

The Effect of Supplements on Tooth Growth in Gerbils

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Overview

The goal of this analysis is to investigate the relationship between the use of various dosages of supplements on tooth growth in gerbils.

Within this study there were two supplements that were given in gerbils (Orange Juice [OJ] and Vitamin C [VC]). Both of these were given to the gerbils in various dosages.

This study also analyzes the impact of these dosages on their overall tooth growth. To see more information about this data set visit [here](#).

Setup Environment and Load Data

Setup the environment by loading the `datasets` library. Make a copy of the `ToothGrowth` data for us to use. Once it has been loaded, just take a quick look through it to find out what is in the data.

```
library(datasets)
library(ggplot2)
data <- ToothGrowth
```

Exploratory Data Analysis

Now that the data has been loaded, let's take a look through it to get a good feeling for what is in it.

```
# Look at the structure of the data
str(data)
```

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

Please refer to the appendix for additional information.

Let's look at the data split out by the dosage to see how the supplements in various amounts changes the tooth growth in the gerbils (**Figure 1**).

```
plot.supplement <- ggplot(data = data, aes(x = supp, y = len, group = supp)) +  
  geom_boxplot(aes(fill = supp)) +  
  labs(  
    x = 'Supplement',  
    y = 'Tooth Length',  
    title = 'The Effect of Supplements on Tooth Length') +  
  facet_grid(. ~ dose) + scale_fill_brewer(palette = 'Set2')
```

Now, let's look to see how the dosages of each supplement effect each other (**Figure 2**).

```
plot.dosage <- ggplot(data = data, aes(x = dose, y = len, group = factor(dose))) +  
  geom_boxplot(aes(fill = factor(dose))) +  
  labs(  
    x = 'Dosage',  
    y = 'Tooth Length',  
    title = 'The Effect of Doses on Tooth Length') +  
  facet_grid(. ~ supp) + scale_fill_brewer(palette = 'Set2')
```

Please refer to the appendix for figures.

Based on our exploratory results, our conclusion is that as the dosage of either Orange Juice (OJ) or Vitamin C (VC) increases, the length of the teeth also increases.

Confidence Intervals and Hypothesis Test

Hypotheses

1. Orange Juice and Vitamin C lead to the same overall tooth growth in gerbils
2. The dose of 0.5 mg per day and 1.0 mg per day lead to the same overall tooth growth in gerbils
3. The dose of 1.0 mg per day and 2.0 mg per day lead to the same overall tooth growth in gerbils
4. The dose of 0.5 mg per day and 2.0 mg per day lead to the same overall tooth growth in gerbils

Investigation

Hypothesis 1

Let's look into which supplement has the largest effect on the overall tooth growth.

```
# Orange Juice and Vitamin C lead to the same overall tooth growth in gerbils  
t.test(len ~ supp, data = data)$conf
```

```
## [1] -0.1710156  7.5710156  
## attr(,"conf.level")  
## [1] 0.95
```

Looking at these results, we have to note that the confidence intervals contains 0. Because of this, we do not have enough evidence to reject the null hypothesis.

Hypothesis 2

```
# The dose of 0.5 mg per day and 1.0 mg per day lead to the same overall tooth growth in gerbils  
t.test( len ~ dose, data[data$dose %in% c(0.5, 1), ] )$conf
```

```
## [1] -11.983781 -6.276219  
## attr("conf.level")  
## [1] 0.95
```

Looking at the confidence interval for this comparison (0.5 mg per day and 1.0 mg per day), and the fact that it does not include 0. We are able to reject the null hypothesis. By rejecting the null hypothesis, we are able to conclude that the difference between the doses have an affect on the total tooth growth of gerbils.

Hypothesis 3

```
# The dose of 1.0 mg per day and 2.0 mg per day lead to the same overall tooth growth in gerbils  
t.test( len ~ dose, data[data$dose %in% c(1, 2), ] )$conf
```

```
## [1] -8.996481 -3.733519  
## attr("conf.level")  
## [1] 0.95
```

Looking at the confidence interval for this comparison (1.0 mg per day and 2.0 mg per day), and the fact that it does not include 0. We are able to reject the null hypothesis. By rejecting the null hypothesis, we are able to conclude that the difference between the doses have an affect on the total tooth growth of gerbils.

