Task 1 8.154 - 8.157 : (HPromotion)

hypothesis: Normal Distribution (the change in heart rate).

1

$\bar{X}_d = 15,2$

$S_d = 2,4$

$n = 12$

$1-\alpha = 0,95$

$\alpha = 0,05$

$\frac{\alpha}{2} = 0,025$

$1-\frac{\alpha}{2} = 0,975$

- 95% CI: $\left(\bar{x}_d \pm t_{n-1, 1-\frac{\alpha}{2}} \cdot \frac{s_d}{\sqrt{n}}\right) = (13,67, 16,72)$

$t_{11, 0,975} = 2,201.$

- Paired t-test (2-sided)

→ Data from 2010 → just take the first 10:

2000	2010 (Baseline heart rate)	$d = (2000-2010)$
84	85	-1
87	77	10
90	81	9
94	81	13
98	79,5	18,5
86	83,75	2,25
88	76,5	11,50
84	77,75	6,25
86	79,25	6,75
98	84,25	13,75
$\bar{x} =$ 89,5	80	$\bar{d} = 9,5$

$s_d = 6,764$

$n = 10$

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

↳ no dif. between mean baseline (2000) heart rate and 2010's one.

- After 10 years of doing treadmill, the avg. baseline heart rate was reduced! Good health indicator!

Test Statistic $t = \frac{\bar{d} - 0}{s_d/\sqrt{n}} = \frac{9,5}{6,764/\sqrt{10}} = 4,44 \geq 0 \Rightarrow \boxed{p\text{-value}} = 2 \cdot P(t_{n-1} \geq t) =$

$= 2P(t_9 \geq 4,44) =$

$\boxed{= 2 \cdot (1 - P(t_9 \leq 4,44))}$

$\begin{cases} P(t_9 \leq 3,25) = 0,995 \\ P(t_9 \leq 4,781) = 0,9995 \end{cases}$ since: $3,25 < 4,44 < 4,781$,

then: $0,995 < P(t_9 \leq 4,44) < 0,9995$

$0,005 > 1 - P(t_9 \leq 4,44) > 0,0005$

$0,01 > 2[1 - P(t_9 \leq 4,44)] > 0,001$

$0,001 < p < 0,01$

$\boxed{H_0 \text{ rejected!}}$

So, the baseline heart rate significantly changed over the 10 years passed.

- $\boxed{99\%\ CI} = \bar{d} \pm t_{9,0,975} \cdot \frac{s_d'}{\sqrt{10}} = 9,5 \pm 2,262 \cdot \frac{6,764}{\sqrt{10}}$

$\hookrightarrow_{a=0,05}$

$1-\frac{a}{2}=0,975$

$\bar{d}=9,5$

$s_d'=6,764$

$t_{9,0,975}=2,262$

$=\boxed{(4,66 \quad ,14,304)}$

Task 2: 8.110 - 8.114 (Microb.)

$\boxed{n=8}$ 95% CI $\rightarrow$ inoculated: $I \rightarrow \bar{I} \pm t_{7,0,975} \cdot \frac{s_I}{\sqrt{8}} = 1,634 \pm 2,365 \cdot \frac{0,92}{\sqrt{8}} = (1,28,\ 1,98)$

$\rightarrow$ uninoculated: $U \rightarrow \bar{U} \pm t_{7,0,975} \cdot \frac{s_U}{\sqrt{8}} = 1,084 \pm 2,365 \cdot \frac{0,51}{\sqrt{8}} = (0,65,\ 1,51)$

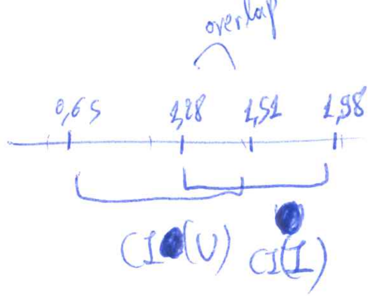
- $\bar{I}=1,634$

$\bar{U}=1,084$

$s_I=0,920$

$s_U=0,510$

$t_{7,0,975}=2,365$

- 

- Only if $CI(U)=CI(I) \Rightarrow$ then there would be no signif. diff between the mean pod weights for the 2 groups. Since $CI(U) \neq CI(I)$ even though they may overlap, this means that we expect their corresponding mean pod weights to be (significantly) diff.

- 2 independent samples: I, U plants. (2 sample t-test).

