Math 3070 § 1. **Valsalva Data: Paired t-Test.** Name: Example
Treibergs December 9, 2010

Data File Used in this Analysis:

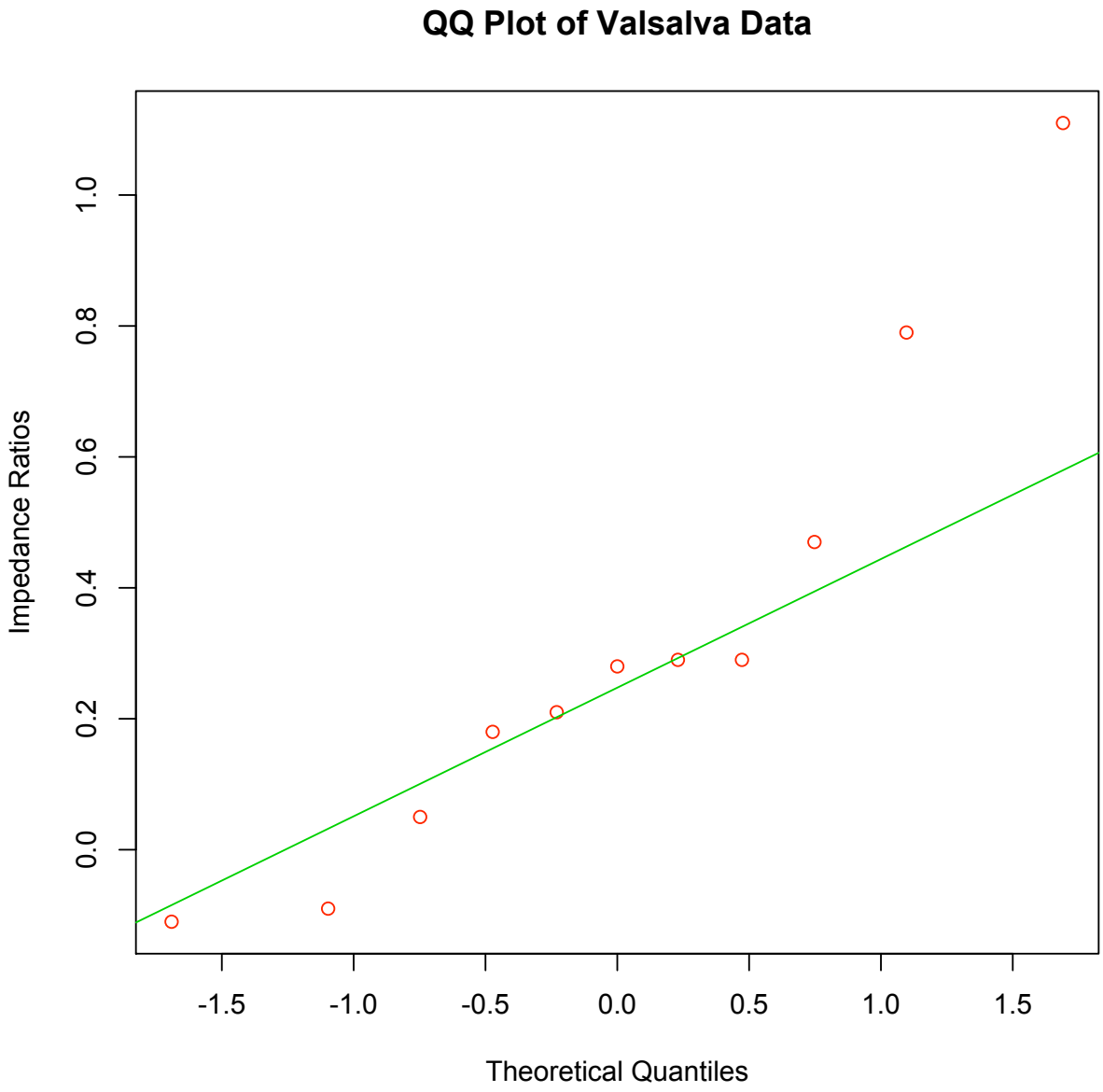
```
# M3070 - 1          Valsalva Data    Dec. 6, 2011
#
#  From Navidi, "Statistics for Engineers and Scientists, 2nd ed."
#  McGraw Hill 2008.
#
# A study "Impedance cardiography..." in Medical and Biomedical Engineering
# and Computing, 2003, on the Valsalva Maneuver to create pressure in
# respiratory airways compared same subjects in a standing and a reclining
# position. For each the the impedance ratio  was measured.
# Does the data show that there is a difference between standing and reclining?
#
Standing Reclining
1.45 0.98
1.71 1.42
1.81 0.7
1.01 1.1
0.96 0.78
0.83 0.54
1.23 1.34
1 0.72
0.8 0.75
1.03 0.82
1.39 0.6
```

