Statistics 305/605: Introduction to Biostatistical Methods for Health Sciences

R Demo for Chapter 11 : Inference for Two Means

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Example Data: Low Birthweight Infants

- Data on 100 infants born with birth weight less than 1500g.
  - Variables are: head circumference (cm), birth length (cm), gestational age (wks), birth weight (g), mother's age (yrs), and toxemia (1=high blood pressure during pregnancy, 0=not)

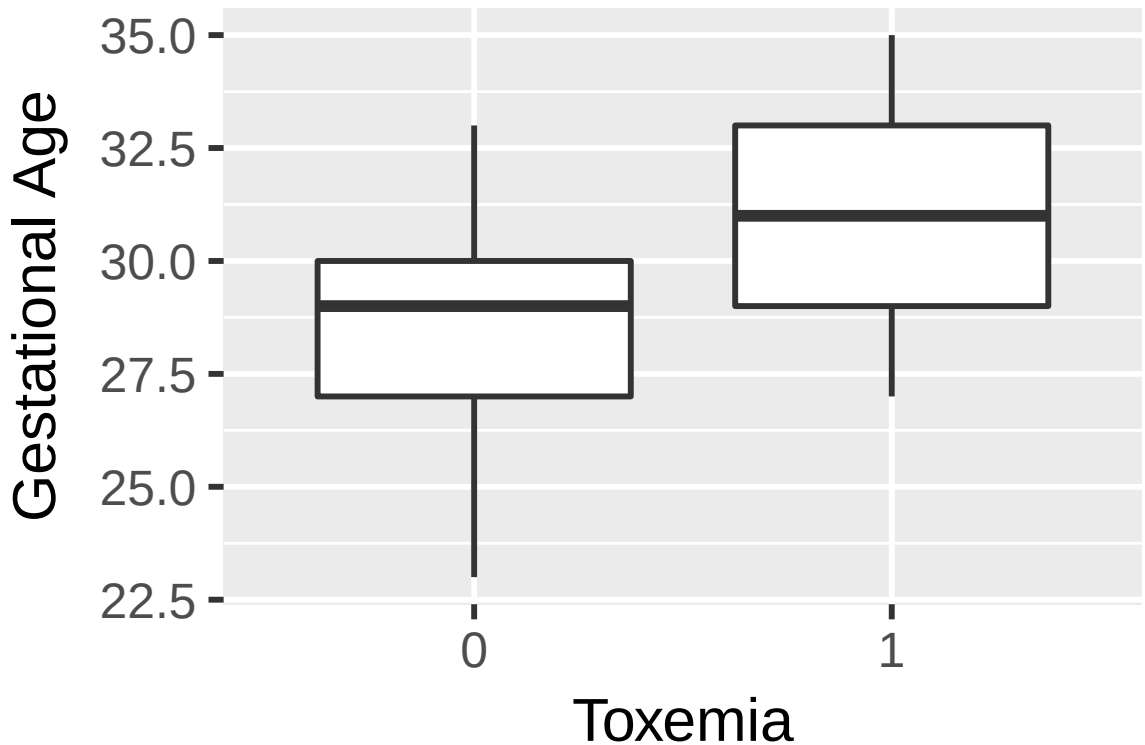
```
uu <- url("http://people.stat.sfu.ca/~jgraham/Teaching/S305_17/Data/lbwt.csv")
lbwt <- read.csv(uu)
head(lbwt)
```

```
##   headcirc length gestage birthwt momage toxemia
## 1       27     41      29    1360     37       0
## 2       29     40      31    1490     34       0
## 3       30     38      33    1490     32       0
## 4       28     38      31    1180     37       0
## 5       29     38      30    1200     29       1
## 6       23     32      25     680     19       0
```

