] -0.03625944 -0.13640055
```

```

# FEATURE SELECTION

# Recursive Feature Elimination (RFE) to Select Predictive Variables:

# FRACTURE is our first column
control <- rfeControl(functions=rfFuncs, method="cv", number=10)
results <- rfe(GLOW_data[, -1], GLOW_data[, 1],
               sizes=c(1:5), rfeControl=control)

print(results)

##
## Recursive feature selection
##
## Outer resampling method: Cross-Validated (10 fold)
##
## Resampling performance over subset size:
##
## Variables    RMSE Rsquared    MAE RMSESD RsquaredSD MAESD Selected
##           1  95.47    0.5639 78.23   3.750    0.04155 3.786      *
##           2  96.81    0.5543 79.17   3.930    0.04536 3.745
##           3  97.60    0.5498 79.88   2.353    0.04308 2.787
##           4  98.88    0.5407 81.12   2.619    0.03719 3.472
##           5 100.13    0.5392 83.28   3.284    0.03631 4.451
##          24  98.37    0.5374 80.03   3.916    0.04202 3.995
##
## The top 1 variables (out of 1):
##      FRACTURE

# CHI SQUARED

#Chi-Squared Test for Categorical Variables: to see their relationship with
the binary target FRACTURE, we perform a chi-squared test for each
categorical variable:

# Identify categorical variables
categorical_vars <- sapply(GLOW_data, is.factor) | sapply(GLOW_data,
is.character)

# Names of categorical variables

```



```

categorical_var_names <- names(GLOW_data)[categorical_vars]

# Perform a Chi-squared test for each categorical variable
for(var in categorical_var_names) {
  tryCatch({
    cat_table <- table(GLOW_data[[var]], GLOW_data$FRACTURE)

    # Ensure the table has more than one level for both rows and columns
    if (all(dim(cat_table) > 1)) {
      chi_res <- chisq.test(cat_table)
      print(paste("Chi-squared test for variable:", var))
      print(chi_res)
    } else {
      print(paste("Variable", var, "cannot be tested due to insufficient data
or lack of variability."))
    }
  }, error = function(e) {
    print(paste("Error in chi-squared test for variable:", var))
    print(e)
  })
}

## [1] "Chi-squared test for variable: PREMENO"
##
## Pearson's Chi-squared test with Yates' continuity correction
##
## data:  cat_table
## X-squared = 0.0042636, df = 1, p-value = 0.9479
##
## [1] "Chi-squared test for variable: RATERISK"
##
## Pearson's Chi-squared test
##
## data:  cat_table
## X-squared = 11.547, df = 2, p-value = 0.003109
##

```

```

## [1] "Chi-squared test for variable: BONEMED"
##
## Pearson's Chi-squared test with Yates' continuity correction
##
## data:  cat_table
## X-squared = 9.7822, df = 1, p-value = 0.001762
##
## [1] "Chi-squared test for variable: BONEMED_FU"
##
## Pearson's Chi-squared test with Yates' continuity correction
##
## data:  cat_table
## X-squared = 16.743, df = 1, p-value = 4.279e-05
##
## [1] "Chi-squared test for variable: BONETREAT"
##
## Pearson's Chi-squared test with Yates' continuity correction
##
## data:  cat_table
## X-squared = 5.9159, df = 1, p-value = 0.015

# NONPARAMETRIC
# Decision Tree w rpart

# Split the data into training and testing sets
set.seed(123) # For reproducibility
indices <- sample(1:nrow(GLOW_data), size = 0.7 * nrow(GLOW_data))
train_data <- GLOW_data[indices, ]
test_data <- GLOW_data[-indices, ]

