

Effect of Vitamin C supplement type on Tooth Growth

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Overview

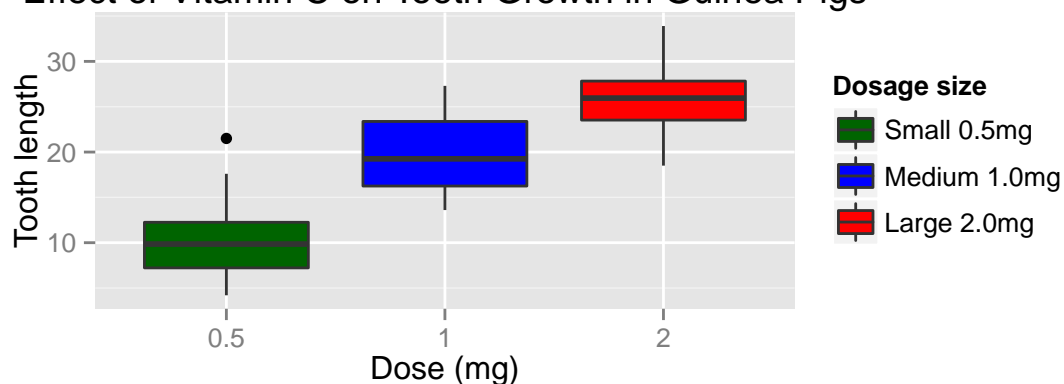
This project will consider the data describing the Effect of Vitamin C on Tooth Growth in Guinea Pigs. These data are sourced from the r datasets and are described at <https://stat.ethz.ch/R-manual/R-devel/library/datasets/html/ToothGrowth.html>.

Summary of tooth growth data for sample guinea pigs

The ToothGrowth dataset is measures of teeth growth between sample groups of guinea pigs. These subjects are split into two groups: one group with a vitamin C solution (VC) and the other group with orange juice (OJ). The dosages within these two groups were varied with some subjects receiving 0.5, 1.0 and 2.0 doses.

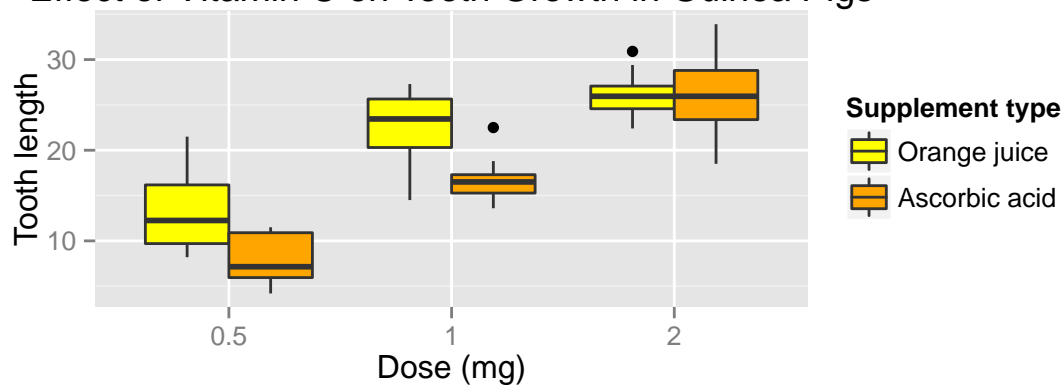
Visualising the dataset gives an overview of the effect of dosage on the tooth growth in the subjects:

Effect of Vitamin C on Tooth Growth in Guinea Pigs



Breaking this down further gives an overview of the variation in the effect of supplement type, at these dosages, on the subjects:

Effect of Vitamin C on Tooth Growth in Guinea Pigs



Assessing the data visually, we can see the dosage size has an effect on tooth growth, with higher dosages having a greater effect. Interestingly, there is a noticeable difference between the mean tooth length for the two methods at low and medium dosages, but there is no discernable difference at a high dosage. This analysis will focus on understanding if there is a statistically significant difference between the two supplement types.

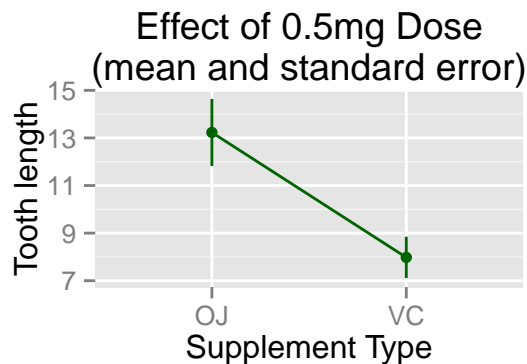
Hypothesis test - Does supplement method affect tooth growth?

The null hypothesis is that the supplement type for delivering vitamin C to the test subjects have the same impact on tooth length. We are testing this same hypothesis at different dosage levels. The alternative hypothesis is that delivering vitamin C by a vitamin C solution, VC, or delivering vitamin C by orange juice, OJ, have different impacts on tooth length. One method may have a stronger or weaker effect than the other.

