

Some questions have different versions, so be sure to find the relevant version for your exam.

Cow milking question:

a) The explanatory variable is the method of milking. The response variable is the amount of milk produced.

A common error was to report the research question “does machine milking tend to produce more milk than human milking” as a variable.

b) This is an independent-samples design. The cows assigned to one group are not matched up in any way with the cows assigned to the other group.

c) A directional hypothesis is needed, because you are to test whether machine milking tends to produce *more* milk than human milking.

d) Type II error is to fail to reject the null hypothesis when it is actually false. In this case type II error means to decide that mechanical milking is not better than human milking when it fact it really is better (produces more milk).

Short answer questions:

a) If you fail to reject the null hypothesis at the .05 significance level, then the P-value must be larger than .05. If the P-value is larger than .05, then it must also be larger than .01. So, you would also fail to reject the null hypothesis at the .01 significance level.

b) The null hypothesis here is expressed in terms of *sample* means, when it should be expressed about *population* means.

c) The confidence interval is very narrow because of the very large sample size.

The high confidence level would tend to produce a wide interval, but the very large sample size (2.4 million) more than compensates for that.

d) The interval procedure is not valid here, because the sample was not randomly selected. In fact, the sample was chosen in such a way (through phone books and vehicle registration lists, with voluntary response) that support for the challenger Republican candidate was much overestimated.

Nicotine lozenge study, weight issues:

a) This is an experiment, because researchers assigned subjects to use either a nicotine lozenge or a placebo lozenge.

b) The first condition is met because of the random assignment of subjects to groups. The second condition is met because of the large sample sizes (over 450 subjects) within both groups.

We do not know if the distributions of weights were normally distributed, but we do not care, because of the large sample sizes.

c) The 95% confidence interval for the *difference* in population mean weights does contain the value zero, so it is plausible that both groups have the same population mean weight. Thus, using the .05 significance level, we would fail to reject the null hypothesis that the population mean weights are equal.

d) The goal of randomization is to balance out all factors other than the explanatory variable (type of lozenge) between the two groups. Weight is a potential confounding variable, but the goal of randomization is to create similar groups with regard to weight. The fact that the CI contains zero, and so the null hypothesis of equal population weights is not rejected, suggests that randomization achieved its purpose.

Nicotine lozenge study, table analysis:

a) The explanatory variable is type of lozenge (nicotine or placebo), and the response is whether the subject resumed smoking or not by the end of six weeks. The table is:

	Placebo lozenge	Nicotine lozenge	Total
Resumed smoking	311	244	555
Did not resume smoking	147	215	362
Total	458	459	917

b) The odds ratio of resuming smoking by the end of six weeks, comparing placebo to nicotine lozenge groups, is: $(311)(215)/[(147)(244)] = 1.864$.

If you divided in the other order, you obtained 0.536, which is fine.

A common error was to calculate the relative risk rather than the odds ratio. The relative risk of resuming smoking by the end of six weeks, comparing placebo to nicotine lozenge groups, is: $(311/458)/(244/459) = .679/.532 = 1.277$.

c) The odds of resuming smoking by the end of six weeks are 1.864 times higher with the placebo lozenge than with the nicotine lozenge.

Nicotine lozenge study, testing effectiveness of nicotine lozenge:

The null hypothesis is that the population proportion who resume smoking is the same for those in nicotine and placebo groups: $p_{\text{nicotine}} = p_{\text{placebo}}$. The alternative is that the population proportion who resume smoking is lower in the nicotine group than in the placebo group: $p_{\text{nicotine}} < p_{\text{placebo}}$.

A common error was to express the hypotheses in terms of a population mean μ rather than a population proportion p . This is not appropriate because “resume smoking or not” is a categorical variable, not a quantitative variable.

b) Because the alternative is directional, the P-value is half of what the chi-square table reveals. The test statistic 20.86 is off the chart for a degree of freedom, so the P-value is less than $.0001/2$, which means that the P-value is less than .00005.

c) With such a small P-value (far less than .01), we reject the null hypothesis at the .01 level.

d) With such a small P-value, and with a randomized experiment, we conclude that there is extremely strong evidence that the nicotine lozenge does help to reduce the rate of smokers who resume smoking, as compared to the placebo lozenge.

e) If the sample sizes were larger (and all else were the same), there would be stronger evidence that the groups differ, so the P-value would be smaller.

f) If the sample proportions were farther apart (and all else were the same), there would be stronger evidence that the groups differ, so the P-value would be smaller.

Nicotine lozenge study, estimating proportion to be helped:

A 99% confidence interval for the population proportion of smokers who would successfully abstain from smoking for 52 weeks with the nicotine lozenge is: $\hat{p} \pm z * \sqrt{\frac{\hat{p}(1-\hat{p})}{n}}$, which is

$.179 \pm 2.576 \sqrt{\frac{.179 * .821}{459}}$, which is $.179 \pm .046$, which is (.133, .225). So, we can be 99%

confident that's somewhere between 13.3% and 22.5% of all smokers would be able to stop smoking for 52 weeks with the nicotine lozenge.