

# The Effect of Supplement on Tooth Growth

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## Getting familiar with the ToothGrowth database

```
library(datasets) ; data("ToothGrowth")  
dim(ToothGrowth)
```

```
## [1] 60  3
```

```
colnames(ToothGrowth)
```

```
## [1] "len"  "supp" "dose"
```

```
head(ToothGrowth)
```

```
##    len supp dose  
## 1  4.2   VC  0.5  
## 2 11.5   VC  0.5  
## 3  7.3   VC  0.5  
## 4  5.8   VC  0.5  
## 5  6.4   VC  0.5  
## 6 10.0   VC  0.5
```

```
str(ToothGrowth)
```

```
## 'data.frame':    60 obs. of  3 variables:  
## $ len : num  4.2 11.5 7.3 5.8 6.4 10 11.2 11.2 5.2 7 ...  
## $ supp: Factor w/ 2 levels "OJ","VC": 2 2 2 2 2 2 2 2 2 2 ...  
## $ dose: num  0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 0.5 ...
```

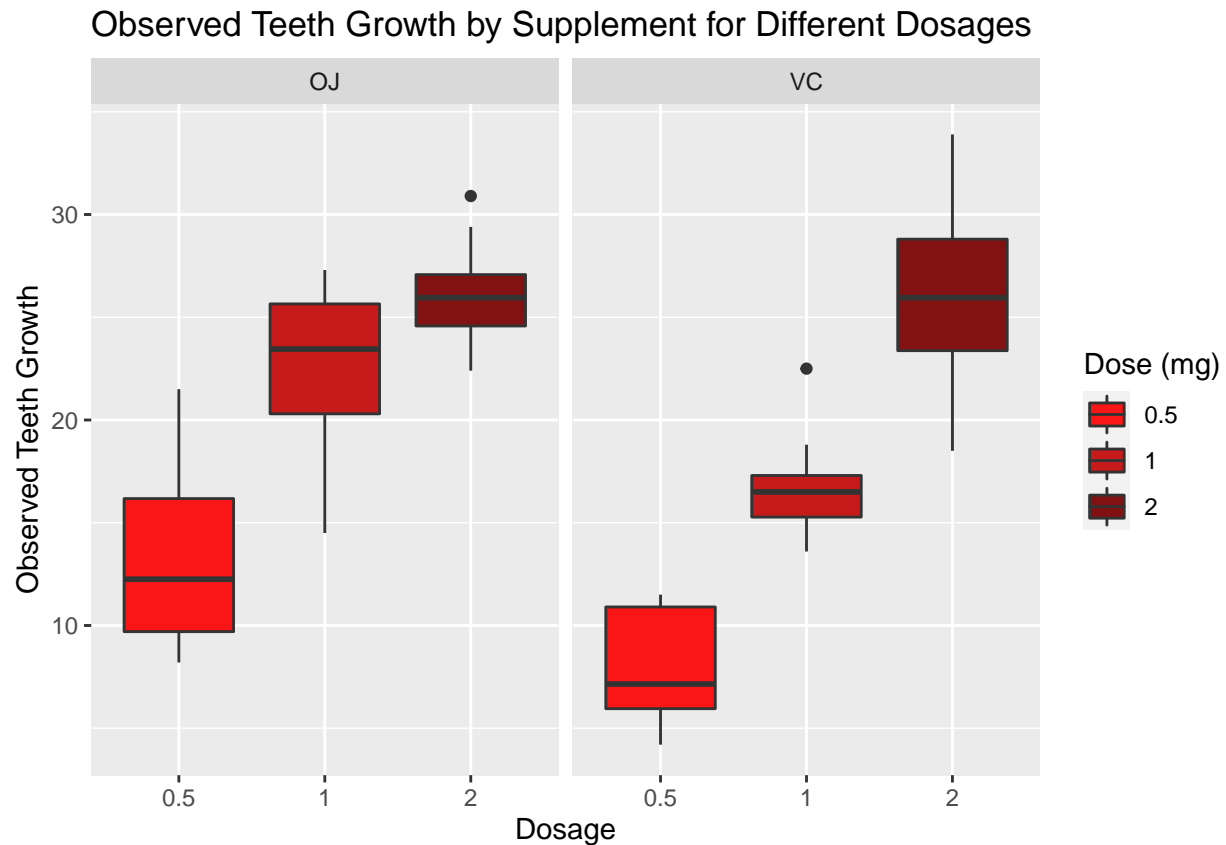
## Providing a basic summary of the data

```
summary(ToothGrowth)
```

```
##      len      supp      dose  
## Min.   : 4.20   OJ:30   Min.    :0.500  
## 1st Qu.:13.07   VC:30   1st Qu.:0.500  
## Median :19.25                Median :1.000  
## Mean   :18.81                Mean   :1.167  
## 3rd Qu.:25.27                3rd Qu.:2.000  
## Max.   :33.90                Max.    :2.000
```