# Fit the decision tree model
model <- rpart(FRACTURE ~ ., data = train_data, method = "class")

# Summary of the model
summary(model)

```

```

## Call:
## rpart(formula = FRACTURE ~ ., data = train_data, method = "class")
##   n= 350
##
##      CP nsplit rel error      xerror      xstd
## 1 1.00      0          1 1.00000000 0.09437989
## 2 0.01      1          0 0.02352941 0.01659020
##
## Variable importance
##           SUB_ID          FRACSCORE      AGExPRIORFRAC
PRIORFRACxAGE_STDZ
##              79              6              6
6
##           HEIGHT
##              4
##
## Node number 1: 350 observations,      complexity param=1
##   predicted class=0   expected loss=0.2428571   P(node) =1
##   class counts:    265    85
##   probabilities: 0.757 0.243
##   left son=2 (265 obs) right son=3 (85 obs)
##   Primary splits:
##           SUB_ID          < 375.5      to the left,   improve=128.714300,
(0 missing)
##           FRACSCORE          < 4.5      to the left,   improve= 10.000520,
(0 missing)
##           AGExPRIORFRAC          < 0.7717861   to the left,   improve=  9.964286,
(0 missing)
##           PRIORFRACxAGE_STDZ          < 0.7717861   to the left,   improve=  9.964286,
(0 missing)
##           NOPRIORFRACxAGE_STDZ < -0.03125856 to the left,   improve=  9.575968,
(0 missing)
##   Surrogate splits:
##           FRACSCORE          < 7.5      to the left,   agree=0.777,
adj=0.082, (0 split)
##           AGExPRIORFRAC          < 0.7717861   to the left,   agree=0.774,
adj=0.071, (0 split)

```

```

##          PRIORFRACxAGE_STDZ < 0.7717861    to the left,  agree=0.774,
adj=0.071, (0 split)

##          HEIGHT                < 151.5      to the right, agree=0.769,
adj=0.047, (0 split)

##

## Node number 2: 265 observations
##   predicted class=0  expected loss=0  P(node) =0.7571429
##   class counts:    265      0
##   probabilities: 1.000 0.000
##
## Node number 3: 85 observations
##   predicted class=1  expected loss=0  P(node) =0.2428571
##   class counts:      0      85
##   probabilities: 0.000 1.000

# Predict on the test data
predictions <- predict(model, test_data, type = "class")

# Evaluate the model
table(Predicted = predictions, Actual = test_data$FRACTURE)

##          Actual
## Predicted    0    1
##           0 110    0
##           1   0  40

# Confusion matrix
confusion_matrix <- table(Predicted = predictions, Actual =
test_data$FRACTURE)

# Accuracy
accuracy <- sum(diag(confusion_matrix)) / sum(confusion_matrix)

# Precision
precision <- confusion_matrix[2, 2] / sum(confusion_matrix[2, ])

# Recall
recall <- confusion_matrix[2, 2] / sum(confusion_matrix[, 2])

```

```

# F1-score
f1_score <- 2 * (precision * recall) / (precision + recall)

# Print the results
print(paste("Accuracy:", accuracy))
## [1] "Accuracy: 1"
print(paste("Precision:", precision))
## [1] "Precision: 1"
print(paste("Recall:", recall))
## [1] "Recall: 1"
print(paste("F1 Score:", f1_score))
## [1] "F1 Score: 1"

# Not great results here

# Lets create a model with variables :  FRACSCORE, WEIGHT, BMI, HEIGHT, and
NOPRIORFRACxAGE_STDZ  and then one that also includes AGExPRIORFRAC  to test

# Model 1 without 'AGExPRIORFRAC'
# Define the formula for the model without AGExPRIORFRAC
formula1 <- FRACTURE ~ FRACSCORE + WEIGHT + BMI + HEIGHT
# Train the model on the training data
modell1 <- rpart(formula1, data = train_data, method = "class")

# Predict on the test data
predictions1 <- predict(modell1, test_data, type = "class")

# Evaluate the model
confusion_matrix1 <- table(Predicted = predictions1, Actual =
test_data$FRACTURE)
accuracy1 <- sum(diag(confusion_matrix1)) / sum(confusion_matrix1)

