1. A clinical trial was designed to test a drug that was believed to decrease blood-clotting time. Forty subjects were selected and randomized to yield two groups, each with n=20. One group was given the drug and the other group was given a placebo, and served as a control. The mean clotting time, given in minutes, for the drug treatment group is 4.90 minutes with variance of 10.24 minutes squared. The mean clotting time for the control group is 7.45 and the variance is 12.96 minutes squared.

   a) State the null hypothesis to test differences between the treatment and control groups.

   $$\mathbf{H_o: \mu_{drug} = \mu_{placebo}}$$

   b) State the appropriate alternative hypothesis.

   $$\mathbf{H_a: \mu_{drug} \neq \mu_{placebo}}$$

   c) Using the above results, set up the appropriate test.

   $$T = \frac{4.9 - 7.45}{\sqrt{\frac{10.24}{20} + \frac{12.96}{20}}}, df = \frac{[(10.24 + 12.96)/20]^2}{\left[(10.24/20)^2/19 + (12.96/20)^2/19\right]/19}$$

2. A class experiment in pharmacology consisted of distributing packets of instant coffee to students. The contents of the packet were to be mixed with hot water and drank shortly before bedtime. The student received packets on two occasions: one time the packet contained a placebo and the other time it contained coffee with caffeine. Among other measurements, the students took their pulse rates (in beats per minute) before consuming the instant coffee or placebo and then again afterward.

   The students were classified as to whether they were coffee drinkers (those who usually consumed two cups or more per day) or non-coffee drinkers (those who usually consumed one or fewer cups per day). The results for 65 non-coffee drinkers and 85 coffee drinkers are given below:

| | 65 Non-Coffee Drinkers | | 85 Coffee Drinkers | |
|---|---|---|---|---|
| | Caffeine | Placebo | Caffeine | Placebo |
| N | 50 | 15 | 44 | 41 |
| Mean | 4.1 | 0.9 | 4.9 | 2 |

   a) State the null and alternative hypotheses for determining if the response is the same among Coffee Drinkers.

   $$\mathbf{H_o: \mu_{cofplac} = \mu_{cofcaf}; \ H_a: \mu_{cofplac} \neq \mu_{cofcaf}}$$

   b) What is the appropriate statistical procedure to test the null hypothesis in a)?

   **The independent two-sample t-test**

   c) What are the degrees of freedom associated with the test statistic in b)?

   **Df = 44+41-2 = 83 (*assuming equal population variances for the two groups)***

d) State the null and alternative hypotheses for determine if the caffeine response is the same between Non-Coffee and Coffee Drinkers.

$\mathbf{H_o:\mu_{nocofcaf} = \mu_{cofcaf};\ H_a:\mu_{nocofcaf} \neq \mu_{cofcaf}}$

e) What is the appropriate statistic procedure to test the null hypothesis in d)?

**The independent two-sample t-test.**

f) What are the degrees of freedom associated with the test statistic in e)?

**Df = 50 + 44 – 2 = 92 (*assuming equal population variances for the two groups)***

3. The following data show the mean number of decayed, missing, and filled teeth (DMF score) in two samples of 3-4 year-0ld children according to their average weekly sweet consumption.

| Consumption | N | Mean | S.D. |
|---|---|---|---|
| $\leq$ 8 oz | 34 | 2.32 | 0.98 |
| > 8 oz | 19 | 3.63 | 1.10 |

a) State the null and alternative hypotheses.

$\mathbf{H_o:\mu_{high} = \mu_{low};\ H_a:\mu_{high} \neq \mu_{low}}$

b) Assume normal populations with equal variance.

**The pooled variance, $s^2$, is** $$s^2 = \frac{33*(.98)^2 + 18*(1.10)^2}{51}$$

c) Using results in the table, set up the calculations for the appropriate test.

$$T = \frac{2.32 - 3.63}{s\sqrt{\frac{1}{34}+\frac{1}{19}}} = -4.47$$

d) What are the degrees of freedom?