We can observe that our dataset is composed by 2 supplements (OJ and VC) and 3 different dosages (0.5, 1.0 and 2.0)

```
## Warning: package 'ggplot2' was built under R version 4.0.5
```



## Comparing Tooth Growth by Supplement and Dosage

First we should split the data in three subsets - one for each dosage - so we are able to run a t-test for each data subset.

```
dose1 <- subset(ToothGrowth, dose %in% c(0.5, 1.0))
dose2 <- subset(ToothGrowth, dose %in% c(0.5, 2.0))
dose3 <- subset(ToothGrowth, dose %in% c(1.0, 2.0))
t.test(len ~ dose, paired = F, var.equal = F, data = dose1)
```

```
##
## Welch Two Sample t-test
##
## data: len by dose
## t = -6.4766, df = 37.986, p-value = 1.268e-07
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -11.983781 -6.276219
## sample estimates:
```

```
## mean in group 0.5    mean in group 1
##           10.605           19.735
```

```
t.test(len~dose, data=dose1, paired=FALSE)
```

```
##
## Welch Two Sample t-test
##
## data: len by dose
## t = -6.4766, df = 37.986, p-value = 1.268e-07
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -11.983781 -6.276219
## sample estimates:
## mean in group 0.5    mean in group 1
##           10.605           19.735
```

```
t.test(len~dose, data=dose2, paired=FALSE)
```

```
##
## Welch Two Sample t-test
##
## data: len by dose
## t = -11.799, df = 36.883, p-value = 4.398e-14
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -18.15617 -12.83383
## sample estimates:
## mean in group 0.5    mean in group 2
##           10.605           26.100
```

```
t.test(len~dose, data=dose3, paired=FALSE)
```

```
##
## Welch Two Sample t-test
##
## data: len by dose
## t = -4.9005, df = 37.101, p-value = 1.906e-05
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -8.996481 -3.733519
## sample estimates:
## mean in group 1 mean in group 2
##           19.735           26.100
```

For all three dose level pairs, the p-value is less than 0.05, and the confidence interval does not contain zero. The mean tooth length increases on raising the dose level. This indicates that we can reject the null hypothesis, and establish that increasing the dose level leads to an increase in tooth length.

But what about the supplement types? Does it have any effect on teeth growth?

```
t.test(len ~ supp, paired = F, var.equal = F, data = ToothGrowth)

##
##  Welch Two Sample t-test
##
## data:  len by supp
## t = 1.9153, df = 55.309, p-value = 0.06063
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  -0.1710156  7.5710156
## sample estimates:
## mean in group OJ mean in group VC
##      20.66333      16.96333
```

The p-value is 0.06, and the confidence interval contains zero. This indicates that we can not reject the null hypothesis that the different supplement types have no effect on tooth length.

## Assumptions

- The populations are independent
- Members of the sample population are representative of the entire population
- The experiment was done with random assignment of individuals to different dose level categories and supplement types
- For the t-tests, the variances are different for the two groups being compared

## Conclusions

With those assumptions above, we are able to conclude that increasing the dose level leads to increased tooth growth, and that the supplement type has no effect on tooth growth.