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))
  )
```

```r
# 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
```

```r
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"
```

```r
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"
```

```r
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

```
model1 <- 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(model1)
```

```
##
## 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)
```

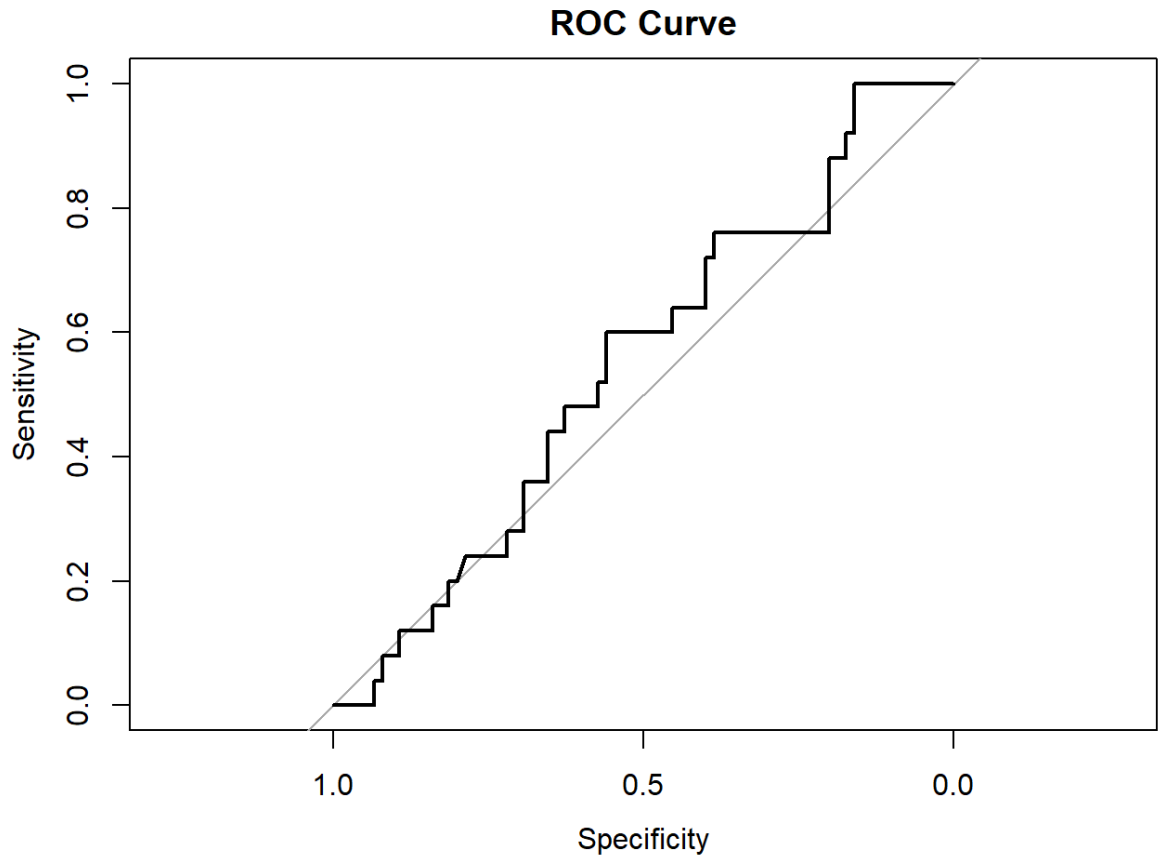
```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction  0  1
##          0 65 22
##          1 10  3
##
##                Accuracy : 0.68
##                  95% CI : (0.5792, 0.7698)
##     No Information Rate : 0.75
##     P-Value [Acc > NIR] : 0.95540
##
##                   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 +
ARMASSIST + RATERISK_EQ_3 + PRIORFRACxAGE_STDZ + NOPRIORFRACxAGE_STDZ,
```

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

# car::vif(improved_model) # Too Much Multicolinearity
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
```

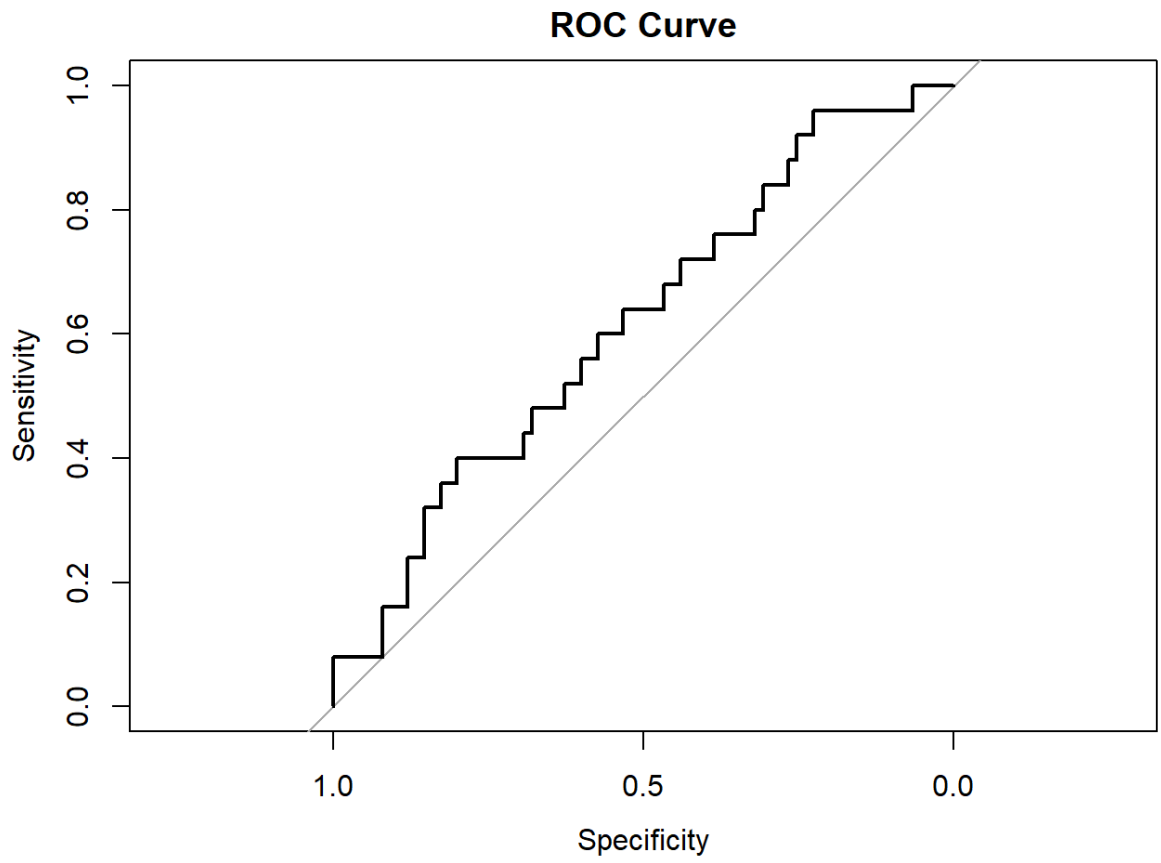
```
# Test Model

