# QALY Analysis

## Univariate Results Summary Table

<table>
<thead>
<tr>
<th></th>
<th>QALYS</th>
<th>InQALYS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>T-test</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Normality tests</td>
<td>Failed</td>
<td>Failed</td>
</tr>
<tr>
<td>Variance equality</td>
<td>Equal</td>
<td>Unequal</td>
</tr>
<tr>
<td>Average Difference</td>
<td>0.21</td>
<td>0.381</td>
</tr>
<tr>
<td>95% CI</td>
<td>0.079 to 0.155</td>
<td>.341 to 0.606</td>
</tr>
<tr>
<td>P value, equal</td>
<td>0.002</td>
<td>0.001</td>
</tr>
<tr>
<td>P value, unequal</td>
<td>0.002</td>
<td>0.001</td>
</tr>
<tr>
<td><strong>Rank Sum (p value)</strong></td>
<td>0.002</td>
<td>0.002</td>
</tr>
<tr>
<td>Kolm-Smirnov (p value)</td>
<td>0.007</td>
<td>0.007</td>
</tr>
<tr>
<td><strong>Bootstrap</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg Diff</td>
<td>0.211</td>
<td></td>
</tr>
<tr>
<td>Nonparametric CI</td>
<td>0.082 to 0.339</td>
<td></td>
</tr>
<tr>
<td>P value, 1-sided nonpar</td>
<td>0.0000</td>
<td></td>
</tr>
<tr>
<td>Parametric CI</td>
<td>0.083 to 0.338</td>
<td></td>
</tr>
<tr>
<td>P value, 2-sided par</td>
<td>0.001</td>
<td></td>
</tr>
</tbody>
</table>

---

```
log: d:\henry\hgclass\costs\analdata\isp2003\data\isporqly.log
log type:  text
opened on:  4 May 2003, 14:09:04
.
. set more off
. clear
. use isporcea
.
* ANALYZE QALYS (variable=qaly)
.
* Summarize the data
.
. sum qaly if treat==0,detail
Disc QALYs, 2 yrs FUP
-------------------------------------------------------------
Percentiles      Smallest
1%        .0839          .0839
5%      .090225          .0839
10%        .105           .08435       Obs                 100
25%      .272           .0848       Sum of Wgt.         100
50%     .5615358                      Mean           .6706056
75%     1.076117       1.475689       Largest       Std. Dev.      .4584712
90%     1.370417       1.584689       Variance       .2101958
95%     1.437619       1.688058       Skewness       .4859957
99%     1.713539       1.739058       Kurtosis       2.096201
.
. sum qaly if treat==1,detail
Disc QALYs, 2 yrs FUP
-------------------------------------------------------------
Percentiles      Smallest
1%      .132275          .12845
5%        .15495         .1361
10%      .218975         .13615       Obs                 100
25%       .4666251       .1379       Sum of Wgt.         100
50%     .9286126                      Mean           .8806011
75%     1.29097         1.730304       Largest       Std. Dev.      .4780884
90%     1.547782         1.73347       Variance       .2285685
95%     1.614945         1.823683       Skewness       .0836841
99%     1.857661         1.891639       Kurtosis       1.912585
```
* Plot the data
* Graphics need to be captured manually

.set scheme s1mono

.histogram qaly, by (treat) kdens
(bin=14, start=.0839, width=.12912424)

* Test for equivalent standard deviations

.sdtest qaly, by(treat)

<table>
<thead>
<tr>
<th>Group</th>
<th>Obs</th>
<th>Mean</th>
<th>Std. Err.</th>
<th>Std. Dev.</th>
<th>[95% Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>placebo</td>
<td>100</td>
<td>.6706056</td>
<td>.0458471</td>
<td>.4584712</td>
<td>[.579635    .7615762]</td>
</tr>
<tr>
<td>active</td>
<td>100</td>
<td>.8806011</td>
<td>.0478088</td>
<td>.4780884</td>
<td>[.785738    .9754642]</td>
</tr>
<tr>
<td>combined</td>
<td>200</td>
<td>.7756033</td>
<td>.0338644</td>
<td>.4789151</td>
<td>[.7088242   .8423825]</td>
</tr>
</tbody>
</table>

