Heart Failure cause and predictions

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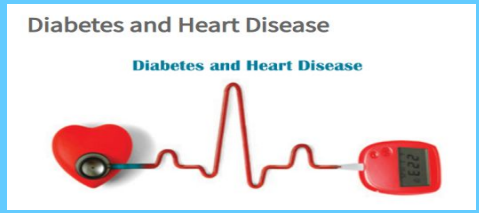
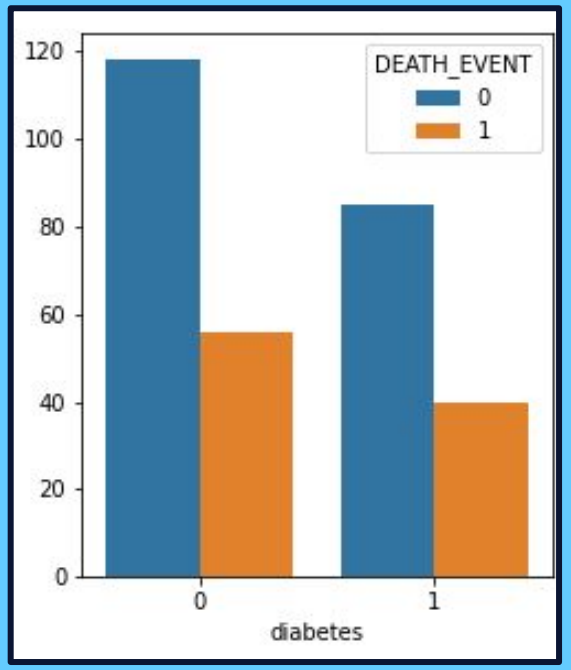
Diabetes effects

Comparison of the research and graph based on the data we have





0= Survived the attack/alive
1= Dead

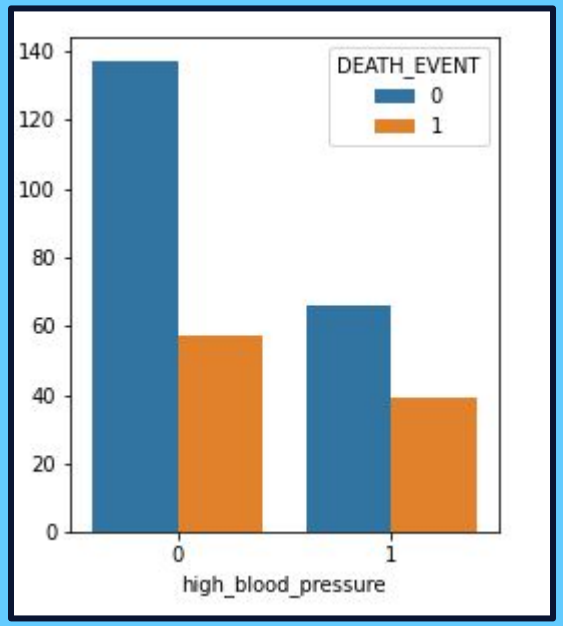
High glucose from diabetes can damage your blood vessels and, therefore, the nerves that control your heart and blood vessels. Over time, this damage can result in heart disease and heart failres.

Both population studies and clinical trials have demonstrated that DM significantly increases the danger of recurrent hospitalizations for heart condition and also the duration of hospital stay in patients with heart disease, and it's related to significantly higher mortality compared with those without diabetes.

Reaserch based on Framingham Heart Study suggest that Having diabetes significantly increased the risk of developing CVD (hazard ratio, 2.5 for women and 2.4 for men) and of dying when CVD was present (hazard ratio, 2.2 for women and 1.7 for men). Diabetic men and women 50 years and older lived on average 7.5 (95% confidence interval, 5.5-9.5) and 8.2 (95% confidence interval, 6.1-10.4) years less than their nondiabetic equivalents. The differences in life expectancy free of CVD were 7.8 and 8.4 years, respectively.