# 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
```

```r
# 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 MOMFRACxARMASSIST

## 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 ...
##  $ 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
MOMFRAC
## 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
WEIGHTxHEIGHT
## 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)
```

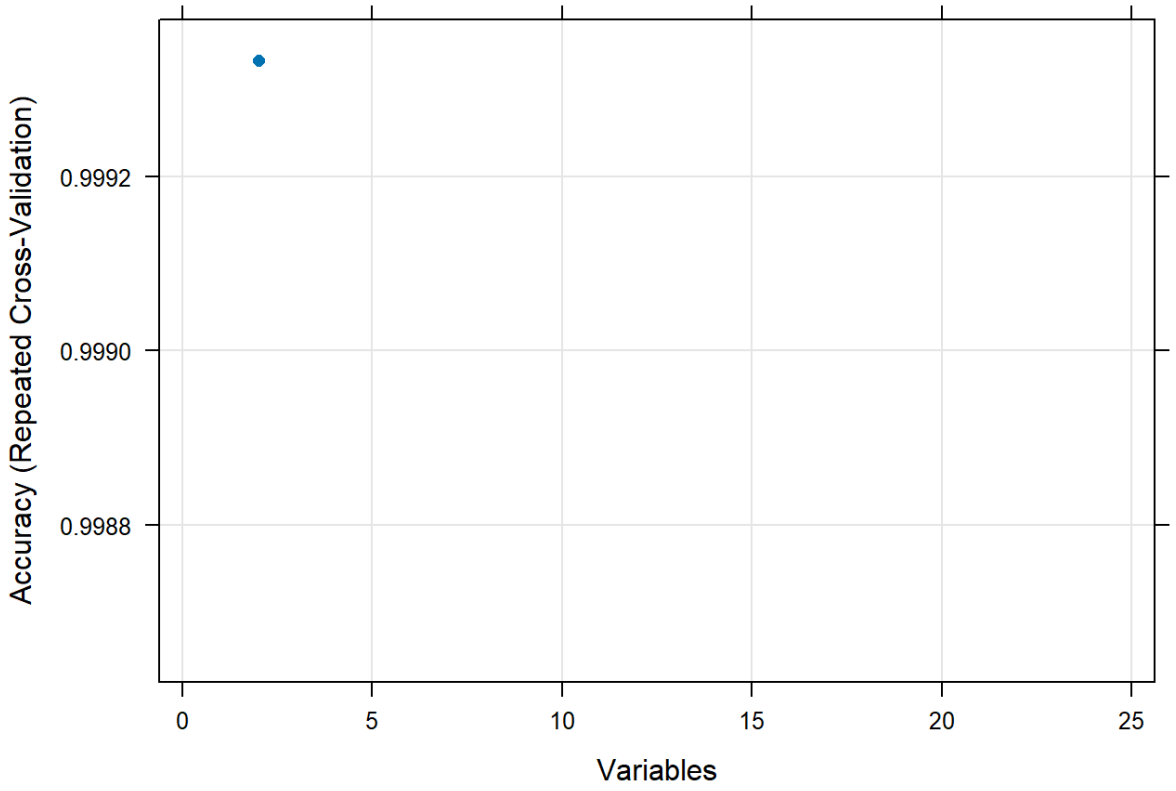
```
##
## Recursive feature selection
##
## Outer resampling method: Cross-Validated (10 fold, repeated 3 times)
##
## Resampling performance over subset size:
##
##  Variables Accuracy  Kappa AccuracySD  KappaSD Selected
```

```
##          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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
```

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## 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
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## 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
```

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## 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
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## 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
```

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## 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
```