$\rightarrow$ We have to test if their variances are equal or not (of the populations that there 2 samples come from): $H_0: \sigma_I^2=\sigma_U^2$ vs $H_1: \sigma_I^2 \neq \sigma_U^2$.

$n_1=n_2=n=8$.

$$f=\left(\frac{s_I^2}{s_U^2}\right)^{-1}=\left(\frac{(0,92)^2}{(0,51)^2}\right)^{-1}=\left(\frac{0,1764}{0,2601}\right)^{-1}=(0,678)^{-1}=1,475>1 \rightarrow \boxed{p}=2\cdot Pr(F_{7,7} \geq 0,678)=$$

$$=2\cdot\left[1-P(F_{7,7}\leq 0,678)\right] \underset{\text{using (R)}}{=} \boxed{1,379}, \ H_0 \text{ accept (equal variances)}.$$

$\boxed{\text{So, we'll use the two-sample t-test for independent samples with equal variances.}}$

Task 2

$H_0: \mu_I = \mu_U$ vs $H_1: \mu_I \neq \mu_U$

$(\sigma_I^2 = \sigma_U^2 = \sigma^2)$.

Test Statistic: $\boxed{t} = \dfrac{\bar{I} - \bar{U}}{S \cdot \sqrt{\frac{1}{8} + \frac{1}{8}}} = \dfrac{1{,}634 - 1{,}084}{0{,}467 \cdot 0{,}5} = \dfrac{0{,}55}{0{,}2335}$

$= \boxed{2{,}355} > 0$

$n_1 = n_2 = n = 8$, $n_1 + n_2 - 2 = 14$

$\bar{I} = 1{,}634$

$\bar{U} = 1{,}084$

$S_I = 0{,}42$

$S_U = 0{,}51$

$$S = \sqrt{\frac{(8-1)S_I^2 + (8-1)S_U^2}{(8+8-2)}} = \sqrt{\frac{7 \cdot (0{,}42)^2 + 7 \cdot (0{,}51)^2}{14}} = 0{,}467$$

$\boxed{p\text{-value}} = 2 \cdot P(t_{14} > t) = 2 \cdot [1 - P(t_{14} \leq 2{,}355)] =$

$= 2[1 - 0{,}9831] = \boxed{0{,}033}$

So, H_0 is rejected at the 5% level. So the mean pod weight between the 2 groups is (statistically) different.

- A 95% CI for the diff in mean pod weights between the 2 groups, is given by:

$\boxed{CI} = (\bar{I} - \bar{U}) \pm t_{14, 0{,}975} \cdot S \cdot \sqrt{\frac{1}{8} + \frac{1}{8}} =$

$= 0{,}55 \pm 2{,}145 \cdot 0{,}2335 =$

$= 0{,}55 \pm 0{,}5 = \boxed{(0{,}05,\ 1{,}05)}$ $\Leftarrow$ 0 is not included, which confirms the findings of the previous 2-sample t-test result. (and that the inoculated plants show statist. more growth).

Task 3 (9.7-9.8) Health Services Administration

- A t-test will not be useful because the data don't seem to be normally distributed $\Rightarrow$ we can see that if we plot the distribution of length of stays for each hospital. (skewed).

So, the 2 samples are non-normal and independent.

$n_1 = 11$, $n_2 = 13$

- Wilcoxon rank-sum test: $\begin{cases} H_0: \text{The median length of stays are the same for the 2 hospitals} \\ H_1: \text{— " — are different.} \end{cases}$

(or alternatively: the 2 samples come from the same distribution)

Data: (combined, (1st → first hospital, 2nd → second hospital)

hos (1st)		ranks	Avg Ranks
5	(1st)	1	1
8	(1st)	2	2
10	(1st)	3	3,5
10		4	3,5
13	(1st)	5	5
21	(1st)	6	6
26	(1st)	7	7
27		8	8
29	(1st)	9	9
32	(1st)	10	10
33	(1st)	11	11
35		12	12
44	(1st)	13	13,5
44		14	13,5
60	(1st)	15	15,5
60		16	15,5
68		17	17
73		18	18
76		19	19
86		20	20
87		21	21
96		22	22
125		23	23
238		24	24

$n_1 = 11$, $n_2 = 13$, $\min(n) = n_1 > 10$, so we'll use the normal approximation method.

for the first hospital (shown as (1st))

- $\boxed{R_1} = 1+2+3{,}5+5+6+7+9+10+11+13{,}5+15{,}5 = \boxed{83{,}5}$

$E(R_1) = \dfrac{n_1(n_1+n_2+1)}{2} = \dfrac{11(11+13+1)}{2} = 137{,}5$

- We notice that there exist ties between the 2 datasets, so we'll use (36) from eq (9.8)

