Analysis of the Healthcare cost and Utilization in Wisconsin hospitals

Business Scenario:

A nationwide survey of hospital costs conducted by the US Agency for Healthcare consists of hospital records of inpatient samples. The given data is restricted to the city of Wisconsin and relates to patients in the age group 0-17 years.

Expectation/goals:

The agency wants to analyze the data to research on healthcare costs and their utilization.

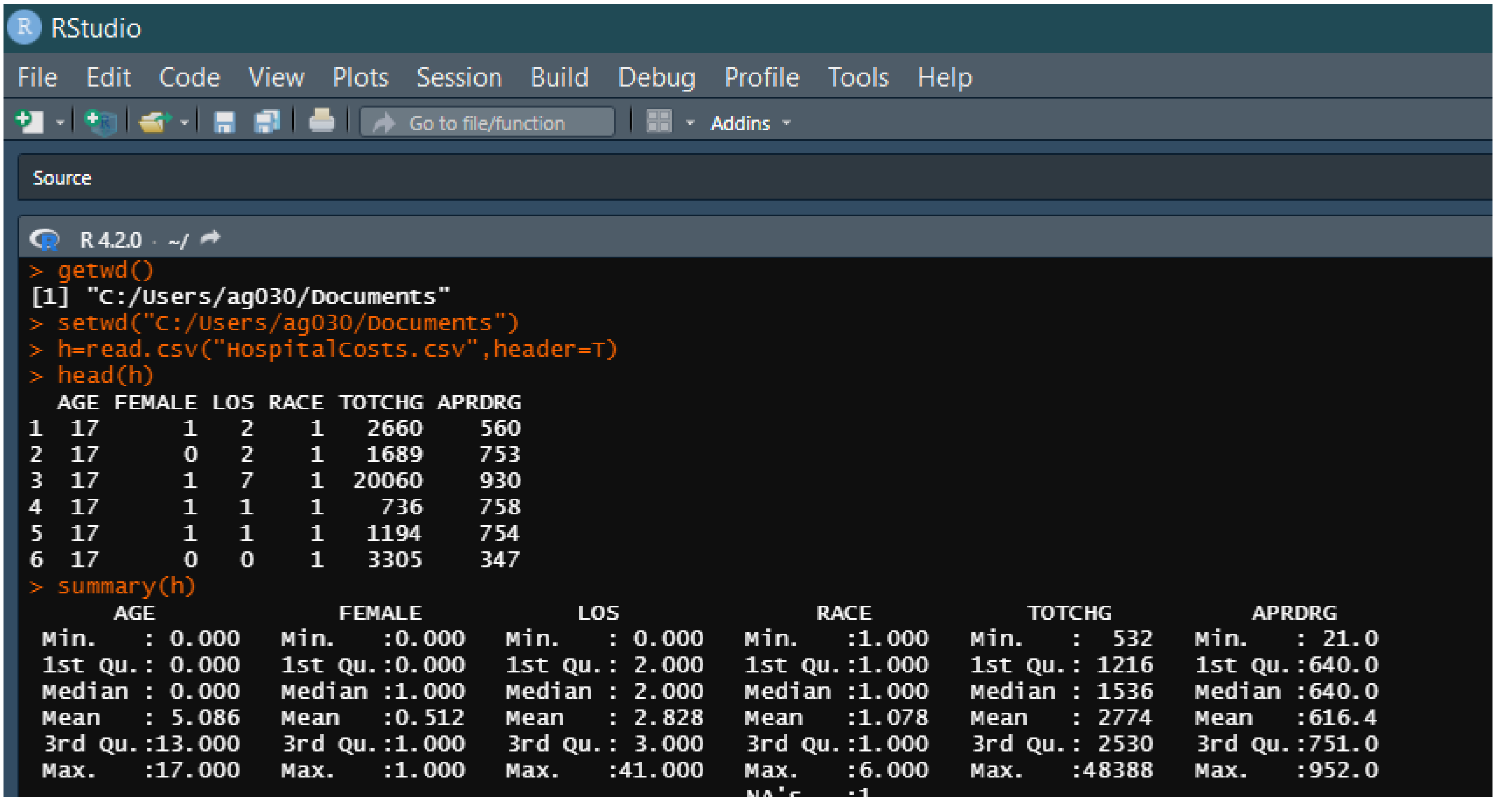
1. To find the age category of people who frequently visit the hospital & has the maximum expenditure:

First of all the summary of the dataset is:

Code:- >getwd()

> setwd("C:/Users/ag030/Documents")
> h=read.csv("HospitalCosts.csv",header=T)
> head(h)
> summary(h)

Output:-



```
> getwd()
[1] "C:/Users/ag030/Documents"
> setwd("C:/Users/ag030/Documents")
> h=read.csv("HospitalCosts.csv",header=T)
> head(h)
  AGE FEMALE LOS RACE TOTCHG APRDRG
1  17      1   2    1   2660    560
2  17      0   2    1   1689    753
3  17      1   7    1  20060    930
4  17      1   1    1    736    758
5  17      1   1    1   1194    754
6  17      0   0    1   3305    347
> summary(h)
      AGE             FEMALE           LOS              RACE            TOTCHG          APRDRG     
 Min.   : 0.000   Min.   :0.000   Min.   : 0.000   Min.   :1.000   Min.   :  532   Min.   : 21.0  
 1st Qu.: 0.000   1st Qu.:0.000   1st Qu.: 2.000   1st Qu.:1.000   1st Qu.: 1216   1st Qu.:640.0  
 Median : 0.000   Median :1.000   Median : 2.000   Median :1.000   Median : 1536   Median :640.0  
 Mean   : 5.086   Mean   :0.512   Mean   : 2.828   Mean   :1.078   Mean   : 2774   Mean   :616.4  
 3rd Qu.:13.000   3rd Qu.:1.000   3rd Qu.: 3.000   3rd Qu.:1.000   3rd Qu.: 2530   3rd Qu.:751.0  
 Max.   :17.000   Max.   :1.000   Max.   :41.000   Max.   :6.000   Max.   :48388   Max.   :952.0  
                                                   NA's   :1                                      
```