R Session:

```
R version 2.10.1 (2009-12-14)
Copyright (C) 2009 The R Foundation for Statistical Computing
ISBN 3-900051-07-0

R is free software and comes with ABSOLUTELY NO WARRANTY.
You are welcome to redistribute it under certain conditions.
Type 'license()' or 'licence()' for distribution details.

  Natural language support but running in an English locale

R is a collaborative project with many contributors.
Type 'contributors()' for more information and
'citation()' on how to cite R or R packages in publications.

Type 'demo()' for some demos, 'help()' for on-line help, or
'help.start()' for an HTML browser interface to help.
Type 'q()' to quit R.
[R.app GUI 1.31 (5538) powerpc-apple-darwin8.11.1]
[Workspace restored from /Users/andrejstreibergs/.RData]
```

```
> tt <- read.table("M3073ValsalvaData.txt",header=TRUE)
> tt
   Standing Reclining
1      1.45      0.98
2      1.71      1.42
3      1.81      0.70
4      1.01      1.10
5      0.96      0.78
6      0.83      0.54
7      1.23      1.34
8      1.00      0.72
9      0.80      0.75
10     1.03      0.82
11     1.39      0.60
> attach(tt)

> ########### RUN PAIRED T-TEST ON VALSALVA DATA. ##############################

> t.test(Standing,Reclining,paired=TRUE)

Paired t-test

data:  Standing and Reclining
t = 2.8707, df = 10, p-value = 0.01665
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 0.0706105 0.5602986
sample estimates:
mean of the differences
              0.3154545
> #### P-VALUE IS SMALL. WE ACCEPT Ha THAT THERE IS A DIFFERENCE OF MEANS ######
> #
> # Now do it by hand
> #
> #
> # the vector of differences

> d <- Standing - Reclining; d
 [1]  0.47  0.29  1.11 -0.09  0.18  0.29 -0.11  0.28  0.05  0.21  0.79
>
>##### THE SAMPLE MEAN, SD, N, nu, FOR THE DIFFERENCES D  ########################
> dbar <- mean(d); dbar
[1] 0.3154545
> stdevd <- sd(d);stdevd
[1] 0.3644548
> n <- length(d); n
[1] 11
> nu <- n-1; nu
[1] 10
```

```
> ############## COMPUTE THE  T-STATISTIC  ########################################

> t <- dbar/(stdevd/sqrt(n));t
[1] 2.870711

> ####  THE P-VALUE IS TWICE THE AREA FOR RIGHT TAIL (TWO-TAILED TEST) ##@##########

> 2*pt(abs(t),nu,lower.tail=FALSE)
[1] 0.01664843

> ################## CI for E(d)  ################################################

> talphaover2 <- qt(.025,nu, lower.tail=FALSE); talphaover2
[1] 2.228139

> c(dbar - talphaover2*stdevd/sqrt(n),dbar + talphaover2*stdevd/sqrt(n))
[1] 0.0706105 0.5602986

> ############## Q-Q PLOTS TO CHECK IF THE NORMALITY ASSUMPTION IS VIOLATED  ######

> qqnorm(d,main="QQ Plot of Valsalva Data",ylab="Impedence Ratios");qqline(d)
> qqnorm(d,main="QQ Plot of Valsalva Data",ylab="Impedance Ratios",col=2);qqline(d,col=3)
>
> ### IT'S PRETTY STRAIGHT. GREEN LINE THROUGH 1ST AND 3RD QUARTILES MISLEADS THE EYE ###
>
```


QQ Plot of Valsalva Data
Impedance Ratios
0.0
0.2
0.4
0.6
0.8
1.0
-1.5
-1.0
-0.5
0.0
0.5
1.0
1.5
Theoretical Quantiles