High blood pressure effects

Comparison of the research and graph based on the data we have



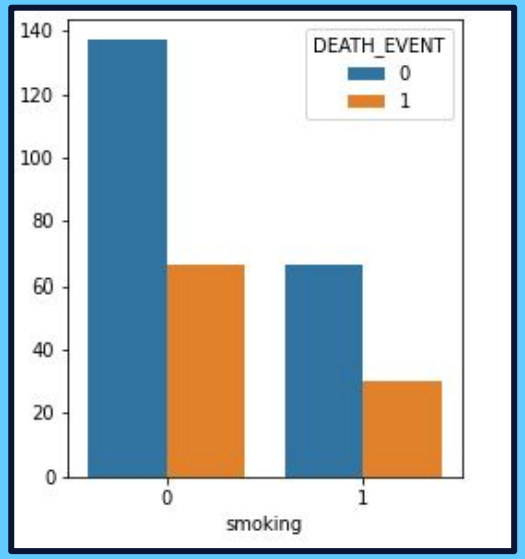
High blood pressure adds to your heart's workload: Narrowed, less elastic arteries make it more difficult for the blood to travel smoothly and easily throughout your body, causing your heart to work harder.Over time, a higher workload leads to an enlarged heart: In order to cope with increased demands, the heart thickens and becomes larger. While it is still able to pump blood, it becomes less efficient. The larger the heart becomes, the harder it works to meet your body's demands for oxygen and nutrients.

HEART.ORG confirms that About 80 million U.S. adults have high blood pressure. That's about 33 percent. About 77 percent of those are using antihypertensive medication, but only 54 of those have their condition controlled. • About 69 percent of people who have a first heart attack, 77 percent of people who have a first stroke and 74 percent who have congestive heart failure have blood pressure higher than 140/90 mm Hg. • Nearly half of people with high blood pressure (46 percent) do not have it under control.

The above Graph from our model also relates that even though many people are alive with high Blood pressure, but there is high possibility that hey might get heart failure and can experience death.