Now AGE: age of the patient discharged

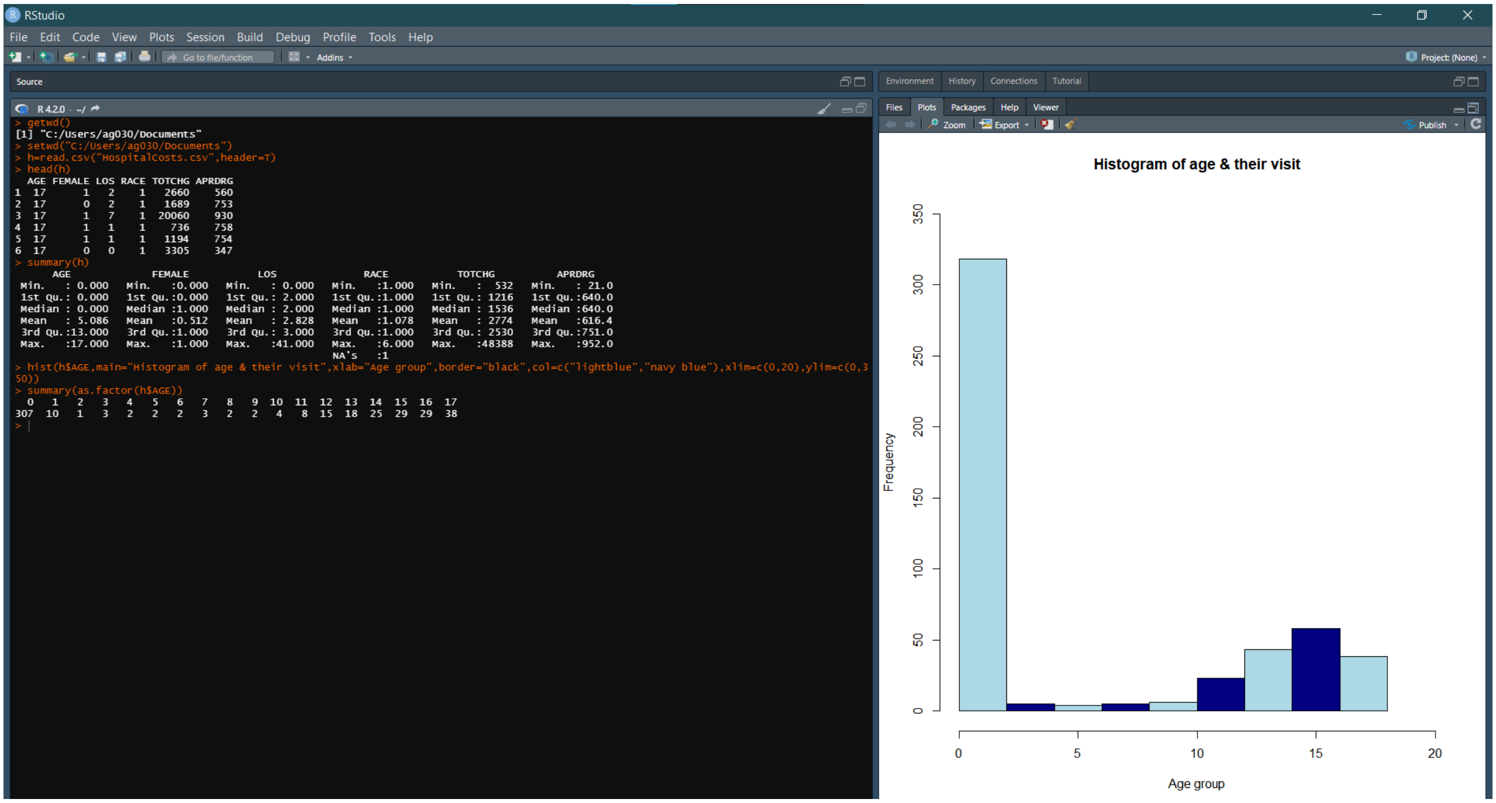
TOTCHG: hospital discharge costs

To find the category that has the highest frequency of hospital visit, we can use histogram as it would display the number of occurences of each category.

Code:-

```
> hist(h$AGE,main="Histogram of age & their visit",xlab="Age group",border="black",col=c("light blue","navy blue"),xlim=c(0,20),ylim=c(0,350))
> summary(as.factor(h$AGE))
```

Output:


RStudio
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Environment History Connections Tutorial
Files Plots Packages Help Viewer
Zoom Export
Publish
Histogram of age & their visit
Frequency
0
50
100
150
200
250
300
350
0
5
10
15
20
Age group

```
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 Mean   : 5.086   Mean   :0.512   Mean   : 2.828   Mean   :1.078   Mean   : 2774   Mean   :616.4  
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 Max.   :17.000   Max.   :1.000   Max.   :41.000   Max.   :6.000   Max.   :48388   Max.   :952.0  
                                                   NA's   :1                                      
> hist(h$AGE,main="Histogram of age & their visit",xlab="Age group",border="black",col=c("lightblue","navy blue"),xlim=c(0,20),ylim=c(0,3
50))
> summary(as.factor(h$AGE))
  0   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17 
307  10   1   3   2   2   2   3   2   2   4   8  15  18  25  29  29  38 
> 
```

Analysis:

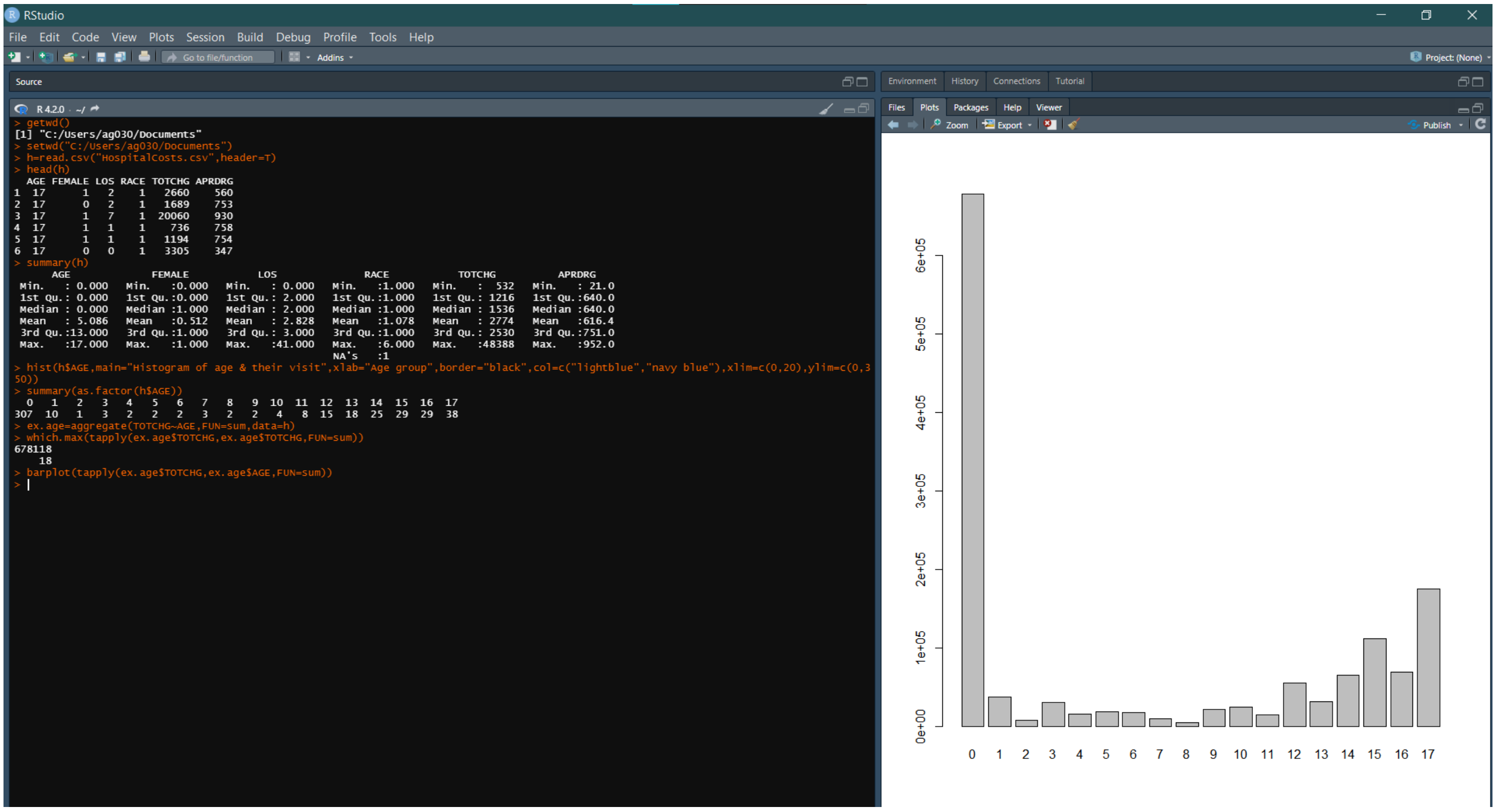
From histogram, we can see that the maximum number of hospital visits are in 0-1 age group, going above 300. From summary of AGE attribute we get the highest number which is 307 in age group 0-1.

The maximum expenditure based on age group:

Code:-

```
> ex.age=aggregate(TOTCHG~AGE,FUN=sum,data=h)
> which.max(tapply(ex.age$TOTCHG,ex.age$TOTCHG,FUN=sum))
> barplot(tapply(ex.age$TOTCHG,ex.age$AGE,FUN=sum))
```

