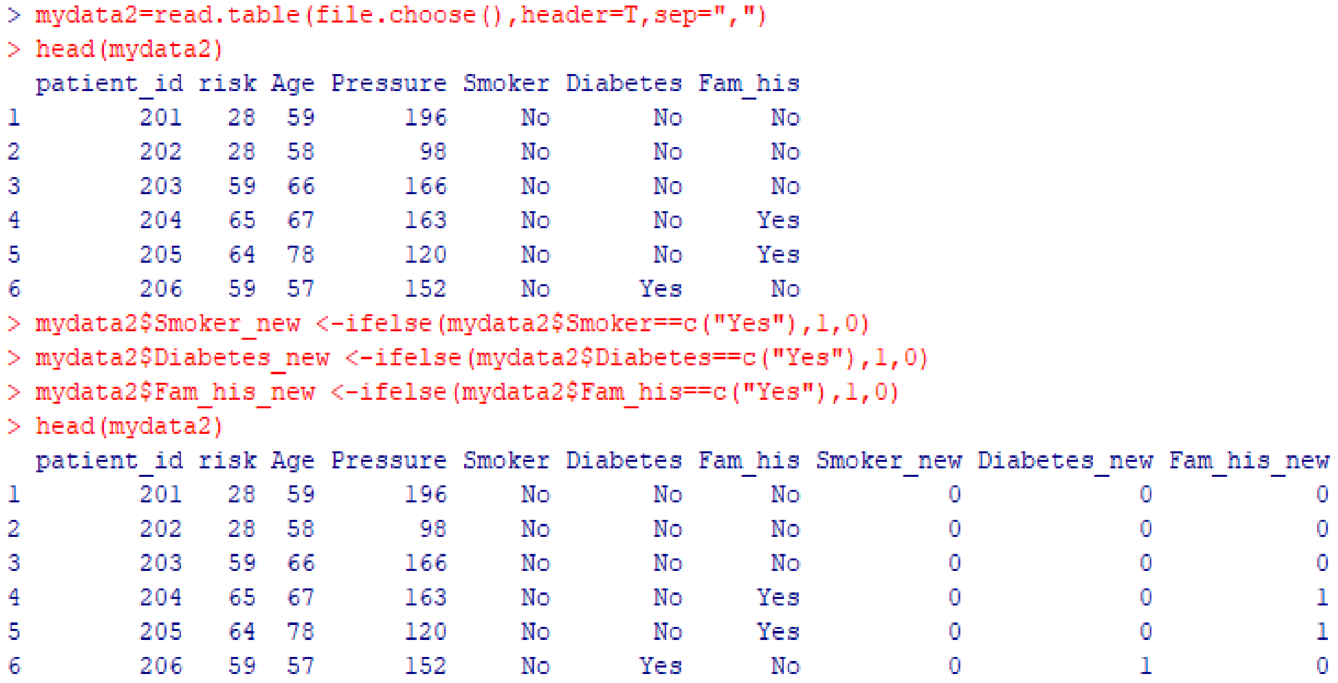
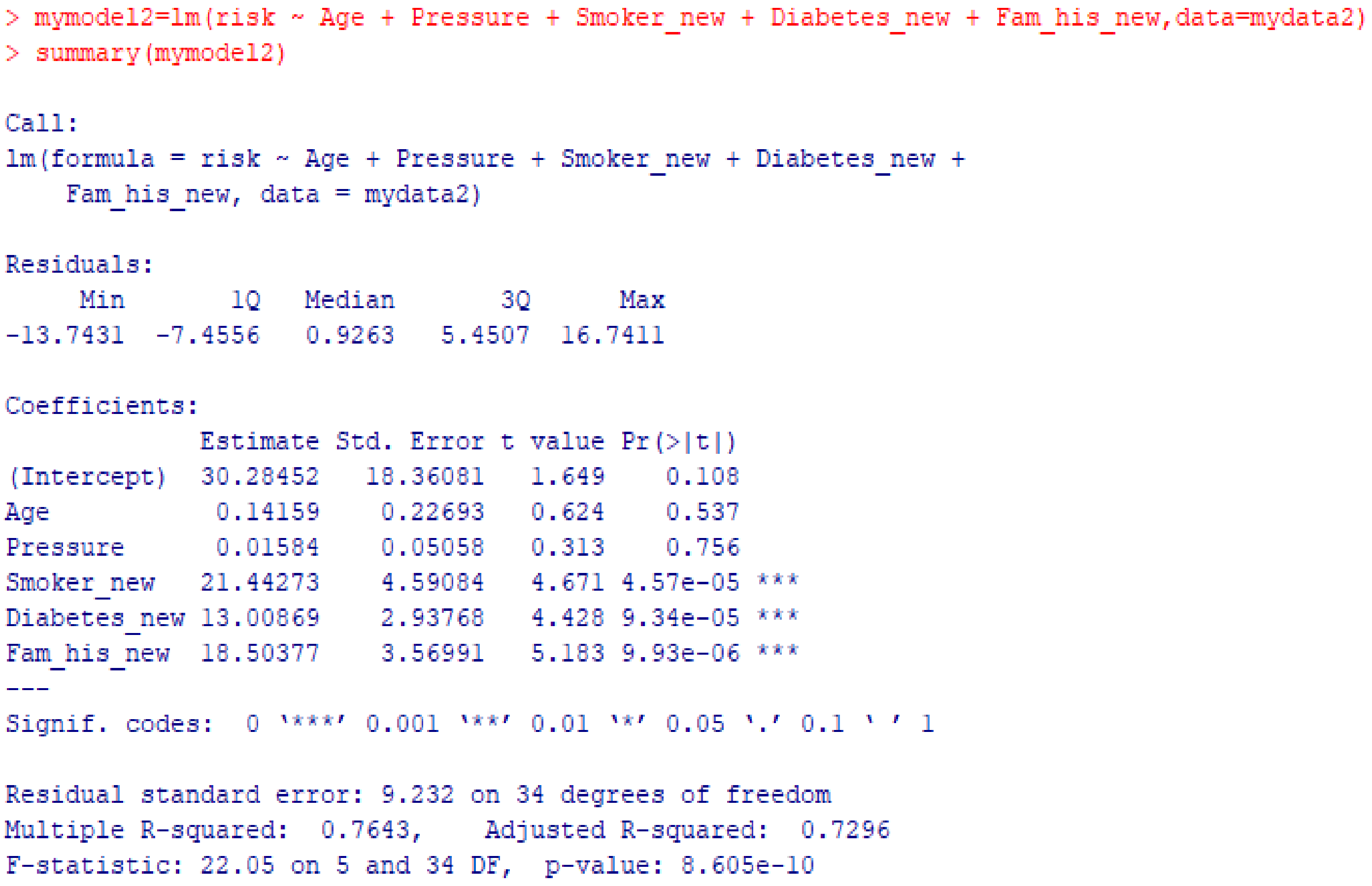
