Homework 7

Question 7.50

Note that $\bar{y}_1 > \bar{y}_2$, so the data do not deviate from H_O in the direction specified by H_A. Thus $P > .50$.
a) H_O is not rejected. There is no evidence that malaria reduces red cell count in this population.
b) Same as part (a).

Question 7.51

Let 1 denote experimental (to be hypnotized) and 2 denote control. Then:

$$\begin{aligned}
SE_{(\bar{y}_1-\bar{y}_2)} &= \sqrt{\frac{.621^2}{8}+\frac{.652^2}{8}} = .3183 \\
t_s &= \frac{6.169-5.291}{.3183} = 2.76 \\
df &= 8+8-2 = 14 \\
t_{.01} &= 2.624 \\
t_{.005} &= 2.977
\end{aligned}$$

a) H_O: Mean ventilation is the same in the "to be hypnotized" condition and in the "control" condition ($\mu_1 = \mu 2$) H_A: Mean ventilation is different in the "to be hypnotized" condition than in the "control" condition ($\mu_1 \neq \mu 2$). H_O is rejected. There is sufficient evidence ($.01 < P < .02$) to conclude that mean ventilation is higher in the "to be hypnotized" condition than in the "control" condition.
b) H_O: Mean ventilation is the same in the "to be hypnotized" condition and in the "control" condition ($\mu_1 = \mu 2$) H_A: Mean ventilation is higher in the "to be hypnotized" condition than in the "control" condition ($\mu_1 > \mu 2$). H_O is rejected. There is sufficient evidence ($.005 < P < .001$) to conclude that mean ventilation is higher in the "to be hypnotized" condition than in the "control" condition.
c) The nondirectional alternative (part(a)) is more appropriate. According to the narrative, the researchers formulated the directional alternative in part (b) *after* they had seen the data. Thus, it would not be legitimate for them to use a directional alternative.

Question 7.54

Let 1 denote experimental (drug) and 2 denote control (placebo). Then:

$$\begin{aligned}
SE_{(\bar{y}_1-\bar{y}_2)} &= \sqrt{\frac{12.05^2}{25}+\frac{13.78^2}{25}} = 3.66 \\
t_s &= \frac{31.96-25.32}{3.66} = 1.81 \\
df &= 25+25-2 = 48 \text{ so we use } 40 \\
t_{.04} &= 1.796 \\
t_{.03} &= 1.924
\end{aligned}$$

a) The null and alternative hypotheses are $H_O : \mu_1 = \mu_2$ and $H_A : \mu_1 > \mu_2$. In words these can be stated as H_O : *The drug is not effective* and H_A : *The drug is effective.* To check the directionality of the data, we note that $\bar{y}_1 > \bar{y}_2$. Thus the data do deviate from H_O in the direction ($\mu_1 > \mu_2$) specified by H_A. Since the P-value is bracketed as $.03 < P < .04$ which is less than $\alpha = .05$ we reject H_O. There is sufficient evidence ($.03 < P < .04$) to conclude that the drug is effective at increasing pain relief.
b) The only change in the calculations from part (a) would be that the one-tailed area would be doubled if the alternative were nondirectional. Thus, the p-value would be between .06 and .08 and at $\alpha = .05$ we would *not* reject H_O.

Question 7.58

The lack of a statistically significant difference in therapeutic responses does not show that the two medications are equally effective. (Recall... we never accept H_O. We can only reject or fail to reject.)

Question 7.59

Let 1 denote male and 2 denote female. Then:

$$\begin{aligned} SE_{(\bar{y}_1-\bar{y}_2)} &= \sqrt{.62^2+.53^2} = .8157 \\ CI &= (137.21-137.18) \pm (1.977)(.8157) = (-1.6, 1.6) \end{aligned}$$

We can be 95% confident that the mean difference does not exceed 1.6 beats per minute, which is small and unimportant (in comparison with, for example, ordinary fluctuations in heart rate from one minute to the next.)

Question 7.64

From the preliminary data, we obtain .3 cm as a guess at σ.
a) If the true difference is .25 cm, then the effect size is:

$$\frac{|\mu_1-\mu_2|}{\sigma} = \frac{.25}{.3} = .83$$

We consult Table 5 for a two-tailed test at $\alpha = .05$ and an effect size of $.83 \approx .85$ to achieve power .80, Table 5 recommends $n = 23$ [1].
b) If the true difference is .50 cm, then the effect size is:

$$\frac{|\mu_1-\mu_2|}{\sigma} = \frac{.50}{.3} = 1.67$$

We consult Table 5 for a two-tailed test at $\alpha = .05$ and an effect size of $1.67 \approx 1.7$ to achieve power .95, Table 5 recommends $n = 11$ [2].