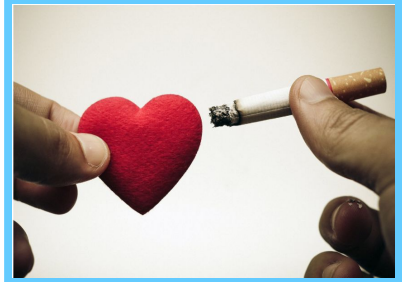
Smoking effects

Comparison of the research and graph based on the data we have

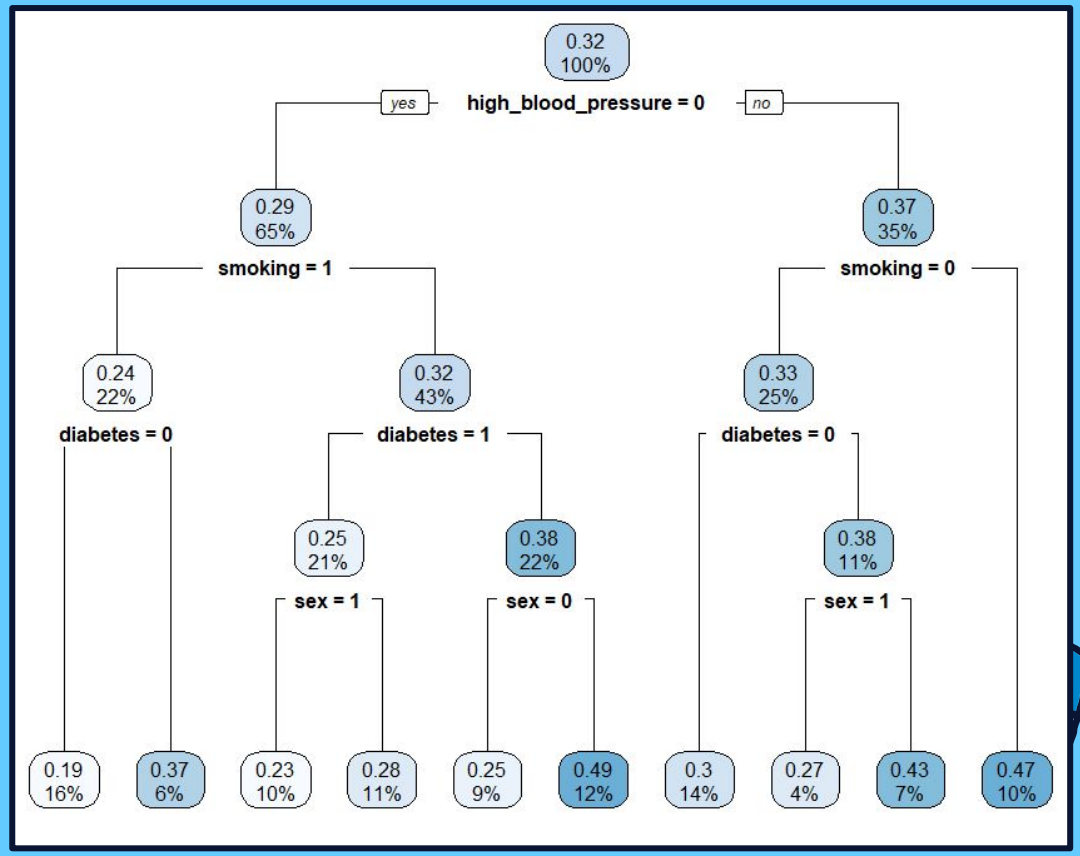


Smoking causes blockages in your arteries makes it harder for the guts to pump blood. This excess strain weakens and damages the guts muscle. Additionally, smoking immediately increases your vital sign and rate, increasing the work your heart must do. Smokers even have an increased risk of attack, which might cause permanent damage to the center muscle.
Over time, smoking contributes to atherosclerosis and increases your risk of getting and dying from cardiovascular disease, cardiopathy, or an attack. Compared with nonsmokers, folks that smoke is more likely to possess cardiopathy and suffer from an attack.

From a research of bmc medicine on prospective study of 188,167 CVD- and cancer-free individuals aged ≥ 45 years from the general Australian population joining the 45 and Up Study from 2006 to 2009 concluded with mean 7.2 years follow-up (1.35 million person-years), 27,511 (crude rate 20.4/1000 person-years) incident fatal and non-fatal major CVD events occurred. They concluded that Current smoking increases the risk of virtually all CVD subtypes, at least doubling the risk of many, including AMI, cerebrovascular disease and heart failure.



DECISION TREE



Death events based on all the factors that we learned about above. **Diabetes, High Blood Pressure, Smoking, Sex.** The Decimal Point numbers shows chance of death for the path in the tree.

HBP
0= NO HIGH BP
1= HAD HIGH BP

SMOKING
0= DOESN'T SMOKE
1= SMOKES

SEX
0= FEMALE
1= MALE

DIABETES
0= HAS DIABETES
1= DOESN'T

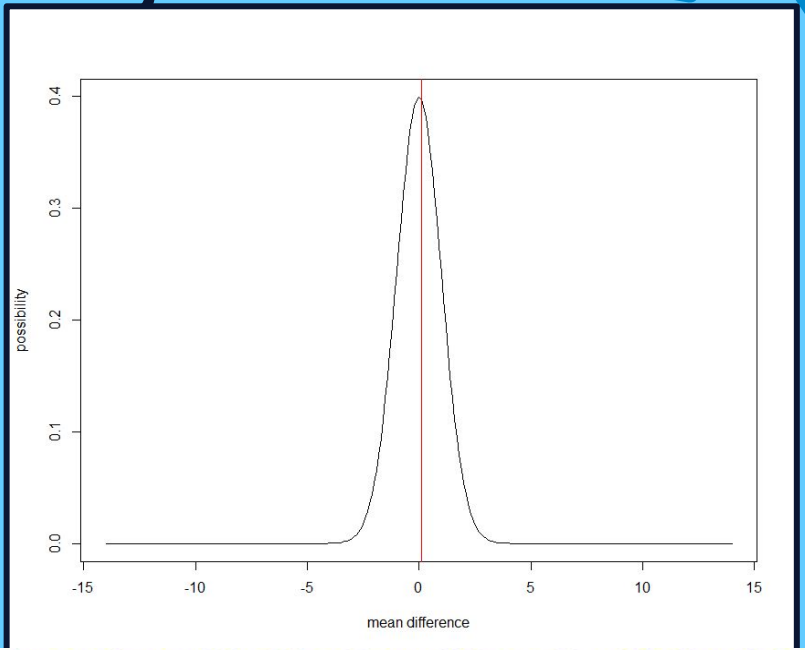
```
> tree1= rpart(DEATH_EVENT~diabetes+high_blood_pressure+smoking+sex,heart_failure_clin
ical_records_dataset,cp=0.0005)
> rpart.plot(tree1)
> printcp(rpart(DEATH_EVENT~diabetes+high_blood_pressure+smoking+sex,heart_failure_cli
nical_records_dataset,cp=0.0005,minsplit=5))

Regression tree:
rpart(formula = DEATH_EVENT ~ diabetes + high_blood_pressure +
    smoking + sex, data = heart_failure_clinical_records_dataset,
    cp = 5e-04, minsplit = 5)

Variables actually used in tree construction:
[1] diabetes            high_blood_pressure sex                 smoking

Root node error: 65.177/299 = 0.21798

n= 299

          CP nsplit rel error xerror     xstd
1 0.00810102      0   1.00000 1.0020 0.044424
2 0.00649864      4   0.96760 1.0504 0.051847
3 0.00584487      5   0.96110 1.0634 0.052886
4 0.00208834      6   0.95525 1.0317 0.052397
5 0.00204570      8   0.95108 1.0376 0.052958
6 0.00074264      9   0.94903 1.0451 0.053441
7 0.00050000     10   0.94829 1.0408 0.053585
```