Ho: sd(placebo) = sd(active)

F(99,99) observed = F_obs = 0.920
F(99,99) lower tail = F_L = F_obs = 0.920
F(99,99) upper tail = F_U = 1/F_obs = 1.087

Ha: sd(1) < sd(2)    Ha: sd(1) != sd(2)    Ha: sd(1) > sd(2)
P < F_obs = 0.3388    P < F_L + P > F_U = 0.6776    P > F_obs = 0.6612
. * T Test of qaly
. ttest qaly, by(treat)

Two-sample t test with equal variances

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<tr>
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</tr>
<tr>
<td>diff</td>
<td>-.2099955</td>
<td>.0662393</td>
<td>-.3406205</td>
<td>-.0793704</td>
<td></td>
</tr>
</tbody>
</table>

Degrees of freedom: 198

Ho: mean(placebo) - mean(active) = diff = 0
Ha: diff < 0  Ha: diff != 0  Ha: diff > 0
| t = -3.1703 | t = -3.1703 | t = -3.1703 |
| P < t = 0.0009 | P > |t| = 0.0018 | P > t = 0.9991 |

. ttest qaly, by(treat) unequal

Two-sample t test with unequal variances

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Satterthwaite's degrees of freedom: 197.653

Ho: mean(placebo) - mean(active) = diff = 0
Ha: diff < 0  Ha: diff != 0  Ha: diff > 0
| t = -3.1703 | t = -3.1703 | t = -3.1703 |
| P < t = 0.0009 | P > |t| = 0.0018 | P > t = 0.9991 |

. * Rank sum test
. ranksum qaly, by(treat)

Two-sample Wilcoxon rank-sum (Mann-Whitney) test

<table>
<thead>
<tr>
<th>treat</th>
<th>obs</th>
<th>rank sum</th>
<th>expected</th>
</tr>
</thead>
<tbody>
<tr>
<td>placebo</td>
<td>100</td>
<td>8758</td>
<td>10050</td>
</tr>
<tr>
<td>active</td>
<td>100</td>
<td>11342</td>
<td>10050</td>
</tr>
<tr>
<td>combined</td>
<td>200</td>
<td>20100</td>
<td>20100</td>
</tr>
</tbody>
</table>

unadjusted variance 167500.00
adjustment for ties -2.26
adjusted variance 167497.74

Ho: qaly(treat==placebo) = qaly(treat==active)
z = -3.157
Prob > |z| = 0.0016

. * Kolmogorov-Smirnov test
. ksmirnov qaly, by(treat)

Two-sample Kolmogorov-Smirnov test for equality of distribution functions:

<table>
<thead>
<tr>
<th>Smaller group</th>
<th>D</th>
<th>P-value</th>
<th>Corrected</th>
</tr>
</thead>
<tbody>
<tr>
<td>placebo:</td>
<td>0.2300</td>
<td>0.005</td>
<td></td>
</tr>
<tr>
<td>active:</td>
<td>0.0000</td>
<td>1.000</td>
<td></td>
</tr>
<tr>
<td>Combined K-S:</td>
<td>0.2300</td>
<td>0.010</td>
<td>0.007</td>
</tr>
</tbody>
</table>

. * Notes on K/S test
. Line 1 tests if group 0 < group 1
. Line 2 tests if group 0 > group 1
. Line 3 provides a joint test
. The p-values are not good approximations
. when n<50
. * Transform of the data
. gen lnqaly = ln(qaly)
. sum lnqaly if treat==0,detail

    |       | Pr(Skewness) | Pr(Kurtosis) | adj chi2(2) | Prob>chi2 |
lnqaly |      0.013 |         0.052 |           8.70 |      0.0129 |

Percentiles       Smallest
1%     -2.47813       -2.47813
5%     -2.405513      -2.47813
10%    -2.253795      -2.47278       Obs               100
25%    -1.301956      -2.46746       Sum of Wgt.       100
50%    -.5770808      -.7141641       Mean              -.7141641
75%    .0732812       .3891253       Largest Std. Dev.  .8877224
90%    .3151013       .4603884       Variance             .7880511
95%    .3629682       .5235789       Skewness             -.6072147
99%    .5384502       .5533215       Kurtosis             2.292477