Question 7.80

Let 1 denote experimental (to be hypnotized) and 2 denote control.
a) H_O Ventilation is not differently affected by the "to be hypnotized" and the "control" conditions. H_A Ventilation is differently affected by the "to be hypnotized" and the "control" conditions. $K_1 = 53$, $K_2 = 11$, $U_s = 53$, $n = 8$, $n' = 8$ and Table 6 gives $.02 < P < .05$. Therefore, H_O is rejected. There is sufficient evidence ($.02 < P < .05$) to conclude that ventilation rate tends to be higher under the "to be hypnotized" condition than under the "control" condition.

Question 7.81

Using the formula $K_1 + K_2 = n \times n'$ and the fact that $K_1 = 0$ we have:
a) $U_s = 9$. With $n = n' = 3$, $U_s = 9$ is under the .10 heading and is the largest entry listed. Thus $P < .10$.
b) $U_s = 16$. With $n = n' = 4$, $U_s = 16$ is under the .05 heading and is the largest entry listed. Thus $P < .05$.
c) $U_s = 25$. With $n = n' = 5$, $U_s = 25$ is under the .01 heading and is the largest entry listed. Thus $P < .01$.

[1] n = 26 is also acceptable depending on rounding
[2] n = 12 is also acceptable depending on rounding

Question 7.82

a) H_O There is no sex difference in preening behavior. H_A There is a sex difference in preening behavior. For $n = n' = 15$ the largest critical value is 189, which is under the .001 heading for a nondirectional alternative. It follows that $P < .001$, so H_O is rejected. There is sufficient evidence ($P < .001$) to conclude that females tend to preen longer than males.
b) H_O There is no sex difference in preening behavior ($\mu_1 = \mu_2$). H_A There is a sex difference in preening behavior ($\mu_1 \neq \mu_2$). For this problem $t_s = (2.127 - 4.093)/.7933 = -2.48$. With $df = n_1 + n_2 - 2 = 28$ Table 4 gives $t_{.01} = 2.467$ and $t_{.005} = 2.763$, so that $.01 < P < .02$. Formula (7.1) yields $df = 15$ and $.02 < P < .04$. In either case, H_O is not rejected, because $P > .01$. There is sufficient evidence to conclude that there is a sex difference in preening behavior.
c) Both tests require independent, random samples. The condition require for the t test but not for the Wilcoxon test is that the population distributions are normal. The frequency distribution for the females is highly skewed, due to the two large observations of 10.7 and 11.7. This casts doubt on the normality condition.
d) $K_1 = 0+0+0+0+0+.5+1+1.5+1.5+2+2+3.5+5+8.5+10 = 35.5$ $K_2 = 5.5+8+11.5+11.5+11.5+13+13+13+13.5+14+15+15+15+15+15 = 189.5$

Question 7.83

Let 1 denote singly housed and let 2 denote group-housed.
a) H_O There is no difference in benzo(a)pyrene concentrations between singly housed and group housed mice. H_A Benzo(a)pyrene concentrations tend to be higher in group-housed mice than in singly housed mice. $K_1 = 0$, $K_2 = 25$, $U_s = 25$ and the shift in the data is in the direction predicted by H_A. With $n = n' = 5$, $U_s = 25$ is under .005 heading for a directional alternative and is the largest entry listed. Thus $P < .005$ and H_O is rejected. There is sufficient evidence ($P < .005$) to conclude that benzo(a)pyrene concentrations tend to be higher in group-housed mice than in singly housed mice.
b) A directional alternative is valid in this case because the researchers were investigating the hypothesis that licking or biting other mice leads to *increase* benzo(a)pyrene concentration. If access to other mice affects benzo(a)pyrene concentration, the effect would be to increase the concentration; a decrease in concentration is not plausible.

Question 7.89

a) H_O Mechanical milking does not produce different cell count than manual milking ($\mu_1 = \mu_2$). H_A Mechanical milking produces a higher cell count than manual milking ($\mu_1 > \mu_2$). For this problem $t_s = (1215.6 - 219.0)/427.54 = 2.33$. With $df = 18$, Table 4 gives $t_{.02} = 2,214$ and $t_{.01} = 2.552$. Formula (7.1) yields $df = 9$; $df = 9$ Table 4 gives $t_{.025} = 2.262$ and $t_{.02} = 2.398$. Using either df value, $P < .05$ and H_O is rejected. There is sufficient evidence to conclude that mechanical milking produces higher cell count than manual milking.
b) H_O Mechanical milking does not produce different cell count than manual milking. H_A Mechanical milking produces higher cell count than manual milking. $U_s = 69$. The shift in the data is in the direction predicted by H_A. With $n = n' = 10$ the entry under .10 for a directional alternative is 68 and the entry under .05 for a directional alternative is 73. Thus, we do not reject H_O. There is insufficient evidence ($.05 < P < .10$) to conclude mechanical milking produces higher cell count than manual milking.
c) Both tests require independent, random samples. The condition require for the t test but not for the Wilcoxon test is that the population distributions are normal. The frequency distribution for the mechanical group is highly skewed. This casts doubt on the normality condition.
d) $K_1 = 10+7+0+10+10+7+1+10+4+10 = 69$ $K_2 = 3+2+1+2+2+3+5+5+5+3 = 31$

