A6. EXERCISES FROM CHAPTER 6

1. Numerous published manuscripts in healthcare begin their analysis section by publishing a table that contains demographic information related to the groups they wish to compare. Often nominal factors are included in such a table and accompanied by a chi-square test p-value.

    a. Explain why the comparison of sample demographics is important.

    The response variables in the study may be in some way associated to demographic information. If so, and if samples are not balanced in terms of those associated demographics, then confounding will be the result. Thus the purpose of such comparison is to assess the samples for potential confounding.

    b. Explain why the chi-square test p-value is **not relevant** in the comparison of samples.

    The chi-square test is an inferential procedure used to draw conclusions about the population. Here, since we are simply interested in comparing the samples, no inference is needed.

    c. In particular authors often interpret large p-values to indicate that there is no difference between the two groups. Explain why this is both incorrect and misleading.

    P-values relate to population inference. Here, we care whether the samples, which are typically drawn from the same population, are different. That assessment should be made based on examination of the observed demographic information. Ideally, the same **distribution** of demographics will be observed in both samples. Typically, however, it is appropriate to settle for something close to that. The further "apart" the two samples are, the greater the impact of any potential confounding. P-values in general say nothing at all about the samples (they are used to infer about populations). Therefore they certainly cannot be used to state that the samples are identical.

2. Based on an observational study examining hundreds of individuals, an author reports that eating red meat is associated with death related to heart disease. A chi-square test for independence is used to come to this conclusion. Explain why the author's conclusion does not follow from the test.

    Association does not imply causation. Perhaps those who eat red meat are also more prone to exercise less and smoke more. There would be too many potential confounding variables here to think of them all. Most potential confounders probably were not even considered by the author. Therefore it is difficult to give too much creditability to this claim.

3. Identify the statistical procedure appropriate to each of the following goals:

    a. Determine whether job satisfaction levels for nurses have changed after a major institutional change (using a questionnaire given both before and after the change to the same group of nurses).

    The McNemar test could be used to assess whether the percentage of positive and negative changes were the same. Alternatively, a one-sample proportions test might be used to estimate the percentage of nurses for whom satisfaction levels improve.

    b. Assess whether or not patient satisfaction (as measured on a five-point scale) depends on the use of pleasant, spontaneous conversation during treatment.

    A chi-square test may be used here to assess whether satisfaction is associated to the conversation. Alternatively, two-sample proportions might be used if the five-point scale can be reasonably converted to a dichotomous variable.

    c. Explore whether or not patient entry-points to the hospital are associated to the amount of pain they experience (as measured by a visual analogue pain scale).

    The VAS scale should generally be treated as ordinal. Measurements should be binned into an appropriate number of groups. Provided there are enough data, this should allow a chi-square test to be used. For those wishing to use interval ratio methods with this scale, please ask yourself: what, exactly, does 2.87324 millimeters of pain imply?

4. Consider the article published by Hamad and Sammour and discussed in Section 6.7. Article Reference: Hamad, B.A.A., and Sammour, H.K. (2013). Weaning practices of mothers attending United Nations Relief and Works Agency health centres in the Gaza Governorates. *Journal of Advanced Nursing*, 69(4), 773-781.

    a. Use statistical software to reproduce the tests these authors conducted in their 3rd and 4th tables on pages 778-779 of the manuscript.

    Chi-square test statistics and p-values should match their output.

    b. Use statistical software to reproduce the proportions output from Section 6.7 as relates to their third table on page 778.

    Confidence intervals should match those given in Section 6.7.

    c. Their fourth table (page 779) incorporates three factors. Identify them and then describe carefully ways in which both Chi-square and McNemar tests might be incorporated.

The factors include time (during/after), problems (yes/no), and approach (sudden/gradual). The authors appropriately used chi-square tests to assess association between problems and approach (separate tests by time). If they wished to look at problems across time (separated by approach), the McNemar test could be used for paired data.

5. Consider the article published by Min-Haeng Cho in *Youth and Society*. Table 2 on page 487 of Cho's manuscript contains the data appropriate for chi-square tests.

   Article Reference: Cho, M. (2004). The strength of motivation and physical activity level during leisure time among youth in South Korea. *Youth and Society*, 35(4): 480-494.

   Use that data to assess the following:

   a. Is frequency of exercise associated to gender?

      The chi-square test does show evidence that the frequency of exercise is associated to gender (chi-square = 123.9, p-value < 0.0001). Based on row percentages, it appears that boys are more likely to exercise often (at least 3-5 times per week). Also, girls are apparently more likely to be non-participants. We should be careful not to provide too much detail here, as we are essentially interpreting sample statistics here, not confidence intervals.

   b. Is duration of exercise associated to gender?

      The chi-square test again shows evidence of an association (chi-square = 109.8, p-value < 0.0001). Based on row percentages, it appears that girls tend to be more likely to exercise for shorter periods of time.

      Note: Some argument could be made here for excluding the non-participants from this question (i.e. conditioning on subjects actually participating in exercise) since non-participation is addressed in part (a).

   c. Is intensity of exercise associated to gender?

      Likewise this chi-square test shows evidence of an association (chi-square = 126.3, p-value < 0.0001). Based on row percentages, it seems that girls tend to be more likely to exercise at lower intensity.

      Again, an argument might be made to remove nonparticipants.

   Make sure to fully analyze each question, assessing the nature of association whenever appropriate.

   Side note: All of these tests have expected counts greater than five, satisfying validity conditions for the chi-square test.