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## 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
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## 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
## 3    Fold01.Rep1
## 4    Fold01.Rep1
## 5    Fold01.Rep1
## 6    Fold01.Rep1
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## 37   Fold01.Rep1
## 38   Fold01.Rep1
## 39   Fold01.Rep1
## 40   Fold02.Rep1
## 41   Fold02.Rep1
## 42   Fold02.Rep1
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## 79   Fold03.Rep1
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## 156  Fold04.Rep1
## 157  Fold05.Rep1
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## 948  Fold05.Rep3
## 949  Fold05.Rep3
## 950  Fold05.Rep3
## 951  Fold05.Rep3
## 952  Fold05.Rep3
## 953  Fold05.Rep3
## 954  Fold05.Rep3
## 955  Fold05.Rep3
## 956  Fold05.Rep3
## 957  Fold05.Rep3
## 958  Fold05.Rep3
## 959  Fold05.Rep3
## 960  Fold05.Rep3
## 961  Fold05.Rep3
## 962  Fold05.Rep3
## 963  Fold05.Rep3
## 964  Fold05.Rep3
## 965  Fold05.Rep3
## 966  Fold05.Rep3
## 967  Fold05.Rep3
## 968  Fold05.Rep3
## 969  Fold05.Rep3
## 970  Fold05.Rep3
## 971  Fold05.Rep3
## 972  Fold05.Rep3
## 973  Fold05.Rep3
## 974  Fold05.Rep3
## 975  Fold05.Rep3
## 976  Fold06.Rep3
## 977  Fold06.Rep3
## 978  Fold06.Rep3
## 979  Fold06.Rep3
## 980  Fold06.Rep3
## 981  Fold06.Rep3
```

```
## 982  Fold06.Rep3
## 983  Fold06.Rep3
## 984  Fold06.Rep3
## 985  Fold06.Rep3
## 986  Fold06.Rep3
## 987  Fold06.Rep3
## 988  Fold06.Rep3
## 989  Fold06.Rep3
## 990  Fold06.Rep3
## 991  Fold06.Rep3
## 992  Fold06.Rep3
## 993  Fold06.Rep3
## 994  Fold06.Rep3
## 995  Fold06.Rep3
## 996  Fold06.Rep3
## 997  Fold06.Rep3
## 998  Fold06.Rep3
## 999  Fold06.Rep3
## 1000 Fold06.Rep3
## 1001 Fold06.Rep3
## 1002 Fold06.Rep3
## 1003 Fold06.Rep3
## 1004 Fold06.Rep3
## 1005 Fold06.Rep3
## 1006 Fold06.Rep3
## 1007 Fold06.Rep3
## 1008 Fold06.Rep3
## 1009 Fold06.Rep3
## 1010 Fold06.Rep3
## 1011 Fold06.Rep3
## 1012 Fold06.Rep3
## 1013 Fold06.Rep3
## 1014 Fold06.Rep3
## 1015 Fold07.Rep3
```

```
## 1016 Fold07.Rep3
## 1017 Fold07.Rep3
## 1018 Fold07.Rep3
## 1019 Fold07.Rep3
## 1020 Fold07.Rep3
## 1021 Fold07.Rep3
## 1022 Fold07.Rep3
## 1023 Fold07.Rep3
## 1024 Fold07.Rep3
## 1025 Fold07.Rep3
## 1026 Fold07.Rep3
## 1027 Fold07.Rep3
## 1028 Fold07.Rep3
## 1029 Fold07.Rep3
## 1030 Fold07.Rep3
## 1031 Fold07.Rep3
## 1032 Fold07.Rep3
## 1033 Fold07.Rep3
## 1034 Fold07.Rep3
## 1035 Fold07.Rep3
## 1036 Fold07.Rep3
## 1037 Fold07.Rep3
## 1038 Fold07.Rep3
## 1039 Fold07.Rep3
## 1040 Fold07.Rep3
## 1041 Fold07.Rep3
## 1042 Fold07.Rep3
## 1043 Fold07.Rep3
## 1044 Fold07.Rep3
## 1045 Fold07.Rep3
## 1046 Fold07.Rep3
## 1047 Fold07.Rep3
## 1048 Fold07.Rep3
## 1049 Fold07.Rep3
```

```
## 1050 Fold07.Rep3
## 1051 Fold07.Rep3
## 1052 Fold07.Rep3
## 1053 Fold07.Rep3
## 1054 Fold08.Rep3
## 1055 Fold08.Rep3
## 1056 Fold08.Rep3
## 1057 Fold08.Rep3
## 1058 Fold08.Rep3
## 1059 Fold08.Rep3
## 1060 Fold08.Rep3
## 1061 Fold08.Rep3
## 1062 Fold08.Rep3
## 1063 Fold08.Rep3
## 1064 Fold08.Rep3
## 1065 Fold08.Rep3
## 1066 Fold08.Rep3
## 1067 Fold08.Rep3
## 1068 Fold08.Rep3
## 1069 Fold08.Rep3
## 1070 Fold08.Rep3
## 1071 Fold08.Rep3
## 1072 Fold08.Rep3
## 1073 Fold08.Rep3
## 1074 Fold08.Rep3
## 1075 Fold08.Rep3
## 1076 Fold08.Rep3
## 1077 Fold08.Rep3
## 1078 Fold08.Rep3
## 1079 Fold08.Rep3
## 1080 Fold08.Rep3
## 1081 Fold08.Rep3
## 1082 Fold08.Rep3
## 1083 Fold08.Rep3
```

```
## 1084 Fold08.Rep3
## 1085 Fold08.Rep3
## 1086 Fold08.Rep3
## 1087 Fold08.Rep3
## 1088 Fold08.Rep3
## 1089 Fold08.Rep3
## 1090 Fold08.Rep3
## 1091 Fold08.Rep3
## 1092 Fold08.Rep3
## 1093 Fold09.Rep3
## 1094 Fold09.Rep3
## 1095 Fold09.Rep3
## 1096 Fold09.Rep3
## 1097 Fold09.Rep3
## 1098 Fold09.Rep3
## 1099 Fold09.Rep3
## 1100 Fold09.Rep3
## 1101 Fold09.Rep3
## 1102 Fold09.Rep3
## 1103 Fold09.Rep3
## 1104 Fold09.Rep3
## 1105 Fold09.Rep3
## 1106 Fold09.Rep3
## 1107 Fold09.Rep3
## 1108 Fold09.Rep3
## 1109 Fold09.Rep3
## 1110 Fold09.Rep3
## 1111 Fold09.Rep3
## 1112 Fold09.Rep3
## 1113 Fold09.Rep3
## 1114 Fold09.Rep3
## 1115 Fold09.Rep3
## 1116 Fold09.Rep3
## 1117 Fold09.Rep3
```