. sum lnqaly if treat==1,detail

    |       | Pr(Skewness) | Pr(Kurtosis) | adj chi2(2) | Prob>chi2 |
lnqaly |      0.001 |         0.791 |           9.58 |      0.0083 |

Percentiles       Smallest
1%     -2.02329      -2.052216
5%     -1.864653     -1.994365
10%    -1.527175     -1.993998       Obs               100
25%    -.7622293     -1.981226       Sum of Wgt.       100
50%    -.0740824     -.3334798
75%    .25252794     .5482972
90%    .4368232      .5501249       Variance             .7206912
95%    .4790713      .6008581       Skewness             -0.8569996
99%    .6191511      .6374438       Kurtosis             2.760989

. sdtest lnqaly, by(treat)

Variance ratio test

<table>
<thead>
<tr>
<th>Group</th>
<th>Mean</th>
<th>Std. Err.</th>
<th>Std. Dev.</th>
<th>[95% Conf. Interval]</th>
</tr>
</thead>
<tbody>
<tr>
<td>placebo</td>
<td>-.7141641</td>
<td>.0887722</td>
<td>.8877224</td>
<td>-.8903705 -.5380208</td>
</tr>
<tr>
<td>active</td>
<td>-.3334798</td>
<td>.0720691</td>
<td>.7206912</td>
<td>-.4764805 -.1904799</td>
</tr>
<tr>
<td>combined</td>
<td>.5238219</td>
<td>.0586025</td>
<td>.8287645</td>
<td>-.6393835 -.4082604</td>
</tr>
</tbody>
</table>

Ho: sd(placebo) = sd(active)
F(99,99) observed = F_obs = 1.517
F(99,99) lower tail = F_L = 1/F_obs = 0.659
F(99,99) upper tail = F_U = F_obs = 1.517

Ha: sd(1) < sd(2)      Ha: sd(1) != sd(2)      Ha: sd(1) > sd(2)
P < F_obs  = 0.9804   P < F_L + P > F_U = 0.0393   P > F_obs = 0.0196
. ttest lnqaly, by(treat)

Two-sample t test with equal variances

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<tr>
<td>placebo</td>
<td>100</td>
<td>-0.7141641</td>
<td>0.0887722</td>
<td>0.8877224</td>
<td>-0.8903075 to -0.5380208</td>
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<td>0.0720691</td>
<td>0.7206912</td>
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<td>-0.6393835 to -0.4082604</td>
</tr>
<tr>
<td>diff</td>
<td></td>
<td>-0.3806844</td>
<td>0.1143436</td>
<td>0.606172</td>
<td>-0.1551382 to 0.551382</td>
</tr>
</tbody>
</table>

Degrees of freedom: 198

Ho: mean(placebo) - mean(active) = diff = 0

<table>
<thead>
<tr>
<th>t</th>
<th>P</th>
<th>t</th>
<th>P</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3.3293</td>
<td>0.0005</td>
<td>-3.3293</td>
<td>0.0005</td>
<td>-3.3293</td>
</tr>
</tbody>
</table>

. ttest lnqaly, by(treat) unequal

Two-sample t test with unequal variances

<table>
<thead>
<tr>
<th>Group</th>
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<td>0.606172</td>
<td>-0.1551382 to 0.551382</td>
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Satterthwaite's degrees of freedom: 189.979

Ho: mean(placebo) - mean(active) = diff = 0

<table>
<thead>
<tr>
<th>t</th>
<th>P</th>
<th>t</th>
<th>P</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3.3293</td>
<td>0.0005</td>
<td>-3.3293</td>
<td>0.0005</td>
<td>-3.3293</td>
</tr>
</tbody>
</table>