Output:-



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5  17      1   1    1   1194    754
6  17      0   0    1   3305    347
> summary(h)
      AGE             FEMALE           LOS              RACE           TOTCHG          APRDRG     
 Min.   : 0.000   Min.   :0.000   Min.   : 0.000   Min.   :1.000   Min.   :  532   Min.   : 21.0  
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 3rd Qu.:13.000   3rd Qu.:1.000   3rd Qu.: 3.000   3rd Qu.:1.000   3rd Qu.: 2530   3rd Qu.:751.0  
 Max.   :17.000   Max.   :1.000   Max.   :41.000   Max.   :6.000   Max.   :48388   Max.   :952.0  
                                                   NA's   :1                                      
> hist(h$AGE,main="Histogram of age & their visit",xlab="Age group",border="black",col=c("lightblue","navy blue"),xlim=c(0,20),ylim=c(0,3
50))
> summary(as.factor(h$AGE))
  0   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17 
307  10   1   3   2   2   2   3   2   2   4   8  15  18  25  29  29  38 
> ex.age=aggregate(TOTCHG~AGE,FUN=sum,data=h)
> which.max(tapply(ex.age$TOTCHG,ex.age$TOTCHG,FUN=sum))
678118 
    18 
> barplot(tapply(ex.age$TOTCHG,ex.age$AGE,FUN=sum))
> 
```

Analysis:-

The maximum expenditure for 0-1 year is 678118.

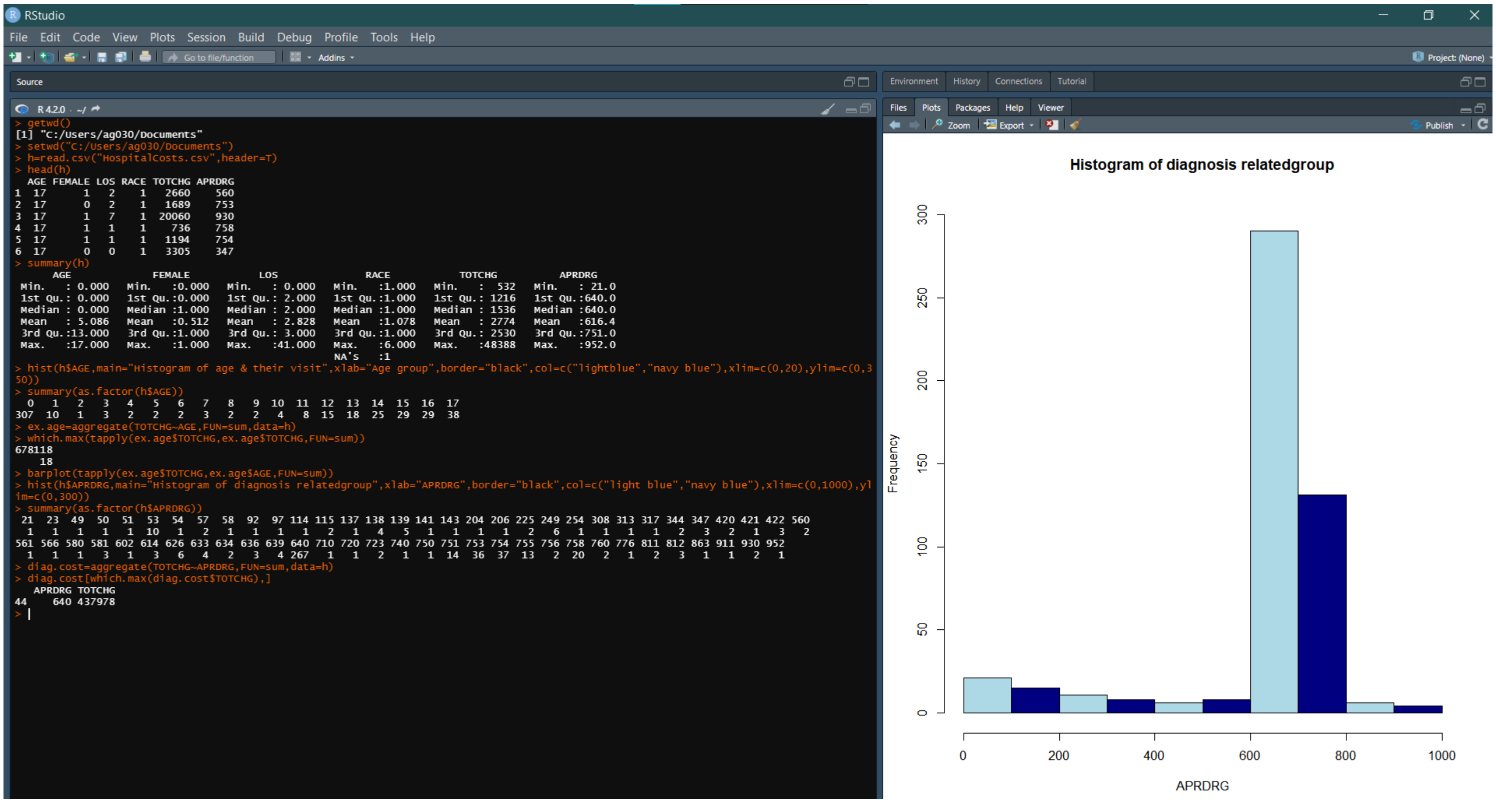
2. <u>To find diagnosis related group that has maximum hospitalization and expenditure:</u>

Now, APRDRG: all patients refined diagnosis related groups
TOTCHG: hospital discharge costs

Code:-

```
> hist(h$APRDRG,main="Histogram of diagnosis related group",xlab="APRDRG",border="black",col=c("light blue","navy blue"),xlim=c(0,1000),ylim=c(0,300))  > summary(as.factor(h$APRDRG))
> diag.cost=aggregate(TOTCHG~APRDRG,FUN=sum,data=h)
> diag.cost[which.max(diag.cost$TOTCHG),]
```

Output:-



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> head(h)
  AGE FEMALE LOS RACE TOTCHG APRDRG
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2  17      0   2    1   1689    753
3  17      1   7    1  20060    930
4  17      1   1    1    736    758
5  17      1   1    1   1194    754
6  17      0   0    1   3305    347
> summary(h)
      AGE             FEMALE           LOS             RACE           TOTCHG          APRDRG     
 Min.   : 0.000   Min.   :0.000   Min.   : 0.000   Min.   :1.000   Min.   :  532   Min.   : 21.0  
 1st Qu.: 0.000   1st Qu.:0.000   1st Qu.: 2.000   1st Qu.:1.000   1st Qu.: 1216   1st Qu.:640.0  
 Median : 0.000   Median :1.000   Median : 2.000   Median :1.000   Median : 1536   Median :640.0  
 Mean   : 5.086   Mean   :0.512   Mean   : 2.828   Mean   :1.078   Mean   : 2774   Mean   :616.4  
 3rd Qu.:13.000   3rd Qu.:1.000   3rd Qu.: 3.000   3rd Qu.:1.000   3rd Qu.: 2530   3rd Qu.:751.0  
 Max.   :17.000   Max.   :1.000   Max.   :41.000   Max.   :6.000   Max.   :48388   Max.   :952.0  
                                                   NA's   :1                                      
> hist(h$AGE,main="Histogram of age & their visit",xlab="Age group",border="black",col=c("lightblue","navy blue"),xlim=c(0,20),ylim=c(0,3
50))
> summary(as.factor(h$AGE))
  0   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17 
307  10   1   3   2   2   2   3   2   2   4   8  15  18  25  29  29  38 
> ex.age=aggregate(TOTCHG~AGE,FUN=sum,data=h)
> which.max(tapply(ex.age$TOTCHG,ex.age$TOTCHG,FUN=sum))
678118 
    18 
> barplot(tapply(ex.age$TOTCHG,ex.age$AGE,FUN=sum))
> hist(h$APRDRG,main="Histogram of diagnosis relatedgroup",xlab="APRDRG",border="black",col=c("light blue","navy blue"),xlim=c(0,1000),yl
im=c(0,300))
> summary(as.factor(h$APRDRG))
 21  23  49  50  51  53  54  57  58  92  97 114 115 137 138 139 141 143 204 206 225 249 254 308 313 317 344 347 420 421 422 560 
  1   1   1   1   1  10   1   2   1   1   1   1   2   1   4   5   1   1   1   1   2   6   1   1   1   1   2   3   2   1   3   2 
561 566 580 581 602 614 626 633 634 636 639 640 710 720 723 740 750 751 753 754 755 756 758 760 776 811 812 863 911 930 952 
  1   1   1   3   1   3   6   4   2   3   4 267   1   1   2   1   1  14  36  37  13   2  20   2   1   2   3   1   1   2   1 
> diag.cost=aggregate(TOTCHG~APRDRG,FUN=sum,data=h)
> diag.cost[which.max(diag.cost$TOTCHG),]
   APRDRG TOTCHG
44    640 437978
> |
```

RStudio
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Project: (None)
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Environment History Connections Tutorial
Files Plots Packages Help Viewer
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Publish
Histogram of diagnosis relatedgroup
Frequency
0
50
100
150
200
250
300
0
200
400
600
800
1000
APRDRG

Analysis:-

From above histogram we can see that 600-700 diagnosis related group is highest and from summary of the APRDRG attribute we get that 640 diagnosis related group has a maximum cost of 437978.