```
## 1118 Fold09.Rep3
## 1119 Fold09.Rep3
## 1120 Fold09.Rep3
## 1121 Fold09.Rep3
## 1122 Fold09.Rep3
## 1123 Fold09.Rep3
## 1124 Fold09.Rep3
## 1125 Fold09.Rep3
## 1126 Fold09.Rep3
## 1127 Fold09.Rep3
## 1128 Fold09.Rep3
## 1129 Fold09.Rep3
## 1130 Fold09.Rep3
## 1131 Fold09.Rep3
## 1132 Fold10.Rep3
## 1133 Fold10.Rep3
## 1134 Fold10.Rep3
## 1135 Fold10.Rep3
## 1136 Fold10.Rep3
## 1137 Fold10.Rep3
## 1138 Fold10.Rep3
## 1139 Fold10.Rep3
## 1140 Fold10.Rep3
## 1141 Fold10.Rep3
## 1142 Fold10.Rep3
## 1143 Fold10.Rep3
## 1144 Fold10.Rep3
## 1145 Fold10.Rep3
## 1146 Fold10.Rep3
## 1147 Fold10.Rep3
## 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
```

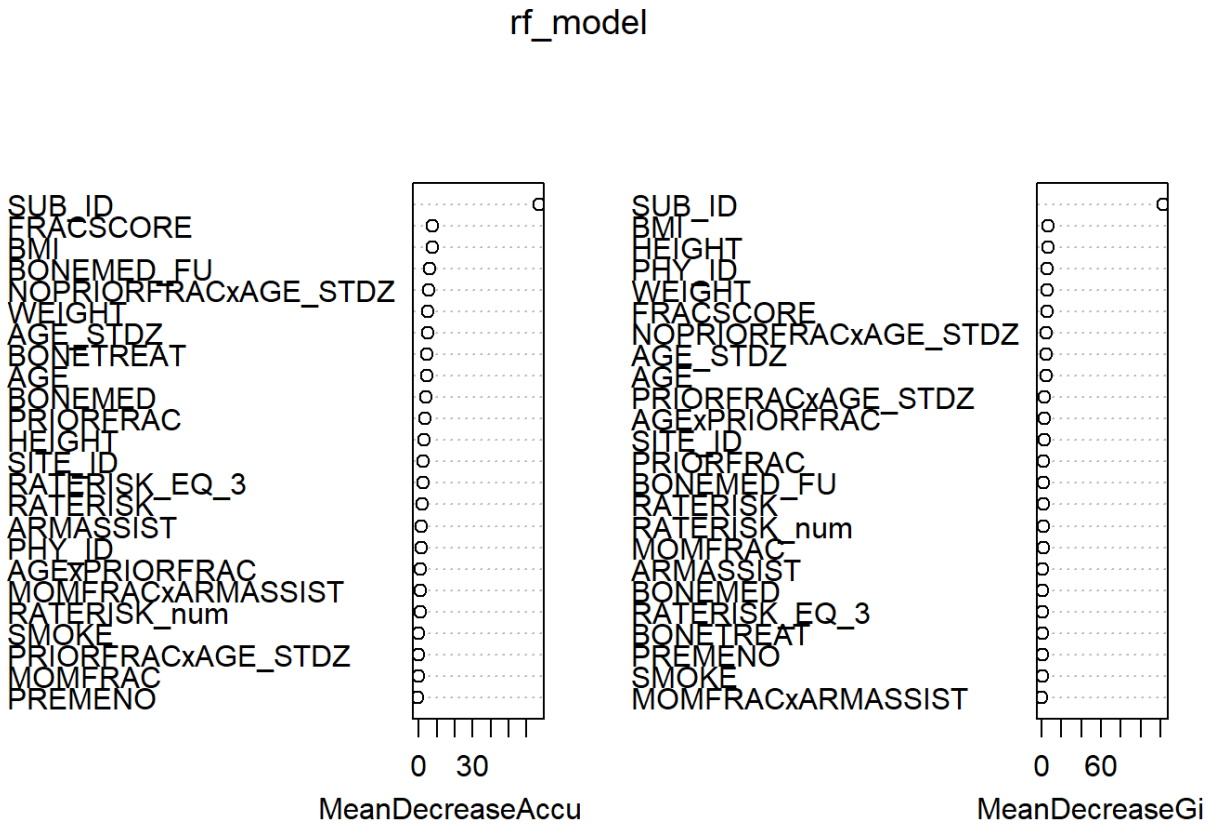
```
# The optimal number of features determined by the RFE process is 5.
# The top 5 variables selected are FRACSCORE, WEIGHT, BMI, HEIGHT, and
AGE_STDZxNOPRIOR
# RANDOM FOREST
# Ensure FRACTURE is a factor if it's categorical
GLOW_data$FRACTURE <- as.factor(GLOW_data$FRACTURE)