* Bootstrap the difference in QALYS
* do bsispqly
* version 7
* BOOTSTRAP METHOD
* This program performs two distinct tasks:
* It defines the set of operations that are
* performed for a single replicate
* It then instructs Stata to run the program loopm
* Task 1: Define program named loopm
* loopm defines the set of operations that
* are performed for a SINGLE bootstrap replicate
* Administrative commands:
* Erase files/programs that are used in
* bootstrap, but may already exist
* capture erase templ.dta
* capture program drop loopm
* Define and initialize program
* program define loopm
  1. local i='1'
  2. while `i'>0 {
  3.   local i = `i' - 1
  4. }
* load dataset of interest
* use isporcea
* Construct a dataset by use of sampling with
* replacement; this algorithm uses the low
* level bootstrap function to maintain the
* a constant sample size in each of the
* treatment groups; as written the algorithm
* draws samples from two randomization groups,
* but the process can be generalized to more
* than two
* preserve
  6. keep if treat==0
  7. bsample
8. save temp1,replace
9. 
set seed 123456789
10. keep if treat==1
11. bsample
12. append using temp1
13. save temp1,replace
14. **** Calculate results of interest ****
15. * This is a generic bootstrap program
16. * One can insert any estimation commands
17. * one wants
18. 
19. sum qaly if treat==0
20. gen plqaly=r(mean)
21. sum qaly if treat==1
22. gen acqaly=r(mean)
23. * Reduce the size of the dataset so that it
24. * retains only the results one wants to save
25. keep plqaly acqaly
26. keep if _n==1
27. ** Call loopm a pre-specified number of times **
28. 
29. quietly loopm 2000
30. *** Finish repetitions ***
31. * Optional: Estimate results based on the
32. bootstrap replicates
33. * we did not calculate the difference in qalys
34. * in each replicate; now that the 2000
35. * iterations are finished, we do so
36. gen qd=acqaly-plqaly (1 missing value generated)
37. * Task 2: Instruct Stata to run the program
38. * loopm
39. * Administrative commands
40. clear
41. set more 1
42. * You can control the seed of the random number
43. * generator (in which case, the program will
44. * perform the same set of random draws every
The following lines save the results in a file called bsispqly.dta and erase some temporary datasets created by the program:

- capture erase bsispqly.dta
- save bsispqly file bsispqly.dta saved
- capture erase templ.dta
- capture erase bootm.dta

end of do-file

- Inspect distribution of qaly differences
- Graphics need to be captured manually
  - set scheme s1mono
  - histogram qd,kdens xline(0)

(bin=33, start=.00005305, width=.01386642)

Notes on histogram command:
- set scheme s1mono yields a black and white graph
- histogram: creates histogram
- kdens adds smoothed curve
- xline adds line at 0 difference
* Nonparametric estimation commands, bootstrap

* Evaluate nonparametric CI (outcome of interest:
  * Do the CI "cover" 0?)

* The coding below identifies the appropriate replicates
  * No matter how many replicates have been generated

* sort qd

list qd if (_n==1+round(_N*0.025),0)|(_n==_N-round(_N*0.025),0)

+----------+----------+--------------------------------------------------------
|       qd |        qd |      2000    .2107453    .0649644    .000053   .4576448
|----------|
51. | .0817669 | .
1950. | .3389538 |
+----------+ .

* Evaluate parametric CI

* sort qd

list qd if (_n==1+round(_N*0.025),0)|(_n==_N-round(_N*0.025),0)

+----------+----------+--------------------------------------------------------
|       qd |        qd |      2000    .2107453    .0649644    .000053   .4576448
|----------|
51. | .0817669 | .
1950. | .3389538 |
+----------+ .

* Evaluate one-tailed nonparametric p value
  * The coding for the p-value accounts for the fact that
  * Group 0's QALYS may exceed Group 1's or vice versa

* sort qd if qd<0

sum qd if qd<0

Variable | Obs | Mean | Std. Dev. | Min | Max
----------+-----+-------+-----------+-----+-----
qd | 0 |

* Upper limit

* Estimate two-sided parametric p value

* Identify the number of degrees of freedom for
  * The test; DOF = N in original sample minus 2
  * Do not modify dof even if variances are
  * Unequal

* preserve

use isporcea

display 2*ttail(dof,tstat)
.00138343
. set more on

. log close
  log: d:\henry\hgclass\costs\analdata\isp2003\data\ispqrylog.log
  log type: text
closed on:  4 May 2003, 14:10:09
-------------------------------------------------------------------