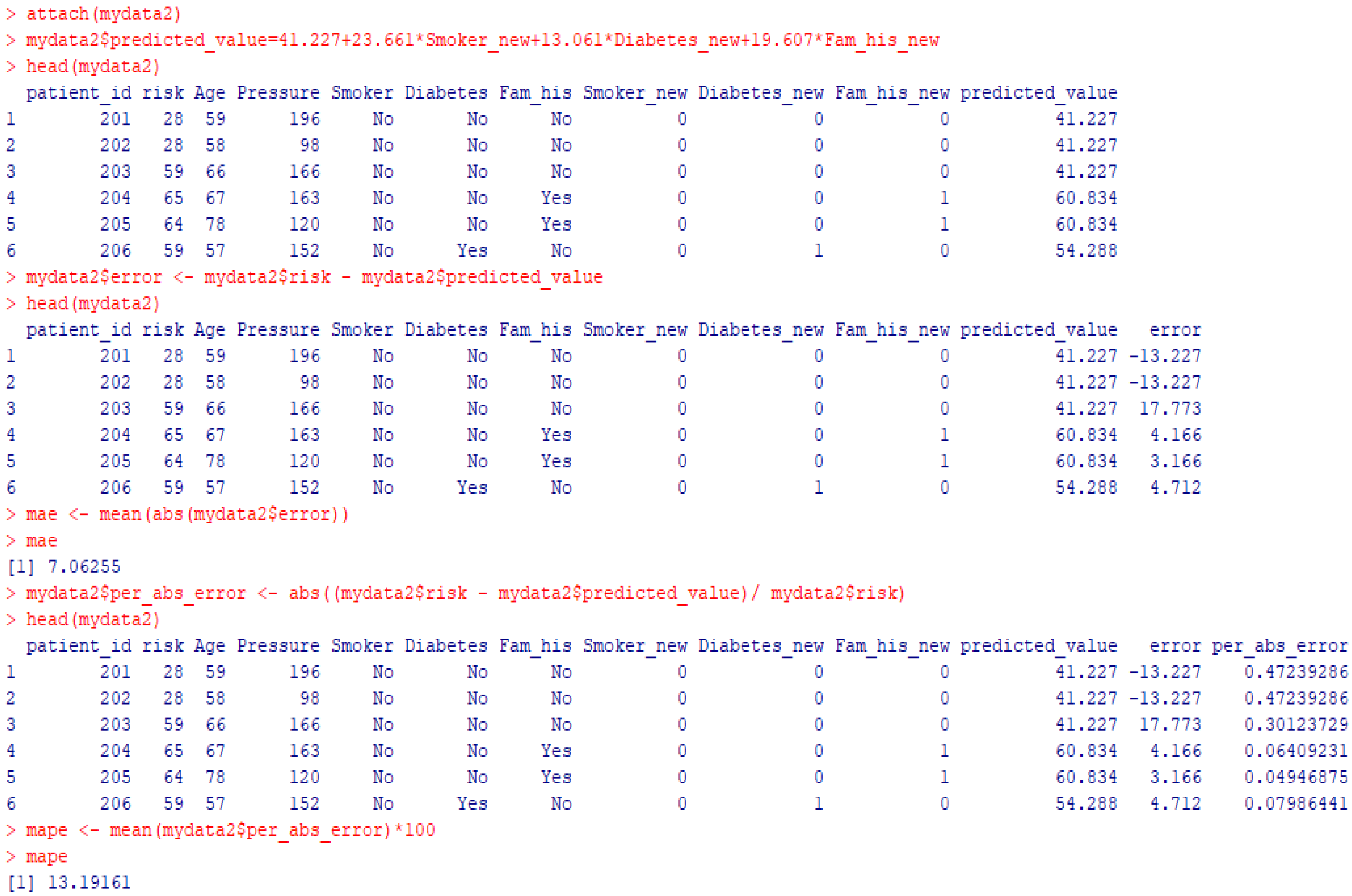
EXERCISE : MULTIPLE REGRESSION MODELLING