3. <u>To analyze if the race of the patient is related to the hospitalization costs:</u>

After removing the null value and converting from numeric to factor, we analyze whether race affect hospital costs or not.

Let, H0: independent variable RACE is not influencing dependent variable TOTCHG vs H1: H0 is not true

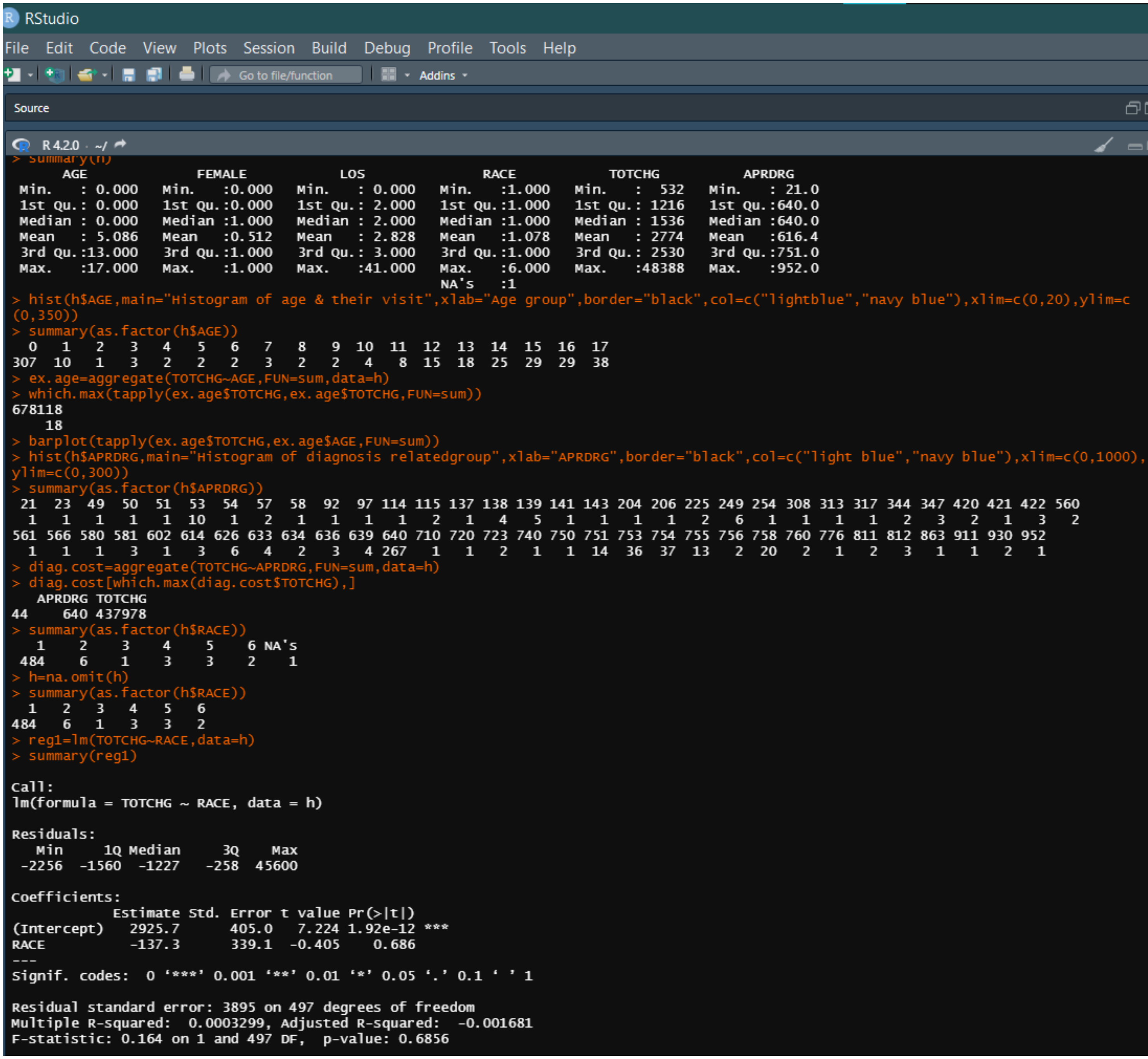
Where, RACE: race of the patient

TOTCHG: hospital discharge costs

Code:-

```
> summary(as.factor(h$RACE))
> h=na.omit(h)
> summary(as.factor(h$RACE))
> reg1=lm(TOTCHG~RACE,data=h)
> summary(reg1)
```

Output:-


RStudio
File Edit Code View Plots Session Build Debug Profile Tools Help
Go to file/function
Addins
Source
R 4.2.0 · ~/

```
> summary(h)
      AGE             FEMALE           LOS              RACE           TOTCHG          APRDRG     
 Min.   : 0.000   Min.   :0.000   Min.   : 0.000   Min.   :1.000   Min.   :  532   Min.   : 21.0  
 1st Qu.: 0.000   1st Qu.:0.000   1st Qu.: 2.000   1st Qu.:1.000   1st Qu.: 1216   1st Qu.:640.0  
 Median : 0.000   Median :1.000   Median : 2.000   Median :1.000   Median : 1536   Median :640.0  
 Mean   : 5.086   Mean   :0.512   Mean   : 2.828   Mean   :1.078   Mean   : 2774   Mean   :616.4  
 3rd Qu.:13.000   3rd Qu.:1.000   3rd Qu.: 3.000   3rd Qu.:1.000   3rd Qu.: 2530   3rd Qu.:751.0  
 Max.   :17.000   Max.   :1.000   Max.   :41.000   Max.   :6.000   Max.   :48388   Max.   :952.0  
                                                   NA's   :1                                      
> hist(h$AGE,main="Histogram of age & their visit",xlab="Age group",border="black",col=c("lightblue","navy blue"),xlim=c(0,20),ylim=c
(0,350))
> summary(as.factor(h$AGE))
  0   1   2   3   4   5   6   7   8   9  10  11  12  13  14  15  16  17 
307  10   1   3   2   2   2   3   2   2   4   8  15  18  25  29  29  38 
> ex.age=aggregate(TOTCHG~AGE,FUN=sum,data=h)
> which.max(tapply(ex.age$TOTCHG,ex.age$TOTCHG,FUN=sum))
678118 
    18 
> barplot(tapply(ex.age$TOTCHG,ex.age$AGE,FUN=sum))
> hist(h$APRDRG,main="Histogram of diagnosis relatedgroup",xlab="APRDRG",border="black",col=c("light blue","navy blue"),xlim=c(0,1000),
ylim=c(0,300))
> summary(as.factor(h$APRDRG))
 21  23  49  50  51  53  54  57  58  92  97 114 115 137 138 139 141 143 204 206 225 249 254 308 313 317 344 347 420 421 422 560 
  1   1   1   1   1  10   1   2   1   1   1   1   2   1   4   5   1   1   1   1   2   6   1   1   1   1   2   3   2   1   3   2 
561 566 580 581 602 614 626 633 634 636 639 640 710 720 723 740 750 751 753 754 755 756 758 760 776 811 812 863 911 930 952 
  1   1   1   3   1   3   6   4   2   3   4 267   1   1   2   1   1  14  36  37  13   2  20   2   1   2   3   1   1   2   1 
> diag.cost=aggregate(TOTCHG~APRDRG,FUN=sum,data=h)
> diag.cost[which.max(diag.cost$TOTCHG),]
   APRDRG TOTCHG
44    640 437978
> summary(as.factor(h$RACE))
   1    2    3    4    5    6 NA's 
 484    6    1    3    3    2    1 
> h=na.omit(h)
> summary(as.factor(h$RACE))
  1   2   3   4   5   6 
484   6   1   3   3   2 
> reg1=lm(TOTCHG~RACE,data=h)
> summary(reg1)

Call:
lm(formula = TOTCHG ~ RACE, data = h)

Residuals:
   Min     1Q Median     3Q    Max 
 -2256  -1560  -1227   -258  45600 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)   2925.7      405.0   7.224 1.92e-12 ***
RACE          -137.3      339.1  -0.405    0.686    
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3895 on 497 degrees of freedom
Multiple R-squared:  0.0003299,	Adjusted R-squared:  -0.001681 
F-statistic: 0.164 on 1 and 497 DF,  p-value: 0.6856
```

Analysis:-

Here, 484 patients out of 499 fall under group 1, showing that the number of observations for 1 category is way higher than others. This will only affect the results from linear regression or ANOVA analysis. From linear regression analysis we can see that p-value is 0.6856 which is greater than 0.05 and F-statistic is also so small. So we accept H0 at 5% level of significanc and can say that RACE doesn’t affect the hospitalization costs.