# Print the results
print(paste("Accuracy for Model 1:", accuracy1))
## [1] "Accuracy for Model 1: 0.6666666666666667"

# Model 2 with 'AGExPRIORFRAC'
# Define the formula for the model with AGExPRIORFRAC

```

```

formula2 <- FRACTURE ~ FRACSCORE + WEIGHT + BMI + HEIGHT + AGExPRIORFRAC

# Train the model on the training data
model2 <- rpart(formula2, data = train_data, method = "class")

# Predict on the test data
predictions2 <- predict(model2, test_data, type = "class")

# Evaluate the model
confusion_matrix2 <- table(Predicted = predictions2, Actual =
test_data$FRACTURE)
accuracy2 <- sum(diag(confusion_matrix2)) / sum(confusion_matrix2)

# Print the results
print(paste("Accuracy for Model 2:", accuracy2))
## [1] "Accuracy for Model 2: 0.6666666666666667"

# Model 3 with AGExPRIORFRAC and MOMFRACxARMASSIST--as well as AGE, HEIGHT,
PRIORFRAC, MOMFRAC, ARMASSIST, and RATERISK_EQ_3.
# Split the data into training and testing sets
set.seed(123) # for reproducibility
indices <- sample(1:nrow(GLOW_data), size = 0.8 * nrow(GLOW_data))
train_data <- GLOW_data[indices, ]
test_data <- GLOW_data[-indices, ]

# Define the model formula
formula <- FRACTURE ~ AGExPRIORFRAC + MOMFRACxARMASSIST + AGE + HEIGHT +
PRIORFRAC + MOMFRAC + ARMASSIST + RATERISK_EQ_3

# Train the model on the training data
model <- rpart(formula, data = train_data, method = "class")

# Predict on the test data
predictions <- predict(model, test_data, type = "class")

# Evaluate the model

```

```

confusion_matrix <- table(Predicted = predictions, Actual =
test_data$FRACTURE)

accuracy <- sum(diag(confusion_matrix)) / sum(confusion_matrix)

# Print the confusion matrix and accuracy
print(confusion_matrix)
##           Actual
## Predicted  0   1
##           0 60 24
##           1  8  8
print(paste("Accuracy:", accuracy))
## [1] "Accuracy: 0.68"

# Now using only FRACSCORE, AGExPRIORFRAC, MOMFRACxARMASSIST

# Split the data into training and testing sets
set.seed(123) # for reproducibility
indices <- sample(1:nrow(GLOW_data), size = 0.8 * nrow(GLOW_data))
train_data <- GLOW_data[indices, ]
test_data <- GLOW_data[-indices, ]

# Define the model formula with the specified variables
formula <- FRACTURE ~ FRACSCORE + AGExPRIORFRAC + MOMFRACxARMASSIST

# Train the model on the training data
model <- rpart(formula, data = train_data, method = "class")

# Predict on the test data
predictions <- predict(model, test_data, type = "class")

# Evaluate the model
confusion_matrix <- table(Predicted = predictions, Actual =
test_data$FRACTURE)
accuracy <- sum(diag(confusion_matrix)) / sum(confusion_matrix)

# Print the confusion matrix and accuracy

```

```

print(confusion_matrix)

##           Actual
## Predicted   0   1
##           0 65 28
##           1   3   4

print(paste("Accuracy:", accuracy))

## [1] "Accuracy: 0.69"

# Rename factor levels for FRACTURE

glow_bonemed_NEW$FRACTURE <- factor(glow_bonemed_NEW$FRACTURE, levels =
c("0", "1"), labels = c("Class0", "Class1"))

# Confirm the change

print(table(glow_bonemed_NEW$FRACTURE)) # This should now show the renamed
classes

##
## Class0 Class1
##      375     125

# Set seed for reproducibility

set.seed(123)

