

# Analysis: Impact of Supplementation on Tooth Growth

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Exploratory analysis and inference on the impact of supplementation on the growth of teeth, based on dosage and supplement used.

Note that the `echo = FALSE` parameter has been added to the code chunks to prevent printing of the R code unless absolutely necessary. To view the details of the code, please view R Markdown file that can be found here: [https://github.com/Chaendryn/StatsInf\\_Project/blob/master/simQ2.Rmd](https://github.com/Chaendryn/StatsInf_Project/blob/master/simQ2.Rmd).

## 1. Exploratory Analysis of the Tooth Growth Data

A trial was conducted to compare the relative impact of supplementation on the rate of tooth growth in guinea pigs, as measured by the length of the actual tooth. Two supplements were tested - *OrangeJuice*(OJ) and *VitaminC*(VC) - in different doses - 0.5, 1.0 and 2.0.

## 2. Basic Summary Statistics of the Data

A basic summary of the data by supplement shows that the median tooth length on *Orange Juice* is 22.70, with a minimum of 8.20 and a maximum of 30.90. The average tooth length is 20.66. That the median tooth length on *Vitamin C* is 16.50, with a minimum of 4.20 and a maximum of 33.90. The average tooth length is 16.96

Given the above statistics, the early conclusion is that supplementation with Orange Juice provides a better average tooth growth in the subjects, with smaller variation across subjects.

## 3. Hypothesis testing

$H_{0a}$  : Supplementation has no impact on the tooth growth ( $\mu = \mu_0$ ).

The population mean  $\mu_0$  of tooth length is 18.8133 and the population standard deviation  $\sigma_0$  is 7.6493.

$H_{1a}$  : Supplementation of Orange Juice has an effect ( $\mu_{1a} \neq \mu_0$ ).

$H_{1b}$  : Supplementation of Vitamen C has an effect. ( $\mu_{1b} \neq \mu_0$ ).

The sample mean  $\mu_{1a}$  of tooth length is 20.6633 across all dosages.

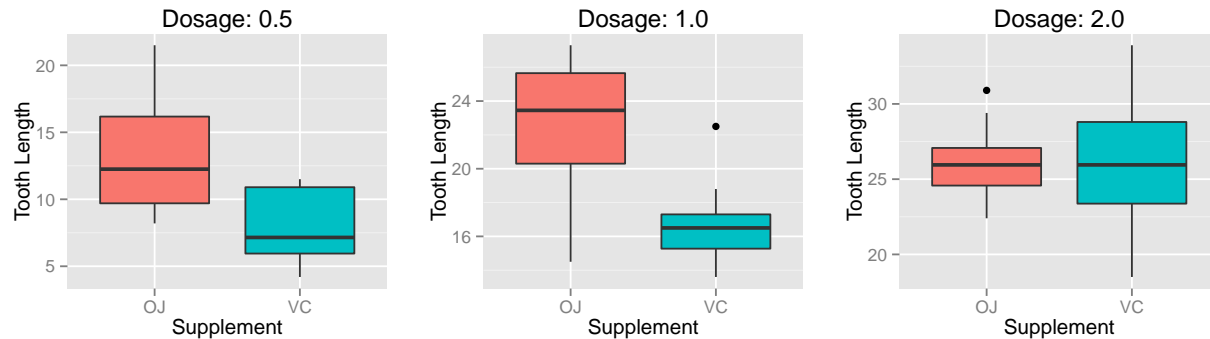
The sample mean  $\mu_{1b}$  of tooth length is 16.9633 across all dosages.

This is clearly not equal to the population mean, therefore one can surmise that there is some impact on tooth length with supplementation - though it's not clear yet whether this impact is significant.

```
##
## Welch Two Sample t-test
##
## data: rawTooth$len by rawTooth$supp
## t = 1.915, df = 55.31, p-value = 0.06063
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -0.171 7.571
## sample estimates:
## mean in group OJ mean in group VC
## 20.66 16.96
```

The  $T$ statistic in this case refers to the difference in average tooth length whether OJ or VC was used as a supplement across all dosages.  $t = 1.9153$  shows that there is very little difference in average tooth length whichever supplement was used across all dosages, but the  $p - value = 0.06063$  is larger than the 0.05 confidence level we were expecting, therefore we can accept the null hypothesis ( $H_{0a}$ ).