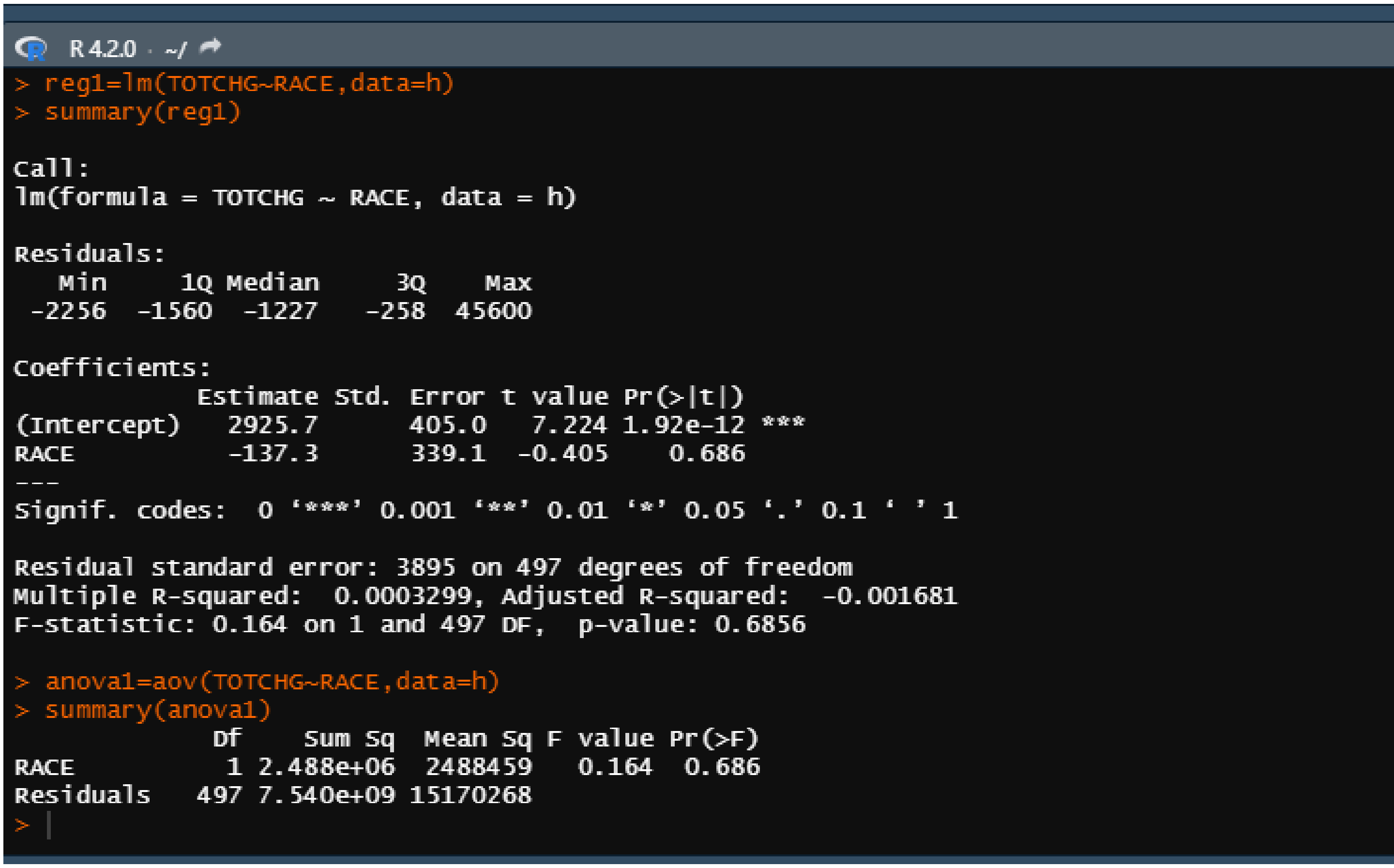
Analysis of using ANOVA

We can also use anova to test how much dependent variable (RACE) affects the independent variable, the hospital costs (TOTCHG).

Code:-

```
> anova1=aov(TOTCHG~RACE,data=h)
> summary(anova1)
```

Output:-



```
> reg1=lm(TOTCHG~RACE,data=h)
> summary(reg1)

Call:
lm(formula = TOTCHG ~ RACE, data = h)

Residuals:
   Min     1Q Median     3Q    Max 
 -2256  -1560  -1227   -258  45600 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)   2925.7      405.0   7.224 1.92e-12 ***
RACE          -137.3      339.1  -0.405    0.686    
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Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3895 on 497 degrees of freedom
Multiple R-squared:  0.0003299,	Adjusted R-squared:  -0.001681 
F-statistic: 0.164 on 1 and 497 DF,  p-value: 0.6856

> anova1=aov(TOTCHG~RACE,data=h)
> summary(anova1)
             Df    Sum Sq  Mean Sq F value Pr(>F)
RACE          1 2.488e+06  2488459   0.164  0.686
Residuals   497 7.540e+09 15170268               
> 
```

Analysis:-

The residual variance(difference between actual variable and predicted variable) is very highwhich implies that there is very little influence from RACE on hospital costs(TOTCHG). Here, F-value, the test statistic, is 0.164 which is small and the p-value is also greater than 0.05. this implies that RACE doesn’t affect hospitalization cost.

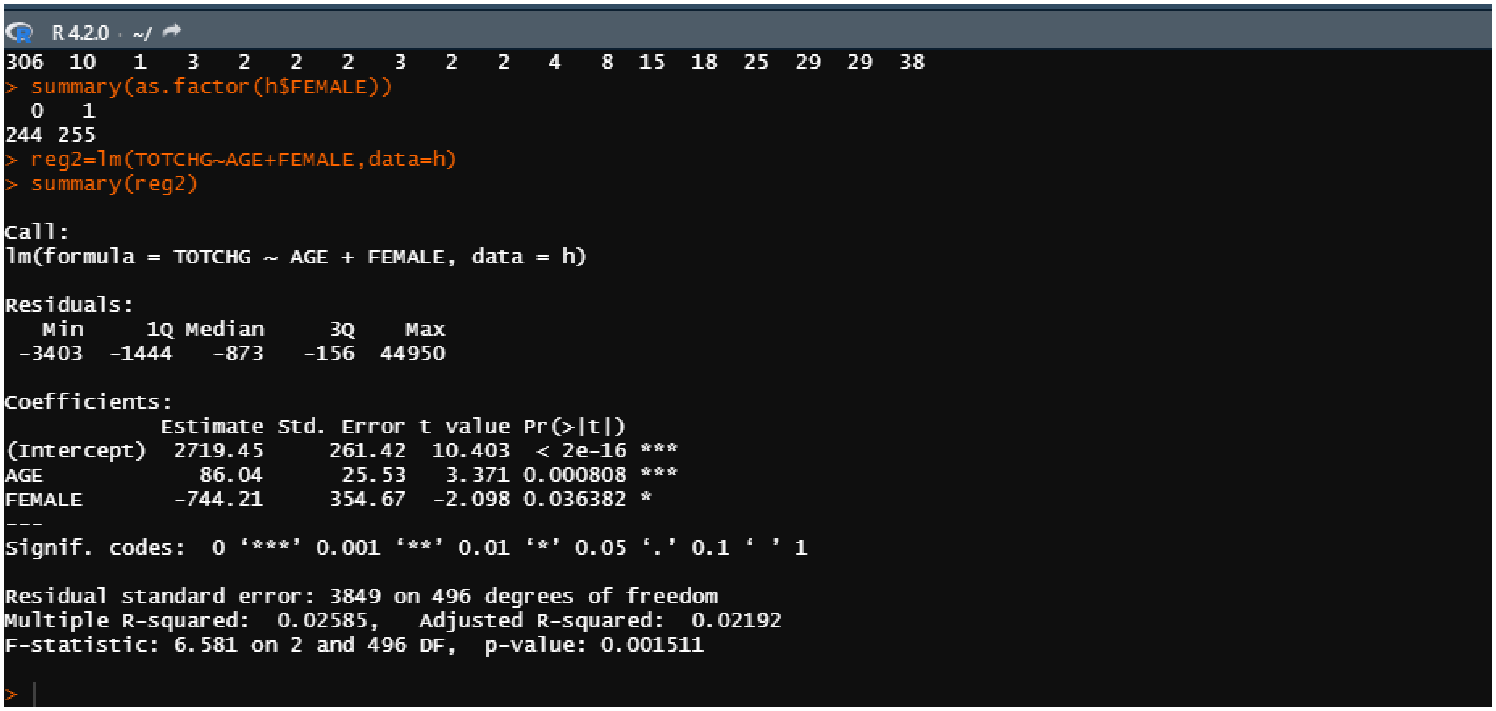
4. <u>To analyze the severity of the hospital costs by age and gender for proper allocation of resources:-</u>

To properly utilize the costs, the agency has to analyze the severity of the hospital costs by age and gender for the proper allocation of resources. Here we will use lm function, taking TOTCHG as dependent variable and taking AGE & FEMALE as independent variables. Let, H0: age and gender doesn’t affect the hospital costs.