# 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
```

```
##                          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
```

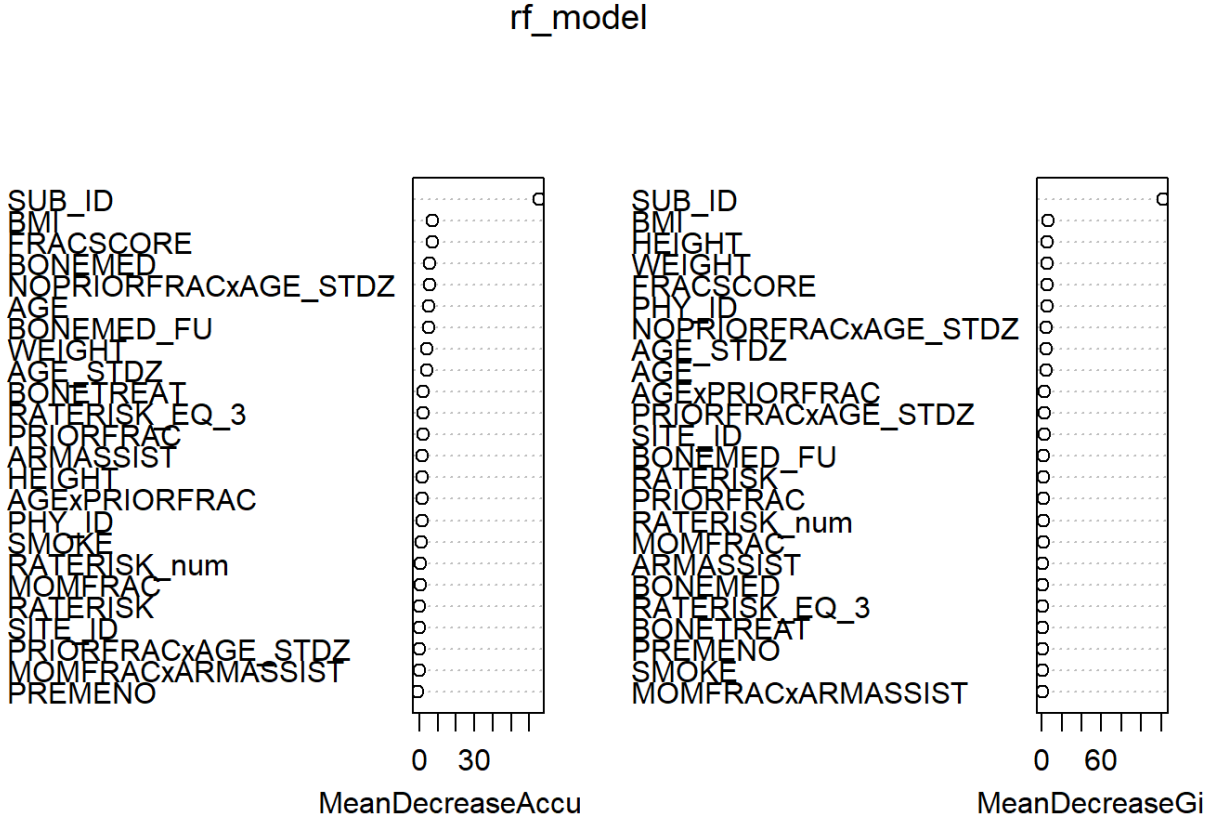
```
# Plot variable importance
varImpPlot(rf_model)
```



```r
# 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)
```

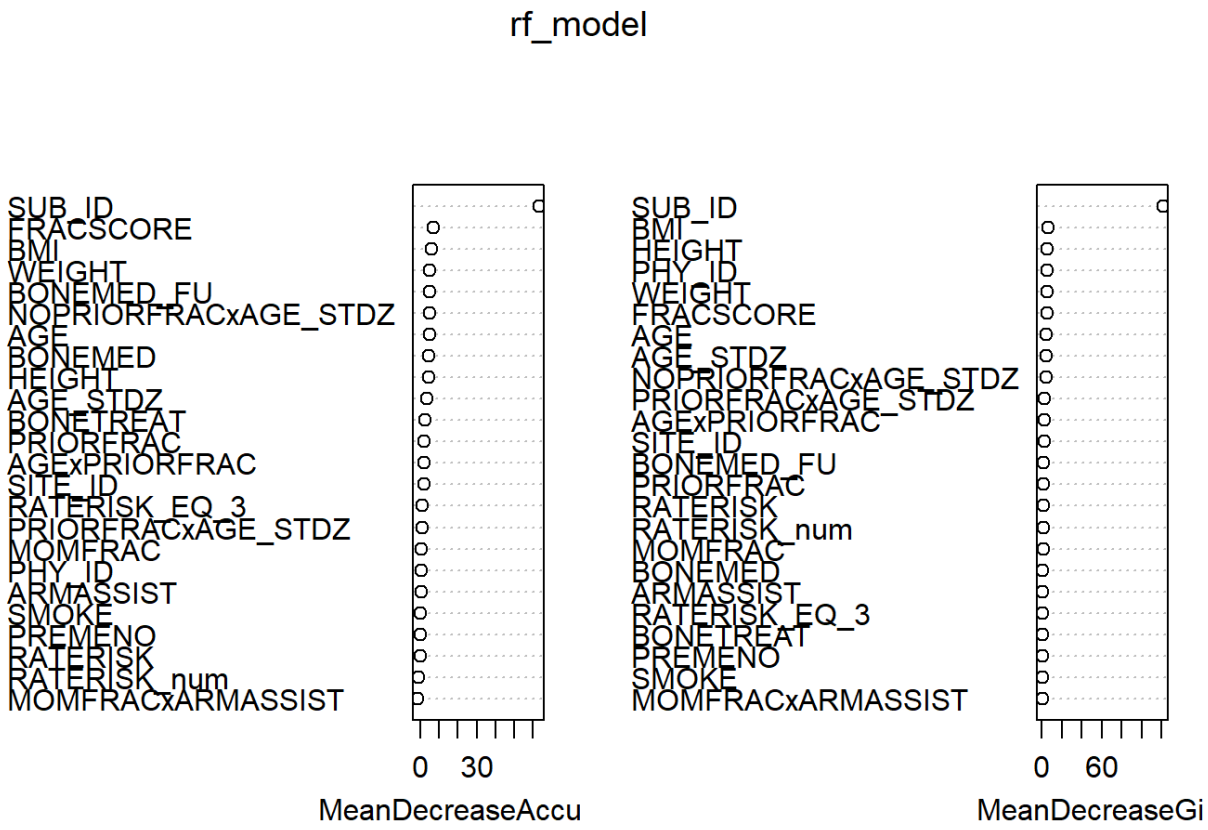