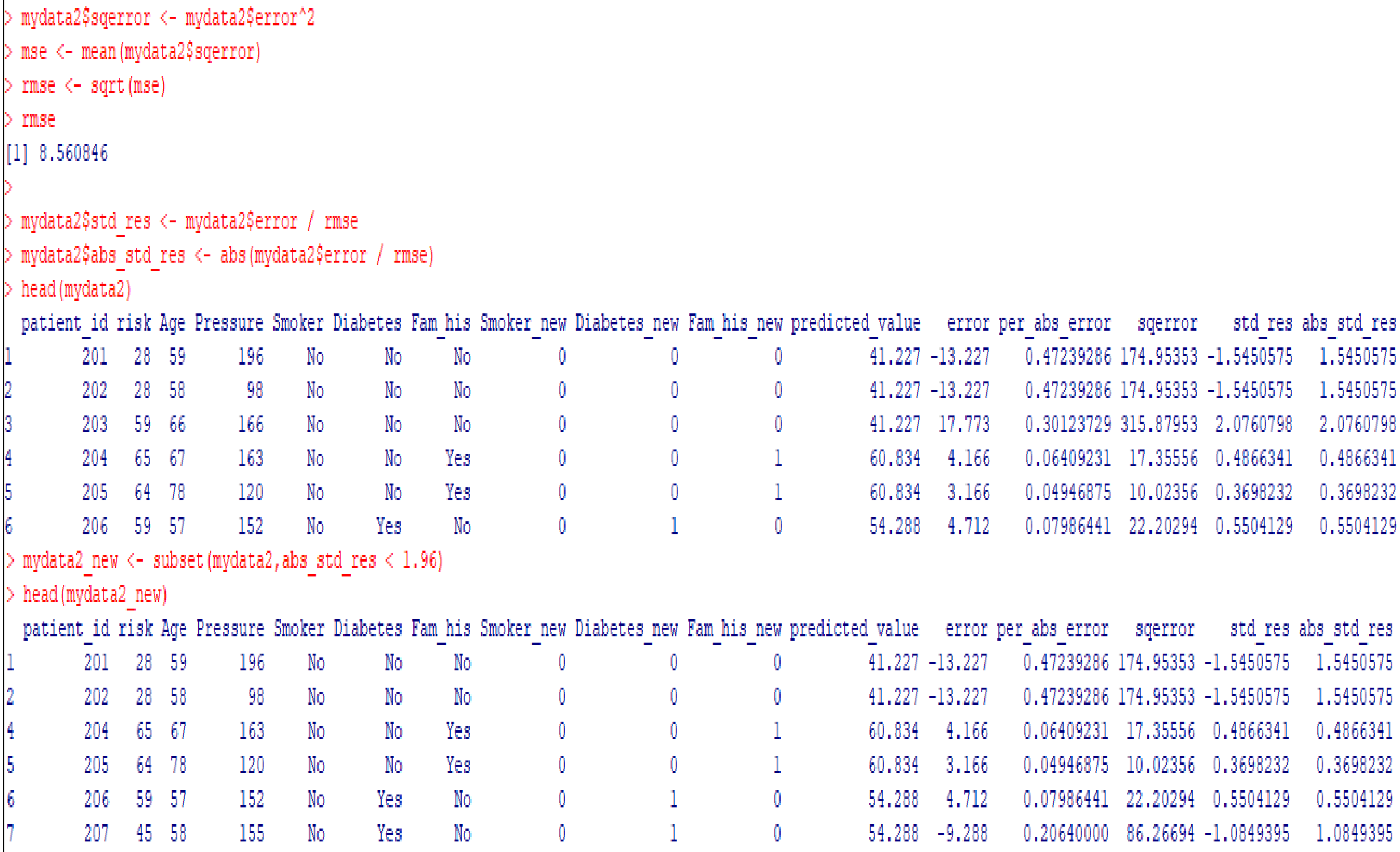
```
> mydata2=read.table(file.choose(),header=T,sep=",")
> head(mydata2)
  patient_id risk Age Pressure Smoker Diabetes Fam_his
1        201   28  59      196     No       No      No
2        202   28  58       98     No       No      No
3        203   59  66      166     No       No      No
4        204   65  67      163     No       No     Yes
5        205   64  78      120     No       No     Yes
6        206   59  57      152     No      Yes      No
> mydata2$Smoker_new <-ifelse(mydata2$Smoker==c("Yes"),1,0)
> mydata2$Diabetes_new <-ifelse(mydata2$Diabetes==c("Yes"),1,0)
> mydata2$Fam_his_new <-ifelse(mydata2$Fam_his==c("Yes"),1,0)
> head(mydata2)
  patient_id risk Age Pressure Smoker Diabetes Fam_his Smoker_new Diabetes_new Fam_his_new
1        201   28  59      196     No       No      No          0            0           0
2        202   28  58       98     No       No      No          0            0           0
3        203   59  66      166     No       No      No          0            0           0
4        204   65  67      163     No       No     Yes          0            0           1
5        205   64  78      120     No       No     Yes          0            0           1
6        206   59  57      152     No      Yes      No          0            1           0
```