Code:-

```
> summary(as.factor(h$AGE))
```

> summary(as.factor(h$FEMALE))
> reg2=lm(TOTCHG~AGE+FEMALE,data=h)
> summary(reg2)
Output:-



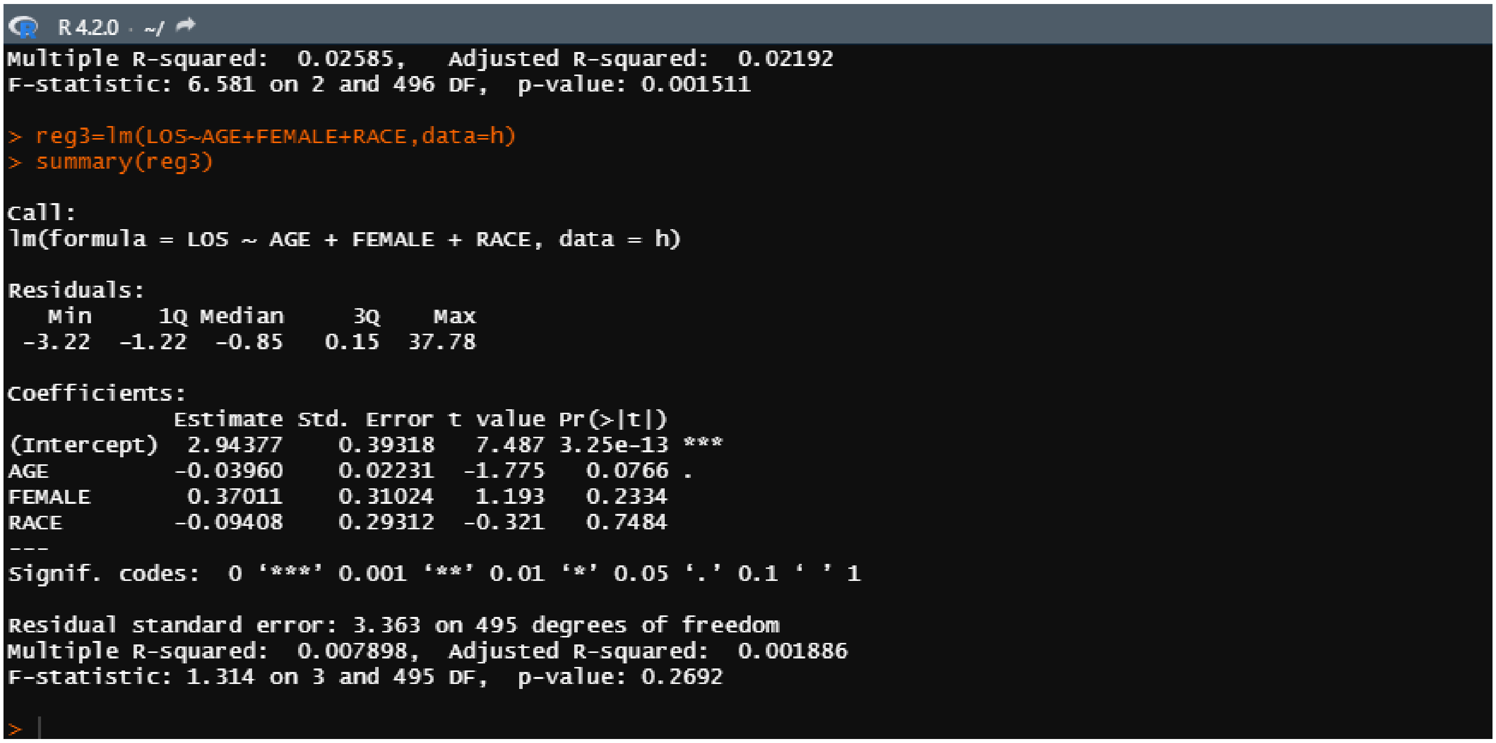
```
306  10   1   3   2   2   2   3   2   2   4   8  15  18  25  29  29  38
> summary(as.factor(h$FEMALE))
  0   1 
244 255 
> reg2=lm(TOTCHG~AGE+FEMALE,data=h)
> summary(reg2)

Call:
lm(formula = TOTCHG ~ AGE + FEMALE, data = h)

Residuals:
   Min     1Q Median     3Q    Max 
 -3403  -1444   -873   -156  44950 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)  2719.45     261.42  10.403  < 2e-16 ***
AGE            86.04      25.53   3.371 0.000808 ***
FEMALE       -744.21     354.67  -2.098 0.036382 *  
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3849 on 496 degrees of freedom
Multiple R-squared:  0.02585,	Adjusted R-squared:  0.02192 
F-statistic: 6.581 on 2 and 496 DF,  p-value: 0.001511

> 
```

Analysis:-
From summary function of FEMALE, we can see that there is equal distribution of female and male in the group. In the linear regression model, the p-values of age and female are all less than 0.05 so the model is statistically significant. So we reject H0 at 5% level of significance and we can say age and gender affect the hospital costs.

5. To find if the length of stay can be predicted from age, gender and race:

Since the length of stay is the crucial factor for inpatients, the agency wants to find if the length of stay can be predicted from age, gender and race. Here we will check if the factors age, gender and race affect the hospital costs or not. If the model is not statistically significant then the factors won’t affect the hospital costs and age, gender and race won’t be able to predict the hospital costs. Let, H0: age, gender and race don’t affect length of stay of inpatients vs H1: H0 is not true.

Code:-
> reg3=lm(LOS~AGE+FEMALE+RACE,data=h)
> summary(reg3)
Output:-



```
Multiple R-squared:  0.02585,   Adjusted R-squared:  0.02192
F-statistic: 6.581 on 2 and 496 DF,  p-value: 0.001511

> reg3=lm(LOS~AGE+FEMALE+RACE,data=h)
> summary(reg3)

Call:
lm(formula = LOS ~ AGE + FEMALE + RACE, data = h)

Residuals:
   Min     1Q Median     3Q    Max
 -3.22  -1.22  -0.85   0.15  37.78

Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)  2.94377    0.39318   7.487 3.25e-13 ***
AGE         -0.03960    0.02231  -1.775   0.0766 .
FEMALE       0.37011    0.31024   1.193   0.2334
RACE        -0.09408    0.29312  -0.321   0.7484
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 3.363 on 495 degrees of freedom
Multiple R-squared:  0.007898,  Adjusted R-squared:  0.001886
F-statistic: 1.314 on 3 and 495 DF,  p-value: 0.2692

> |
```

Analysis:-

Here, p value is higher than 0.05 for age, gender and race, so there is no linear relationship between these variables and length of stay. Hence, we can reject H0 at 5% level of significance, so we can say that age, gender and race cannot be used to predict the length of stay of inpatients.