```r
# Random Forest W SEED

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
```

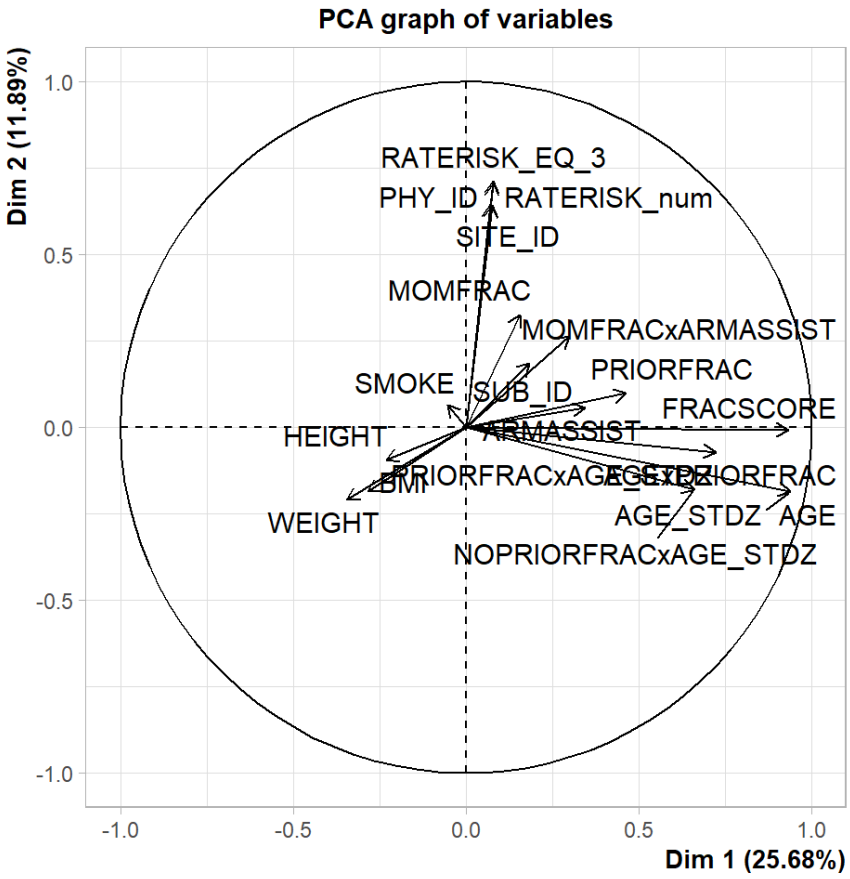



```
# PRINCIPAL COMPONENT ANALYSIS


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)
```

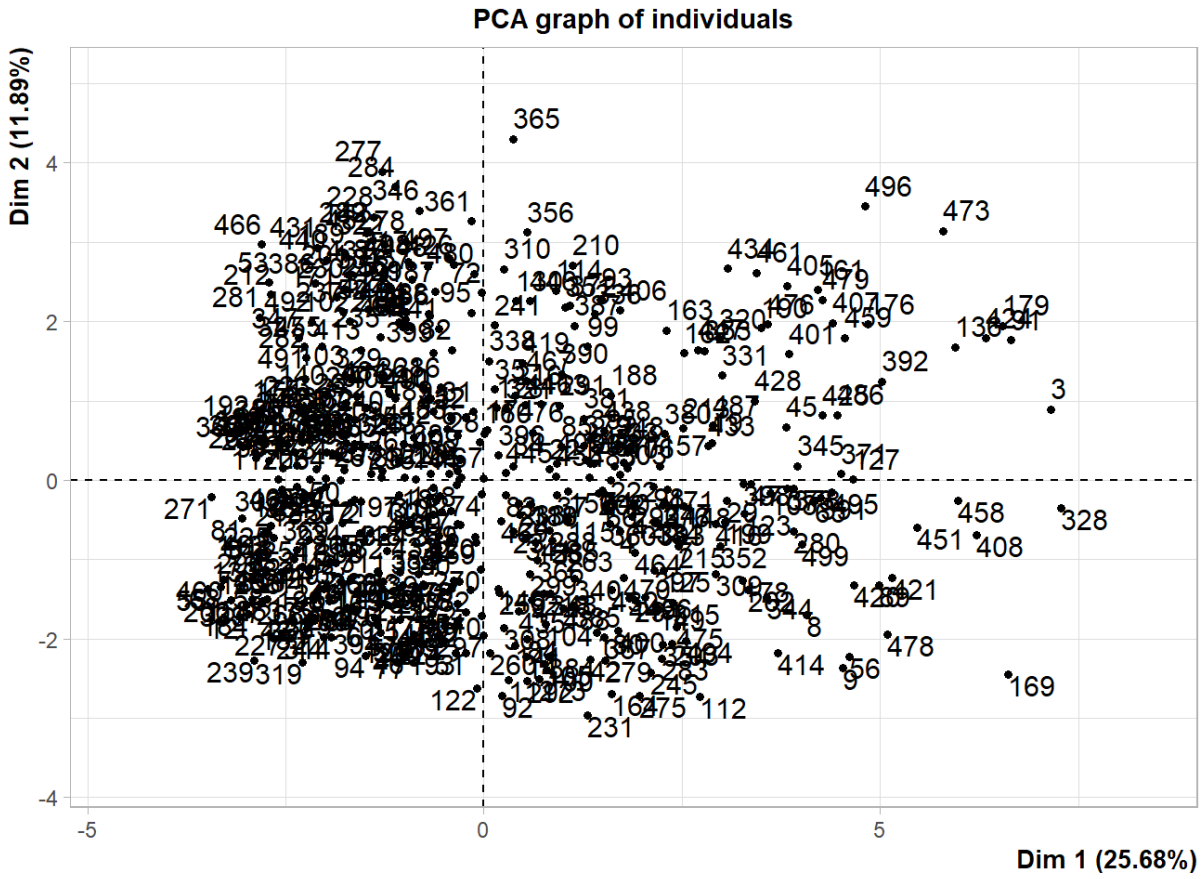
```r
# Print PCA results
print(res.pca)
```