Question 7.93

Let 1 denote Vermilion River and let 2 denote Black River. H_O The populations from which the two samples were drawn have the same distribution of tree species per plot. H_A Biodiversity is greater along the Vermilion River than along the Black River. $K_1 = 80$, $K_2 = 37$, $U_s = 80$; the data deviate from H_O in the direction specified by H_A. With $n = n' = 13$ and a directional alternative, the .10 entry in Table 6 is 79 and the .05 entry is 84. Thus, the P-value is between .05 and .10 so we reject H_O. There is sufficient evidence ($.05 < P < .10$) to conclude that biodiversity is greater along the Vermilion River than the Black River.

Question 7.95

H_O Ovarian pH is not related to progesterone response ($\mu_1 = \mu_2$). H_A Ovarian pH is related to progesterone response ($\mu_1 \neq \mu_2$). For this problem:

$$\begin{aligned}
SE_{(\bar{y}_1 - \bar{y}_2)} &= \sqrt{\frac{.129^2}{18} + \frac{.081^2}{6}} = .04492 \\
t_s &= \frac{7.373 - 7.708}{.04492} = -7.46 \\
df &= 22 \\
t_{.0005} &= 3.792
\end{aligned}$$

Thus, $P < .001$, so we reject H_O. There is sufficient evidence ($P < .001$) to conclude that ovarian pH is lower among responders to progesterone than among non-responders.

Question 7.99

Let 1 denote low chromium and let 2 denote normal. H_O Low chromium diet does not affect GITH ($\mu_1 = \mu_2$). H_A Low chromium diet does affect GITH ($\mu_1 \neq \mu_2$).

$$\begin{aligned}
SE_{(\bar{y}_1 - \bar{y}_2)} &= \sqrt{\frac{5.526^2}{14} + \frac{4.123^2}{10}} = 1.970 \\
t_s &= \frac{51.75 - 53.17}{1.970} = -.72 \\
df &= 22 \\
t_{.20} &= .858
\end{aligned}$$

So $P > .40$. Thus, we do not reject H_O. There is insufficient evidence ($P > .40$) to conclude that low chromium diet affects GITH in rats [3].

Question 7.101

a) $CI = (51.75 - 53.17) \pm (2.074)(1.970) = (-5.5, 2.7)$ [4]
b) All values in the confidence interval are smaller in magnitude than 8 thousand; thus the data support the conclusion that the difference is "unimportant".
c) The confidence interval indicates that the difference could be larger in magnitude than 4 thousand or small; thus the data do not indicate whether the difference is "unimportant".

[3] For students using SOCR, results will be $n_1 = 14, n_2 = 10, \bar{y}_1 = 51.75, \bar{y}_2 = 53.17, df = 22, t_s = \pm.73, p = .47$
[4] For students using SOCR, results will be $SE = 1.95, CI = (51.75 - 53.17) \pm (2.074)(1.95) = (-5.5, 2.6)$

Question 7.103

Let 1 denote amphetamine and let 2 denote control.
a) H_O Amphetamine is not related to water consumption ($\mu_1 = \mu_2$). H_A Amphetamine is associated with decreased water consumption ($\mu_1 < \mu_2$)

$$\begin{aligned} SE_{(\bar{y}_1 - \bar{y}_2)} &= \sqrt{\frac{27.850^2}{4} + \frac{25.322^2}{4}} = 18.82 \\ t_s &= \frac{129.375 - 156}{18.82} = -1.415 \\ df &= 6 \\ t_{.20} &= .906 \\ t_{.10} &= 1.440 \end{aligned}$$

So $.10 < P < .20$. Thus we do not reject H_O. There is insufficient evidence ($.10 < P < .20$) to conclude that amphetamine is associated with decreased water consumption.
b) H_O Amphetamine is not related to water consumption. H_A Amphetamine is associated with decreased water consumption. $K_1 = 4$, $K_2 = 12$, $U_s = 12$ the data deviate from H_O in the direction specified by H_A. With $n = n' = 4$ and a directional alternative, the smallest entry is 13, under the .10 heading. Thus, $P > .10$ and we do not reject H_O. There insufficient evidence $P > .10$ to conclude that amphetamine is associated with decreased water consumption.