$H_{0b}$  : **Supplementation at different doses has no effect dependent on dosage.**



From the plot above we can see that at 0.5 and 1.0 dosages, Orange Juice out-performs Vitamin C with a wider tooth length distribution and a higher sample average. But once we reach the 2.0 dosage mark, Vitamin C has a similar average tooth growth, although bigger variance in the sample.

$H_{0c}$  : **Supplementation of Orange Juice is no better than Vitamin C at 0.5 dosage.**

```
##
## Welch Two Sample t-test
##
## data: dose05$len by dose05$supp
## t = 3.17, df = 14.97, p-value = 0.006359
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  1.719 8.781
## sample estimates:
## mean in group OJ mean in group VC
##      13.23      7.98
```

The  $T$ statistic = 3.1697 shows that there is a significant variation in tooth length based on the supplement used. A  $p - value = 0.006359$  shows difference is not by chance, therefore we reject the null hypothesis ( $H_{0c}$ ).

$H_{0d}$  : **Supplementation of Orange Juice is no better than Vitamin C at 1.0 dosage.**

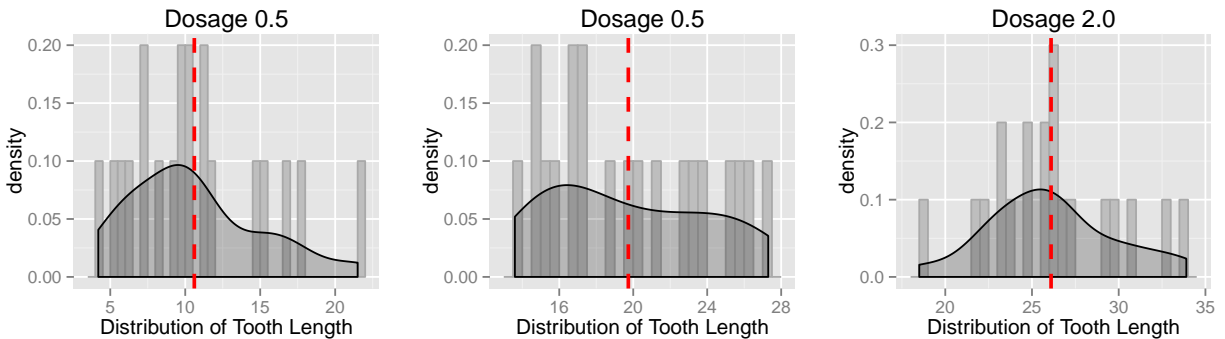
```
##
## Welch Two Sample t-test
##
## data: dose10$len by dose10$supp
## t = 4.033, df = 15.36, p-value = 0.001038
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
##  2.802 9.058
## sample estimates:
## mean in group OJ mean in group VC
##      22.70      16.77
```

The  $T_{statistic} = 4.0328$  shows that there is a significant variation in tooth length based on the supplement used. A  $p - value = 0.0010338$  shows the difference in we are not by chance, therefore we reject the null hypothesis ( $H_{0d}$ ).

$H_{0e}$  : **Supplementation of Orange Juice is no better than Vitamin C at 2.0 dosage.**

```
##
## Welch Two Sample t-test
##
## data: dose20$len by dose20$supp
## t = -0.0461, df = 14.04, p-value = 0.9639
## alternative hypothesis: true difference in means is not equal to 0
## 95 percent confidence interval:
## -3.798 3.638
## sample estimates:
## mean in group OJ mean in group VC
##          26.06          26.14
```

The  $T_{statistic} = -0.0461$  shows that there is very little variation in tooth length based on the supplement used. A  $p - value = 0.9639$  shows that the variation is by chance, therefore we fail to reject the null hypothesis ( $H_{0e}$ ).



## 4. Conclusions

### Assumptions made:

The 60 guinea pigs in the dataset are the whole of the population. Therefore the population mean and standard deviations are calculated on the complete dataset.

Each guinea pig was given either Orange Juice or Vitamin C - the observations are not paired and are independent.

Conclusions drawn from the above testing indicates that supplementation of either Orange Juice or Vitamin C taken across the whole population with no significance given to the dosage, results in very little difference being seen.

It is therefore important to test for dosage specific impacts. From the tests done, it is clear that Orange Juice performs better at lower dosages (0.5 and 1.0) to promote tooth growth than does Vitamin C. This difference however become markedly smaller once higher dosages are reached (2.0).

**Final conclusion:** Supplementation has an impact on tooth growth in guinea pigs but it is dosage dependent.