CMD 305 - COURSE

(RESEARCH METHODOLOGY & BIOSTATISTICS)

TUTORIAL TOPIC: p-value & CONFIDENCE INTERVALS (Solutions)

1. Definition of "p-value"

Mark correct and false statements as: (Yes/No)

A "p" stands for probability and it ranges from 0 to 1.	Yes
A p-value of ≤ 0.05 is considered as not statistically significant	No
A p-value of >0.05 is considered as statistically significant	No
Statistically significant is more important than clinical significant	No
The p-value is the probability of getting an outcome as extreme as or more extreme than the actually observed outcome (sample) under the null hypothesis.	Yes
Usually the null hypothesis is a statement of "no effect", "no difference" or "=0" and we are eager to find evidence against it.	Yes
When large samples are available, even small deviations from the null hypothesis will be significant.	Yes

2. Conclusions based on "p-value"

There are two groups of employees (Teaching staff and Hospital staff)

H0: Mean Income$_1$ = Mean Income$_2$

You draw a random sample of size 30 from each population.

(i)Statistical Test-result: p = 0.016

Mark correct and false conclusions as: (Yes /No)

a)	Statistically, the mean income of the two employee groups is equal.	NO
b)	With probability 0.016 teaching staff has the same mean income as hospital staff.	NO
c)	The sample data is not compatible (p=0.016) with the null hypothesis: the mean income in the two groups is equal.	YES
d)	We could not find a significant (at level 0.05) difference in mean income of two groups.	NO
e)	Data did not show a significant difference in mean income of two groups.	NO
f)	The sample data is compatible (p=0.0.016) with the null hypothesis that teaching and hospital staff have the same mean income.	NO

(ii) Statistical Test-result: p = 0.09

Mark correct and false conclusions as: (Yes/No)

a)	Mean income in the two groups did not differ significantly (p=0.09).	Yes
b)	Mean income in the two groups differs significantly (p=0.09).	NO
c)	The null hypothesis, that the mean income of teaching and hospital are equal, is rejected at significance level α=0.05.	NO
d)	The null hypothesis, that the mean income of teaching and hospital are equal, is not rejected at significance level α=0.05.	Yes

3) Definition of Confidence Interval

a)	A confidence interval always covers the true parameter.	NO
b)	A confidence interval covers the true parameter with a given probability.	NO
c)	A confidence interval covers the statistic with a given probability.	NO
d)	In 100 repeated samples, 95% its confidence intervals will contain the true parameter	YES

4). Duality of p-value and 95% confidence intervals:

Which of the 4 statements given below are either consistent or inconsistent by both p-values and 95% confidence intervals? And also comment on the width of the confidence interval where ever it is consistent.

a) A study comparing BMI (each 50 male and female) reported mean difference (male-female) = 6.0, p = 0.10, CI 95% = [-1 to 40]

Answer: The mean BMI difference between male and female in the target population is not statistically significant (p=0.10, which is >0.05) also the 95% confidence interval for difference of mean value of BMI included the null value "zero" (of no difference). **Hence both p-value and 95% CI are consistent**. The width of confidence interval is large due to small sample size (each 50 male and female), which indicates low precision of the estimate.

b) A study comparing BMI (each 500 male and female) reported means difference (male-female) = 10.5, p = 0.01 CI 95% = [-2; 15]

Answer: The p-value and 95% CI are not consistent. Because p=0.01 which is <0.05 (statistically significant), where as 95% CI included the null value "zero" (of no difference).

c) A study comparing Systolic .BP (each 50 male and female) reported mean difference (male-female) = 8.0, p = 0.0001 CI 95% = [-2; 20]

Answer: The p-value and 95% CI are not consistent. Because p=0.0001 which is <0.05 (highly statistically significant), where as 95% CI included the null value "zero" (of no difference).

d) A study comparing Systolic BP (each 500 male and female) reported mean difference (male-female) = 7.5, p = 0.0001 CI 95% = [4.5; 12.0]

Answer: The mean Systolic BP difference between male and female in the target population is highly statistically significant (p=0.0001, which is <0.05) also the 95% confidence interval for difference of mean value of Systolic BP does not included the null value "zero" (of no difference). **Hence both p-value and 95% CI are consistent**. The width of confidence interval is small due to large sample size (each 500 male and female), which indicates a good precision of the estimate

5) In a sample of 100 children taken from a rural community, it was found anemia prevalence as 35%. Construct 95 % confidence interval for the prevalence of anemia for that community and give your inference. Also comment on the width of confidence interval.
[Use: 95% CI for population proportion = p ± confidence factor × S.error of (p),
Where confidence factor=1.96 and S.error of (p) = 4.8]

Solution:

95% Confidence Interval for population proportion: $p \pm 1.96 \; se(p)$

Where $\text{se(p)} = \sqrt{\frac{pq}{n}}$

Given sample proportion p = 0.35 ,

and $\text{se(p)} = \sqrt{\frac{0.35x0.65}{100}} = 0.04769$

95% confidence limits are (0.35 $\pm$ 1.96 x 0.048) = 0.2559" to 0.4441" = 26% to 44%

With 95% confidence, we expect that the anemia prevalence in the population will be as minimum as 26% and as high as 44%. The width of 95% confidence interval is wide, due to sample size of 100 children, which indicates lack of precision of the estimate.