We have a Relative error which is 0.94829 which is under the limit, thus we can accept this. I Used the mini split as computed by pritncp() to minimize the relative error.

So, which leads to heart failure more, smoking or high diabetes

NULL HYPOTHESIS: **Smoking and having High Diabetes leads to equal effects of heart failure and Death**

ALTERNATIVE HYPOTHESIS: **having High Diabetes can lead to more chances of heart failure and death rather when compared to smoking**



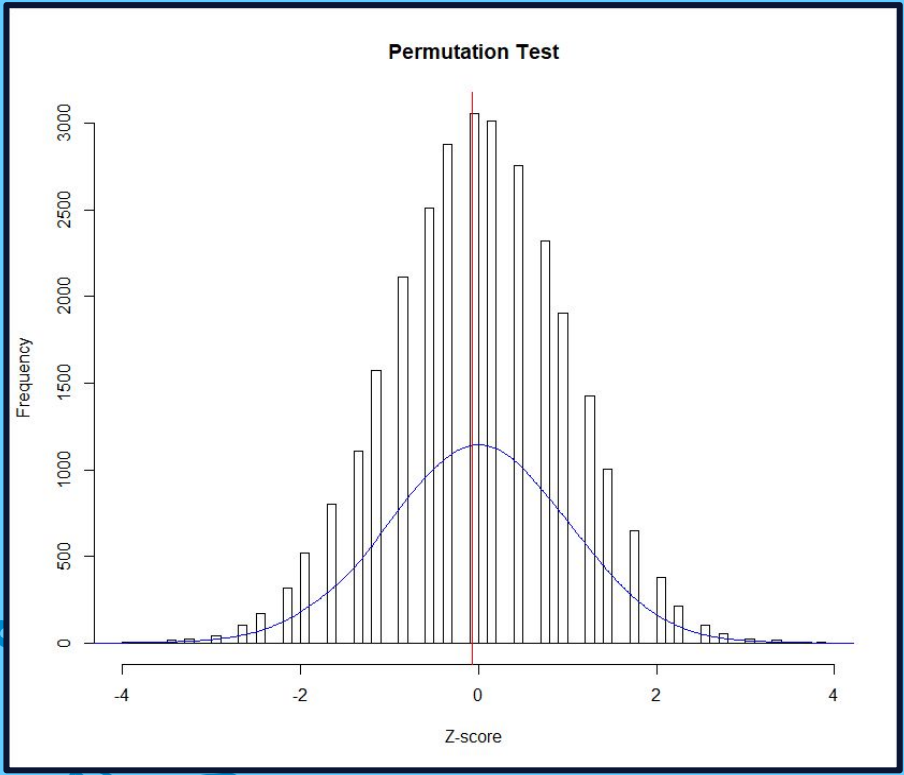

```
> plot(x=seq(from = -14, to= 14, by=0.1),y=dnorm(seq(from = -14, to= 14,  by=0.1),mean=0),type='l',xlab = 'mean difference',  ylab='possibility')
> abline(v=Z.score, col='red')
> pnorm(Z.score)
[1] 0.5471024
> p=1-pnorm(Z.score)
> p
[1] 0.4528976
```

```
> Diabetes.data= subset(heart_failure_clinical_records_dataset,heart_failure_clinical_records_dataset$diabetes==1)
> Sokers.data= subset(heart_failure_clinical_records_dataset,heart_failure_clinical_records_dataset$smoking==1)
> mean.diabetes= mean(Diabetes.data$DEATH_EVENT)
> mean.smokers=mean(Sokers.data$DEATH_EVENT)
```

```
> mean.diabetes
[1] 0.32
> mean.smokers
[1] 0.3125
> sd.diabetes= sd(Diabetes.data$DEATH_EVENT)
> sd.smokers=sd(Sokers.data$DEATH_EVENT)
> sd.diabetes
[1] 0.4683533
> sd.smokers
[1] 0.4659456
> num.diabetes=length(Diabetes.data$DEATH_EVENT)
> num.smokers= length(Sokers.data$DEATH_EVENT)
> num.diabetes
[1] 125
> num.smokers
[1] 96
> sd.db.sm= sqrt(sd.diabetes^2/num.diabetes+sd.smokers^2/num.smokers)
> sd.db.sm
[1] 0.06337469
> Z.score=(mean.diabetes-mean.smokers)/sd.db.sm
> Z.score
[1] 0.1183438
```

