Statistical Inference Project: An Analysis of the Effects of Vitamin C Dosing and Supplement Type on Tooth Growth in Guinea Pigs

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Overview

In this project we will analyze the impact of vitamin C dosage (0.5, 1, and 2 mg/day) and delivery method (orange juice and ascorbic acid) on the length of odontoblasts (which are the cells responsible for tooth growth) in 60 guinea pigs.

Here is a summary of our data.

```
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
```

There are three variables: len, supp, and dose with 60 total observations.

Exploratory Analysis

First we will explore the mean odontoblast lengths versus dosage and supplement type.

```
ToothGrowth %>% group_by(dose) %>% summarize(avg=mean(len))
```

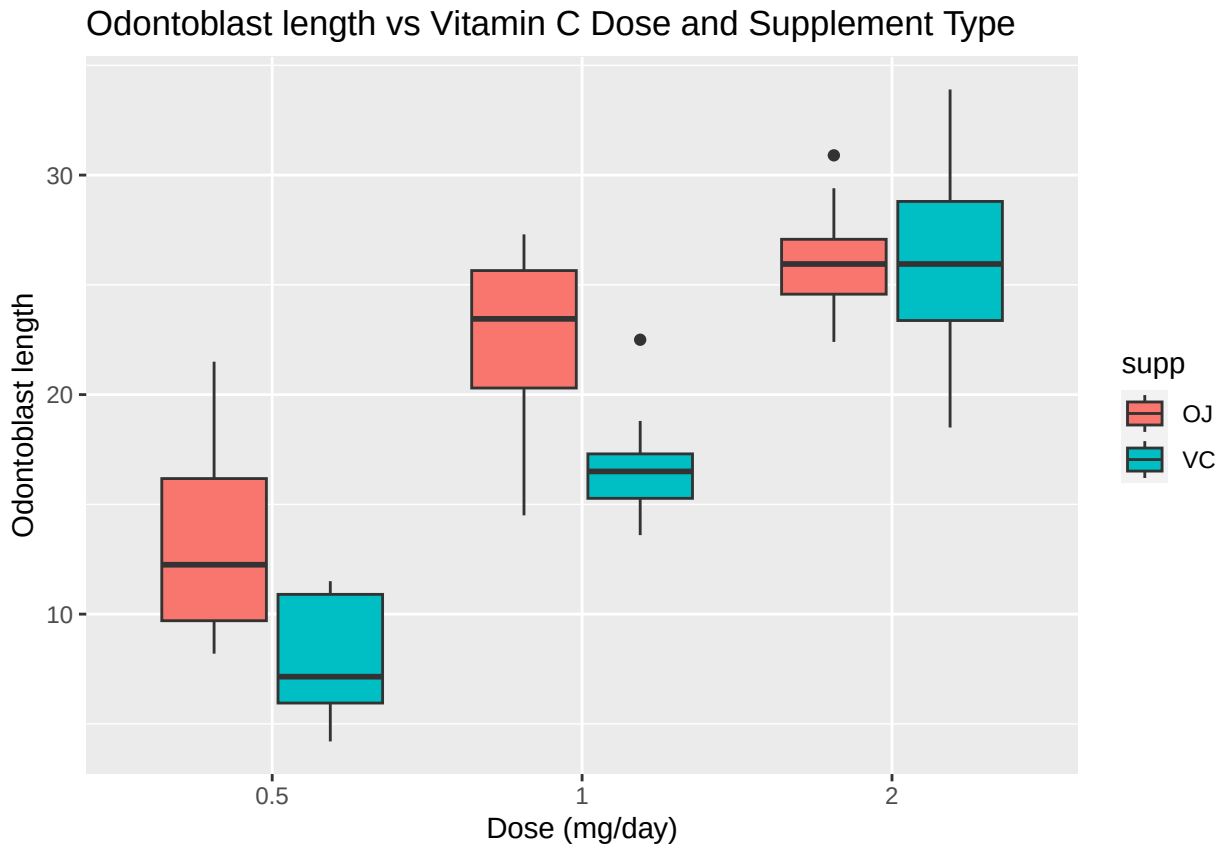
```
## # A tibble: 3 x 2
##    dose   avg
##   <dbl> <dbl>
## 1   0.5  10.6
## 2   1    19.7
## 3   2    26.1
```

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

```
## # A tibble: 6 x 3
## # Groups:   dose [3]
```

```
##    dose supp    avg
##   <dbl> <fct> <dbl>
## 1   0.5 OJ    13.2
## 2   0.5 VC     7.98
## 3   1   OJ    22.7
## 4   1   VC    16.8
## 5   2   OJ    26.1
## 6   2   VC    26.1
```

```
ToothGrowth$dose <- as.factor(ToothGrowth$dose)
g <- ggplot(data=ToothGrowth,aes(dose,len)) + geom_boxplot(aes(fill=supp)) + labs(x="Dose (mg/day)", y="
print(g)
```



The summaries and means show us that odontoblast length increases as the Vitamin C dose increases. It also shows that Orange Juice delivery results in higher growth than Ascorbic Acid at 0.5 mg/day and 1.0 mg/day of Vitamin C.