```
## **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"
```

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




```
plot(res.pca, choix="ind") # For individual (observation) 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
```

```r
# 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
```

```r
# 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
```

```r
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])
```

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


# Print the results
print(paste("Accuracy:", accuracy))
```

```
## [1] "Accuracy: 1"
```

```r
print(paste("Precision:", precision))
```

```
## [1] "Precision: 1"
```

```r
print(paste("Recall:", recall))
```

```
## [1] "Recall: 1"
```

```r
print(paste("F1 Score:", f1_score))
```

```
## [1] "F1 Score: 1"
```

```r
# 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
model1 <- rpart(formula1, data = train_data, method = "class")


# Predict on the test data
predictions1 <- predict(model1, 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: 0.666666666666667"
```

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

```r
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: 0.666666666666667"
# 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
```

```r
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
```

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

```
## [1] "Accuracy: 0.68"
```

```r
# 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)
```

```r
# 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.
```

```r
# 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)
```

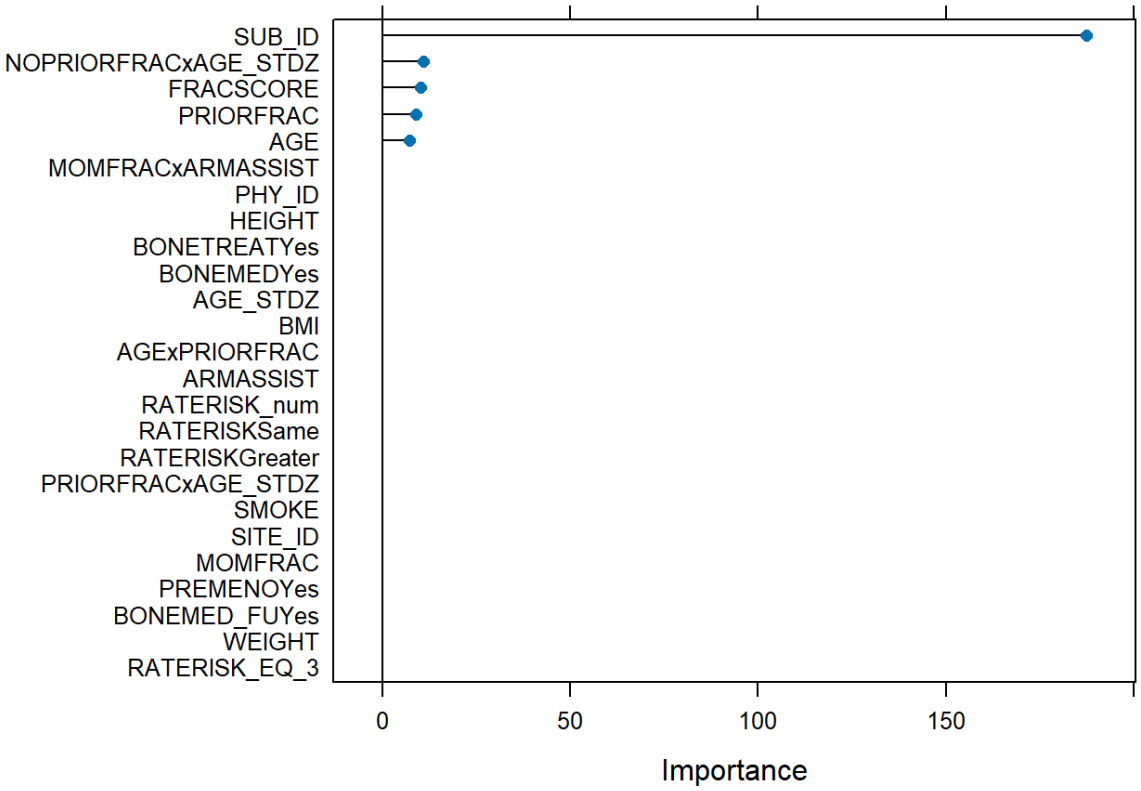
```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction Class0 Class1
##     Class0     75      0
##     Class1      0     25
##
##                Accuracy : 1
##                  95% CI : (0.9638, 1)
##     No Information Rate : 0.75
##     P-Value [Acc > NIR] : 3.207e-13
##
##                   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))
```

```r
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
```

```r
# 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)
```

