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JOHNS HOPKINS
BLOOMBERG
SCHOOL of PUBLIC HEALTH

Section E

The Unpaired t-test: More Examples

Example 1: CE Costs in Maryland

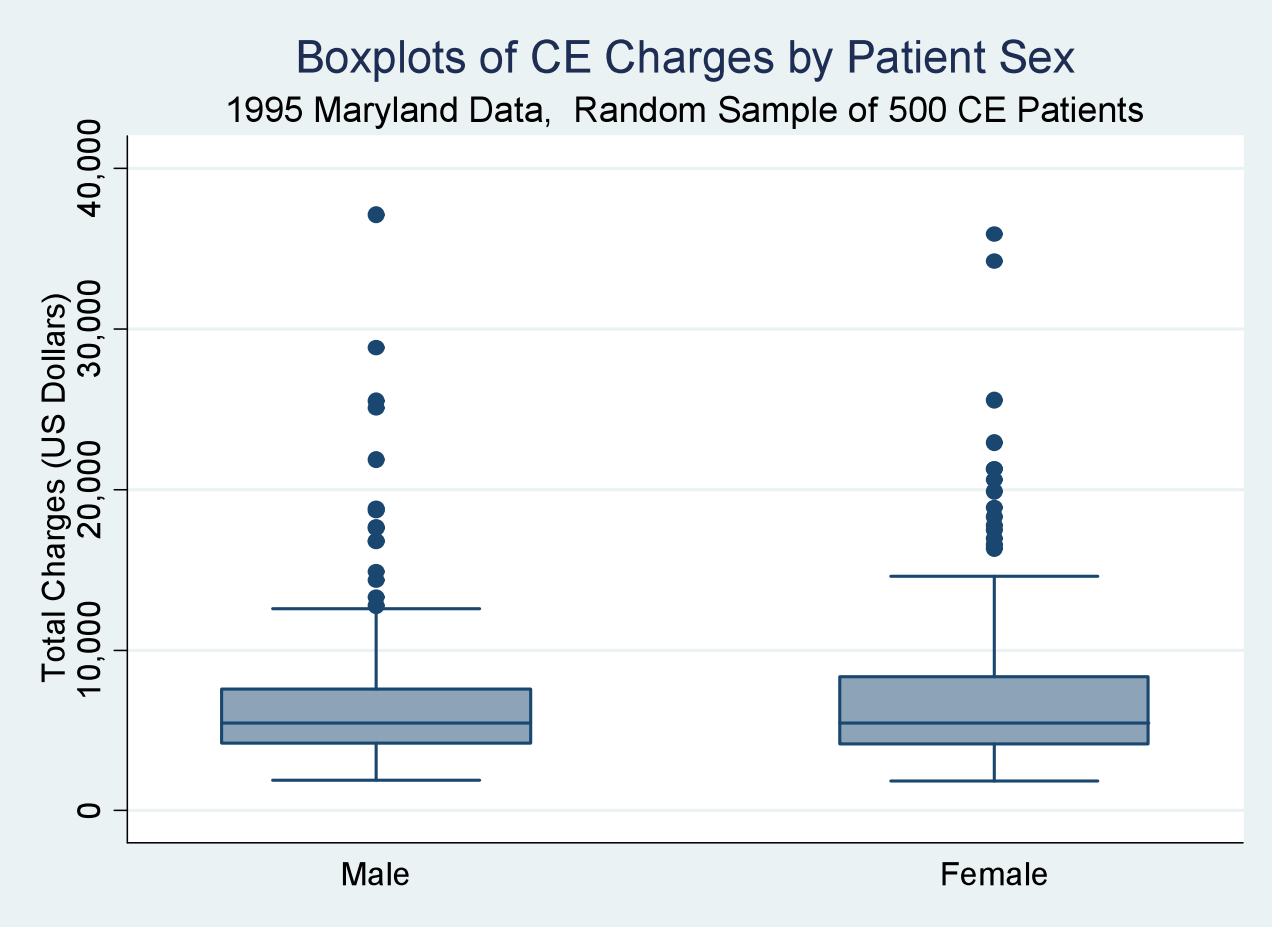
- Random sample of 500 Carotid Endarterectomy (CE) procedures performed in State of Maryland, 1995

- Some results:

	Males	**Females**
Mean Charges (U.S. $)	6,615	7,088
SD (U.S. $)	4,220	4908
N	271	229

Example 1 :Boxplots!

