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STAT 3004
Assignment 2

Question 1
(Please refer to page 3)

Question 2

a) $H_0: \Delta = 0$ vs $H_1: \Delta \neq 0$

$X_0^2 = \frac{(|115-81|-1)^2}{23}$

≈ 1.5652

p-value ≈ 0.2109

Since p-value > 0.05, we do not reject H_0 at $\alpha = 0.05$.

b) Wilcoxon signed-rank test

-ve	count	+ve	count	t_i	avg(rank)
-3	2	3	4	6	20.5
-2	2	2	5	7	14
-1	4	1	6	10	5.5

$R^+ = 6(5.5) + 5(14) + 4(20.5)$

$= 185$

$E(R^+) = \frac{23(24)}{4}$

$= 138$

$Var(R^+) = \frac{23(24)(47)}{24} - \frac{10^3+7^3+6^3-10-7-6}{48}$

$= 1049$

$H_0: \Delta = 0$ vs $H_1: \Delta \neq 0$

$|T_0| = \frac{|185-138|-\frac{1}{2}}{\sqrt{1049}}$

≈ 1.4357

p-value ≈ 0.1511

Since p-value > 0.05, we do not reject H_0 at $\alpha = 0.05$

c) $R_1 = 220$

$E(R_1) = \frac{12(12+15+1)}{2}$

$= 168$

$Var(R_1) = \frac{12(15)}{12}(12+15+1)$

$= 420$

con't c) $H_0: \Delta = 0$ vs $H_1: \Delta \neq 0$

$|T_0| = \frac{|220-168|-\frac{1}{2}}{\sqrt{420}}$

≈ 2.5129

p-value ≈ 0.012

Since p-value < 0.05, we reject H_0 at $\alpha = 0.05$.

Question 3

a) Yates-corrected χ^2 test

H_0: the prevalence of otorrhea for the ear drop group is the same as the observation group. vs

H_1: the prevalence of otorrhea for the ear drop group is not the same as the observation group.

b)

	with otorrhea	without otorrhea	
Eardrops	4	72	76
Observation	41	34	75
	45	106	151

	with otorrhea	without otorrhea
Eardrops	22.65	53.35
Observation	22.35	52.65

$X^2 = \frac{(|4-22.65|-0.5)^2}{22.65} + \frac{(|72-53.35|-0.5)^2}{53.35} + \frac{(|41-22.35|-0.5)^2}{22.35} + \frac{(|34-52.65|-0.5)^2}{52.65}$

≈ 41.7103

p-value $\approx 1.0585 \times 10^{-10}$

Since p-value < 0.05, we reject H_0 at $\alpha = 0.05$

Question 4

a) Fisher's exact test

b) H_0: the feeding performance for titmice is the same as that of goldfinches.
H_1: the feeding performance for titmice is not the same as that of goldfinches.

	striped seeds	black oil seed	
titmice	4	1	5
goldfinches	5	19	24
	9	20	29

	striped seeds	black oil seed	
titmice	x	$5-x$	5
goldfinches	$9-x$	$15+x$	24
	9	20	29

$\left|\frac{x}{9} - \frac{5-x}{20}\right| \geq \left|\frac{4}{9} - \frac{1}{20}\right|$

$|29x - 45| \geq 71$

$\Rightarrow x \geq 4$ or $x \leq -1$

extreme value $x = \{4, 5\}$

con't b) p-value $= \dfrac{\binom{8}{4}\binom{20}{1} + \binom{8}{5}}{\binom{29}{5}}$

≈ 0.0223

Since p-value < 0.05, we reject H_0 at $\alpha = 0.05$

c) Yates-corrected χ^2 test

d) H_0: the feeding performance of goldfinches is the same on different days vs
H_1: the feeding performance of goldfinches is not the same on different days

	Day 1	Day 2	Day 3	Day 4
Black oil	14.2	14.2	8.88	49.71
Striped	9.8	9.8	6.12	34.29

$$X^2 = \sum_{cell} \frac{(|O_{ij} - E_{ij}| - 0.5)^2}{E_{ij}}$$

≈ 5.0739

p-value ≈ 0.1665

Since p-value > 0.05, we do not reject H_0 at $\alpha = 0.05$

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STAT3004 Assignment 2

Question 1

PARAMETRIC METHOD

We examine the equal variances assumption by using F test for equal variances of 2 independent samples

$H_0: \sigma^2_{lighter\ smoking} = \sigma^2_{heavier\ smoking}$ vs $H_1: \sigma^2_{lighter\ smoking} \neq \sigma^2_{heavier\ smoking}$

```
> var.test(data$fn1, data$fn2)
      F test to compare two variances
data:  data$fn1 and data$fn2
F = 0.80995, num df = 40, denom df = 40, p-value = 0.5081
alternative hypothesis: true ratio of variances is not equal to 1
95 percent confidence interval:
 0.4319271 1.5188134
sample estimates:
ratio of variances
         0.8099486
```

Since p-value > 0.05, we do not reject H_0 at $\alpha = 0.05$

We, then, use t test for equal means of 2 independent samples, given their variances are equal

$H_0: \mu_{lighter\ smoking} = \mu_{heavier\ smoking}$ vs $H_1: \mu_{lighter\ smoking} \neq \mu_{heavier\ smoking}$

```
> t.test(data$fn1, data$fn2, var.equal = T)
      Two Sample t-test
data:  data$fn1 and data$fn2
t = 0.03004, df = 80, p-value = 0.9761
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.04774195  0.04920536
sample estimates:
mean of x mean of y
0.6648780 0.6641463
```

Since p-value > 0.05, we do not reject H_0 at $\alpha = 0.05$

NONPARAMETRIC METHOD

We use Wilcoxon rank-sum test to test whether 2 medians are equal for 2 independent samples

$H_0: \Delta = 0$ vs $H_1: \Delta \neq 0$

```
> fn = c(data$fn1, data$fn2)
> label = c(rep("LST", length(data$fn1)), rep("HST", length(data$fn2)))
> wilcox.test(fn~label,
+             alternative = "two.sided",
+             mu = 0,
+             paired = F,
+             exact = F,
+             correct = T,
+             conf.int = F)
      Two Sample t-test
data:  data$fn1 and data$fn2
t = 0.03004, df = 80, p-value = 0.9761
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.04774195  0.04920536
sample estimates:
mean of x mean of y
0.6648780 0.6641463
```

Since p-value > 0.05, we do not reject H_0 at $\alpha = 0.05$

There are no difference in between parametric and nonparametric methods for the given dataset. Those methods suggest that there is no significant difference in mean or median BMD between lighter smoking and heavier smoking.