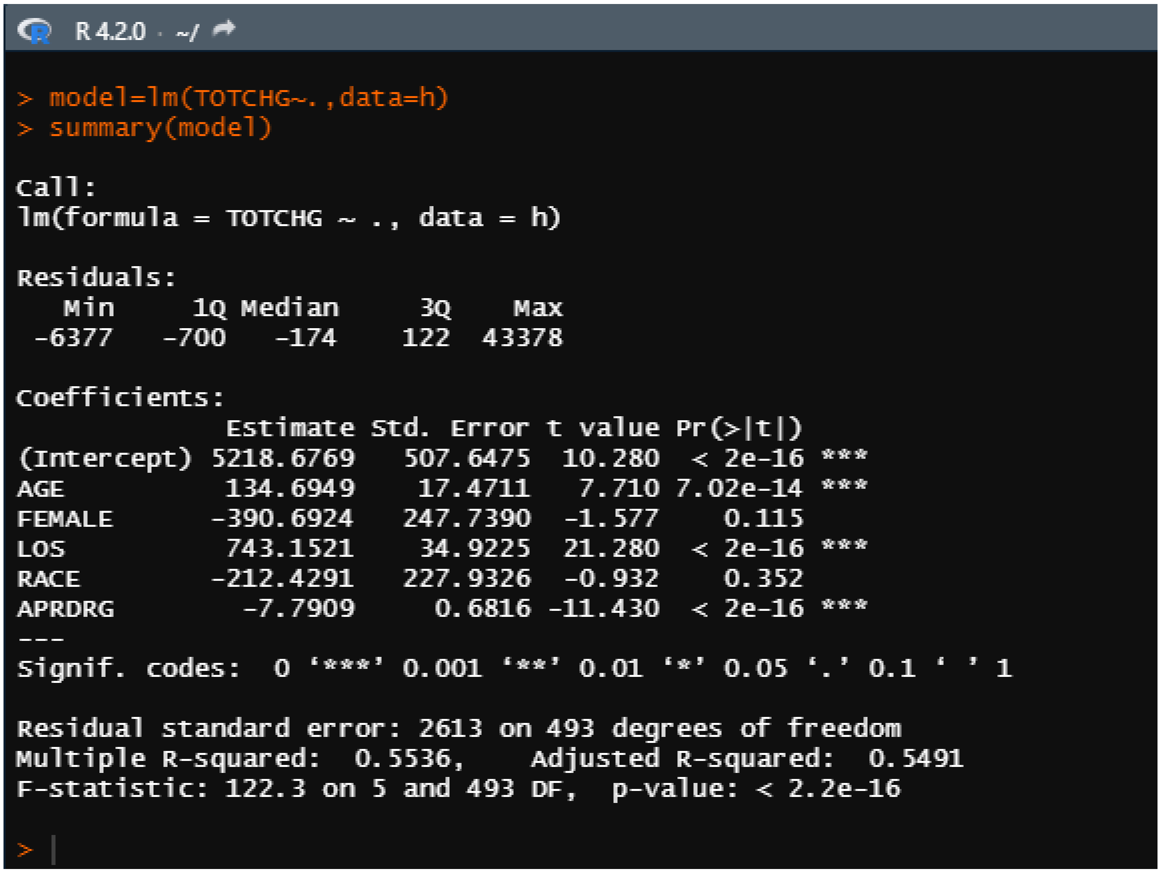
6. <u>To perform a complete analysis:</u>

To perform a complete analysis, the agency wants to find the variable that mainly affects the hospital costs. Here, we will check if age (AGE), gender (FEMALE), length of stay (LOS), race (RACE) and patients refined diagnosis related groups (APRDRG) affect the hospital costs or not. First, we check the p-values of the independent variables. The independent variables whose p values will not be less
than 0.05 that is who has no (*) we will remove them and make a new model. Thus, we will check which model will be statistically significant.

Code:-

```
> model=lm(TOTCHG~.,data=h)
> summary(model)
```

Output:-



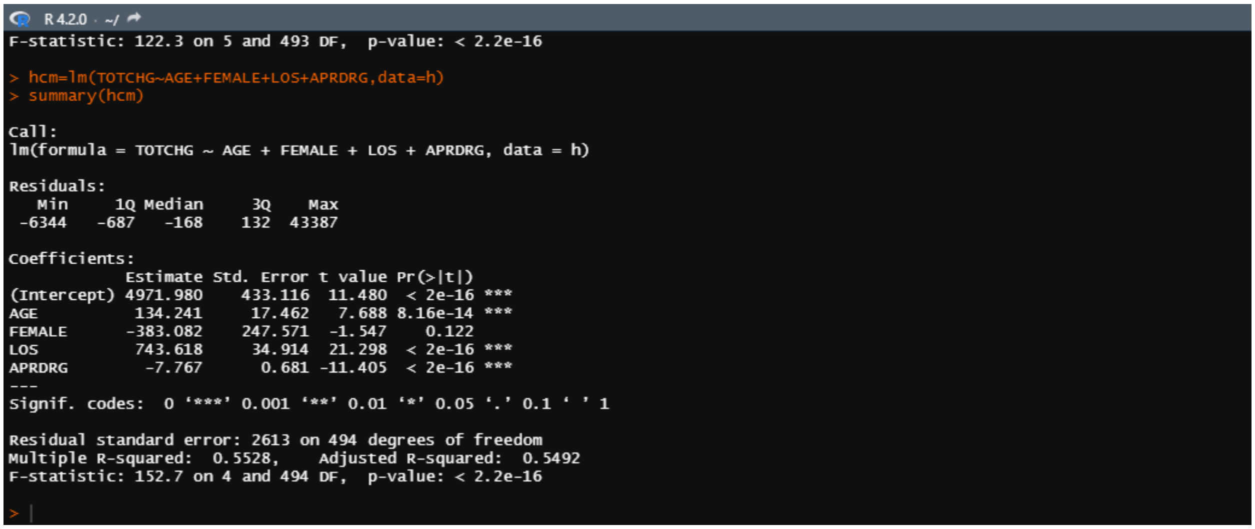
```
> model=lm(TOTCHG~.,data=h)
> summary(model)

Call:
lm(formula = TOTCHG ~ ., data = h)

Residuals:
   Min     1Q Median     3Q    Max 
 -6377   -700   -174    122  43378 

Coefficients:
             Estimate Std. Error t value Pr(>|t|)    
(Intercept) 5218.6769   507.6475  10.280  < 2e-16 ***
AGE          134.6949    17.4711   7.710 7.02e-14 ***
FEMALE      -390.6924   247.7390  -1.577    0.115    
LOS          743.1521    34.9225  21.280  < 2e-16 ***
RACE        -212.4291   227.9326  -0.932    0.352    
APRDRG        -7.7909     0.6816 -11.430  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2613 on 493 degrees of freedom
Multiple R-squared:  0.5536,	Adjusted R-squared:  0.5491 
F-statistic: 122.3 on 5 and 493 DF,  p-value: < 2.2e-16

> 
```

Analysis:-
Here, the p values of gender and race of patients are higher than 0.05 so that means FEMALE and RCAE don’t affect the hospital costs. The p values of AGE, LOS, APRDRG have (***) so the p values are less than 0.05 that means AGE, LOS, APRDRG affect the hospital costs.

Code:-

> hcm=lm(TOTCHG~AGE+FEMALE+LOS+APRDRG,data=h)
> summary(hcm)

