Effect of Vitamin C on Tooth Growth in Guinea Pigs

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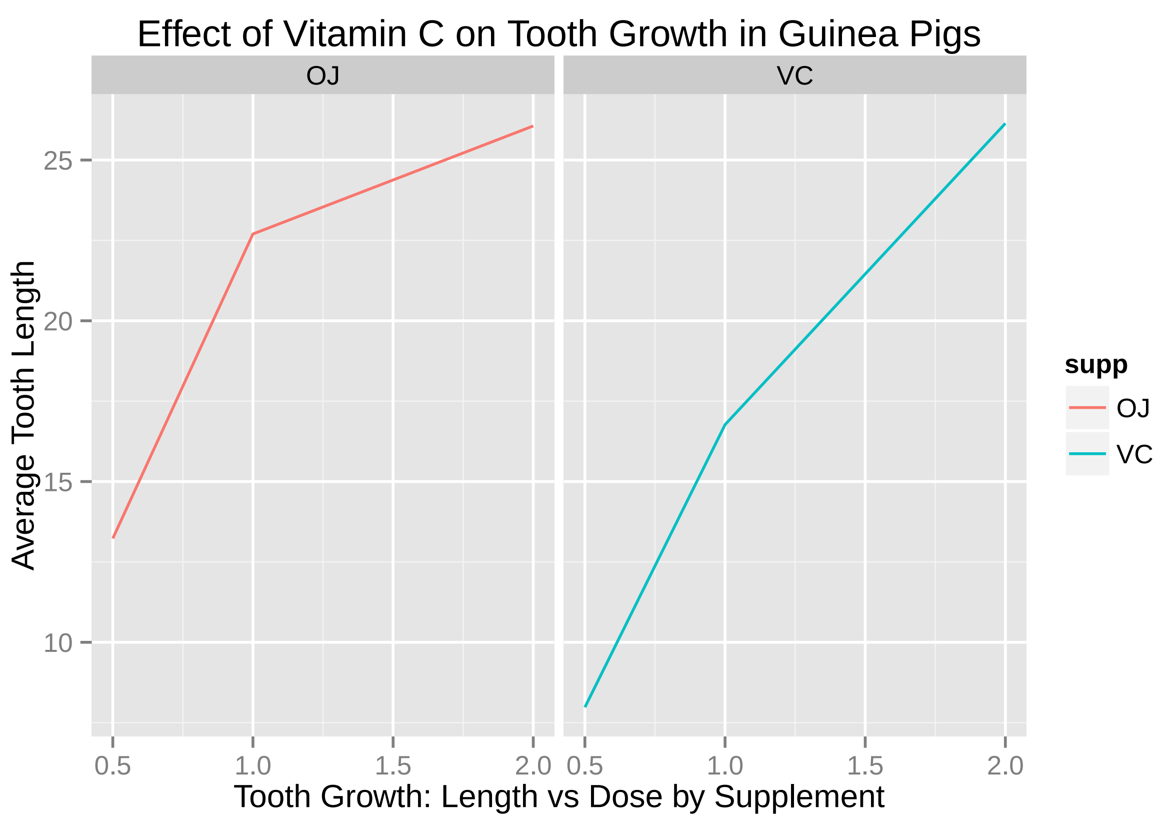
Overview:

This paper delves into the effect of vitamin C on tooth growth in Guinea Pigs to determine if the there is a significant difference in either delivery method or dosage. Let us begin by pulling in the data and doing some elementary visual exploratory analysis of mean tooth growth at each dosage level for a given delivery method. ##Exploratory Analysis:

```
library(magrittr)
suppressMessages(library(dplyr))
library(ggplot2)

data(ToothGrowth)
ToothGrowthSummary <- ToothGrowth  %>% group_by(supp, dose) %>%
    summarize(mean_len = mean(len))
ggplot(ToothGrowthSummary, aes(x=dose, y = mean_len, col=supp)) +
    geom_line() + facet_grid(. ~ supp) +
    labs(x = 'Tooth Growth: Length vs Dose by Supplement',
         y = 'Average Tooth Length') +
    ggtitle('Effect of Vitamin C on Tooth Growth in Guinea Pigs')
```



Given the plot, it would seem intuitive that there is no significant difference in delivery methods of vitamin C at dosages of 2.0 mg. However, there may be a significant difference at levels .5 and 1.0. The following 'R' functions will be used to determine if there is indeed a significant difference at the questionable dosage levels or is it just statistical chance.