6). To examine the hypothesis that the low birth weight babies have a higher risk of coronary diseases in later life, a study was conducted in 100 low birth weight babies and in 100 babies born with normal

weight. It was found that 15% among the former 10% in the latter had life time incidence of chronic diseases. Obtain 95% CI for the difference in proportions in these two groups. Is there a statistically significant difference in the incidence of coronary diseases of low birth weight babies and babies born with normal weight?
[Use: 95% CI for (P1-P2) = (p1-p2) ± confidence factor × S.error of (p1-p2),
Where confidence factor=1.96 and S.error of (p1-p2) = 0.0466]

Solution: 95% C I for (P1-P2) is (p1-p2) ± $Z_{(1-\alpha)}$ se (p1-p2)

$$se\ \ of\ \ (p_1 - p_2) = \sqrt{\left(\frac{p_1 q_1}{n_1}\right) + \left(\frac{p_2 q_2}{n_2}\right)}$$

Where $Z_{(1-\alpha)}$ = 1.96 for 95% confidence

Given p1=incidence of chronic diseases in LBW group = 0.15 and

p2= incidence of chronic diseases in normal group = 0.10

$$se\ (p_1 - p_2) = \sqrt{\left(\frac{0.15x0.85}{100}\right) + \left(\frac{0.1x0.9}{100}\right)} = 0.0466$$

95% C I for (P1-P2) is [(0.15-0.10) ± 1.96x0.0466] = - 0.0432 to 0.1432= -4.32% to14.32%

The CI shows that coronary diseases in LBWs would be as higher as 14.32% when compared to normal group. As the 95% confidence intervals for difference of proportions (incidence of coronary disease) included “zero” (null value of no difference), it can inferred that there is no statistically significant difference between low birth weight babies and normal weight babies.

7) Interpretation of p-values and 95% confidence intervals in the following abstract:

Title: The Outcome of Extubation Failure in a Community Hospital Intensive Care Unit: A CohortStudy.

Seymour CW, Martinez A, Christie JD, Fuchs BD. *Critical Care 2004*, 8:R322-R327 (20July 2004)

Introduction: Extubation failure has been associated with poor intensive care unit (ICU) and hospital outcomes in tertiary care medical centers. Given the large proportion of critical care delivered in the community setting, our purpose was to determine the impact of extubation failure on patient outcomes in a community hospital ICU.

Methods: A retrospective cohort study was performed using data gathered in a 16-bed medical/surgical ICU in a community hospital. During 30 months, all patients with acute respiratory failure admitted to the ICU were included in the source population if they were mechanically ventilated by endotracheal tube for more than 12hours. Extubation failure was defined as reinstitution of mechanical ventilation within 72 hours (n= 60), and the control cohort included patients who were successfully extubated at 72 hours (n =93).

Results: The primary outcome was total ICU length of stay after the initial extubation. Secondary outcomes were total hospital length of stay after the initial extubation, ICU mortality, hospital mortality, and total hospital cost. Patient groups were similar in terms of age, sex, and severity of illness, as assessed using admission Acute Physiology and Chronic Health Evaluation II score ($P > 0.05$). Both ICU (1.0 versus 10 days; $P < 0.01$) and hospital length of stay (6.0 versus 17 days; $P < 0.01$) after initial extubation were significantly longer in reintubated patients.ICU mortality was significantly higher in patients who failed extubation (odds ratio = 12.2, 95%confidence interval [CI] = 1.5–101; $P < 0.05$), but there was no significant difference in hospital mortality (odds ratio = 2.1, 95% CI = 0.8–5.4; $P < 0.15$). Total hospital costs (estimated from direct and indirect charges) were significantly increased by a mean of US$33,926 (95% CI =US$22,573–45,280; $P < 0.01$).

Conclusion: Extubation failure in a community hospital is univariately associated with prolonged inpatient care and significantly increased cost. Corroborating data from tertiary care centers, these adverse outcomes highlight the importance of accurate predictors of extubation outcome.

Answer the following questions:

(1) What is the sample size in each of Extubation failure and successfully extubated groups?

Answer: Extubation failure =60 and successfully extubated =93

(2) On what basis the authors had mentioned that the patients groups were similar?

Answer: By using $P >0.05$.

(3) Is there a statistically significant difference in ICU and hospital length of stay initial extubation in re intubated patients? If yes what are the corresponding p-values?

Answer: Yes, Both ICU (1.0 versus 10 days; $P < 0.01$) and hospital length of stay (6.0 versus 17 days; $P < 0.01$) after initial extubation were significantly longer in reintubated patients.

(4) How to interpret ICU mortality odds ratio =12.2? Is it statistically significant?

Answer: The odd s of ICU mortality is 12.2 times higher in patients who failed extubation, when compared with the patients who successfully extubated. Yes the Odds ratio is statistically significant as p-value is <0.05.

(5) What is the interpretation of its 95% confidence interval: 1.5- 101. Why this confidence interval is very wide?

Answer: This study shows an odds ratio of 12.2. If this study is repeated 100 times, 95 times the odds ratio lies within 1.5 and 101. This indicates the odds ratio of 12.2 is not a precise estimate. The confidence interval is wide could be due to low sample size (60 and 93).