Hypotheses

We will test two main hypotheses

- Does vitamin C dose impact tooth growth?
- Does delivery method impact tooth growth?

Analyses

0.5 vs 1.0 mg/day of Vitamin C

```
t.test(len ~ dose,paired=FALSE,var.equal=FALSE,data=ToothGrowth[ToothGrowth$dose!=2,])
```

```
##
##  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 between group 0.5 and group 1 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
```

We ran an unpaired t-test comparing 0.5 and 1.0 mg/day. The average growth for 0.5 mg/day is 10.6 and the average growth for 1.0 mg/day is 19.7. The confidence interval of the difference does not contain 0 and the p value is much less than 0.05. This would indicate that 1.0 mg/day is more effective than 0.5 mg/day at driving odontoblast growth.

1.0 vs 2.0 mg/day of Vitamin C

```
t.test(len ~ dose,paired=FALSE,var.equal=FALSE,data=ToothGrowth[ToothGrowth$dose!=0.5,])
```

```
##
##  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 between group 1 and group 2 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
```

We ran an unpaired t-test comparing 1.0 and 2.0 mg/day. The average growth for 1.0 mg/day is 19.7 and the average growth for 2.0 mg/day is 26.1. The confidence interval of the difference does not contain 0 and the p value is much less than 0.05. This would indicate that 2.0 mg/day is more effective than 1.0 mg/day at driving odontoblast growth.

Orange Juice vs Ascorbic Acid at 0.5 mg/day

```
t.test(len ~ supp,paired=FALSE,var.equal=FALSE,data=ToothGrowth[ToothGrowth$dose==0.5,])
```

```
##
##  Welch Two Sample t-test
##
## data:  len by supp
## t = 3.1697, df = 14.969, p-value = 0.006359
## alternative hypothesis: true difference in means between group OJ and group VC is not equal to 0
## 95 percent confidence interval:
##  1.719057 8.780943
## sample estimates:
## mean in group OJ mean in group VC
##            13.23             7.98
```

We ran an unpaired t-test comparing orange juice and ascorbic acid at a dosage of 0.5 mg/day. The average growth for orange juice is 13.2 and the average growth for ascorbic acid is 8.0. The confidence interval of the difference does not contain 0 and the p value is much less than 0.05. This would indicate that orange juice is more effective than ascorbic acid at driving odontoblast growth at 0.5 mg/day.

Orange Juice vs Ascorbic Acid at 1.0 mg/day

```
t.test(len ~ supp,paired=FALSE,var.equal=FALSE,data=ToothGrowth[ToothGrowth$dose==1.0,])
```

```
##
##  Welch Two Sample t-test
##
## data:  len by supp
## t = 4.0328, df = 15.358, p-value = 0.001038
## alternative hypothesis: true difference in means between group OJ and group VC is not equal to 0
## 95 percent confidence interval:
##  2.802148 9.057852
## sample estimates:
## mean in group OJ mean in group VC
##            22.70            16.77
```

We ran an unpaired t-test comparing orange juice and ascorbic acid at a dosage of 1.0 mg/day. The average growth for orange juice is 22.7 and the average growth for ascorbic acid is 16.8. The confidence interval of the difference does not contain 0 and the p value is much less than 0.05. This would indicate that orange juice is more effective than ascorbic acid at driving odontoblast growth at 1.0 mg/day.

Orange Juice vs Ascorbic Acid at 1.0 mg/day

```
t.test(len ~ supp,paired=FALSE,var.equal=FALSE,data=ToothGrowth[ToothGrowth$dose==2.0,])
```

```
##
##  Welch Two Sample t-test
##
## data:  len by supp
## t = -0.046136, df = 14.04, p-value = 0.9639
## alternative hypothesis: true difference in means between group OJ and group VC is not equal to 0
## 95 percent confidence interval:
```

```
##  -3.79807  3.63807
## sample estimates:
## mean in group OJ mean in group VC
##            26.06            26.14
```

We ran an unpaired t-test comparing orange juice and ascorbic acid at a dosage of 2.0 mg/day. The average growth for orange juice is 26.1 and the average growth for ascorbic acid is 26.1. The confidence interval of the difference does contain 0 and the p value is 0.96. This would indicate that there is no observable difference between orange juice and ascorbic acidd at driving odontoblast growth at 2.0 mg/day.