- We actually have luxury of individual level data here



Example 1

- 95% CIs for 1995 CE costs by patient sex
  - Females: $7{,}088 \pm 2 \times \frac{4{,}908}{\sqrt{229}} \rightarrow 7{,}088 \pm 2 \times 324 \rightarrow (\$6{,}440\,,\,\$7{,}736)$
  - Males: $6{,}615 \pm 2 \times \frac{4{,}220}{\sqrt{271}} \rightarrow 6{,}615 \pm 2 \times 256 \rightarrow (\$6{,}103\,,\,\$7{,}127)$

Example 1

- Two sample t-test, unequal standard deviations assumption

```
. ttesti 229 7088 4908 271 6615 4220, unequal

Two-sample t test with unequal variances
------------------------------------------------------------------------------
         |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       x |     229        7088    324.3298        4908    6448.933    7727.067
       y |     271        6615    256.3467        4220    6110.307    7119.693
---------+--------------------------------------------------------------------
combined |     500    6831.634    203.4591    4549.484    6431.892    7231.376
---------+--------------------------------------------------------------------
    diff |                 473    413.4047               -339.4305    1285.431
------------------------------------------------------------------------------
    diff = mean(x) - mean(y)                                      t =   1.1442
Ho: diff = 0                     Satterthwaite's degrees of freedom =  452.669

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.8734         Pr(|T| > |t|) = 0.2532          Pr(T > t) = 0.1266
```

Example 1: Summary

- In a study conducted to assess determinants of CE procedure costs in Maryland, a random sample of 500 CE patients from 1995 was analyzed

- This consisted of 229 females with average costs of $7,088 (95% CI: 6,440 to 7,736), and 271 males with average costs $6,625 (95% CI: 6,103 to 7,127)

- While the females in the sample had average costs of $473 greater than males in the samples, this difference in average costs is not statistically significant (p = .25)
  - The 95% CI for the female to male average cost differential is $-339 to $1,285

Example 2

- The following data is taken from a 1990 study comparing (random samples of) adolescents with bulimia to adolescents without bulimia; both groups had similar body composition and levels of physical activity*

- The following table shows summary data on daily calorie intake by bulimia status

	Bulimia	**No Bulimia**
Mean Daily Caloric Intake (kcal/kg)	22.1	29.7
SD (kcal/kg))	4.6	6.5
N	23	15

Source: *Example based on data taken from Pagano, M., Gauvreau, K. (2000). Principles of biostatistics, 2nd ed. Duxbury Press (based on research by Gwirtsman, et al. (1989) Decreased calorie intake. *American Journal of Clinical Nutrition*, 49.

Example 2

- Abstract from article:

ABSTRACT: Patients with bulimia (binge-purge syndrome) frequently complain that they consume a very restrictive diet to avoid gaining weight. To investigate this claim, 23 hospitalized bulimic patients were assessed daily for bodyweight, caloric intake, macronutrient diet content, activity measures, and body composition estimates during weight-stable periods. Bulimic. patients ate fewer kilocalories per kilogram body weight (22.1 ±4.6 kcal/kg) than did age-matched normal women (29.7 ±6.5 kcal/kg) but had similar activity levels and body composition. Clinical variables, such as history of laxative abuse, anorexia, or obesity, and physiological characteristics, such as body weight, activity level, or dietary content, could not account for this difference in caloric consumption. Bulimic patients tended to eat a diet lower in fat and higher in protein than did control subjects. These results agree with observations of increased efficiency ofcaloric utilization in obese patients and support patient complaints of a tendency to gain weight easily.

