Effect of Vitamin C Delivery Methods and Dosage on Tooth Growth in Guinea Pigs

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February 5, 2559 BE

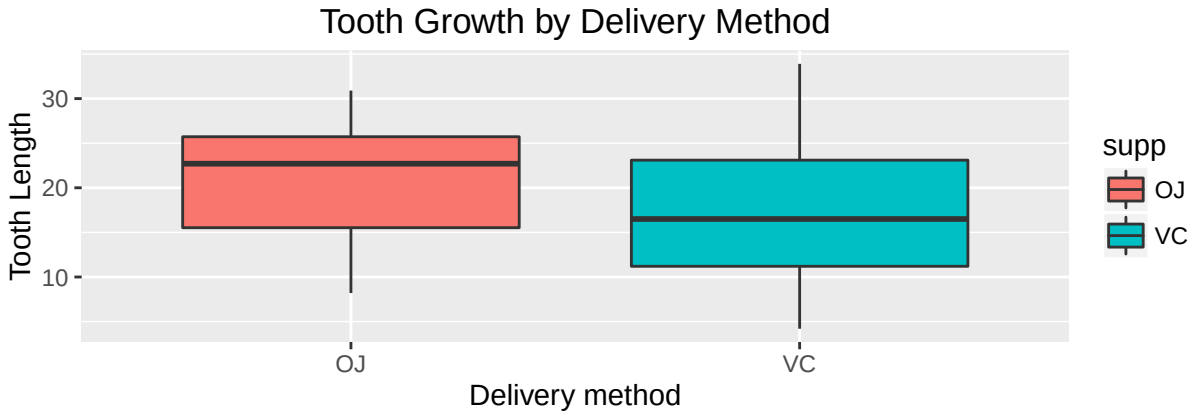
Overview

The ToothGrowth dataset investigates the effect of vitamin C on tooth growth in 60 guinea pigs. It consists of response (tooth length), delivery methods (supp) and dosage of vitamin C (dose).

Exploratory Data Analysis

Effects of Delivery Method and Dosage on Tooth Growth

Both delivery methods seem to have similar effect on tooth growth. OJ has higher mean whereas VC has higher variability. Dosage seems to have a positive relationship with tooth length. OJ seems to have better effect when dose is 0.5 and 1.0 whereas both seems to be about as effective at 2.0 dose.



Variable Transformation

Tooth length (len) is a numerical data where as delivery methos (supp) and dosage of vitamin C (dose) are categorical variables. Dosage consists of only 0.5, 1.0, 2.0 so it is more suitably treated as categorical variable.

```
##       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
```

Hypothesis Tests and Confidence Intervals

Effects by Delivery Methods

We perfrom two-tailed unpaired t-test with unequal variances to find out if different delivery methods have different effects on tooth length. p-value:

```
## [1] 0.06063451
```

Confidence interval at 95%:

```
## [1] -0.1710156  7.5710156
```

Effects by Dosage

We perfrom one-tailed unpaired t-test with equal variances to find out if different dosage have different effects on tooth length.

Dose: 0.5 has less effect than 1.0

p-value:

```
## [1] 6.341504e-08
```

Confidence interval at 95%:

```
## [1]      -Inf -6.753323
```

Dose: 1.0 has less effect than 2.0

```
## [1] 9.532148e-06
```

Confidence interval at 95%:

```
## [1]     -Inf -4.17387
```

Effects by Dosage Controlled by Delivery Methods

We perfrom two-tailed unpaired t-test with equal variances to find out if different dosage (0.5, 1.0 and 2.0) have different effects on tooth length when controlling by delivery methods.

Difference between 0.5 Dosage of OJ and AC

```
## [1] 0.006358607
```

Confidence interval at 95%:

```
## [1] 1.719057 8.780943
```

Difference between 1.0 Dosage of OJ and AC

```
## [1] 0.001038376
```

Confidence interval at 95%:

```
## [1] 2.802148 9.057852
```

Difference between 2.0 Dosage of OJ and AC

```
## [1] 0.9638516
```

Confidence interval at 95%:

```
## [1] -3.79807  3.63807
```

Conclusion

From testing the hypotheses we can conclude that:

- Delivery methods do not have differing effects on tooth growth.
- Dosage positively affects tooth growth.
- OJ and VC have statistically different effects at 0.5 and 1.0 dose (most likely OJ is more effective); the difference is not statistically significant at 2.0 dose.

The underlying assumptions for these conclusions are:

- The guinea pigs are randomized to each delivery method and dosage, thus the effect of confounders are minimized.
- The 60 guinea pigs are representative of the guinea pig population, in order for the our sample results to be generalized.
- Respective assumptions for hypothesis tests already mentioned in the section above.

Appendix

All codes used to create the report. Download data and get summary.

```
data("ToothGrowth")
tooth <- ToothGrowth
summary(tooth)
```

Plot exploratory data analysis.

```
require(ggplot2)
require(gridExtra)
#By delivery methods
g1<-ggplot(aes(x = supp, y = len), data = ToothGrowth)  +
       geom_boxplot(aes(fill = supp))  +
       labs(title = "Tooth Growth by Delivery Method") +
       labs(x = "Delivery method") + labs(y="Tooth Length")

#By deliver methods and dosage
g2<-ggplot(aes(x = supp, y = len), data = ToothGrowth)  +
       geom_boxplot(aes(fill = supp)) + facet_wrap(~ dose) +
       labs(title = "Tooth Growth by Delivery Method and Dosage") +
       labs(x = "Delivery method") + labs(y="Tooth Length")

#Plot both
grid.arrange(g1,g2,ncol=1)
```

Hypothesis Test 1

```
t1<-t.test(data=tooth,len~supp,paired=FALSE,var.equal=FALSE)
t1$p.value
t1$conf.int[1:2]
```

Hypothesis Test 2

```
t2<-t.test(data=tooth[tooth$dose==0.5|tooth$dose==1.0,],len~dose,paired=FALSE,
           var.equal=FALSE,alternative='less')
t2$p.value
t2$conf.int[1:2]
```

Hypothesis Test 3

```
t3<-t.test(data=tooth[tooth$dose==1.0|tooth$dose==2.0,],len~dose,paired=FALSE,
           var.equal=FALSE,alternative='less')
t3$p.value
t3$conf.int[1:2]
```

Hypothesis Test 4

```
t4<-t.test(data=tooth[tooth$dose==0.5&(tooth$supp=='OJ'|tooth$supp=='VC'),],
           len~supp,paired=FALSE,var.equal=FALSE)
t4$p.value
t4$conf.int[1:2]
```

Hypothesis Test 5

```
t5<-t.test(data=tooth[tooth$dose==1.0&(tooth$supp=='OJ'|tooth$supp=='VC'),],
           len~supp,paired=FALSE,var.equal=FALSE)
t5$p.value
t5$conf.int[1:2]
```

Hypothesis Test 6

```
t6<-t.test(data=tooth[tooth$dose==2.0&(tooth$supp=='OJ'|tooth$supp=='VC'),],
           len~supp,paired=FALSE,var.equal=FALSE)
t6$p.value
t6$conf.int[1:2]
```