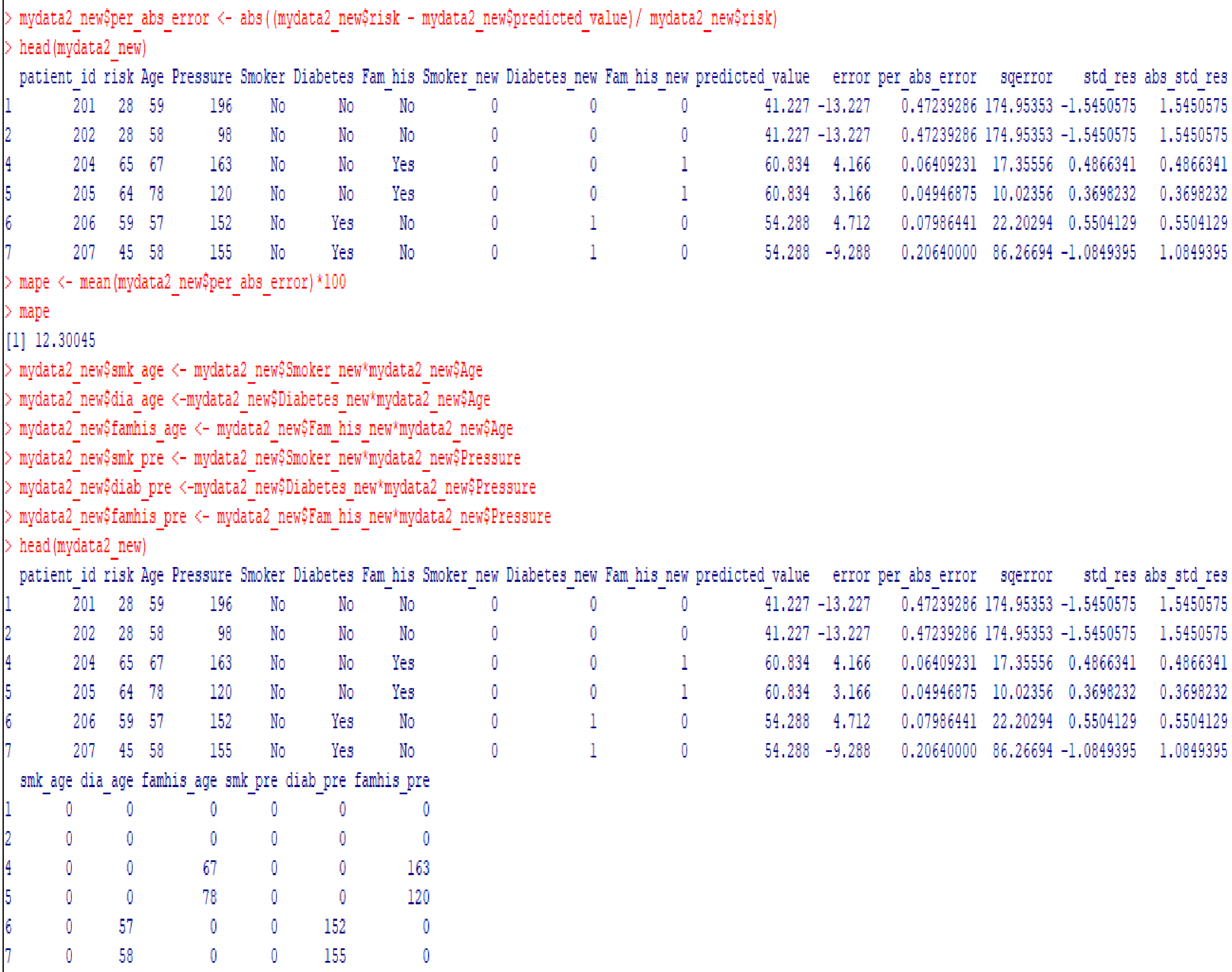
```
> mymodel2=lm(risk ~ Age + Pressure + Smoker_new + Diabetes_new + Fam_his_new,data=mydata2)
> summary(mymodel2)

Call:
lm(formula = risk ~ Age + Pressure + Smoker_new + Diabetes_new + 
    Fam_his_new, data = mydata2)

Residuals:
     Min       1Q   Median       3Q      Max 
-13.7431  -7.4556   0.9263   5.4507  16.7411 

Coefficients:
             Estimate Std. Error t value Pr(>|t|)    
(Intercept) 30.28452   18.36081   1.649    0.108    
Age          0.14159    0.22693   0.624    0.537    
Pressure     0.01584    0.05058   0.313    0.756    
Smoker_new  21.44273    4.59084   4.671 4.57e-05 ***
Diabetes_new 13.00869    2.93768   4.428 9.34e-05 ***
Fam_his_new  18.50377    3.56991   5.183 9.93e-06 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 9.232 on 34 degrees of freedom
Multiple R-squared:  0.7643,    Adjusted R-squared:  0.7296 
F-statistic: 22.05 on 5 and 34 DF,  p-value: 8.605e-10
```



```
> attach(mydata2)
> mydata2$predicted_value=41.227+23.661*Smoker_new+13.061*Diabetes_new+19.607*Fam_his_new
> head(mydata2)
  patient_id risk Age Pressure Smoker Diabetes Fam_his Smoker_new Diabetes_new Fam_his_new predicted_value
1        201   28  59      196     No       No      No          0            0           0          41.227
2        202   28  58       98     No       No      No          0            0           0          41.227
3        203   59  66      166     No       No      No          0            0           0          41.227
4        204   65  67      163     No       No     Yes          0            0           1          60.834
5        205   64  78      120     No       No     Yes          0            0           1          60.834
6        206   59  57      152     No      Yes      No          0            1           0          54.288
> mydata2$error <- mydata2$risk - mydata2$predicted_value
> head(mydata2)
  patient_id risk Age Pressure Smoker Diabetes Fam_his Smoker_new Diabetes_new Fam_his_new predicted_value   error
1        201   28  59      196     No       No      No          0            0           0          41.227 -13.227
2        202   28  58       98     No       No      No          0            0           0          41.227 -13.227
3        203   59  66      166     No       No      No          0            0           0          41.227  17.773
4        204   65  67      163     No       No     Yes          0            0           1          60.834   4.166
5        205   64  78      120     No       No     Yes          0            0           1          60.834   3.166
6        206   59  57      152     No      Yes      No          0            1           0          54.288   4.712
> mae <- mean(abs(mydata2$error))
> mae
[1] 7.06255
> mydata2$per_abs_error <- abs((mydata2$risk - mydata2$predicted_value)/ mydata2$risk)
> head(mydata2)
  patient_id risk Age Pressure Smoker Diabetes Fam_his Smoker_new Diabetes_new Fam_his_new predicted_value   error per_abs_error
1        201   28  59      196     No       No      No          0            0           0          41.227 -13.227    0.47239286
2        202   28  58       98     No       No      No          0            0           0          41.227 -13.227    0.47239286
3        203   59  66      166     No       No      No          0            0           0          41.227  17.773    0.30123729
4        204   65  67      163     No       No     Yes          0            0           1          60.834   4.166    0.06409231
5        205   64  78      120     No       No     Yes          0            0           1          60.834   3.166    0.04946875
6        206   59  57      152     No      Yes      No          0            1           0          54.288   4.712    0.07986441
> mape <- mean(mydata2$per_abs_error)*100
> mape
[1] 13.19161
```