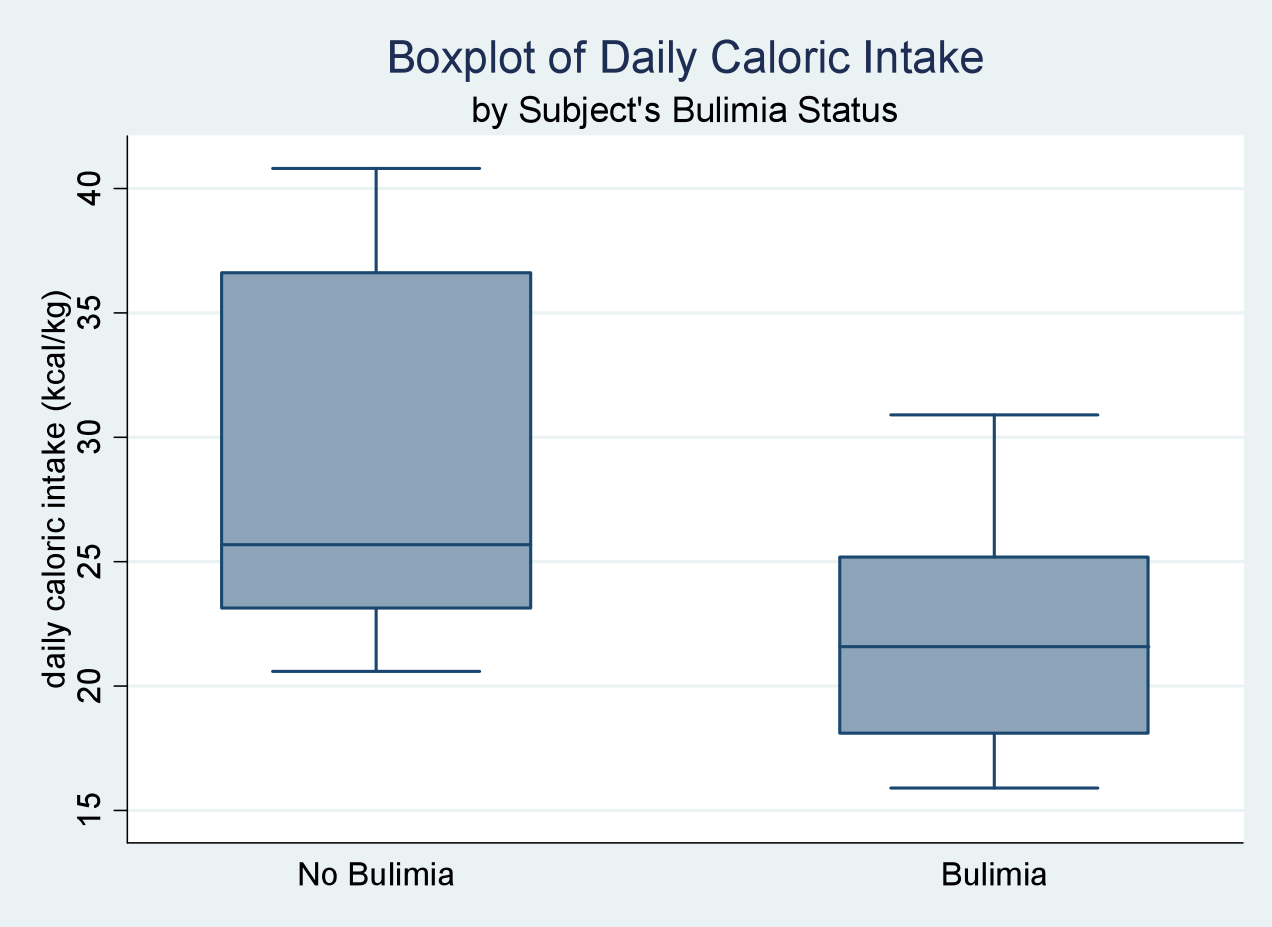
Example 2

- Abstract from article:

ABSTRACT: Patients with bulimia (binge-purge syndrome) frequently complain that they consume a very restrictive diet to avoid gaining weight. To investigate this claim, 23 hospitalized bulimic patients were assessed daily for bodyweight, caloric intake, macronutrient diet content, activity measures, and body composition estimates during weight-stable periods. Bulimic. patients ate fewer kilocalories per kilogram body weight (22.1 ±4.6 kcal/kg) than did age-matched normal women (29.7 ±6.5 kcal/kg) but had similar activity levels and body composition. Clinical variables, such as history of laxative abuse, anorexia, or obesity, and physiological characteristics, such as body weight, activity level, or dietary content, could not account for this difference in caloric consumption. Bulimic patients tended to eat a diet lower in fat and higher in protein than did control subjects. These results agree with observations of increased efficiency ofcaloric utilization in obese patients and support patient complaints of a tendency to gain weight easily.

