Quiz 3

BSTA 512, Winter 2024

Mar 11, 2024

Name: Answer Key

Instructions

There are **8 total pages** in the exam and **8 questions** (5 multiple choice and 3 free response). Please make sure you have all of the pages!

1. I have written a "30 minute" quiz. However, you have 50 minutes from 2:00 - 2:50pm.
2. The quiz is open book and open notes. You may use books other than the class textbook, you may use anything on our course webpage, and you may use reference websites (like Wikipedia, Googling expected value of specific distribution, etc.).
3. No cheating will be tolerated. If one person is caught cheating, I will need to reconsider how to administer Quiz 2. Cheating includes:
    - Using ChatGPT
    - Using question and answer threads typically seen on sites like StackExchange, WikiHow, Quora, Reddit, StackOverflow, Chegg, etc.
    - Asking other students in the room or looking at other students' quiz work.
4. Each multiple choice question is worth 3 points. The free response questions are labelled with their point value.
5. You may use headphones during the quiz.
6. **There are two questions that require small calculations. You may use an app, R, or another calculator for these problems.**

Grading

For Nicky to fill out:

Question	Points	Potential Points
Questions 1-5		15
Questions 6-8		13
Total		28

Questions

Questions 1-5 will use the following study and models:

Using simulated data, we are looking at the relationship between peak exercise heart rate, age, and physical activity level (PAL):

- Peak exercise heart rate: outcome measured in beats per minute (bpm)
- Age (years): individuals are 40 to 80 years old, and centered at 60 years old. Age^c is for the centered age
- Physical activity level (PAL): 3 categories including light, moderate, and vigorous activity

We can run the following four models:

Model 1: $HR = \beta_0 + \beta_1 Age^c + \epsilon$

Model 2: $HR = \beta_0 + \beta_1 \cdot I(PAL = \text{Moderate}) + \beta_2 \cdot I(PAL = \text{Vigorous}) + \epsilon$

Model 3: $HR = \beta_0 + \beta_1 Age^c + \beta_2 \cdot I(PAL = \text{Moderate}) + \beta_3 \cdot I(PAL = \text{Vigorous}) + \epsilon$

Model 4: $HR = \beta_0 + \beta_1 Age^c + \beta_2 \cdot I(PAL = \text{Moderate}) + \beta_3 \cdot I(PAL = \text{Vigorous}) + \beta_4 \cdot Age^c \cdot I(PAL = \text{Moderate}) + \beta_5 \cdot Age^c \cdot I(PAL = \text{Vigorous}) + \epsilon$

1. Which two models would we compare to determine if physical activity level is an effect modifier of age (as it relates to peak exercise heart rate)?

   a. Model 1 vs. Model 2

   b. Model 1 vs. Model 3

   c. Model 2 vs. Model 3

   d. Model 2 vs. Model 4

   e. Model 3 vs. Model 4

2. Which two models would we compare to determine if physical activity level is a confounder of age (as it relates to peak exercise heart rate)?

   a. Model 1 vs. Model 2

   b. Model 1 vs. Model 3

   c. Model 2 vs. Model 3

   d. Model 2 vs. Model 4

   e. Model 3 vs. Model 4

3. Let's say we ran Model 4:

$$
\begin{aligned}
HR = &\beta_0 + \beta_1 Age^c + \beta_2 \cdot I(PAL = \text{Moderate}) + \beta_3 \cdot I(PAL = \text{Vigorous}) + \\
&\beta_4 \cdot Age^c \cdot I(PAL = \text{Moderate}) + \beta_5 \cdot Age^c \cdot I(PAL = \text{Vigorous}) + \epsilon
\end{aligned}
$$

   and got the following regression table.

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	131.357	1.670	78.665	0.000	128.063	134.650
Age_c	-1.286	0.175	-7.350	0.000	-1.632	-0.941
PALModerate	23.743	2.275	10.438	0.000	19.257	28.229
PALVigorous	47.569	2.320	20.501	0.000	42.993	52.146
Age_c:PALModerate	-0.604	0.225	-2.687	0.008	-1.048	-0.161
Age_c:PALVigorous	-0.712	0.226	-3.146	0.002	-1.158	-0.265

How would we interpret the estimate for β_5?

a. The mean difference in age's effect, comparing moderate to light physical activity, is -0.71 bpm.

b. The mean difference in age's effect, comparing moderate to light physical activity, is -0.6 bpm.

c. The mean difference in age's effect, comparing vigorous to light physical activity, is -0.71 bpm.

d. The mean difference in age's effect, comparing vigorous to light physical activity, is -0.6 bpm.

4. Let's say we ran Model 2:

$$HR = \beta_0 + \beta_1 \cdot I(PAL = \text{Moderate}) + \beta_2 \cdot I(PAL = \text{Vigorous}) + \epsilon$$

and got the following regression table.