We have Z value of 0.12 which is high when related with a High P value 0.45. We have a statistically significant evidence from which we reject the NUll HYPOTHESIS. Having High Diabetes will lead to having more posility of heart failure and Death.

PERMUTATION TEST



WE USED PERMUTATION TESTING TO FIND IT OUT

With a P value of 0.46, we can statistically confirm that Males are more likely to have more heart failures than compared to female

```
> Permutation(299,heart_failure_clinical_records_dataset,"DEATH_EVENT","sex",1,0,tail="R")
[1] 0.458194
```

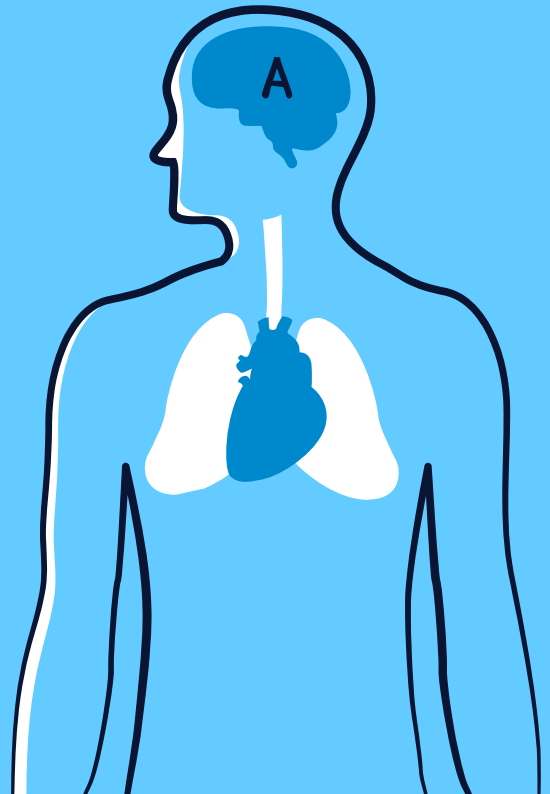
OKAY, SO WHAT ARE THE FACTORS FROM WHICH WE CAN DETERMINE HEART FAILURE AND DEATH

```
> HeartFailure.lm= lm(DEATH_EVENT~+age+diabetes+high_blood_pressure+sex+smoking, data =HeartTrain)
> summary(HeartFailure.lm)

Call:
lm(formula = DEATH_EVENT ~ +age + diabetes + high_blood_pressure +
    sex + smoking, data = HeartTrain)

Residuals:
    Min      1Q  Median      3Q     Max
-0.6005 -0.3956 -0.2497  0.5293  0.8150

Coefficients:
                   Estimate Std. Error t value Pr(>|t|)
(Intercept)       -0.211100   0.166764  -1.266 0.206771
age                0.009549   0.002539   3.761 0.000212 ***
diabetes           0.042877   0.062856   0.682 0.495796
high_blood_pressure  0.021706   0.062836   0.345 0.730065
sex               -0.033597   0.071615  -0.469 0.639392
smoking           -0.017790   0.071411  -0.249 0.803474
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.4757 on 244 degrees of freedom
Multiple R-squared:  0.05856,   Adjusted R-squared:  0.03926
F-statistic: 3.035 on 5 and 244 DF,  p-value: 0.01119
```

