BST 140.651
Problem Set 4
Due in the Biostat Main office by 5:00pm October 28th

Problem 1. A study of blood alcohol levels (mg/100 ml) at post mortem examination from traffic accident victims involved taking one blood sample from the leg, A, and another from the heart, B. The results were (Note -1 indicates a missing value).

Case	A	B	Case	A	B
1	44	44	11	265	277
2	265	269	12	27	39
3	250	256	13	68	84
4	153	154	14	230	228
5	88	83	15	180	187
6	180	185	16	149	155
7	35	36	17	286	290
8	494	502	18	72	80
9	249	249	19	39	50
10	204	208	20	272	-1

a. Create a graphical display comparing a case's blood alcohol level in the heart to that in the leg. Comment on any interesting patterns from your graph.

b. Create a graphical display of the distribution of the difference in blood alcohol levels between the heart and the leg.

c. Do these results indicate that in general blood alcohol levels may differ between samples taken from the leg and the heart? Give confidence intervals and p-values as appropriate. Interpret your results in words.

Problem 2. Forced expiratory volume FEV is a standard measure of pulmonary function. We would expect that any reasonable measure of pulmonary function would reflect the fact that a person's pulmonary function declines with age after age 20. Suppose we test this hypothesis by looking at 10 nonsmoking males ages 35-39, heights 68-72 inches and measure their FEV initially and then once again 2 years later. We obtain this data.

Person	Year 0 FEV (L)	Year 1 FEV (L)	Person	Year 0 FEV (L)	Year 2 FEV (L)
1	3.22	2.95	6	3.25	3.20
2	4.06	3.75	7	4.20	3.90
3	3.85	4.00	8	3.05	2.76
4	3.50	3.42	9	2.86	2.75
5	2.80	2.77	10	3.50	3.32

a. What are the appropriate null and alternative hypotheses in this case? What is the meaning of a Type I and Type II error here. (Explain in words.)

b. Perform a statistical analysis. Interpret in words.

Problem 3. Another aspect of the preceding study involves looking at the effect of smoking on baseline pulmonary function and on change in pulmonary function over time. We must be careful since FEV depends on many factors, particularly age and height. Suppose we have a comparable group of 15 men in the same age and height group who are smokers and we measure their FEV at year 0. The data are given (For purposes of this exercise assume equal variance where appropriate).

Person	FEV Year 0 (L)	FEV Year 2 (L)	Person	FEV Year 0 (L)	FEV Year 2 (L)
1	2.85	2.88	9	2.76	3.02
2	3.32	3.40	10	3.00	3.08
3	3.01	3.02	11	3.26	3.00
4	2.95	2.84	12	2.84	3.40
5	2.78	2.75	13	2.50	2.59
6	2.86	3.20	14	3.59	3.29
7	2.78	2.96	15	3.30	3.32
8	2.90	2.74			

a. What are the appropriate null and alternative hypothesis to compare the smokers and nonsmokers at baseline? Perform the test. Give the p-value and interpret.

b. Perform a statistical analysis to determine if the change in pulmonary function over 2 years is the same in two groups. State your assumptions. Interpret in words. Give a p-value and interpret.

c. Graphically display the distribution of change in pulmonary function for smokers and nonsmokers (from the previous problem)for example, use a box-plot, QQ plot or histogram.

d. Reanswer part b. by first transforming the FEV data by taking logs. Are the p-values the same? If not, which one might be preferable to report?

e. Do you think this is a good experimental design to answer b? If not, could you think of a better design?

Problem 4. In a trial to compare a stannous fluoride dentifrice A, with a commericially available fluoride free dentifrice D, 260 children received A and 289 received D for a 3-year period. The mean DMFS increments (the number of new Decayed Missing and Filled tooth Surfaces) were 9.78 with standard deviation 7.51 for A and 12.83 with standard deviation 8.31 for D. Is this good evidence that, in general, one of these dentifrices is better than the other at reducing tooth decay? If so, within what limits would the average annual difference in DMFS increment be expected to be?

A. Using a computer, generate 100 random variables that have a normal distribution with mean 10 and standard deviation $\sigma = 2$. Transform the data by using the transformation e^x.

   i. Graphically display the transformed and untransformed data and describe the shape of the distributions. Does it look normal? If you were first given the transformed data, what transformation would you use to help achieve normality.

   ii. Calculate the sample mean, sample variance and standard error of the mean for the transformed and untransformed data. Are the sample variances different? In one or two sentences, briefly explain why.

B. Repeat part A assuming $\sigma = 0.2$ and also $\sigma = 0.02$.

Problem 5. A study was conducted comparing muscle function between patients with rheumatoid arthritis (RA) and osteoarthritis (OA). A 10-point scale was used to assess balance and coordination where a high score indicates better coordination.

	Mean Score	SD	N
RA	3.4	3.2	36
OA	2.5	2.7	30

a. Test if the variances of RA and OA scores are equal.

b. Test if mean scores are the same for RA and OA subjects, report a $p-$value. State all assumptions of your test procedure.

c. Suppose a larger study is planned. How many subjects would be needed to detect a difference of 1 unit in mean scores with 90% power with equal sample sizes in each group and a 2-sided test with significance level $\alpha = .05$.

Problem 6. Suppose N subjects are assigned to one of two treatment groups (A and B). A two-sample T test will be performed to test the two means.

a. Suppose the variances of σ_A^2 and σ_B^2 of the two treatment groups are known. What fraction f of the N subjects should be assigned to group A, and the remaining fraction $(1 - f)$ to group B, if we wish to maximize the power of the study at a fixed alternative, and significance level.

b. In practice we usually use equal allocation (half to A and half to B). Discuss in a paragraph or two, the pros and cons of using equal allocation.