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	128.756	1.998	64.427	0	124.815	132.697
PALModerate	34.852	2.726	12.783	0	29.475	40.229
PALVigorous	74.918	2.783	26.919	0	69.430	80.407

What is the expected peak exercise heart rate for moderate exercise?

a. 128.76 bpm

b. 34.85 bpm

c. 74.92 bpm

d. 163.61 bpm

e. 203.67 bpm

5. We found that physical activity level was not an effect modifier of age. Based on the following regression tables for Model 1 and Model 3, what is the percent change in age's coefficient? And is physical activity level a confounder of age?

Model 1:

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	165.670	2.259	73.322	0	161.215	170.126
Age_c	-1.092	0.213	-5.135	0	-1.511	-0.672

Model 3:

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	129.822	1.612	80.512	0	126.642	133.002
Age_c	-0.880	0.085	-10.385	0	-1.047	-0.713
PALModerate	32.835	2.204	14.899	0	28.489	37.182
PALVigorous	73.020	2.248	32.476	0	68.586	77.454

a. $\Delta\% = 100\% \cdot \dfrac{-1.09 - (-0.88)}{-0.88} = -24.04\%$, Confounder

b. $\Delta\% = 100\% \cdot \dfrac{-0.88 - (-1.09)}{-1.09} = -19.38\%$, Confounder

c. $\Delta\% = 100\% \cdot \dfrac{-1.09 - (-0.88)}{-0.88} = -24.04\%$, Not a confounder

d. $\Delta\% = 100\% \cdot \dfrac{-0.88 - (-1.09)}{-1.09} = -19.38\%$, Not a confounder

Questions 6-8 will use the following study and analysis:

A study is conducted to examine the role of age (measured in days) and birth weight (BWT in ounces) as predictors of infant systolic blood pressure (SBP, mm Hg). I have centered age around its mean of 3.3 days and centered birth weight around its mean of 120.3 ounces. Let's say we fit the following model:

$$\text{SBP} = \beta_0 + \beta_1 \text{BWT}^c + \beta_2 \text{Age}^c + \beta_3 \cdot \text{BWT}^c \cdot \text{Age}^c + \epsilon$$

We have the following regression table:

term	estimate	std.error	statistic	p.value	conf.low	conf.high
(Intercept)	88.29	0.53	165.92	0.00	87.13	89.45
bwt_c	0.13	0.03	4.36	0.00	0.06	0.19
age_c	5.86	0.58	10.19	0.00	4.61	7.12
bwt_c:age_c	-0.13	0.05	-2.49	0.03	-0.24	-0.02

6. (5 points) Please interpret the intercept for in the above regression equation. Please include the 95% confidence interval.

The expected systolic blood pressure is
0.5 pts 0.5 pts
88.29 mm Hg (95% CI: 87.13, 89.45) for
0.5 pts 0.5 pts 0.5 pts 0.25 pts 0.25 pts
3.3 day old infants with a 120.3 ounce birthweight.
0.5 pts 0.5 pts 0.5 pts 0.5 pts

7. (5 points) Please interpret the coefficient for birth weight (β_1, main effect of birth weight) in the above regression equation. Please include the 95% confidence interval.

(when 3.3 days, centered age is 0...)

For infants that are 3.3 days old, for every
0.5 pts 0.5 pts
1 ounce increase in birthweight, the expected
0.25 pts 0.5 pts 0.5 pts 0.5 pts
systolic blood pressure increases by 0.13 mmHg
0.25 pts 0.5 pts 0.5 pts
(95% CI: 0.06, 0.19)
0.25 pts 0.25 pts 0.25 pts

8. (3 points) Using the above regression table, what is the fitted regression line for systolic blood pressure for 4.3-day old infant? Please include the estimated values in the regression table and simplify the line as much as possible. (Hint: it might help to first write out the fitted regression equation.)

4.3 day old infant:

$$Age^c = Age - \overline{Age}$$
$$= 4.3 - 3.3 \text{ days}$$
$$Age^c = 1 \text{ day}$$

0.5 pt for centerd age

$$\widehat{SBP} = 88.29 + 0.13\, BWT^c + 5.89\, Age^c - 0.13\, BWT^c\, Age^c$$

1 pt for starting eqn (if final ans not correct)

0.5 pt for hat on SBP

$$= 88.29 + 0.13\, BWT^c + 5.86\,(1) - 0.13\, BWT^c\,(1)$$

0.5 pts: putting age in equation

combining correct coefficients

$$= \underbrace{[88.29 + 5.86]}_{0.25 \text{ pt}} + \underbrace{(0.13 - 0.13)}_{0.25 \text{ pt}}\, BWT^c$$
$$= 94.15 - 0 \cdot BWT^c$$
$$= 94.15$$

@ 4.3 days, the regression line is flat!