What is the relative error, and how can we use this

```
> regr.error(HeartTest$PredictedDeath,HeartTest$DEATH_EVENT)
       mae        mse       rmse       mape
0.3390721 0.1296179 0.3600249        Inf
```

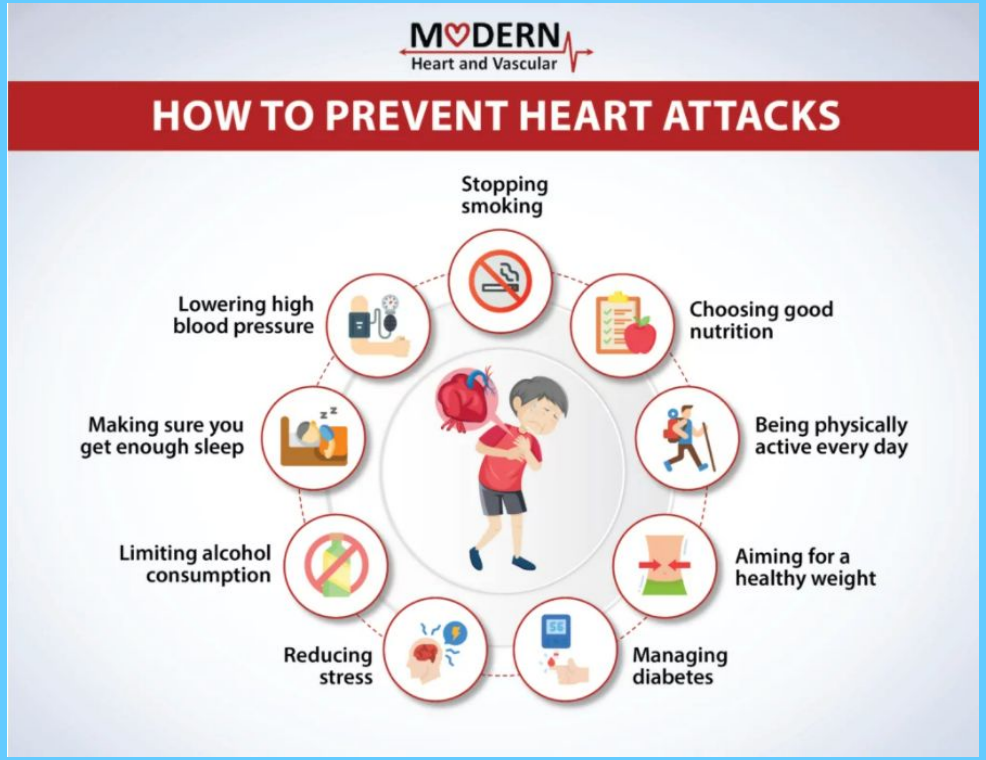
I use Different Independent variable which make the prediction of whether or not you will have heart failure that can result in death. I got a error of 0.3600 which is a positive small value.



That denotes that if anyone has the Independent Variables that I used will indeed is in a risk of experiencing Heart Failure which can further result in Death as well. We should start some getting connected with an doctor and bring his attention towards this.

FELT LIKE TIME TO CHANGE??

HERE ARE SIMPLE THINGS TO DO TO SAVE OUR LIFE



WORK CITED AND CREDITS

DATA
https://bmcmedinformdecismak.biomedcentral.com/articles/10.1186/s12911-020-1023-5/tables/1
https://www.kaggle.com/andrewmvd/heart-failure-clinical-data // Study Understanding and Help Credits to DEV_YOUNGCHAN

Diabetes and Heart Failure
https://jamanetwork.com/journals/jamainternalmedicine/fullarticle/412633

Smoking effects
https://www.winchesterhospital.org/health-library/article?id=663619

HIgh Blood Pressure
https://www.bmj.com/content/370/bmj.m3222


THANKS!!