- We have $\boxed{g=3}$ tied groups with 2 common obs. each, so:

$$\boxed{Var(R_1)} = \frac{n_1 n_2}{12}\left[n_1+n_2+1 - \frac{\sum_{i=1}^{g} t_i(t_i^2-1)}{(n_1+n_2)(n_1+n_2-1)}\right] =$$

$$= \frac{11\cdot 13}{12}\left[11+13+1 - \frac{3\cdot\left[2(2^2-1)\right]}{(11+13)(11+13-1)}\right] =$$

$$= 11{,}91667\cdot\left(25 - \frac{18}{24\cdot 23}\right) =$$

$$= \boxed{297{,}5282}.$$

So, the test statistic is:

$$\boxed{T} = \frac{|R_1 - E(R_1)| - 0{,}5}{\sqrt{Var(R_1)}} =$$

$$= \frac{|83{,}5 - 137{,}5| - 0{,}5}{\sqrt{297{,}5282}} = \frac{53{,}5}{17{,}249} =$$

$$\simeq \boxed{3{,}10}$$

- $\boxed{p\text{-value}} = 2(1-\Phi(T)) =$

$$= 2(1-\underbrace{\Phi(3{,}10)}_{0{,}9990}) \simeq \boxed{0{,}002}$$

⇒ Ho rejected, results show that there is a significantly statistical difference between the length of stay of the 2 hospitals.

$\boxed{\text{Task 4}}$ 9.13–9.26. : [Otolaryngology, Pediatrics] ③

- H_0: The duration of effusion in breastfed babies and the duration of effusion in bottle-fed babies come from the same distribution.

vs

H_1: –»– they come from diff. distributions.

- The distribution of effusion in both samples is very skewed and seems to be far from normal ⇒ (so a parametric paired-sample t-test shouldn't be used in this case).

- **The** 2-samples are paired (common age, sex, sosioeconomic status) ⇒ we'll use the Wilcoxon signed-rank test. non-zero diff.: $\boxed{n = 23}$ → use the normal approximation method (eq. 9.6)

# pair	breastfed (br) (days)	bottle-fed (bot) (days)	d = br − bot	sign	|d|	Range of ranks	Avg. ranks
1	20	18	2	+	2 ✓	5-7	6
2	11	35	-24	−	24 ✓	19	19
3	3	7	-4	−	4 ✓	9	9
4	24	182	-158	−	158 ✓	21	21
5	7	6	1	+	1 ✓	1-4	2,5
6	28	33	-5	−	5 ✓	10-11	10,5
7	58	223	-165	−	165 ✓	22	22
8	7	7	0				
9	39	57	-18	−	18 ✓	18	18
10	17	76	-59	−	59 ✓	20	20
11	17	186	-169	−	169 ✓	23	23
12	12	29	-17	−	17 ✓	17	17
13	52	39	13	+	13 ✓	16	16
14	14	15	-1	−	1 ✓	1-4	2,5
15	12	21	-9	−	9 ✓	13	13
16	30	28	2	+	2 ✓	5-7	6
17	7	8	-1	−	1 ✓	1-4	2,5
18	15	27	-12	−	12 ✓	14-15	14,5
19	65	77	-12	−	12 ✓	14-15	14,5
20	10	12	-2	−	2 ✓	5-7	6
21	7	8	-1	−	1 ✓	1-4	2,5
22	19	16	3	+	3 ✓	8	8
23	34	28	6	+	6 ✓	12	12
24	25	20	5	+	5 ✓	10-11	10,5

$n=23$

- R_1 = rank-sum of positive diff. $= 6 + 2,5 + 16 + 6 + 8 + 12 + 10,5 \Rightarrow$ $\Rightarrow \boxed{R_1 = 61}$.

- $\boxed{E(R_1)} = \dfrac{n(n+1)}{4} = \dfrac{23 \cdot 24}{4} = \boxed{138}$.

