

# Tooth Growth Data Analysis

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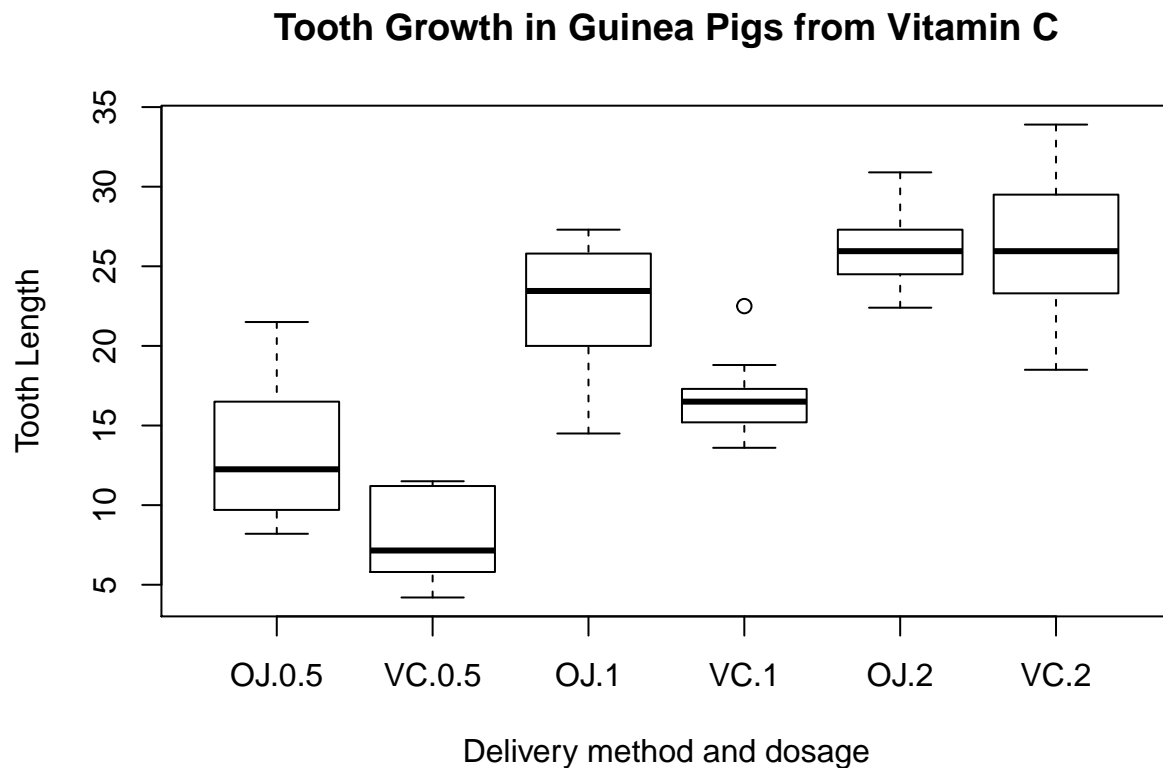
## Overview

This project looks at the Tooth Growth dataset, part of the R dataset package, and determines what effect the dose and delivery method of vitamin C has on tooth growth in guinea pigs, if any.

## Experiment Setup

60 guinea pigs were evenly divided into 6 groups of 10 guinea pigs each: 3 groups were given vitamin C as orange juice in doses of 0.5, 1, and 2 mg/day, respectively, and the remaining 3 groups were given vitamin C as ascorbic acid in doses of 0.5, 1, and 2 mg/day, respectively.

## Data Analysis



It appears that higher doses of vitamin C is positively correlated with greater tooth growth, and that, at doses below 2 mg/day, orange juice promotes greater tooth growth than ascorbic acid.

Let's look at the means and standard variations of tooth growth of each group:

```
tbl_df(ToothGrowth) %>% group_by(supp, dose) %>% summarize(mean = mean(len), sd = sd(len))
```

```
## # A tibble: 6 x 4
## # Groups:   supp [2]
##   supp   dose mean    sd
##   <fct> <dbl> <dbl> <dbl>
## 1 OJ     0.5  13.2  4.46
## 2 OJ     1    22.7  3.91
## 3 OJ     2    26.1  2.66
## 4 VC     0.5   7.98  2.75
## 5 VC     1    16.8  2.52
## 6 VC     2    26.1  4.80
```

Is it true that, on average, higher doses of vitamin C is positively correlated with greater tooth growth?

```
summary(lm(len ~ dose, ToothGrowth))
```

```
##
## Call:
## lm(formula = len ~ dose, data = ToothGrowth)
##
## Residuals:
##      Min       1Q   Median       3Q      Max
## -8.4496 -2.7406 -0.7452  2.8344 10.1139
##
## Coefficients:
##              Estimate Std. Error t value Pr(>|t|)
## (Intercept)   7.4225     1.2601    5.89 2.06e-07 ***
## dose          9.7636     0.9525   10.25 1.23e-14 ***
## ---
## Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
##
## Residual standard error: 4.601 on 58 degrees of freedom
## Multiple R-squared:  0.6443, Adjusted R-squared:  0.6382
## F-statistic: 105.1 on 1 and 58 DF,  p-value: 1.233e-14
```

We see a very small p-value (well below an alpha of 0.05), and a relatively strong R-squared value, indicating that there does seem to be a positive correlation between the two factors.

Is orange juice more effective than ascorbic acid?

At all doses (alpha = 0.05):

```
t.test(subset(ToothGrowth, supp=='OJ')$len, subset(ToothGrowth, supp=='VC')$len, alternative = "g", var
```

```
##
## Welch Two Sample t-test
##
## data:  subset(ToothGrowth, supp == "OJ")$len and subset(ToothGrowth, supp == "VC")$len
## 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
```

We get a p-value of 0.03, thus we reject the null hypothesis in favor of the hypothesis that orange juice is generally more effective than ascorbic acid at promoting tooth growth.

This is even more visible at lower doses:

```
t.test(subset(ToothGrowth, supp=='OJ' & dose==0.5)$len, subset(ToothGrowth, supp=='VC' & dose==0.5)$len
```

```
##
## Welch Two Sample t-test
##
## data: subset(ToothGrowth, supp == "OJ" & dose == 0.5)$len and subset(ToothGrowth, supp == "VC" & dose == 0.5)$len
## t = 3.1697, df = 14.969, p-value = 0.003179
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
## 2.34604      Inf
## sample estimates:
## mean of x mean of y
## 13.23      7.98
```

```
t.test(subset(ToothGrowth, supp=='OJ' & dose==1.0)$len, subset(ToothGrowth, supp=='VC' & dose==1.0)$len
```

```
##
## Welch Two Sample t-test
##
## data: subset(ToothGrowth, supp == "OJ" & dose == 1)$len and subset(ToothGrowth, supp == "VC" & dose == 1)$len
## t = 4.0328, df = 15.358, p-value = 0.0005192
## alternative hypothesis: true difference in means is greater than 0
## 95 percent confidence interval:
## 3.356158      Inf
## sample estimates:
## mean of x mean of y
## 22.70      16.77
```

The p-values are very small, thus we reject the null hypothesis in favor of the alternative hypothesis that orange juice is more effective than ascorbic acid at promoting tooth growth.