**Assuming equal population variances, df = 34 + 19 – 2 = 51**

e) Set up the calculations for a 95% confidence interval for the difference in DMF score between the two populations. The correct confidence coefficient is 2.01.

$$-1.31 \pm 2.01 * 1.02\sqrt{\frac{1}{34}+\frac{1}{19}}$$

4. A recent study attempted to compare the working environment in offices where smoking was permitted with that in offices where smoking was not permitted. Measurements were made of carbon monoxide (CO) at 1:20 pm in 40 work areas. Where smoking was permitted, the mean CO=11.6 parts per million (ppm) and the standard deviation CO=7.3 ppm. Where smoking was banned, the mean CO=6.9 ppm and the standard deviation CO=2.7 ppm. What statistical procedure would be appropriate to see whether or not the mean CO is different in the two types of working environments?

   **The independent two-sample t-test with unequal variances.**

5. **Gynecology.** A study was conducted to compare the age at menarche (age at the first menstrual period) of girls entering the first-year class of a small U.S. private college (in the year 1975) with that of girls entering the first-year class of the same college in 1985. This study is in response to reports of differences over time in other countries. Suppose that 30 girls in the 1975 class have mean age at menarche of 12.78 years with a standard deviation of 0.43 years and 40 girls in the class of 1985 have a mean age at menarche of 12.42 years with a standard deviation of 0.67 years.

   a) What are the appropriate null and alternative hypotheses to test whether or not the mean ages at menarche are comparable in the two populations of girls? Justify your choice of the appropriate hypotheses.

   $$H_o: \mu_{1975} = \mu_{1985}; \; H_a: \mu_{1975} \neq \mu_{1985}$$

   **We are not sure whether the average age is higher or lower between the two populations.**

   b) Perform the hypothesis test indicated in part (a), state your decision/conclusions.

   **Test statistic, T = 2.73, df = 66.59. One would reject the null hypothesis at the 5 percent level of significance and conclude the mean age at menarche are not the same.**

   c) What is the advantage of comparing two different cohorts within the same school, as opposed to comparing the 1975 entering class of one school with the 1985 entering class of another school?

   **The groups are likely mre comparable within the same school. Variables we did not measure could effect age at menarche within the school are more likely to be similar than between different schools.**

6. **Pulmonary Disease.** A study was performed to look at the effect of mean ozone exposure on change in pulmonary function. Fifty hikers were recruited into a study; 25 of the hikers hiked on days with low-ozone exposure and 25 hiked on days with high-ozone exposure. The change in pulmonary function after a 4-hour hike was recorded for each subject. (*Change in FEV1 = baseline – follow-up*).

Summary statistics for the two groups are as follows:

Comparison of change in FEV on high- vs low-ozone days

| Group | N | Mean change in $FEV_1$ | SD |
|---|---|---|---|
| Low Ozone days | 25 | 0.042 | 0.106 |
| High-ozone days | 25 | 0.101 | 0.253 |

a) What test can be used to determine if the mean change in FEV1 differs between the high-ozone and low-ozone days?

**The independent two-sample t-test with unequal variances**

b) Implement the test in part (a), give the p-value (two-sided) and state your decision/conclusions.

**Test statistic, T = 1.075, df = 32. The p-value is 0.29. Since our p-value is much larger than the 5 percent significance level, we would not reject the null hypothesis and conclude that the mean $FEV_1$ levels between the two groups are not different.**

c) Suppose we determined a 95 percent confidence interval for the true mean change in pulmonary function on high-ozone days. Is this confidence interval narrower, wider or the same width as a 90 percent confidence interval? (*Do not have to actually derive the confidence interval*)

**The 95 percent confidence interval would be wider because the critical t-value for the 95$^{th}$ percentile of the t-distribution with 32 degrees of freedom will be larger than the t-value for the 90$^{th}$ percentile of the same t-distribution (i.e., with 32 degrees of freedom.**