- Ties exist ($g=4$ tied groups), so for the variance of R_1, we'll use the (3b) formula (eq 9.6):

$$\boxed{Var(R_1)} = \frac{n(n+1)(2n+1)}{24} - \sum_{i=1}^{g=4} \frac{(t_i^3 - t_i)}{48} = \frac{23 \cdot 24 \cdot 47}{24} - \frac{\overbrace{(4^3-4)}^{60} + \overbrace{(3^3-3)}^{24} + \overbrace{(2^3-2)\times 2}^{12}}{48}$$

$$= 1081 - 2 = \boxed{1079}.$$

- So, the test statistic is: $\boxed{T} = \dfrac{|R_1 - E(R_1)| - \frac{1}{2}}{\sqrt{Var(R_1)}} = \dfrac{76.5}{\sqrt{1079}} = 2,33 \simeq \boxed{2,33}$

$T \sim N(0,1)$

- p-value $= 2 \cdot [1 - \Phi(T)] = 2 \cdot [1 - \underbrace{\Phi(2,33)}_{0,9898}] = 0,0204$, $\Rightarrow$ results stat. significant,

Ho reject $\Rightarrow$ the duration of effusion is diff. distributed between the 2 cases {breast-fed babies, bottle-fed}

Looking at the signs of the differences in duration, we observe shorter duration of effusion in breastfed babies, compared to the bottle-fed ones.

Task 5

(10.13)

Had Urethritis before

	Diagnosis: gonorrhea related	non-gonorrhea related	
YES	160	50	210
NO	40	55	95
	200	105	305

(9)

We'll use the Chi-Square test → 2×2 contigency table (independent samples)

$\hat{p}_1 = \frac{160}{200} = 80\%$ → p_1: probability of a patient having gonorrhea (while he had prior episode of urethritis)

$\hat{p}_2 = \frac{50}{105} \approx 48\%$ → p_2: probability of a patient having nongonococcal urethritis (while he had prior episode of urethritis)

$H_0: p_1 = p_2 = p$ vs $H_1: p_1 \neq p_2$

no relationship between present diagnosis and prior episode of urethritis.

- Expected Table values: $E_{11} = \frac{210 \cdot 200}{305} = 137,7$ $E_{21} = \frac{95 \cdot 200}{305} = 62,3$

$E_{12} = \frac{210 \cdot 105}{305} = 72,3$ $E_{22} = \frac{95 \cdot 105}{305} = 32,7$

- $E_{ij} > 5 \ \forall i,j = 1,2$ so the normal approximation method can be used.

- Test Statistic: $X^2 = \frac{(160-137,7-0,5)^2}{137,7} + \frac{(50-72,3-0,5)^2}{72,3} + \frac{(40-62,3-0,5)^2}{62,3} + \frac{(55-32,7-0,5)^2}{32,7} = \cong 32,18$

- $p\text{-value} = P(X_1^2 > X^2) = P(X_1^2 > 32,18) = 1 - P(X_1^2 \leq 32,18)$.

$\begin{cases} P(X_1^2 \leq 10,83) = 0,999 \\ P(X_1^2 \leq 32,18) > P(X_1^2 \leq 10,83) \end{cases} \Rightarrow P(X_1^2 \leq 32,18) > 0,999 \Rightarrow 1 - P(X_1^2 \leq 32,28) < 0,001$

$\boxed{p\text{-value} < 0,001}$

results are stat. significant.

we reject H_0, so there is an association between present diagnosis and prior episodes of urethritis.

Also, by comparing $\hat{p}_1$ and $\hat{p}_2$ estimations it seems that you have a larger probability of being diagnosed with gonorrhea if you had prior episodes of urethritis.

(10.6-10.7). "Receiving an antibiotic" and "Receiving a bacterial culture" are both categorical variables, each one having only two possible outcomes (yes/no).

We'll use the Chi-Square test on the observed data:

		Received bacterial culture YES	NO	
Received Antibiotic	YES	2	5	7
	NO	4	14	18
		6	19	25

→ For example: $O_{11} = 2$ because in the table 2.13 (with the hospital data), only 2 patients both received an antibiotic and a bacterial culture.

• $\hat{p}_1 = \frac{2}{6} = 0{,}33 = 33\%$ p_1: prob. to receive bact. culture when also received antibiotic

• $\hat{p}_2 = \frac{5}{19} = 0{,}26 = 26\%$ p_2: prob. to not receive bact. culture →

→ We want to test the hypothesis → $H_0: p_1 = p_2 = p$ vs $H_1: p_1 \neq p_2$

↳ no relationship between the 2 categorical variables.