Example 2: Boxplots

- Again, luxury of individual level data:



Example 2

- 95% CIs for average daily calorie intake by bulimia status
  - Bulimia: $22.1 \pm t_{.95,22} \times \frac{4.6}{\sqrt{23}} \rightarrow 22.1 \pm 2.07 \times .96 \approx (20.1\,kcal/kg\,, 24.1\,kcal/kg)$
  - No bulimia: $29.7 \pm t_{.95,14} \times \frac{6.5}{\sqrt{15}} \rightarrow 29.7 \pm 2.14 \times 1.7 \rightarrow (26.1\,kcal/kg,\ 33.3\,kcal/kg)$

Example 2 in Stata

- Two sample t-test, unequal standard deviations assumption:

```
. ttesti 23 22.1 4.6 15 29.7 6.5, unequal

Two-sample t test with unequal variances
------------------------------------------------------------------------------
         |     Obs        Mean    Std. Err.   Std. Dev.   [95% Conf. Interval]
---------+--------------------------------------------------------------------
       x |      23        22.1    .9591663         4.6    20.11081    24.08919
       y |      15        29.7    1.678293         6.5    26.10042    33.29958
---------+--------------------------------------------------------------------
combined |      38        25.1     1.06055    6.537666    22.95112    27.24888
---------+--------------------------------------------------------------------
    diff |                -7.6    1.933046               -11.59811   -3.601887
------------------------------------------------------------------------------
    diff = mean(x) - mean(y)                                      t =  -3.9316
Ho: diff = 0                     Satterthwaite's degrees of freedom =  23.0727

    Ha: diff < 0                 Ha: diff != 0                 Ha: diff > 0
 Pr(T < t) = 0.0003         Pr(|T| > |t|) = 0.0007          Pr(T > t) = 0.9997
```

Summary

- From the article:

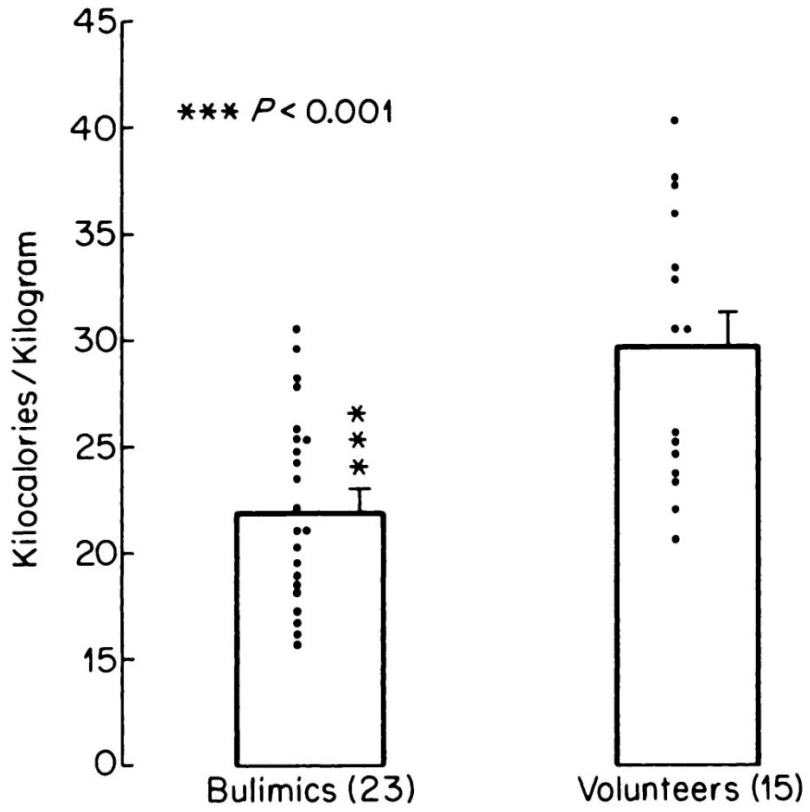


FIG 1. Normal-weight bulimic patients (n = 23) had significantly lower caloric intake per kilogram body weight than age- and sex-matched volunteers (n = 15). This was highly significant ($p < 0.001$)