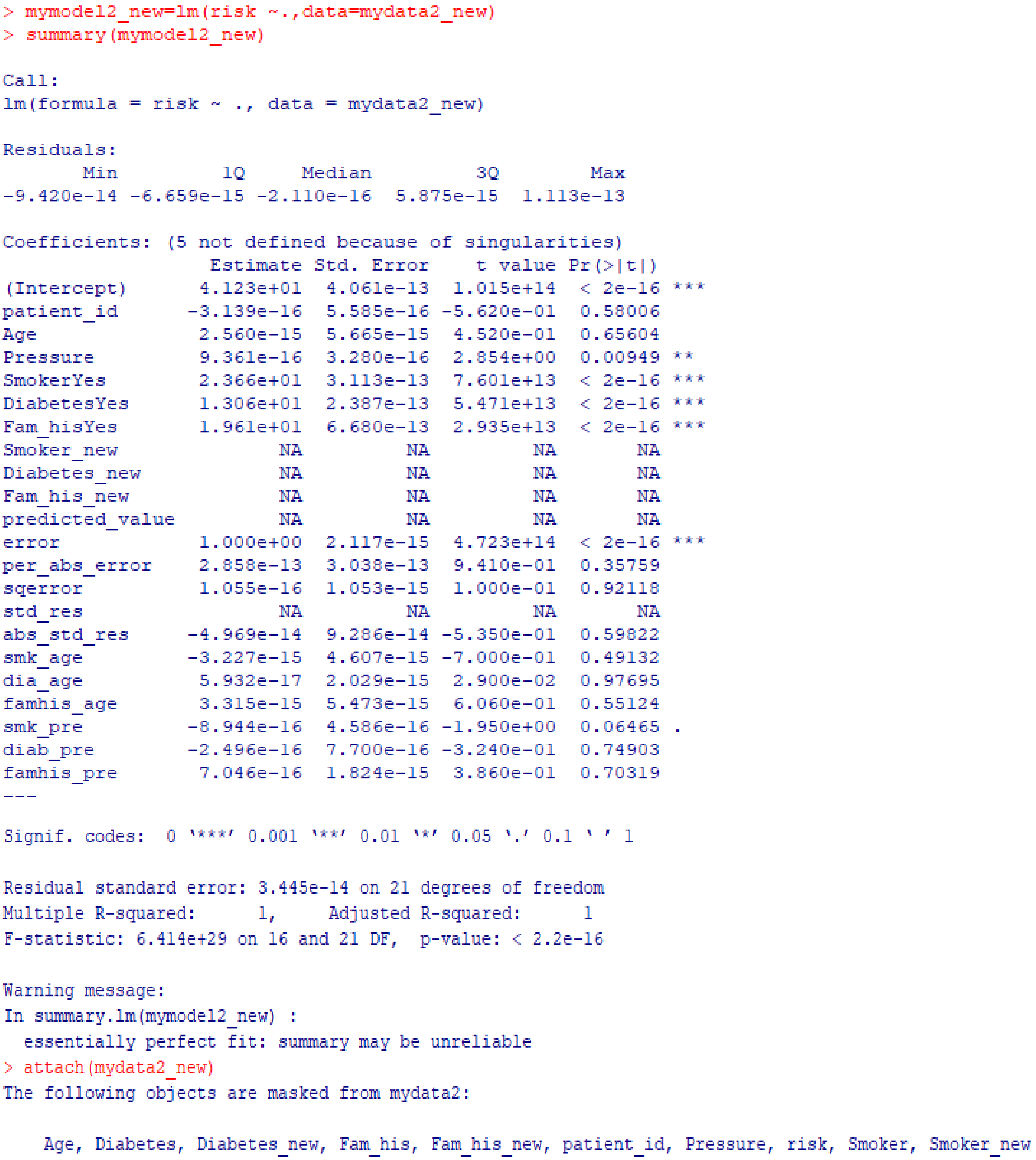


```
> mydata2$sqerror <- mydata2$error^2
> mse <- mean(mydata2$sqerror)
> rmse <- sqrt(mse)
> rmse
[1] 8.560846
>
> mydata2$std_res <- mydata2$error / rmse
> mydata2$abs_std_res <- abs(mydata2$error / rmse)
> head(mydata2)
  patient_id risk Age Pressure Smoker Diabetes Fam_his Smoker_new Diabetes_new Fam_his_new predicted_value   error per_abs_error    sqerror    std_res abs_std_res
1        201   28  59      196     No       No      No          0            0           0          41.227 -13.227    0.47239286 174.95353 -1.5450575   1.5450575
2        202   28  58       98     No       No      No          0            0           0          41.227 -13.227    0.47239286 174.95353 -1.5450575   1.5450575
3        203   59  66      166     No       No      No          0            0           0          41.227  17.773    0.30123729 315.87953  2.0760798   2.0760798
4        204   65  67      163     No       No     Yes          0            0           1          60.834   4.166    0.06409231  17.35556  0.4866341   0.4866341
5        205   64  78      120     No       No     Yes          0            0           1          60.834   3.166    0.04946875  10.02356  0.3698232   0.3698232
6        206   59  57      152     No      Yes      No          0            1           0          54.288   4.712    0.07986441  22.20294  0.5504129   0.5504129
> mydata2_new <- subset(mydata2,abs_std_res < 1.96)
> head(mydata2_new)
  patient_id risk Age Pressure Smoker Diabetes Fam_his Smoker_new Diabetes_new Fam_his_new predicted_value   error per_abs_error    sqerror    std_res abs_std_res
1        201   28  59      196     No       No      No          0            0           0          41.227 -13.227    0.47239286 174.95353 -1.5450575   1.5450575
2        202   28  58       98     No       No      No          0            0           0          41.227 -13.227    0.47239286 174.95353 -1.5450575   1.5450575
4        204   65  67      163     No       No     Yes          0            0           1          60.834   4.166    0.06409231  17.35556  0.4866341   0.4866341
5        205   64  78      120     No       No     Yes          0            0           1          60.834   3.166    0.04946875  10.02356  0.3698232   0.3698232
6        206   59  57      152     No      Yes      No          0            1           0          54.288   4.712    0.07986441  22.20294  0.5504129   0.5504129
7        207   45  58      155     No      Yes      No          0            1           0          54.288  -9.288    0.20640000  86.26694 -1.0849395   1.0849395
```