→ Expected values table:

$$E_{11} = \frac{7 \cdot 6}{25} = 1{,}68 \quad , \quad E_{12} = \frac{7 \cdot 19}{25} = 5{,}32$$

$$E_{21} = \frac{18 \cdot 6}{25} = 4{,}32 \quad , \quad E_{22} = \frac{18 \cdot 19}{25} = 13{,}068$$

$E_{11} < 5$, so we cannot use the contigency table method. Insted, we'll use $\boxed{\text{Fisher's Exact Test}}$

(1) → First, we enumerate all possible tables with the same row and column margins as the observed table:

a	b
c	d

a=0

0	7
6	12

a=1

1	6
5	13

a=2

2	5
4	14

a=3

3	4
3	15

a=4

4	3
2	16

a=5

5	2
1	17

a=6

6	1
0	18

$N_1 = 7$, $N_2 = 18$
$M_1 = 6$, $M_2 = 19$. $N = 25$

(2) → Now, we compute the exact probabilities of each table (using eq. (10.6) or (10.7)):

a	b
c	d

$$P(a,b,c,d) = \frac{(a+b)!\,(c+d)!\,(a+c)!\,(b+d)!}{n!\,a!\,b!\,c!\,d!} = \frac{N_1!\,N_2!\,M_1!\,M_2!}{n!\,a!\,b!\,c!\,d!}$$

Task 5 | 10.6–10.7 (cont).

$$\cdot P(0, 7, 6, 12) = \frac{7!\,\cancel{18!}\,\cancel{6!}\,\cancel{19!}}{\cancel{25!}\,0!\,\cancel{7!}\,\cancel{6!}\,\cancel{12!}} = 0{,}105 \quad [= P(X=0), \text{ from eq. } (10.7)]$$

(above the numerator: $13\cdot14\cdot15\cdot16\cdot17\cdot18$; below the denominator: $20\cdot21\cdot22\cdot23\cdot24\cdot25$)

$$\cdot P(X=1) = \frac{7!\,18!\,6!\,19!}{25!\,1!\,6!\,5!\,13!} = 0{,}339$$

$\cdot P(X=2) = 0{,}363$, $P(X=3) = 0{,}161$, $P(X=4) = 0{,}03$, $P(X=5) = 0{,}0021$

↑ observed table → $\begin{array}{|c|c|}\hline 2 & 5 \\ \hline 4 & 14 \\ \hline\end{array}$

$P(X=6) = 0{,}00004$

(3) $P_a = P(0) + P(1) + P(2) = 0{,}806$

$P_b = P(2) + P(3) + P(4) + P(5) + P(6) = 0{,}557$

$\boxed{\text{p-value}} = 2 \times \min(P_a, P_b, 0.5) = 2 \times 0{,}5 = \boxed{1}$ → Ho accept, so there is no association between receiving a bacterial culture and receiving antibiotics while in the hospital.

Task 6 | 10.19 – 10.22 – Otolaryngology

group	Num	Num of children with otorrhea at 2 weeks
Antibiotic ear drops	76	4
Oral antibiotics	77	34
Observation (no treatment)	75	41
Total:	228	79

• Observation Group: After 2 weeks of no treatment, the child can either have or not the otorrhea disease. So the number of children from the obs. group that still have otorrhea after 2 weeks, follows the binomial distribution where "success" (p) is considered to have the disease after 2 weeks! So $\boxed{\hat{p} = \frac{41}{75} = 0{,}55}$ is a point estimate for the prevalence of otorrhea. ($n = 75$) ($\hat{q} = 1 - \hat{p} = 0{,}45$). So $\boxed{n\hat{p}\hat{q}} = 75 \cdot 0{,}55 \cdot 0{,}45 = 18{,}5625 \boxed{>5}$

Since $n\hat{p}\hat{q} > 5$, we can use the normal-theory method to calculate a 95% CI for the prevalence of otorrhea (eq. 6.19)

The $\boxed{CI}$ is: $\hat{p} \pm z_{1-\alpha/2}\sqrt{\frac{\hat{p}\hat{q}}{n}}$ →, $1-\alpha = 0{,}95 \Rightarrow 1 - \frac{\alpha}{2} = 0{,}975$, $z_{0{,}975} = 1{,}96$

$$\rightarrow 0{,}55 \pm 1{,}96\sqrt{\frac{0{,}55 \cdot 0{,}45}{75}} = 0{,}55 \pm 1{,}96 \cdot 0{,}0574 = 0{,}55 \pm 0{,}113 = \boxed{(0{,}44,\ 0{,}66)}$$

• Same logic as before now for the ear drop group:

$n = 76$, $\boxed{\hat{p}} = \frac{4}{76} = \boxed{0{,}053}$, $\hat{q} = 1 - p = 0{,}947$, $n\hat{p}\hat{q} = 76 \cdot 0{,}053 \cdot 0{,}947 = 3{,}81 < 5$

$X = 4$

But, here we cannot use the normal approximation method.