# Splitting the data into training and testing sets again

trainIndex <- createDataPartition(glow_bonemed_NEW$FRACTURE, p = 0.8, list =
FALSE)

train_data <- glow_bonemed_NEW[trainIndex, ]
test_data <- glow_bonemed_NEW[-trainIndex, ]

# Verifying that FRACTURE is included and properly formatted

head(train_data$FRACTURE)

## [1] Class0 Class0 Class0 Class0 Class0 Class0
## Levels: Class0 Class1

head(test_data$FRACTURE)

## [1] Class0 Class0 Class0 Class0 Class0 Class0
## Levels: Class0 Class1

## Set seed for reproducibility

set.seed(123)

```



```

# Define training control
train_control <- trainControl(method = "cv", number = 10, savePredictions =
"final", classProbs = TRUE)

# Train the model using caret with cross-validation
model_caret <- train(FRACTURE ~ ., data = glow_bonemed_NEW, method = "rpart",
trControl = train_control, tuneLength = 10)

# Print the best model's results
print(model_caret)

## CART
##
## 500 samples
## 24 predictor
## 2 classes: 'Class0', 'Class1'
##
## No pre-processing
## Resampling: Cross-Validated (10 fold)
## Summary of sample sizes: 449, 449, 451, 451, 449, 451, ...
## Resampling results across tuning parameters:
##
##   cp          Accuracy   Kappa
##   0.0000000  0.9979592  0.9946331
##   0.1111111  0.9979592  0.9946331
##   0.2222222  0.9979592  0.9946331
##   0.3333333  0.9979592  0.9946331
##   0.4444444  0.9979592  0.9946331
##   0.5555556  0.9979592  0.9946331
##   0.6666667  0.9979592  0.9946331
##   0.7777778  0.9979592  0.9946331
##   0.8888889  0.9979592  0.9946331
##   1.0000000  0.7501000  0.0000000
##
## Accuracy was used to select the optimal model using the largest value.
## The final value used for the model was cp = 0.8888889.

```

```

# Ensure test data FRACTURE is also a factor (if it's not already)
test_data$FRACTURE <- factor(test_data$FRACTURE)

# Predict on the test data
predictions <- predict(model_caret, newdata = test_data, type = "raw")

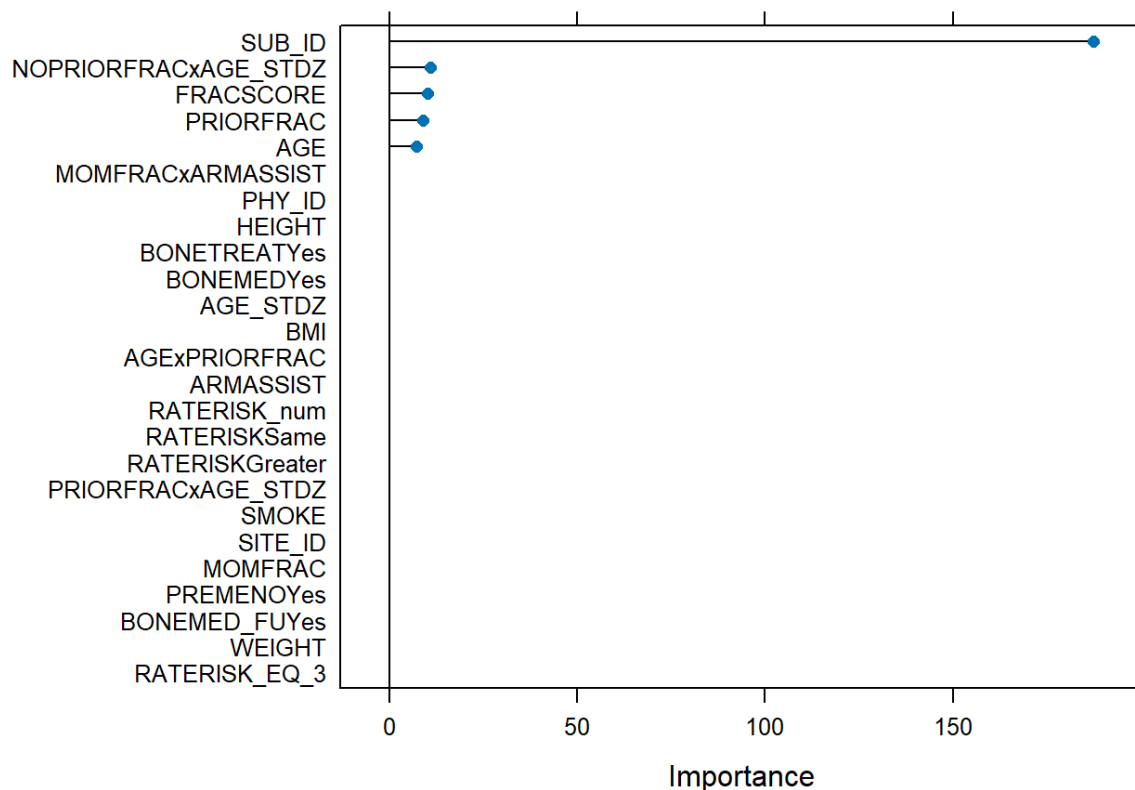
# Evaluate the model using confusionMatrix from caret
conf_matrix <- confusionMatrix(predictions, test_data$FRACTURE)
print(conf_matrix)