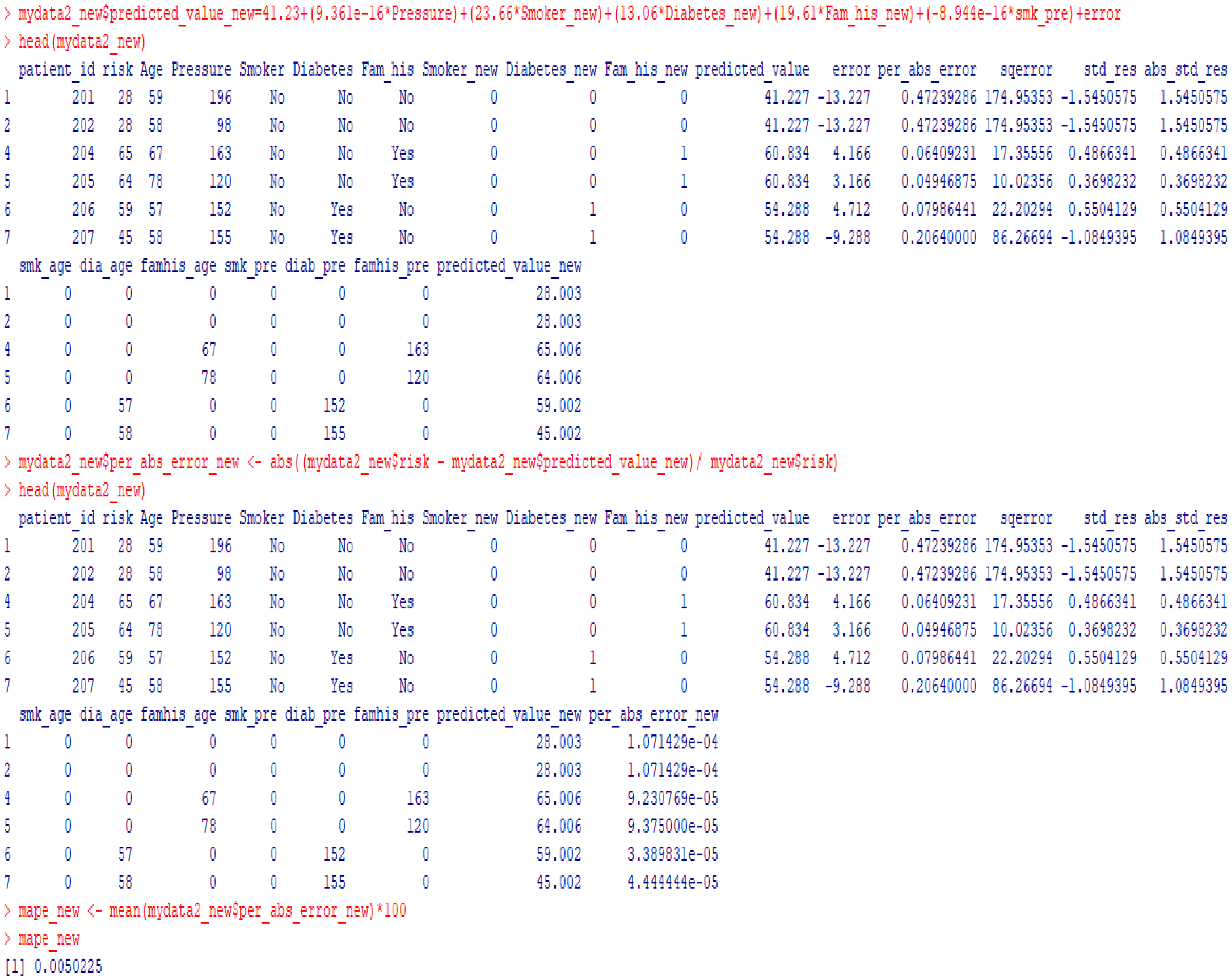


```
> mydata2_new$per_abs_error <- abs((mydata2_new$risk - mydata2_new$predicted_value)/ mydata2_new$risk)
> head(mydata2_new)
  patient_id risk Age Pressure Smoker Diabetes Fam_his Smoker_new Diabetes_new Fam_his_new predicted_value   error per_abs_error   sqerror    std_res abs_std_res
1        201   28  59      196     No       No      No          0            0           0          41.227 -13.227    0.47239286 174.95353 -1.5450575   1.5450575
2        202   28  58       98     No       No      No          0            0           0          41.227 -13.227    0.47239286 174.95353 -1.5450575   1.5450575
4        204   65  67      163     No       No     Yes          0            0           1          60.834   4.166    0.06409231  17.35556  0.4866341   0.4866341
5        205   64  78      120     No       No     Yes          0            0           1          60.834   3.166    0.04946875  10.02356  0.3698232   0.3698232
6        206   59  57      152     No      Yes      No          0            1           0          54.288   4.712    0.07986441  22.20294  0.5504129   0.5504129
7        207   45  58      155     No      Yes      No          0            1           0          54.288  -9.288    0.20640000  86.26694 -1.0849395   1.0849395
> mape <- mean(mydata2_new$per_abs_error)*100
> mape
[1] 12.30045
> mydata2_new$smk_age <- mydata2_new$Smoker_new*mydata2_new$Age
> mydata2_new$dia_age <-mydata2_new$Diabetes_new*mydata2_new$Age
> mydata2_new$famhis_age <- mydata2_new$Fam_his_new*mydata2_new$Age
> mydata2_new$smk_pre <- mydata2_new$Smoker_new*mydata2_new$Pressure
> mydata2_new$diab_pre <-mydata2_new$Diabetes_new*mydata2_new$Pressure
> mydata2_new$famhis_pre <- mydata2_new$Fam_his_new*mydata2_new$Pressure
> head(mydata2_new)
  patient_id risk Age Pressure Smoker Diabetes Fam_his Smoker_new Diabetes_new Fam_his_new predicted_value   error per_abs_error   sqerror    std_res abs_std_res
1        201   28  59      196     No       No      No          0            0           0          41.227 -13.227    0.47239286 174.95353 -1.5450575   1.5450575
2        202   28  58       98     No       No      No          0            0           0          41.227 -13.227    0.47239286 174.95353 -1.5450575   1.5450575
4        204   65  67      163     No       No     Yes          0            0           1          60.834   4.166    0.06409231  17.35556  0.4866341   0.4866341
5        205   64  78      120     No       No     Yes          0            0           1          60.834   3.166    0.04946875  10.02356  0.3698232   0.3698232
6        206   59  57      152     No      Yes      No          0            1           0          54.288   4.712    0.07986441  22.20294  0.5504129   0.5504129
7        207   45  58      155     No      Yes      No          0            1           0          54.288  -9.288    0.20640000  86.26694 -1.0849395   1.0849395
  smk_age dia_age famhis_age smk_pre diab_pre famhis_pre
1       0       0          0       0        0          0
2       0       0          0       0        0          0
4       0       0         67       0        0        163
5       0       0         78       0        0        120
6       0      57          0       0      152          0
7       0      58          0       0      155          0
```