Hypothesis 4

```
# The dose of 0.5 mg per day and 2.0 mg per day lead to the same overall tooth growth in gerbils  
t.test( len ~ dose, data[data$dose %in% c(0.5, 2), ] )$conf
```

```
## [1] -18.15617 -12.83383  
## attr("conf.level")  
## [1] 0.95
```

Looking at the confidence interval for this comparison (0.5 mg per day and 2.0 mg per day), and the fact that it does not include 0. We are able to reject the null hypothesis. By rejecting the null hypothesis, we are able to conclude that the difference between the doses have an affect on the total tooth growth of gerbils.

Conclusions

Based on the analysis provided above, we are able to conclude the following:

- The type of supplement does not affect the total tooth length in gerbils.
- The total dosage of a supplement that a gerbil receives directly impacts the length of their teeth.

Appendix

Data Definition

Below are a few other pieces of analysis which were completed in order to get a better sense of the data that we are investigating.

```
# Look at the top few rows of the data  
head(data)
```

```
##      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
```

```
# Look at the summary of the data  
summary(data)
```

```
##           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
```

Figures

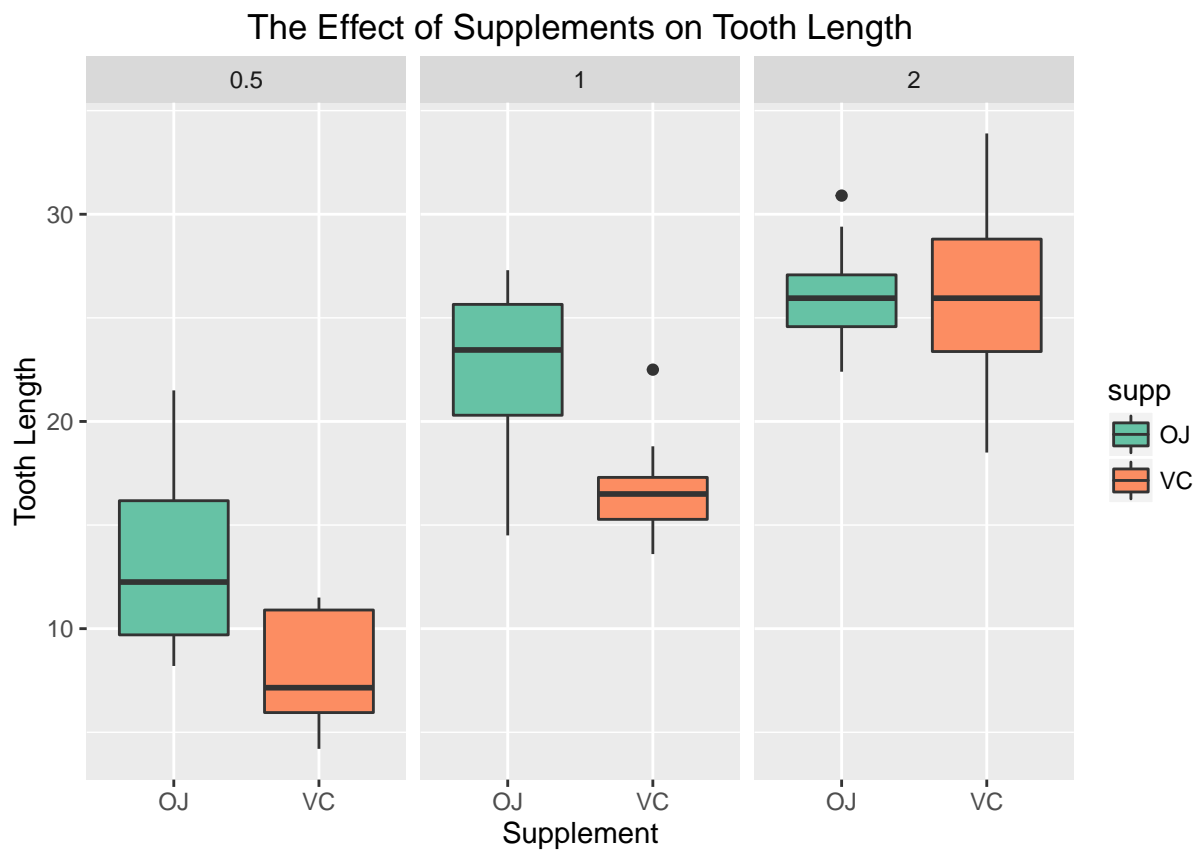


Figure 1: The effect of each supplement on the overall tooth growth in gerbils.

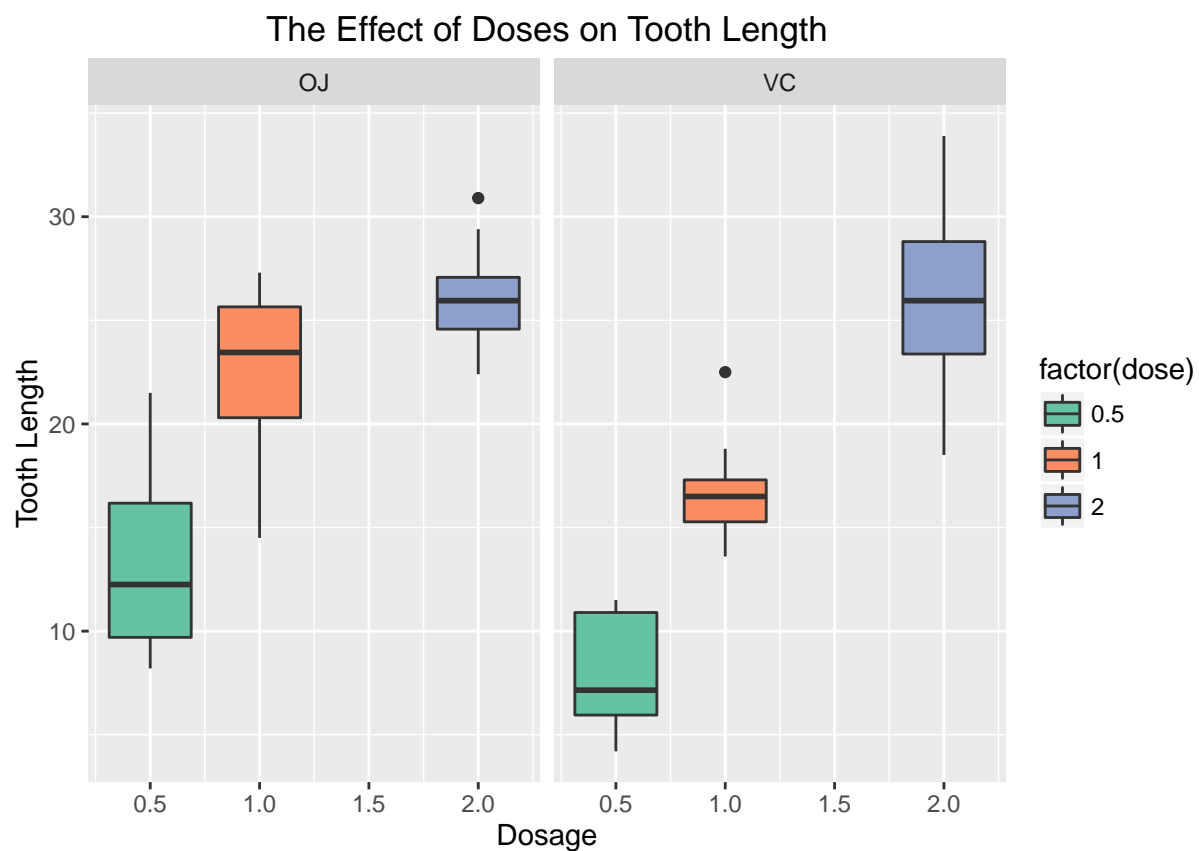


Figure 2: The effect of the dosage (in mg) on the overall tooth growth in gerbils.