## Confusion Matrix and Statistics
##
##              Reference
## Prediction Class0 Class1
##      Class0      75      0
##      Class1       0     25
##
##              Accuracy : 1
##              95% CI : (0.9638, 1)
##      No Information Rate : 0.75
##      P-Value [Acc > NIR] : 3.207e-13
##
##              Kappa : 1
##
##      McNemar's Test P-Value : NA
##
##              Sensitivity : 1.00
##              Specificity : 1.00
##      Pos Pred Value : 1.00
##      Neg Pred Value : 1.00
##              Prevalence : 0.75
##      Detection Rate : 0.75
##      Detection Prevalence : 0.75
##      Balanced Accuracy : 1.00
##

```

```
##          'Positive' Class : Class0
##
# Model importance
importance <- varImp(model_caret, scale = FALSE)
print(importance)

## rpart variable importance
##
##    only 20 most important variables shown (out of 25)
##
##              Overall
## SUB_ID          187.500
## NOPRIORFRACxAGE_STDZ  10.974
## FRACSCORE        10.202
## PRIORFRAC         8.918
## AGE              7.261
## PREMENOYes        0.000
## RATERISK_EQ_3      0.000
## HEIGHT            0.000
## PHY_ID            0.000
## SMOKE              0.000
## AGExPRIORFRAC      0.000
## AGE_STDZ           0.000
## WEIGHT            0.000
## MOMFRAC            0.000
## BONETREATYes       0.000
## PRIORFRACxAGE_STDZ  0.000
## RATERISKSame        0.000
## ARMASSIST          0.000
## BMI                0.000
## BONEMEDYes         0.000
plot(importance)
```



```
# Probability predictions for ROC curve
prob_predictions <- predict(model_caret, newdata = test_data, type = "prob")
roc_curve <- roc(response = test_data$FRACTURE, predictor =
prob_predictions$Class1)

## Setting levels: control = Class0, case = Class1
## Setting direction: controls < cases
plot(roc_curve)

# Check the current size of classes in training data
table(train_data$FRACTURE)

##
## Class0 Class1
##    300    100

# Apply SMOTE to balance the classes, ensuring we have an even number of
cases for each class

# Here we calculate the number of cases needed to balance the classes
majority_size <- max(table(train_data$FRACTURE))
```

```

minority_size <- min(table(train_data$FRACTURE))
desired_size <- 2 * majority_size # Desired total size after oversampling

# Using SMOTE for oversampling the minority class
if (minority_size < majority_size) {
  smote_data <- ovun.sample(FRACTURE ~ ., data = train_data, method = "over",
N = desired_size, seed = 123)$data
} else {
  smote_data <- train_data # No need for oversampling if classes are
balanced
}

