

R ToothGrowth Analysis: A Look at Effects of Vitamin C on the Length of Odontoblasts in Guinea Pigs.

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Overview

The dataset, ToothGrowth, in R looks at the effects of Vitamin C on tooth growth in guinea pigs. The study observed the response in length of odontoblasts (cells responsible for tooth growth) in 60 guinea pigs. Each animal received one of three dose levels of vitamin C (.5, 1, and 2 mg/day) by one of two delivery methods, orange juice or ascorbic acid. This report finds that 2 mg/day regardless of the supplement type leads to the highest length of odontoblasts in guinea pigs.

Load the Data

First I load the data into R. You can see that there are 60 rows, one for each guinea pig and 3 columns. the 3 variables are length of odontoblasts, supplement type (VC or OJ), and dose of vitamin c.

```
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)
```

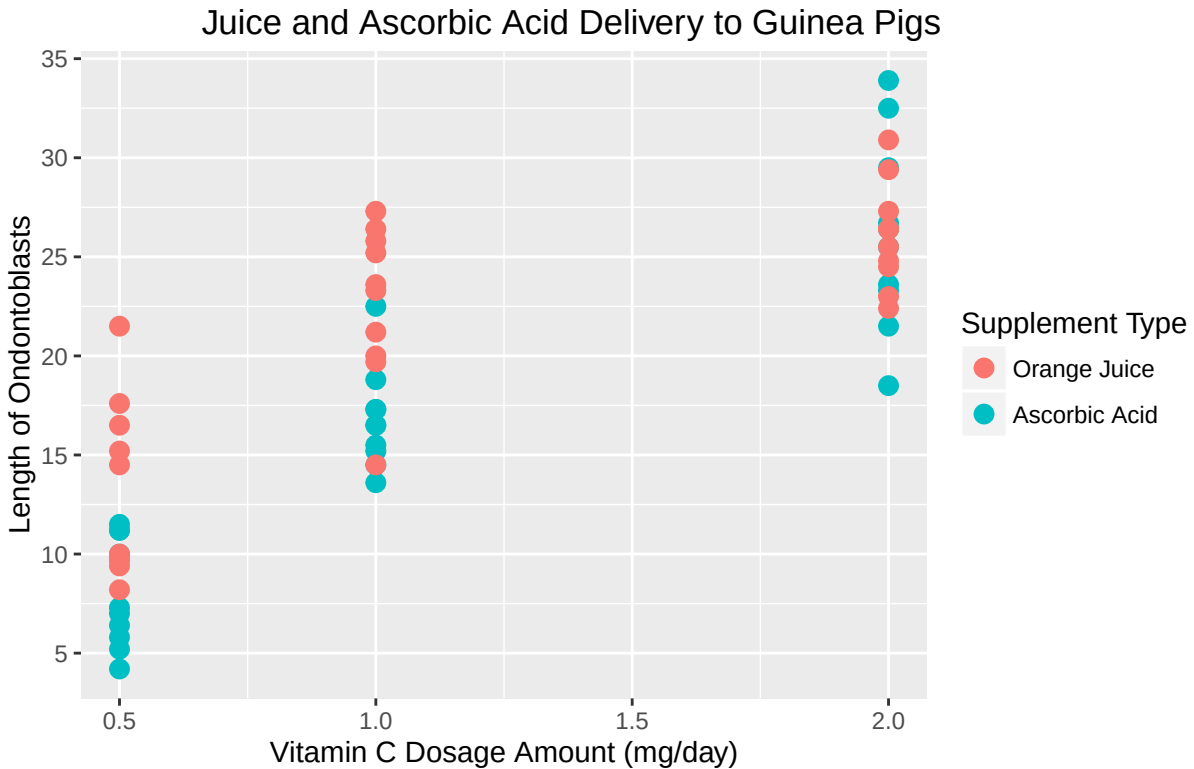
```
## [1] 60  3
```

Exploratory Data Analysis

Here I perform some basic exploratory data analytics and graph the length of odontoblasts both by supplement type and dose.