Output:-

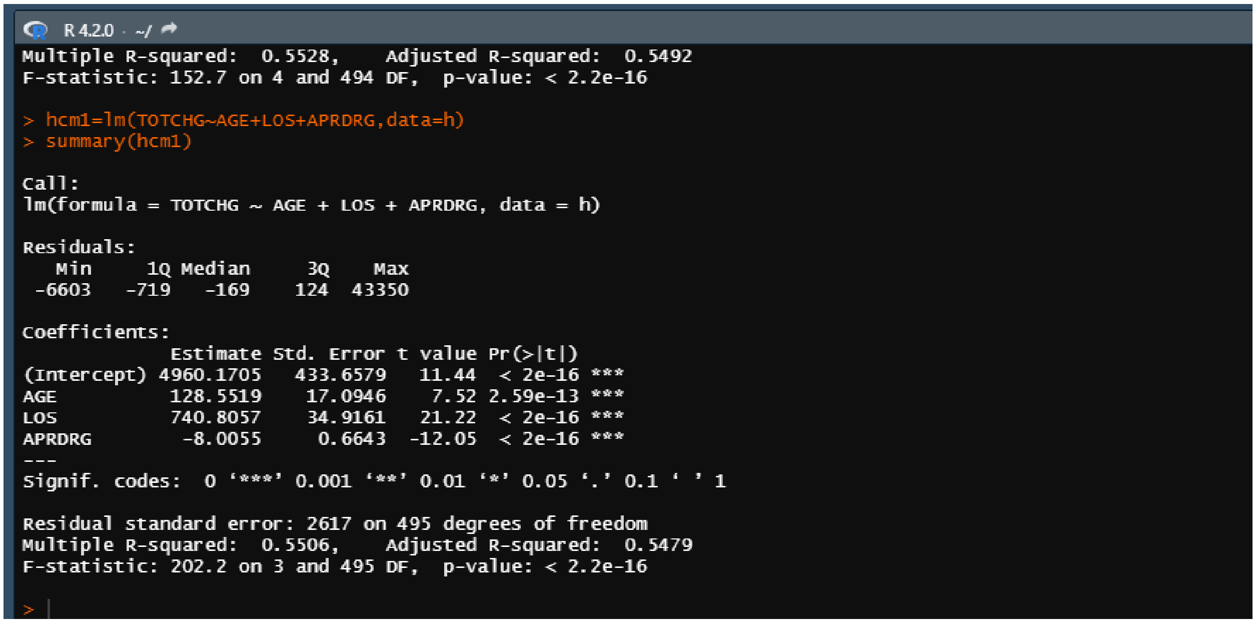


```
F-statistic: 122.3 on 5 and 493 DF,  p-value: < 2.2e-16

> hcm=lm(TOTCHG~AGE+FEMALE+LOS+APRDRG,data=h)
> summary(hcm)

Call:
lm(formula = TOTCHG ~ AGE + FEMALE + LOS + APRDRG, data = h)

Residuals:
   Min     1Q Median     3Q    Max 
 -6344   -687   -168    132  43387 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept) 4971.980    433.116  11.480  < 2e-16 ***
AGE          134.241     17.462   7.688 8.16e-14 ***
FEMALE      -383.082    247.571  -1.547    0.122    
LOS          743.618     34.914  21.298  < 2e-16 ***
APRDRG        -7.767      0.681 -11.405  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2613 on 494 degrees of freedom
Multiple R-squared:  0.5528,	Adjusted R-squared:  0.5492 
F-statistic: 152.7 on 4 and 494 DF,  p-value: < 2.2e-16

> 
```

Analysis:-
After removing RACE, we can see that the p value of FEMALE is not less than 0.05. so in next model we remove FEMALE.

Code:-
> hcm1=lm(TOTCHG~AGE+LOS+APRDRG,data=h)
> summary(hcm1)

Output:-



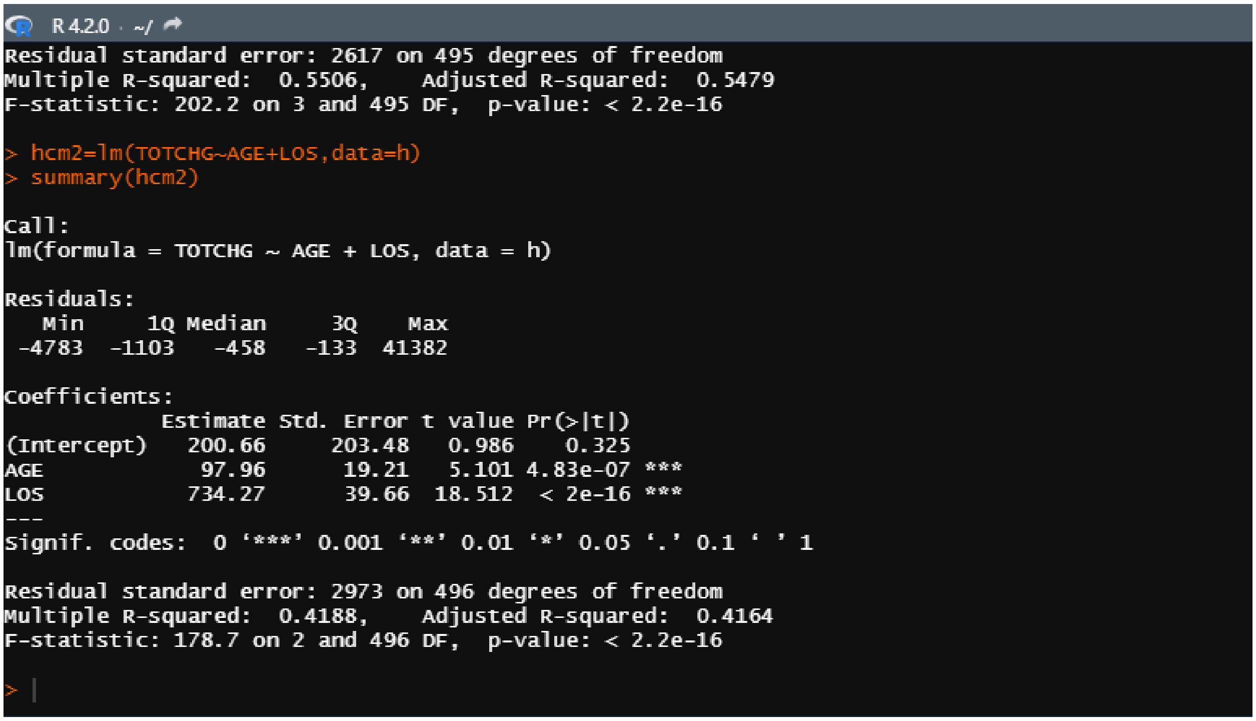
```
Multiple R-squared:  0.5528,	Adjusted R-squared:  0.5492 
F-statistic: 152.7 on 4 and 494 DF,  p-value: < 2.2e-16

> hcm1=lm(TOTCHG~AGE+LOS+APRDRG,data=h)
> summary(hcm1)

Call:
lm(formula = TOTCHG ~ AGE + LOS + APRDRG, data = h)

Residuals:
   Min     1Q Median     3Q    Max 
 -6603   -719   -169    124  43350 

Coefficients:
             Estimate Std. Error t value Pr(>|t|)    
(Intercept) 4960.1705   433.6579   11.44  < 2e-16 ***
AGE          128.5519    17.0946    7.52 2.59e-13 ***
LOS          740.8057    34.9161   21.22  < 2e-16 ***
APRDRG        -8.0055     0.6643  -12.05  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2617 on 495 degrees of freedom
Multiple R-squared:  0.5506,	Adjusted R-squared:  0.5479 
F-statistic: 202.2 on 3 and 495 DF,  p-value: < 2.2e-16

> 
```

Analysis:-
After removing FEMALE and RACE we get the above result. But, t-value of APRDRG is negative we will drop it.

Code:-

```
> hcm2=lm(TOTCHG~AGE+LOS,data=h)
> summary(hcm2)
```

Output:-



```
Residual standard error: 2617 on 495 degrees of freedom
Multiple R-squared:  0.5506,	Adjusted R-squared:  0.5479 
F-statistic: 202.2 on 3 and 495 DF,  p-value: < 2.2e-16

> hcm2=lm(TOTCHG~AGE+LOS,data=h)
> summary(hcm2)

Call:
lm(formula = TOTCHG ~ AGE + LOS, data = h)

Residuals:
   Min     1Q Median     3Q    Max 
 -4783  -1103   -458   -133  41382 

Coefficients:
            Estimate Std. Error t value Pr(>|t|)    
(Intercept)   200.66     203.48   0.986    0.325    
AGE            97.96      19.21   5.101 4.83e-07 ***
LOS           734.27      39.66  18.512  < 2e-16 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 2973 on 496 degrees of freedom
Multiple R-squared:  0.4188,	Adjusted R-squared:  0.4164 
F-statistic: 178.7 on 2 and 496 DF,  p-value: < 2.2e-16

> |
```

Analysis:-

In model, we took all the independent variables (AGE, FEMALE, LOS, RACE, APRDRG) and got p values of FEMALE and RACE were higher than 0.05. So. In next model that is in hcm we took four independent variables (AGE, FEMALE, LOS, APRDRG) and got that all the p values were less than 0.05 except FEMALE. In hcm1, we removed three independent variables (AGE, LOS, APRDRG). As, we saw APRDRG has negative t-value so we dropped that factor, but after removing in the last model hcm2, the residual standard error become higher than model hcm1.

So, we have seen that removing race and gender doesn’t change the R square value but removing APRDRG in hcm2 increases the standard error. Hence, hcm1 seems to be better.

The AGE, LOS, APRDRG mainly affect the hospital costs. RACE and gender haven’t that much impact on hospital costs.