# Check the new balance of the dataset after SMOTE
table(smote_data$FRACTURE)

```

```

##
## Class0 Class1
##      300      300

```

```

# Retrain the model using the balanced dataset
balanced_model <- train(FRACTURE ~ ., data = smote_data, method = "rpart",
trControl = train_control, tuneLength = 10)

```

```

# Predict on the original test set
balanced_predictions <- predict(balanced_model, newdata = test_data, type =
"raw")

```

```

# Confusion matrix to evaluate the model
balanced_conf_matrix <- confusionMatrix(balanced_predictions,
test_data$FRACTURE)
print(balanced_conf_matrix)

```

```

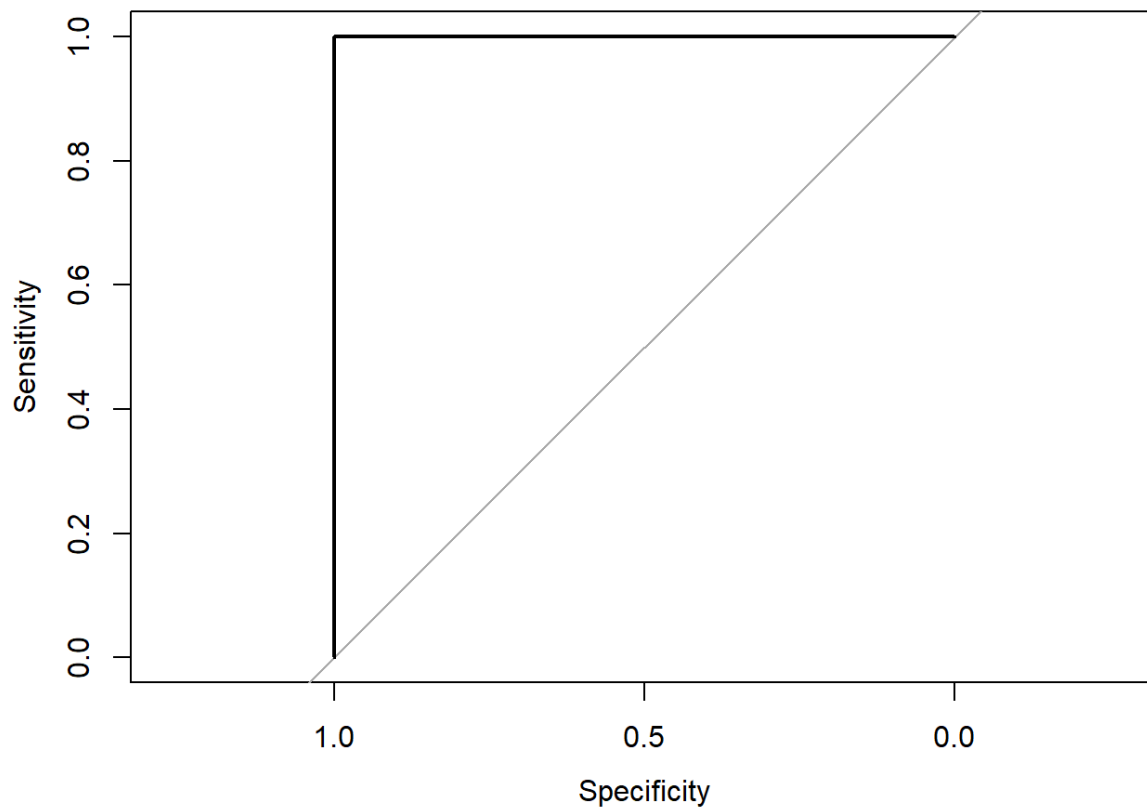
## Confusion Matrix and Statistics
##
##              Reference
## Prediction Class0 Class1
##      Class0      75      0
##      Class1       0     25

```