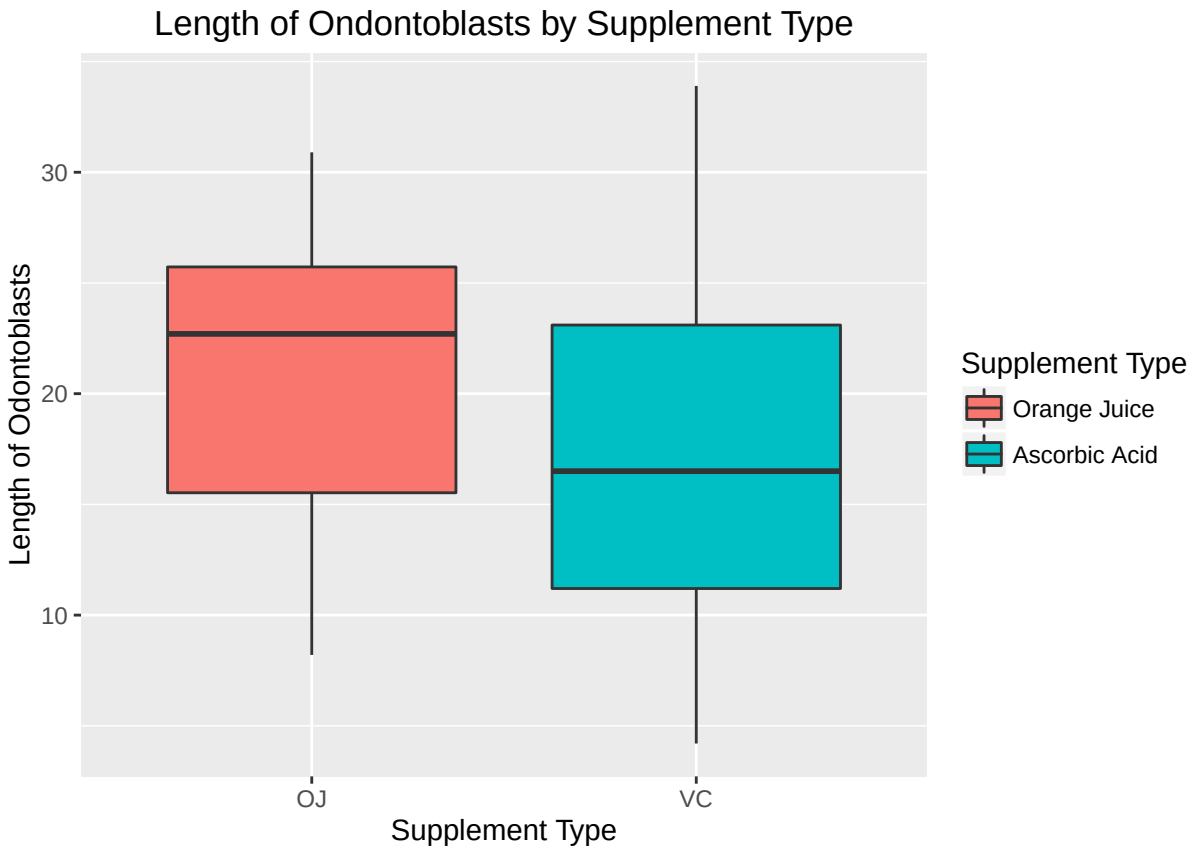
```
library(ggplot2)
qplot(dose, len, data=ToothGrowth, color=supp, size=I(3)) +
  scale_y_continuous(breaks=seq(0,40,5)) +
  labs(title= "Length of Odontoblasts for Varying Vitamin C Dosage Through Orange\nJuice and Ascorbic Acid Delivery to Guinea Pigs",
        x='Vitamin C Dosage Amount (mg/day)',
        y='Length of Ondontoblasts') +
  scale_colour_discrete(name='Supplement Type',
                        labels= c('Orange Juice', 'Ascorbic Acid'))
```

