

# Tooth Growth Analysis

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The goal of this report is to analyze the ToothGrowth data in R in order to investigate the impact of vitamin C on the tooth growth in guinea pigs.

## 1. Loading the data and basic exploratory analysis

```
data(ToothGrowth)
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
```

```
dim(ToothGrowth)
```

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

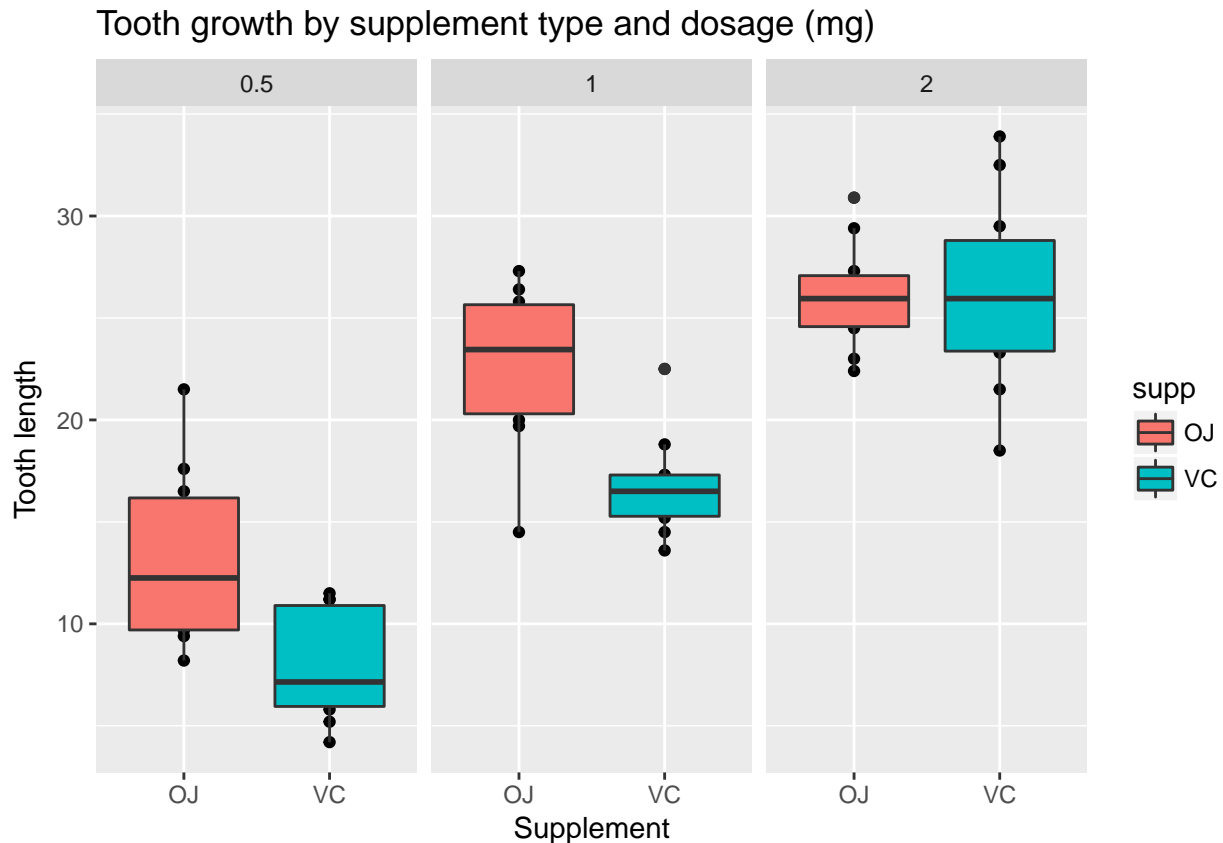
```
str(ToothGrowth)
```

```
## '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 ...
```

The data consists of 60 observations for 3 variables: Tooth length (numeric), supplement type, VC or OJ (factor) and the dosage in milligrams of this supplement (numeric)

```
library(ggplot2)
```

```
qplot(supp,len,data=ToothGrowth, facets=~dose, main="Tooth growth by supplement type and dosage (mg)",x.lim=c(4,12),y.lim=c(0,16))
```



One can observe a positive correlation between the dosage and the tooth growth. For lower dosage, the affect of VC seems weaker than OJ, but this difference dissapears with the highest dosage.

## 2.Hypothesis Testing:

### 1 Difference of effect between supplements

Ho = no difference in tooth growth when using the supplement OJ and VC ( $\text{lenOJ} == \text{lenVC}$ ) Ha = Tooth grow more when using supplement OJ instead of VC. ( $\text{lenOJ} > \text{lenVC}$ )

Assumptions -Variances of tooth growth are different for different supplements and their dosage. -Tooth growth follows normal distribution. -variables are i.i.d.

Procedure: - tooth growth by supplement type from the data

```
OJ = ToothGrowth$len[ToothGrowth$supp == 'OJ']
VC = ToothGrowth$len[ToothGrowth$supp == 'VC']
```

-One-tailed independent t-test with unequal variance.

```
t.test(OJ, VC, alternative = "greater", paired = FALSE, var.equal = FALSE, conf.level = 0.95)
```

```
##
## Welch Two Sample t-test
##
## data: OJ and VC
## t = 1.9153, df = 55.309, p-value = 0.03032
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
```

```
## 0.4682687      Inf
## sample estimates:
## mean of x mean of y
## 20.66333 16.96333
```

As the p-value < 0.05 the null hypothesis is rejected. -> Supplement OJ has bigger effect on tooth growth than supplement VC

## 2 Difference of effects among dosages

2.1(Comparison between affect of dosage 0.5 and 1)  $H_0$ = no difference in tooth growth between dosages.  
 $H_a$ = more tooth growth when the dosage increases.

Procedure: -tooth growth by dosage.

```
doseHalf = ToothGrowth$len[ToothGrowth$dose == 0.5]
doseOne = ToothGrowth$len[ToothGrowth$dose == 1]
doseTwo = ToothGrowth$len[ToothGrowth$dose == 2]
```

-One-tailed independent t-test with unequal variance.

```
t.test(doseHalf, doseOne, alternative = "less", paired = FALSE, var.equal = FALSE, conf.level = 0.95)
```

```
##
## Welch Two Sample t-test
##
## data: doseHalf and doseOne
## t = -6.4766, df = 37.986, p-value = 6.342e-08
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##      -Inf -6.753323
## sample estimates:
## mean of x mean of y
## 10.605 19.735
```

As the p-value < 0.05 the null hypothesis is rejected. (There is a difference in effects on tooth growth for dosages 0.5 and 1, dosage 1 having bigger effect)

2.2(Comparison between affect of dosage 1 and 2)

```
t.test(doseOne, doseTwo, alternative = "less", paired = FALSE, var.equal = FALSE, conf.level = 0.95)
```

```
##
## Welch Two Sample t-test
##
## data: doseOne and doseTwo
## t = -4.9005, df = 37.101, p-value = 9.532e-06
## alternative hypothesis: true difference in means is less than 0
## 95 percent confidence interval:
##      -Inf -4.17387
## sample estimates:
## mean of x mean of y
## 19.735 26.100
```

As the p-value < 0.05 the null hypothesis is rejected. (There is a difference in effects on tooth growth for dosages 1 and 2, dosage 2 having bigger effect)

-> Dosage matters: The more supplement, the more tooth growth