Instead, we'll use the exact method (eq. 6.20)

The 95% $CI = (p_1, p_2)$ where p_1, p_2 satisfy:

$$\Rightarrow \begin{cases} Pr(X \geq x \mid p = p_1) = \frac{\alpha}{2} = \sum_{k=x}^{n} \binom{n}{k} p_1^k (1-p_1)^{n-k} \\ Pr(X \leq x \mid p = p_2) = \frac{\alpha}{2} = \sum_{k=0}^{x} \binom{n}{k} p_2^k (1-p_2)^{n-k} \end{cases}$$

$1 - \alpha = 0{,}95$

$\alpha = 0{,}05$

$\boxed{\frac{\alpha}{2} = 0{,}025}$

$$\begin{cases} P(X \geq 4 \mid p = p_1) = 0{,}025 \\ P(X \leq 4 \mid p = p_2) = 0{,}025 \end{cases} \rightarrow$$

$$\Rightarrow \begin{cases} \sum_{k=4}^{76} \binom{76}{k} p_1^k \cdot (1-p_1)^{76-k} = 0{,}025 \\ \sum_{k=0}^{4} \binom{76}{k} p_2^k (1-p_2)^{76-k} = 0{,}025 \end{cases}$$

... I used the R function: binom.test(4, 76, p = 4/76) and got a 95% CI as:

$$\boxed{CI = (p_1, p_2) = (0{,}0145\ ,\ 0{,}1293)}$$

- To compare the prevalence of otorrhea for the ear drop group vs the observation group, we will use a two-sample test for binomial proportions: (we consider the two samples as independent)

p_1: probability that after 2 weeks of treatment with antibiotic ear drops, you'll still have otorrhea.

p_2: probability that after 2 week of no treatment, you'll still have otorrhea.

Hypothesis to test: $H_0: p_1 = p_2 = p$ vs $H_1: p_1 \neq p_2$.

$n_1 = 76$, $\hat{p}_1 = 0{,}053$

$n_2 = 75$, $\hat{p}_2 = 0{,}55$

We'll try to use the Normal-Theory Method (eq. 10.3). First we have to see if the normal approximation to the binomial distribution is valid for each of the 2 samples:

$$\boxed{\hat{p}} = \frac{n_1\hat{p}_1 + n_2\hat{p}_2}{n_1 + n_2} = \frac{76 \cdot 0{,}053 + 75 \cdot 0{,}55}{76 + 75} \cong \boxed{0{,}3} \qquad \hat{q} = 1 - \hat{p} = 0{,}7$$

• $n_1\hat{p}\hat{q} = 76 \cdot 0{,}3 \cdot 0{,}7 = 15{,}96 > 5$

• $n_2\hat{p}\hat{q} = 75 \cdot 0{,}3 \cdot 0{,}7 = 15{,}75 > 5$

$\Rightarrow$ So, YES we'll use the normal theory two-sample test for binomial proportions.

Task 5 | 20.19 - 21.22 (cont).

6

The test statistic is:

$$\boxed{z} = \frac{|\hat{p}_1 - \hat{p}_2| - \left(\frac{1}{2n_1} + \frac{1}{2n_2}\right)}{\sqrt{\hat{p}\hat{q}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)}} = \frac{|0{,}053 - 0{,}55| - \left(\frac{1}{2\cdot 76} + \frac{1}{2\cdot 75}\right)}{\sqrt{0{,}3\cdot 0{,}7\cdot\left(\frac{1}{76} + \frac{1}{75}\right)}} =$$

$$= \frac{0{,}497 - 0{,}0132}{\sqrt{0{,}005632}} = \frac{0{,}4838}{0{,}0746} = \boxed{6{,}485} \rightarrow \Phi(6{,}485) = 1.$$

• p-value $p = \min\{2(1-\Phi(z)), 1\} = \min\{0, 1\} = 0$. So, since the p-value $< 0{,}001$ the results are highly significant and we reject the H_0 at the 95% significance level. So the prevalence of otorrhea between the 2 group is different and judging the sample proportions ($\hat{p}_1 = 0{,}053$, $\hat{p}_2 = 0{,}55$) the antibiotic ear drops seem to be a better alternative to no treatment for the otorrhea disease.

End