Impact of Vitamin C on Tooth Development

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1. Synopsis

This analysis will investigate the impact of Vitamin C on tooth development. A study was performed in which 60 guinea pigs were given Vitamin C at various dosage levels (0.5, 1.0, and 2.0 mg/day) and by one of two delivery methods (Orange Juice and Ascorbic Acid). The length of odontoblasts (cells responsible for tooth growth) were measured at the conclusion of the study.

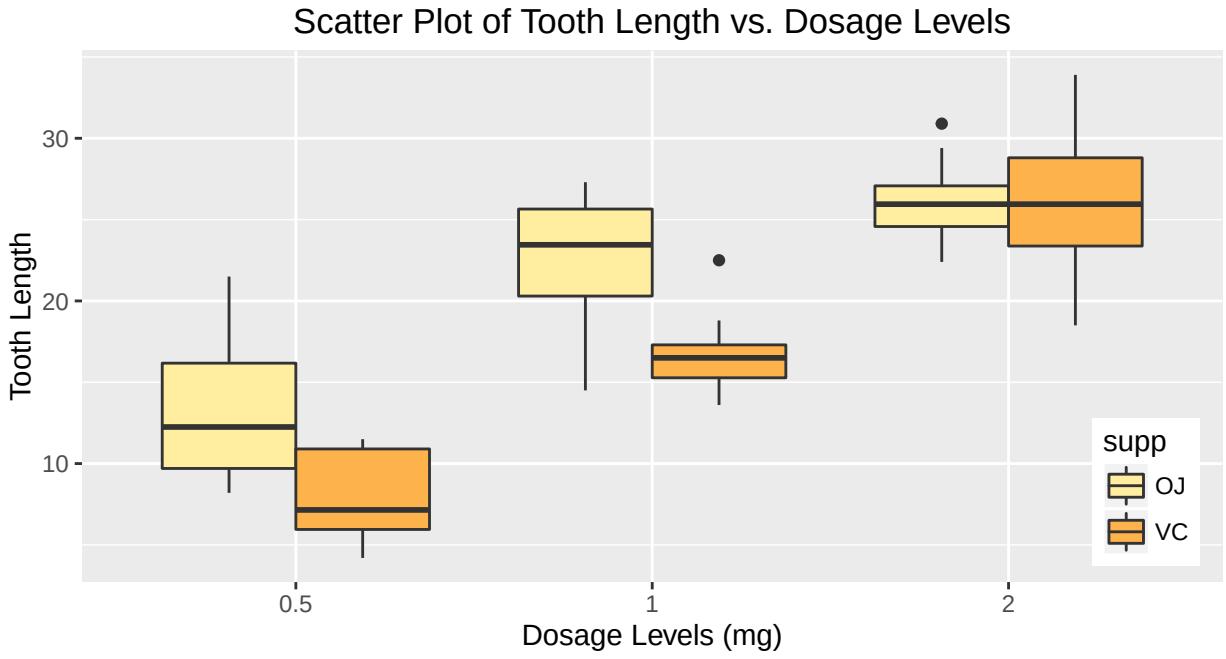
2. Prepare Environment & Data

Load the necessary libraries, ToothGrowth data, and make necessary modifications to the data.

```
library(ggplot2)
library(datasets)
library(gridExtra)
data("ToothGrowth")
ToothGrowth$dose <- factor(ToothGrowth$dose) # Convert dose to factor
```

3. Data Summary & Exploratory Data Analysis

The data is a set of 60 observations. Each of these observations include variables for length of odontoblasts (teeth), dosage levels, and vitamin delivery method (OJ = Orange Juice, VC = Ascorbic Acid). *R code for graph creation is included in the Appendix*



Performing some basic exploratory data analysis using a factored scatterplot yields some preliminary observations:

1. Increased dosage levels appear to have a positive impact on tooth length.
2. Orange Juice (OJ) appears to have more positive impact on tooth length than Ascorbic Acid (AA) at lower dosage levels.

4. Compare Tooth Growth by Treatment

Further analysis using confidence intervals and hypothesis testing provides greater statistical insight into these preliminary observations

4.1 Tooth Growth by Dosage Level

The different dosage levels must first be prepared in order to create statistical comparisons

```
dose_05_10 <- subset(ToothGrowth, dose %in% c(0.5, 1.0))
dose_05_20 <- subset(ToothGrowth, dose %in% c(0.5, 2.0))
dose_10_20 <- subset(ToothGrowth, dose %in% c(1.0, 2.0))
```

T tests are conducted on each of the dosage combinations to determine if the Null Hypothesis may be rejected for any of these. The Null Hypothesis is that there is **no correlation** between the Dosage Levels and Tooth Growth.

```
t.test(len ~ dose, paired = F, var.equal = F, data = dose_05_10)
```

```
##
##  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, paired = F, var.equal = F, data = dose_05_20)
```

```
##
##  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
```

```r
t.test(len ~ dose, paired = F, var.equal = F, data = dose_10_20)
```

```
##
##  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
```

The confidence intervals for each of these dosage levels allow the Null Hypothesis to be rejected.

- 0.5mg & 1.0mg Dosage Confidence Interval [-11.9838, -6.2762] -> **Reject Null**
- 0.5mg & 2.0mg Dosage Confidence Interval [-18.1562, -12.8338] -> **Reject Null**
- 1.0mg & 2.0mg Dosage Confidence Interval [-8.9965, -3.7335] -> **Reject Null**

Increased Vitamin C dosage levels appear to have a positive effect on Tooth Growth.

4.2 Tooth Growth by Delivery Method

Analyzing the data for statistical correlation between Tooth Growth and Delivery Type, the Null Hypothesis is tested. The Null Hypothesis is that there is **no correlation** between Delivery Method and Tooth Growth.

```r
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 95% Confidence Interval is [-0.1710156, 7.5710156], which includes zero. **Do not Reject the null hypothesis**

Conclusions

1. There is statistical evidence to support that increased dosages of vitamin C have a positive effect on Tooth Growth.
2. There is not statistical evidence to support any finding that vitamin delivery method has any effect on Tooth Growth.

Appendix

R Code for Initial Exploratory Data Analysis Scatter Plot

```
ggplot(ToothGrowth,aes(dose,len)) +
    geom_boxplot(aes(fill=supp)) +
    scale_fill_brewer(palette="YlOrRd") +
    theme(legend.position=c(1,0.3),legend.justification=c(1,1)) +
    labs(title="Scatter Plot of Tooth Length vs. Dosage Levels",x="Dosage Levels (mg)",y="Tooth Length")
```