Gestational Age by Toxemia: Boxplots

- Explore differences graphically with boxplots:

```
library(dplyr)
lbwt <- mutate(lbwt,toxCateg = factor(toxemia))
library(ggplot2)
ggplot(lbwt,aes(x=toxCateg,y=gestage)) +
         labs(x="Toxemia",y="Gestational Age") + geom_boxplot()
```



Software Notes

- Use `mutate()` to make changes to a dataset.
  - In the example, we added a new variable called `toxCateg` to the `lbwt` dataset.
  - Whereas `toxemia` is a numeric variable with values 0 and 1, `toxCateg` is an explicitly categorical (or `factor`) variable, still having values 0 and 1.
  - In R, categorical variables are known as "factors".
- We have used `ggplot()` to do the boxplots of `gestage` by toxemia categories (`toxCateg`).
  - For a boxplot, the call to aesthetic argument, `aes`, must specify an x-variable that is a factor.
  - `labs()` specifies the x- and y-axis labels.
  - `geom_boxplot()` adds the boxplots.
- Note: Data "wrangling", processing and graphics take up 90% of an analyst's time (that's why data scientists get paid big bucks). Not to worry though because we will have templates to work from in this class.

Gestational Age by Toxemia: Histograms

```
ggplot(lbwt,aes(x=gestage,fill=toxCateg)) +
         labs(x="Gestational Age") + geom_histogram(binwidth=1)
```

Software Note

- For a histogram, setting the aesthetic argument `fill` to `fill=toxCateg` specifies that the bars of the histogram are to be filled with different colors for the different categories of `toxCateg`.
  - Gives the impression of histograms stacked one upon the other.

Gestational Age by Toxemia: Summary Statistics

- The sample means and SDs of gestational age for each toxemia category are summarized below.

```
library(dplyr)
lbwt %>%
  group_by(toxCateg) %>%
  summarize(mean=mean(gestage),sd=sd(gestage))
```

```
## # A tibble: 2 x 3
##   toxCateg     mean       sd
##      <fctr>    <dbl>    <dbl>
## 1        0 28.35443 2.320687
## 2        1 30.90476 2.321740
```

Software Notes

```
lbwt %>%
  group_by(toxCateg) %>%
  summarize(mean=mean(gestage),sd=sd(gestage))
```

- The code that produced the summaries should be read as:
  - Start with the `lbwt` dataset,
  - Group observations in this dataset by the variable `toxCateg`; i.e., partition the observations into groups defined by the categories of `toxCateg`, and
  - Summarize the sample mean and SD of the `gestage` variable within each group.
  - The "forward pipe" %>% is the "glue" that connects these steps together.
- This short video (time 5:22) gives a nice explainer on the forward pipe.

Gestational Age Differences by Toxemia

Can use a 2-sample t-test:

```
t.test(gestage ~ toxCateg,data=lbwt,conf.level=0.90)
```

```
##
##  Welch Two Sample t-test
##
## data:  gestage by toxCateg
## t = -4.4745, df = 31.465, p-value = 9.365e-05
## alternative hypothesis: true difference in means is not equal to 0
## 90 percent confidence interval:
##  -3.516280 -1.584383
## sample estimates:
## mean in group 0 mean in group 1
##        28.35443        30.90476
```

- In the call to `t.test()`, the "formula" `gestage ~ toxCateg` tells R to think of `gestage` as a function of `toxCateg`.
  - We'll use R formulas again when we study regression.
- The argument `conf.level` sets the level, or coverage probability, C, of the CI.

Reading the output

```
##
##  Welch Two Sample t-test
##
## data:  gestage by toxCateg
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## alternative hypothesis: true difference in means is not equal to 0
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## mean in group 0 mean in group 1
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```

- Under H_0, the test statistic T's distribution is approximately a t distribution on $\nu = 31.465$ degrees of freedom.
- The software compares the observed value -4.4745 of the test statistic to this reference distribution, to get a p-value of .00009366115.
- It gives the requested 90% CI for the difference in group means.
- It also gives us the sample means in the 2 groups.