Confidence Limit Testing

For each dosage level the two sided T test with default of 95% confidence is chosen over the a standard normal test, due to the small sample size. Furthermore, we shall be conservative and choose to assume unequal variance across the two delivery methods.

The assumed default alternative hypothesis for the 't' test is "two.sided" meaning that the difference in sample means of the two delivery methods is H_A is $\mu_{OJ} \neq \mu_{VC}$. Thus our NULL hypothesis, H_0 is $\mu_{OJ} = \mu_{VC}$

```r
# Subset the data for 0.5 mg doseage by delivery method.
OJ0_5 <- ToothGrowth %>% filter(supp=='OJ' & dose < 1.0)
VC0_5 <- ToothGrowth %>% filter(supp=='VC' & dose < 1.0)

# Two sided 'T' test assumming unequal variance across groups at 0.5 mg doseage
t.test(OJ0_5$len - VC0_5$len, paired=F, var.equal = TRUE)
```

```
##
##  One Sample t-test
##
## data:  OJ0_5$len - VC0_5$len
## t = 2.9791, df = 9, p-value = 0.01547
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  1.263458 9.236542
## sample estimates:
## mean of x
##      5.25
```

Given the large statistic, and p value $< .05$, we reject the H_0 and accept H_A that the difference in tooth growth at 0.5 mg across the two delivery methods is statistically significant; the sample means are not equal. We also see evidence of this in the fact that 0 is not contained in the confidence interval.

```r
# Subset the data for 1.0 mg doseage by delivery method.
OJ1_0 <- ToothGrowth %>% filter(supp=='OJ' & dose > .5 & dose < 2.0)
VC1_0 <- ToothGrowth %>% filter(supp=='VC' & dose > .5 & dose < 2.0)

# Two sided 'T' test assumming unequal variance across groups at 1.0 mg doseage
t.test(OJ1_0$len - VC1_0$len, paired=F, var.equal = TRUE )
```

```
##
##  One Sample t-test
##
## data:  OJ1_0$len - VC1_0$len
## t = 3.3721, df = 9, p-value = 0.008229
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  1.951911 9.908089
```

```
## sample estimates:
## mean of x
##      5.93
```

Again given the large statistic, and p value $< .05$, we reject the H_0 and accept H_A, that the difference in tooth growth at 1.0 mg across the two delivery methods is statistically significant; the sample means are not equal. We also see evidence of this in the fact that 0 is not contained in the confidence interval.

```r
# Subset the data for 2.0 mg doseage by delivery method.
OJ2_0 <- ToothGrowth %>% filter(supp=='OJ' & dose > 1.0)
VC2_0 <- ToothGrowth %>% filter(supp=='VC' & dose > 1.0)

# Two sided 'T' test assumming equal variance across groups at 2.0 mg doseage
t.test(OJ2_0$len - VC2_0$len,  paired=F, var.equal = TRUE)
```

```
##
##  One Sample t-test
##
## data:  OJ2_0$len - VC2_0$len
## t = -0.0426, df = 9, p-value = 0.967
## alternative hypothesis: true mean is not equal to 0
## 95 percent confidence interval:
##  -4.328976  4.168976
## sample estimates:
## mean of x
##     -0.08
```

At 2.0 mg there is a different outcome from the previous two cases. Here our test reports a small t statistic, and p value $> .05$. We also observe that the confidence interval of the test contains 0. Consequently the NULL hypothesis H_0 should be accepted. There is a statistically insignificant difference in tooth growth at 2.0 mg across the two delivery methods.