18-PST-029



```
> mymodel2_new=lm(risk ~.,data=mydata2_new)
> summary(mymodel2_new)

Call:
lm(formula = risk ~ ., data = mydata2_new)

Residuals:
       Min         1Q     Median         3Q        Max 
-9.420e-14 -6.659e-15 -2.110e-16  5.875e-15  1.113e-13 

Coefficients: (5 not defined because of singularities)
                 Estimate Std. Error    t value Pr(>|t|)    
(Intercept)     4.123e+01  4.061e-13  1.015e+14  < 2e-16 ***
patient_id     -3.139e-16  5.585e-16 -5.620e-01  0.58006    
Age             2.560e-15  5.665e-15  4.520e-01  0.65604    
Pressure        9.361e-16  3.280e-16  2.854e+00  0.00949 ** 
SmokerYes       2.366e+01  3.113e-13  7.601e+13  < 2e-16 ***
DiabetesYes     1.306e+01  2.387e-13  5.471e+13  < 2e-16 ***
Fam_hisYes      1.961e+01  6.680e-13  2.935e+13  < 2e-16 ***
Smoker_new             NA         NA         NA       NA    
Diabetes_new           NA         NA         NA       NA    
Fam_his_new            NA         NA         NA       NA    
predicted_value        NA         NA         NA       NA    
error           1.000e+00  2.117e-15  4.723e+14  < 2e-16 ***
per_abs_error   2.858e-13  3.038e-13  9.410e-01  0.35759    
sqerror         1.055e-16  1.053e-15  1.000e-01  0.92118    
std_res                NA         NA         NA       NA    
abs_std_res    -4.969e-14  9.286e-14 -5.350e-01  0.59822    
smk_age        -3.227e-15  4.607e-15 -7.000e-01  0.49132    
dia_age         5.932e-17  2.029e-15  2.900e-02  0.97695    
famhis_age      3.315e-15  5.473e-15  6.060e-01  0.55124    
smk_pre        -8.944e-16  4.586e-16 -1.950e+00  0.06465 .  
diab_pre       -2.496e-16  7.700e-16 -3.240e-01  0.74903    
famhis_pre      7.046e-16  1.824e-15  3.860e-01  0.70319    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.445e-14 on 21 degrees of freedom
Multiple R-squared:      1,	Adjusted R-squared:      1 
F-statistic: 6.414e+29 on 16 and 21 DF,  p-value: < 2.2e-16

Warning message:
In summary.lm(mymodel2_new) :
  essentially perfect fit: summary may be unreliable
> attach(mydata2_new)
The following objects are masked from mydata2:

    Age, Diabetes, Diabetes_new, Fam_his, Fam_his_new, patient_id, Pressure, risk, Smoker, Smoker_new
```



```
> mydata2_new$predicted_value_new=41.23+(9.361e-16*Pressure)+(23.66*Smoker_new)+(13.06*Diabetes_new)+(19.61*Fam_his_new)+(-8.944e-16*smk_pre)+error
> head(mydata2_new)
  patient_id risk Age Pressure Smoker Diabetes Fam_his Smoker_new Diabetes_new Fam_his_new predicted_value   error per_abs_error   sqerror    std_res abs_std_res
1        201   28  59      196     No       No      No          0            0           0          41.227 -13.227    0.47239286 174.95353 -1.5450575   1.5450575
2        202   28  58       98     No       No      No          0            0           0          41.227 -13.227    0.47239286 174.95353 -1.5450575   1.5450575
4        204   65  67      163     No       No     Yes          0            0           1          60.834   4.166    0.06409231  17.35556  0.4866341   0.4866341
5        205   64  78      120     No       No     Yes          0            0           1          60.834   3.166    0.04946875  10.02356  0.3698232   0.3698232
6        206   59  57      152     No      Yes      No          0            1           0          54.288   4.712    0.07986441  22.20294  0.5504129   0.5504129
7        207   45  58      155     No      Yes      No          0            1           0          54.288  -9.288    0.20640000  86.26694 -1.0849395   1.0849395
  smk_age dia_age famhis_age smk_pre diab_pre famhis_pre predicted_value_new
1       0       0          0       0        0          0              28.003
2       0       0          0       0        0          0              28.003
4       0       0         67       0        0        163              65.006
5       0       0         78       0        0        120              64.006
6       0      57          0       0      152          0              59.002
7       0      58          0       0      155          0              45.002
> mydata2_new$per_abs_error_new <- abs((mydata2_new$risk - mydata2_new$predicted_value_new)/ mydata2_new$risk)
> head(mydata2_new)
  patient_id risk Age Pressure Smoker Diabetes Fam_his Smoker_new Diabetes_new Fam_his_new predicted_value   error per_abs_error   sqerror    std_res abs_std_res
1        201   28  59      196     No       No      No          0            0           0          41.227 -13.227    0.47239286 174.95353 -1.5450575   1.5450575
2        202   28  58       98     No       No      No          0            0           0          41.227 -13.227    0.47239286 174.95353 -1.5450575   1.5450575
4        204   65  67      163     No       No     Yes          0            0           1          60.834   4.166    0.06409231  17.35556  0.4866341   0.4866341
5        205   64  78      120     No       No     Yes          0            0           1          60.834   3.166    0.04946875  10.02356  0.3698232   0.3698232
6        206   59  57      152     No      Yes      No          0            1           0          54.288   4.712    0.07986441  22.20294  0.5504129   0.5504129
7        207   45  58      155     No      Yes      No          0            1           0          54.288  -9.288    0.20640000  86.26694 -1.0849395   1.0849395
  smk_age dia_age famhis_age smk_pre diab_pre famhis_pre predicted_value_new per_abs_error_new
1       0       0          0       0        0          0              28.003      1.071429e-04
2       0       0          0       0        0          0              28.003      1.071429e-04
4       0       0         67       0        0        163              65.006      9.230769e-05
5       0       0         78       0        0        120              64.006      9.375000e-05
6       0      57          0       0      152          0              59.002      3.389831e-05
7       0      58          0       0      155          0              45.002      4.444444e-05
> mape_new <- mean(mydata2_new$per_abs_error_new)*100
> mape_new
[1] 0.0050225
```