```

##
##           Accuracy : 1
##           95% CI : (0.9638, 1)
##       No Information Rate : 0.75
##       P-Value [Acc > NIR] : 3.207e-13
##
##           Kappa : 1
##
##  McNemar's Test P-Value : NA
##
##       Sensitivity : 1.00
##       Specificity : 1.00
##       Pos Pred Value : 1.00
##       Neg Pred Value : 1.00
##       Prevalence : 0.75
##       Detection Rate : 0.75
##       Detection Prevalence : 0.75
##       Balanced Accuracy : 1.00
##
##       'Positive' Class : Class0
##
# Probability predictions for ROC curve
balanced_prob_predictions <- predict(balanced_model, newdata = test_data,
type = "prob")
balanced_roc_curve <- roc(response = test_data$FRACTURE, predictor =
balanced_prob_predictions$Class1)
## Setting levels: control = Class0, case = Class1
## Setting direction: controls < cases
plot(balanced_roc_curve)

```

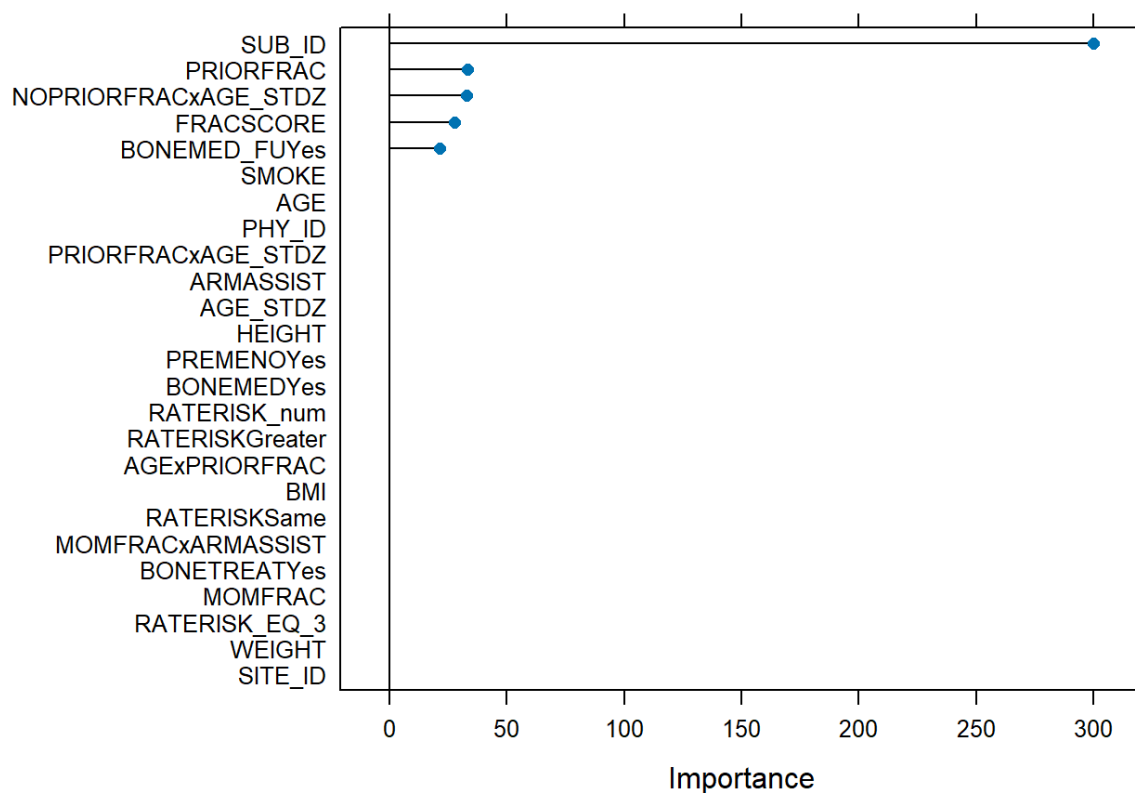


