STAT 301 HW16 due Mon Nov 2

You may work with one partner on this assignment, submitting one report with both names, provided that both students contribute substantially to the work. Word-processed reports are preferred to hand-written ones. Please copy/paste relevant computer output into your report as appropriate.

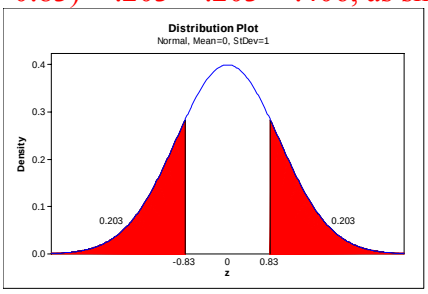
Nicotine Lozenge?

Helping smokers to quit continues to be a very important and challenging public health goal. In a recent study of the effectiveness of a nicotine lozenge, smokers who wanted to quit were recruited to participate thorough advertisements near four sites in the United Kingdom and 11 sites in the United States. Those smokers who met the screening qualifications were randomly assigned to one of two groups: one group received nicotine lozenges and the other group received placebo lozenges. The subjects were compared on various background variables at the beginning of the study, and at the end of the study they were compared on whether or not they successfully abstained from smoking.

Of the 459 subjects in the nicotine group, 42.9% were male. Of the 458 subjects in the placebo group, 40.2% were male.

a) Conduct a significance test, using a normal approximation, of whether these proportions differ significantly at the .05 level. Report the hypotheses, test statistic, *p*-value, and test decision. Also summarize your conclusion.

The hypotheses are H_0: $\pi_{nicotine} = \pi_{placebo}$, where π_i represents the population proportion of males in group *i*, vs. H_a: $\pi_{nicotine} \neq \pi_{placebo}$. The test statistic is $z = \dfrac{\hat{p}_n - \hat{p}_p}{\sqrt{\hat{p}_c(1-\hat{p}_c)\left(\frac{1}{n_n}+\frac{1}{n_p}\right)}} = \dfrac{.429 - .402}{\sqrt{.416(.584)\left(\frac{1}{459}+\frac{1}{458}\right)}} \approx 0.83$. The p-value is $\Pr(Z \geq 0.83) + \Pr(Z \leq -0.83) = .203 + .203 = .406$, as shown in the Minitab graph below:



With such a large p-value, there's no reason to doubt the null hypothesis. The observed proportions of males in the two groups do not differ significantly at the .05 significance level.

b) Explain why the researchers would be glad for the null hypothesis not to be rejected in the test in a).

A primary purpose of random assignment is to balance out all variables that might affect the response between the treatment groups. The researchers would be glad to find that random assignment succeeded in balancing out gender between the two groups.

At the end of the 52-week study, 17.9% of the nicotine group had successfully abstained from smoking, compared to 9.6% of the placebo group.

c) Organize these data in a 2×2 table, with the explanatory variable in columns.

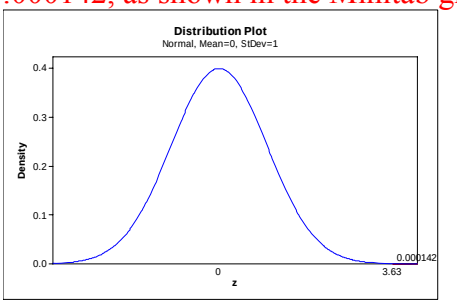
	Nicotine lozenge	Placebo lozenge	Total
Successfully abstained from smoking	82	44	126
Did not successfully abstain	377	414	791
Total	459	458	917

d) Use the normal approximation to test whether these data provide strong evidence that the nicotine lozenge is more effective than the placebo lozenge, using the .01 significance level. Report the hypotheses, test statistic and p-value. Also verify that the technical conditions are satisfied, and summarize your conclusion from this test.

The hypotheses are H_0: $\pi_{nicotine} = \pi_{placebo}$, where π_i represents the population proportion who successfully abstain in group i, vs. H_a: $\pi_{nicotine} > \pi_{placebo}$. The test statistic is $z =$

$$\frac{\hat{p}_n - \hat{p}_p}{\sqrt{\hat{p}_c(1-\hat{p}_c)\left(\frac{1}{n_n}+\frac{1}{n_p}\right)}} = \frac{.179 - .096}{\sqrt{.137(.863)\left(\frac{1}{459}+\frac{1}{458}\right)}} \approx 3.63.$$

The p-value = Pr(Z ≥ 3.63) = .000142, as shown in the Minitab graph below:



With such a very small p-value, the experimental data provide very strong evidence that the success rate is significantly higher in the nicotine group than in the placebo group. The difference in success rates between the two groups is statistically significant at the .01 level. The technical conditions are satisfied because of the random assignment to groups and because each group has at least 5 who successfully abstained and at least 5 who did not.

e) Based on this study and your test result, is it legitimate to draw a cause-and-effect conclusion between the nicotine lozenge and the increased rate of abstaining from smoking? Explain.

Yes, it is legitimate to conclude that the nicotine lozenge caused a higher rate of quitting success, because this was a randomized experiment with a highly significant difference between the treatment groups.

f) Produce a 95% confidence interval for the difference in proportions of successfully abstaining from smoking between the two groups. Also interpret this interval.

This confidence interval is: $(\hat{p}_n - \hat{p}_p) \pm z^* \sqrt{\frac{\hat{p}_n(1-\hat{p}_n)}{n_n} + \frac{\hat{p}_p(1-\hat{p}_p)}{n_p}}$, which is

$(.179 - .096) \pm 1.96\sqrt{\frac{.179 \times .821}{459} + \frac{.096 \times .904}{458}}$, which is .083 ± 1.96×.0226, which is .083 ± .044, which is the interval (.039, .127). We can be 95% confident that the difference in success rates between the nicotine and placebo groups is between .039 and .127. This interval is entirely positive, indicating that the nicotine lozenge has a significantly higher rate of success than the placebo, but this may not seem like a big difference.

g) Produce a 95% confidence interval for the odds ratio of successfully abstaining from smoking between the two groups. Also interpret this interval.

The log odds ratio (using natural log) for the observed data is $\ln(2.047) \approx 0.716$. A 95% confidence interval for the log odds ratio is given by: $0.716 \pm 1.96\sqrt{\frac{1}{82} + \frac{1}{377} + \frac{1}{44} + \frac{1}{414}}$, which is 0.716 ± 1.96×.200, which is 0.716 ± 0.392, which is the interval (0.324, 1.108). A 95% confidence interval for the odds ratio is therefore: $(e^{0.324}, e^{1.108})$, which is (1.38, 3.03). We can be 95% confident that the odds of successfully abstaining from smoking are between 1.38 and 3.03 times higher with the nicotine lozenge than with the placebo lozenge. This interval is entirely above 1, indicating that the odds of successfully abstaining are significantly higher with the nicotine lozenge than with the placebo, possibly as much as 3 times higher.

h) Now consider only the subjects that received nicotine lozenges. Produce a 95% confidence interval to estimate the population proportion who would successfully abstain from smoking for 52 weeks when using the nicotine lozenge. Also interpret this interval.

This 95% confidence interval is $\hat{p} \pm z^* \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$, which is $.179 \pm 1.96\sqrt{\frac{.179 \times .821}{459}}$, which is .179 ± 1.96×.018, which is .179 ± .035, which is the interval (.144, .214). Even though the nicotine lozenge is significantly better than a placebo lozenge, we only expect that between 14.4% and 21.4% of smokers would successfully quit for a year with the nicotine lozenge.