We'll reject this null hypothesis and accept the alternate if it is less than 5% likely that it is true. That is we'll conclude there is no difference in the effect on tooth growth between the different supplement types. We'll accept the null hypothesis and reject the alternate if it's 95% likely that it is true. That is we'll conclude there is a significant difference in the effect on tooth growth between the different supplement types.

Consider low dosage of 0.5

- Mean tooth length for 0.5 dose by VC is 8 and mean tooth length for 0.5 dose by OJ is 13.
- The variance for 0.5 dose by VC is 7.5 and the variance for 0.5 dose by OJ is 20

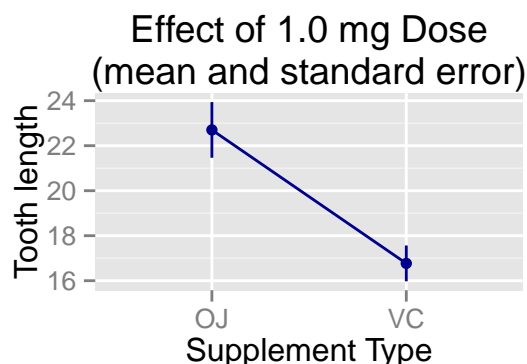


Applying a two-tailed t.test to these two samples with different variances based on the hypothesis that the means are not significantly different, returns a confidence interval of -8.8, -1.7 and a p-value of 0.0064.

This tells us we can only be 0.64% certain that the difference between the means of the samples can be explained as sampling error, this is outside our 95% confidence interval. We can discard the null hypothesis in favour of the alternate. That is, there is a significant difference between the two methods in their effect on tooth length at a medium dosage. The nature of this difference is that OJ has a greater effect on tooth growth than VC at a low dosage.

Consider medium dosage of 1.0

- Mean tooth length for 1.0 dose by VC is 17 and mean tooth length for 1.0 dose by OJ is 23.
- The variance for 1.0 dose by VC is 6.3 and the variance for 1.0 dose by OJ is 15

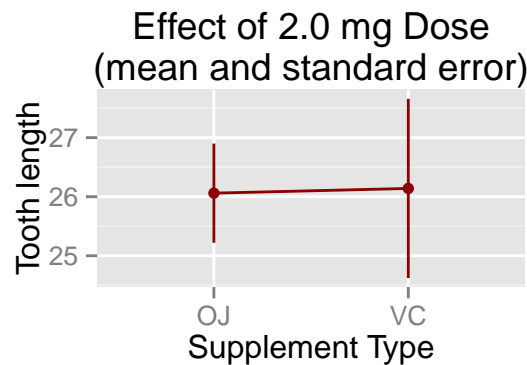


Applying a two-tailed t.test to these two samples with different variances based on the hypothesis that the means are not significantly different, returns a confidence interval of -9.1, -2.8 and a p-value of 0.001.

This tells us we can only be 0.1% certain that the difference between the means of the samples can be explained as sampling error, this is outside our 95% confidence interval. We can discard the null hypothesis in favour of the alternate. That is, there is a significant difference between the two methods in their effect on tooth length at a medium dosage. The nature of this difference is that OJ has a greater effect on tooth growth than VC at a medium dosage.

Consider high dosage of 2.0

- Mean tooth length for 2.0 dose by VC is 26 and the mean tooth length for 2.0 dose by OJ is 26.
- Variance for 2.0 dose by VC is 23 and the variance for 2.0 dose by OJ is 7



Applying a two-tailed t.test to these two samples with different variances based on the hypothesis that the means are not significantly different, returns a confidence interval of -3.6380705, 3.7980705 and a p-value of 0.9638516. So there is very little difference between the means but the variation is quite different.

This tells us we can be 96% certain that the difference between the means of the samples can be explained as sampling error. We can accept the null hypothesis. That is, there is no significant difference between the two supplement types in their effect on tooth length at a high dosage.

Conclusions and assumptions

The ToothGrowth data shows the effect of vitamin C dosage at 0.5mg, 1.0mg and 2.0mg, as well the effect of supplement types, vitamin C solution or orange juice, on the tooth growth of small sample groups guinea pigs. We've considered the difference in effect of the supplement type at the different dosages. Because the sample size is small, this difference is assessed using the t-distribution, to test whether the difference could be the result of sample error or the result of a difference in the effect of the supplement types.

For this analysis, I have assumed a 95% confidence interval on a two-tailed test. That is, I have considered whether there is a positive or negative difference between VC and OJ supplement types and their effect on tooth growth at different vitamin C dosages.

In conclusion, there is a significant difference in effect on tooth growth between the supplement types at low and medium dosages however there is no difference in effect between the supplement types at high dosages.