```
# Model importance
balanced_importance <- varImp(balanced_model, scale = FALSE)
print(balanced_importance)

## rpart variable importance
##
##   only 20 most important variables shown (out of 25)
##
##               Overall
## SUB_ID          300.00
## PRIORFRAC        33.40
## NOPRIORFRACxAGE_STDZ 32.83
## FRACSCORE        27.65
## BONEMED_FUYes    21.58
## RATERISK_num       0.00
## RATERISK_EQ_3      0.00
## MOMFRACxARMASSIST  0.00
```

```
## MOMFRAC                0.00
## AGE_STDZ               0.00
## SMOKE                  0.00
## AGE                    0.00
## SITE_ID                0.00
## PHY_ID                 0.00
## HEIGHT                 0.00
## WEIGHT                 0.00
## BONEMEDYes             0.00
## RATERISKGreater        0.00
## RATERISKSame           0.00
## BONETREATYes           0.00
```

```
plot(balanced_importance)
```



```
# Model Iteration
```

```
# Adjust dataset based on feature importance if necessary # For example,  
dropping a less important feature:
```



```

# train_data_adjusted <- train_data[, !(names(train_data) %in%
c("LEAST_IMPORTANT_FEATURE"))]

# test_data_adjusted <- test_data[, !(names(test_data) %in%
c("LEAST_IMPORTANT_FEATURE"))]

# Retrain the model on the adjusted data

# model_adjusted <- train(FRACTURE ~ ., data = train_data_adjusted, method =
"rpart",

#                               trControl = train_control, tuneLength = 10)

# Cross-Validation Reevaluation

# Adjusted training control with class probabilities

# train_control <- trainControl(method = "cv", number = 10, savePredictions =
"final", classProbs = TRUE)

# Train the models (for both cv_model and rf_model, this is just a
placeholder for the complete training code)

# Predict probabilities from both models

# cv_prob_predictions <- predict(cv_model, newdata = test_data_adjusted, type
= "prob")

# rf_prob_predictions <- predict(rf_model, newdata = test_data_adjusted, type
= "prob")

# Create ensemble predictions

# ensemble_prob <- (cv_prob_predictions$Class1 + rf_prob_predictions$Class1)
/ 2

# ensemble_predictions <- ifelse(ensemble_prob > 0.5, "Class1", "Class0")

# Evaluate ensemble model

# ensemble_conf_matrix <- confusionMatrix(as.factor(ensemble_predictions),
test_data_adjusted$FRACTURE)

# print(ensemble_conf_matrix)

# Calculate different performance metrics

# conf_matrix <- confusionMatrix(predictions, test_data$FRACTURE)

```

```
# print(conf_matrix$byClass) # Gives you Precision, Recall, F1 score etc.
# CV
train_control <- trainControl(method = "repeatedcv", number = 10, repeats =
3, savePredictions = "final", classProbs = TRUE)
model <- train(FRACTURE ~ ., data = train_data, method = "rf", trControl =
train_control)
# Feature Importance Analysis
importance <- varImp(model, scale = FALSE)
print(importance)
```

```
## rf variable importance
##
## only 20 most important variables shown (out of 25)
##
## Overall
## SUB_ID 136.99942
## PRIORFRAC 2.50617
## FRACSCORE 2.22789
## BMI 1.12568
## NOPRIORFRACxAGE_STDZ 1.08681
## HEIGHT 0.82258
## AGExPRIORFRAC 0.74321
## PRIORFRACxAGE_STDZ 0.70363
## PHY_ID 0.63552
## AGE_STDZ 0.60221
## WEIGHT 0.44571
## AGE 0.40569
## BONEMED_FUYes 0.29818
## BONEMEDYes 0.22496
## RATERISK_num 0.20971
## SITE_ID 0.20385
## ARMASSIST 0.16815
## BONETREATYes 0.13213
## PREMENOYes 0.08728
## MOMFRAC 0.08713
```