Length of Odontoblasts for Varying Vitamin C Dosage Through Orange



From the looks of the graph it clearly shows that as the dosage amount increased, so did the length of the odontoblasts. It also appears that orange juice leads to higher lengths compared to ascorbic acid. To affirm this I look at the average lengths of OJ vs VC without factoring for dosage.

```
g <- ggplot(ToothGrowth, aes(supp, len))
g <- g + geom_boxplot(aes(fill=supp))
g <- g + labs(title="Length of Odontoblasts by Supplement Type",
              x="Supplement Type",
              y="Length of Odontoblasts")
g <- g + scale_fill_discrete(name='Supplement Type', labels= c('Orange Juice', 'Ascorbic Acid'))
g
```



You can see that OJ has higher lengths compared to VC.

Summary of Data

Here I performed a basic summary of the data and looked at averages of OJ and VC.

```
summary(ToothGrowth)
```

```
##      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
```

```
library(data.table)
supmeans <- setDT(ToothGrowth)[,mean(len), by=supp]
names(supmeans) <- c('supplement', 'mean')
supmeans
```

```
##    supplement    mean
## 1:         VC 16.96333
## 2:         OJ 20.66333
```

```
with(ToothGrowth, tapply(len, list(dose,supp), mean))
```

```
##           OJ      VC
## 0.5 13.23  7.98
## 1   22.70 16.77
## 2   26.06 26.14
```

So we can see that OJ has a higher mean length. Also, OJ has higher mean length compared to VC for doses 0.5 and 1 but not for 2 mg/day.

Tooth Growth by Supp and Dose

First, I look at the independant group t confidence intervals for the difference in means of Orange Juice and Ascorbic Acid. I will calculate this both plugging into the formula and t.test.

```
n <- 30
mnoj <- supmeans[2,mean]
mnvc <- supmeans[1,mean]
dif <- mnoj-mnvc
quant <- qt(.975, df=n+n-2)
supvar <- setDT(ToothGrowth)[,var(len), by=supp]
names(supvar) <- c('supplement', 'variance')
varoj <- supvar[2,variance]
varvc <- supvar[1,variance]
```

Here I get the means and variances for OJ and VC. I now need to find the pooled variance estimator.

```
sp <- ((n-1)*varvc + (n-1)*varoj)/(n+n-2)
sp <- round(sp, 2)
```

The pooled variance is 55.98. Now I plug it into my t confidence formula.

```
tci <- dif + c(-1,1) * quant * sqrt(sp) * sqrt(1/30+1/30)
```

Another way to do this:

```
tt <- t.test(len~supp, data=ToothGrowth)
tt
```

```
##
## 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
```

So the confidence interval is -0.1710156, 7.5710156. Since this goes through 0, as well as the p-value is .06, we cannot reject the null hypothesis and thus we cannot say OJ leads to higher length of odontoblasts than Ascorbic Acid.

Now, I look at the average lengths for vitamin c dosage.

```
t.5_1 <- with(ToothGrowth, t.test(len[dose==0.5], len[dose==1]))
t.5_1

##
## Welch Two Sample t-test
##
## data: len[dose == 0.5] and len[dose == 1]
## 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 of x mean of y
## 10.605 19.735
```

Here the p-value is 0 and the confidence intervals are -11.9837813, -6.2762187. This says that we can reject the null hypothesis and thus increasing the dosage to 1 mg/day from .5 mg/day leads to increase in length of odontoblasts.

Finally I look at the average lengths for vitamin c dosage of 1 mg/day to 2 mg/day.

```
t1_2 <- with(ToothGrowth, t.test(len[dose==1], len[dose==2]))
t1_2

##
## Welch Two Sample t-test
##
## data: len[dose == 1] and len[dose == 2]
## 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 of x mean of y
## 19.735 26.100
```

Here the p-value is 0 and the confidence intervals are -8.9964805, -3.7335195. This says that we can reject the null hypothesis as well and thus increasing the dosage to 2 mg/day from 1 mg/day leads to an even higher increase in length of odontoblasts. Overall it appears that 2 mg/day regardless of delivery leads to the highest length of odontoblasts in guinea pigs.