INTERPRETATION:

MODEL SUMMARY

Model	R Value	R^2	Adjusted R^2	F Value	Significant value (P Value)	Results
1	0.8742	0.7643	0.7296	22.05	8.605e-10	Significant

Significant at 1% level.

COEFFICIENT TABLE

	Estimate	Standard Error	t- value	Pr(>|t|)	Result
Intercept	30.28452	18.36081	1.649	0.108	Insgnificant
Age	0.14159	0.22693	0.624	0.537	Insgnificant
Pressure	0.01584	0.05058	0.313	0.756	Insgnificant
Smoker_new	21.44273	4.59084	4.671	4.57e-05	Significant at 0.1%
Diabetes_new	13.00869	2.93768	4.428	9.34e-05	Significant at 0.1%
Fam_his_new	18.50377	3.56991	5.183	9.93e-06	Significant at 0.1%

1)Here the dependent variable is ‘RISK’ and the independent variables are Age ,Pressure, Smoker_new ,Diabetes_new,Fam_his_new.First we converted the categorical variables into numerical variables . The variables Age and Pressure are insignificant. A smoker has 21.44273 times risk than a non-smoker. A diabetic person has 13.00869 times risk than a non-diabetic person.Similarly a person with a family history of the same problem has 18.50377 times risk.

2) A new variable predicted_value is created in the table and values for the dependent variable ‘risk’ is predicted using R code. The predicted values for the first six patients are as follows:

Patient_ID	Risk	predicted_value
201	28	41.227
202	28	41.227
203	59	41.227
204	65	60.834
205	64	60.834
206	59	54.288

3)We found out mean absolute error and mean absolute percentage error.The values are as follows MAE=7.0625 , MAPE=13.19161.

4)The outliers are detected and they are removed from the model.Then the mean absolute percentage error is calculated .It was reduced to 12.30045.

5)Interactions between the variables are calculated and thus a new model is built.

MODEL SUMMARY

Model	R	R Square	Adjusted R Square	F value	Significant value (p value)	Results
2	1	1	1	6.414e+29	<2.2e-16	Significant

Significant at 1% level.

COEFFICIENT TABLE

	Estimate	Std. Error	t value	Pr (>|t|)	Result
Intercept	4.123e+01	4.061e-13	1.015e+14	<2e-16	Significant at 0.1%
Age	2.560e-15	5.665e-15	4.520e-01	0.65604	Insignificant
Pressure	9.361e-16	3.280e-16	2.854e+00	0.00949	Significant at 1%
Smoker_new	2.366e+01	3.113e-13	7.601e+13	<2e-16	Significant at 0.1%
Diabetes_new	1.306e+01	2.387e-13	5.471e+13	<2e-16	Significant at 0.1%
Fam_his_new	1.961e+01	6.680e-13	2.935e+13	<2e-16	Significant at 0.1%
smk_age	-3.227e-15	4.607e-15	-7.000e-01	0.49132	Insignificant
dia_age	5.932e-17	2.029e-15	2.900e-02	0.97695	Insignificant
famhis_age	3.315e-15	5.473e-15	6.060e-01	0.55124	Insignificant
smk_pre	-8.944e-16	4.586e-16	-1.950e+00	0.06465	Significant at 10%
diab_pre	-2.496e-16	7.700e-16	-3.240e-01	0.74903	Insignificant
famhis_pre	7.046e-16	1.824e-15	3.860e-01	0.70319	Insignificant
error	1.000e+00	2.117e-15	4.723e+14	<2e-16	Significant at 0.1%

6)Here the variables Pressure,Smoker_new,Diabetes_new,Fam_his_new ,smk_pre are significant.And thus values for the independent variable are predicted using the new model. The mean absolute percentage error for the new model is 0.0050225.