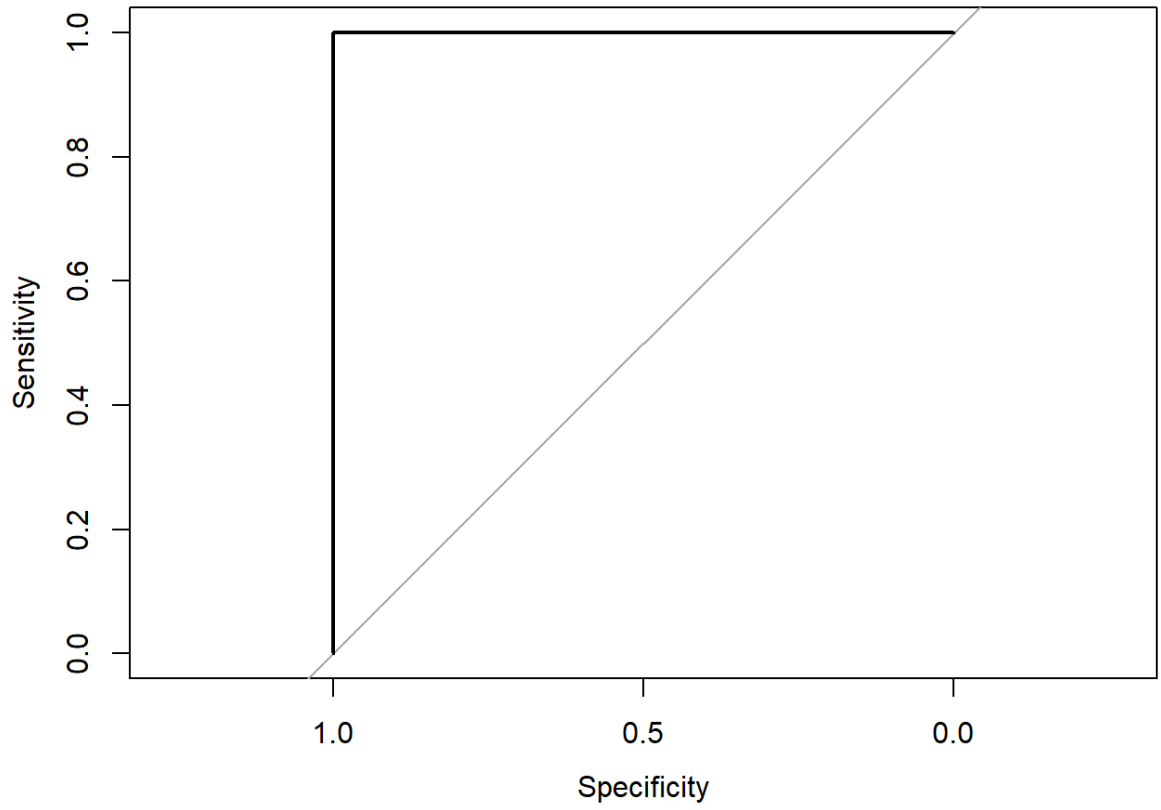
```
## Confusion Matrix and Statistics
##
##           Reference
## Prediction Class0 Class1
##     Class0     75      0
##     Class1      0     25
```

```
##
##                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)
```

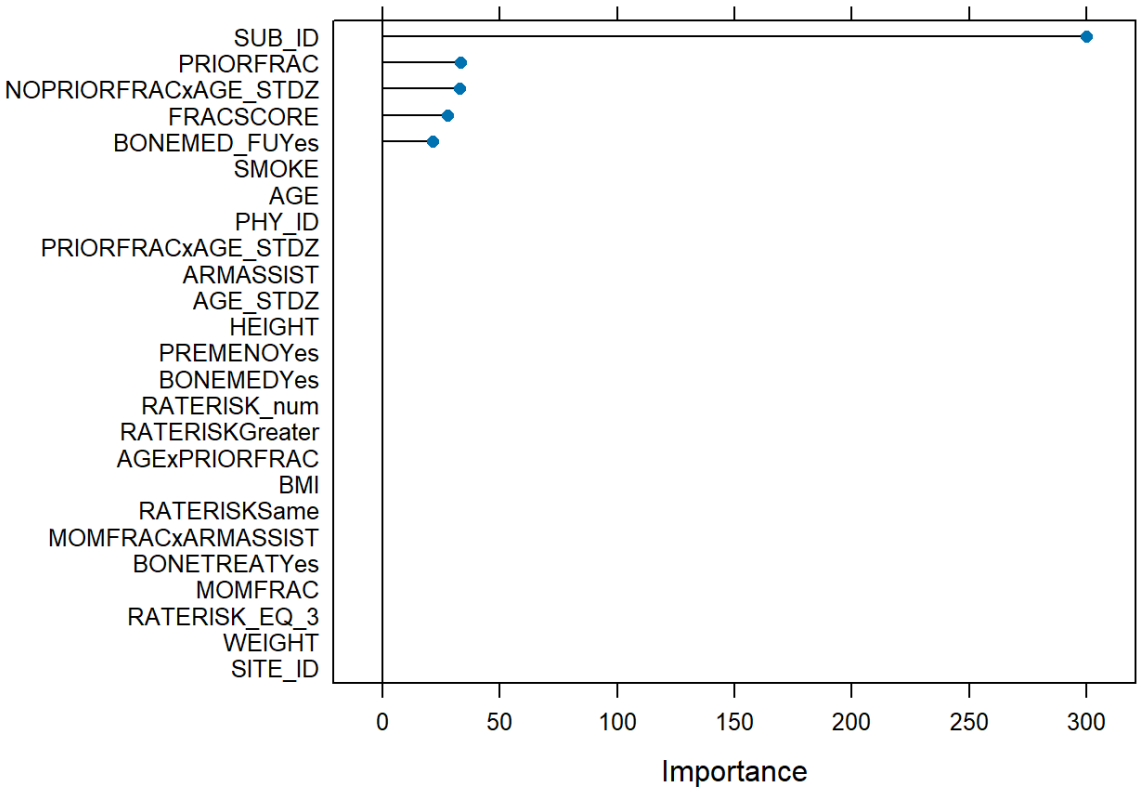



```
# Model importance
balanced_importance <- varImp(balanced_model, scale = FALSE)
print(balanced_importance)
```

```
## 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)
```

```r
# 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
```