Quiz: Midterm Exam

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Good Luck!

Question 1 1 pts

In taking this examination, I affirm that I will adhere to the Harvard policies on academic integrity. All work on this examination will be my own. I affirm that I have not been told of the content of the examination from any other student, nor will I disclose the content of the examination to other students who have not yet taken the examination. Any violation of this agreement will result in a score of 0 on this examination.

By clicking "I agree" I acknowledge that I understand this policy.

- (•) I agree

Question 2 1 pts

A small p-value for a test of association indicates that the magnitude of the association between the exposure and the outcome must be large. (Assume no other sources of the following: bias, confounding, effect modification or measurement error.)

- (•) [illegible]
- ( ) False

Question 3 1 pts

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Question 3 1 pts

The p-value can be interpreted as the probability that a result as extreme or more extreme than the one observed would occur due to random variation, if the null hypothesis were false. (Assume no other sources of the following: bias, confounding, effect modification or measurement error.)

- ( ) True
- (•) False

Question 4 1 pts

$$Z^2 = \frac{[X - E(X \mid H_0)]^2}{Var(X \mid H_0)} \sim \chi^2_1$$

The test statistic shown above:

- ( ) Is usually a one-sided test
- (•) Under the null, follows a Chi-square distribution on I-1 degrees of freedom
- ( ) Always has one degree of freedom

Question 5 1 pts

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Question 5 1 pts

Hypothesis tests and p-values can be useful because they

- ○ Summarize the consistency of the observed data with the state of nature described by the alternative hypothesis
- ○ Summarize the precision of the estimated association between an exposure and an outcome
- ◉ All of the choices are correct
- ○ Summarize the consistency of the observed data with the state of nature described by the null hypothesis

Question 6 1 pts

A confidence interval has the interpretation that, given your observed data, there is a 95% probability that the true value of the parameter of interest falls within the confidence interval. (Assume no other sources of the following: bias, confounding, effect modification or measurement error.)

- ◉ True
- ○ False

Question 7 1 pts

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Question 7 1 pts

Imagine that you are conducting a cumulative incidence analysis of stratified data from a closed cohort study. In a particular stratum, 8 of the 27 exposed subjects developed the outcome of interest before the end of follow-up, but there were no unexposed subjects in this stratum at the start of follow-up. Will this stratum contribute information to the Mantel-Haenszel cumulative incidence ratio? (Assume no other sources of the following: bias, confounding, effect modification or measurement error.)

- ◉ No
- ○ Yes

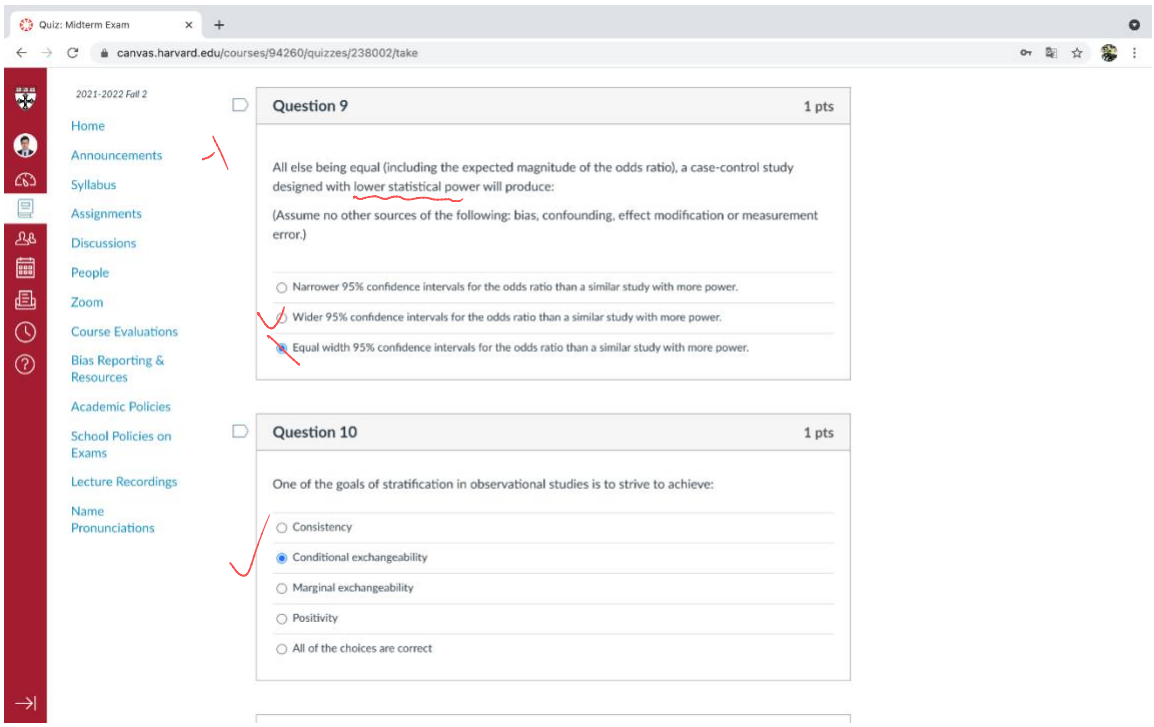
Question 8 2 pts

Assuming no confounding, no selection bias, and no information bias, what percent of correctly constructed 95% confidence intervals of the incidence rate difference will contain the estimated value of the incidence rate difference computed from that study? 100 %

What percent are expected to contain the true value of the incidence rate difference?

95 %.

Question 9 1 pts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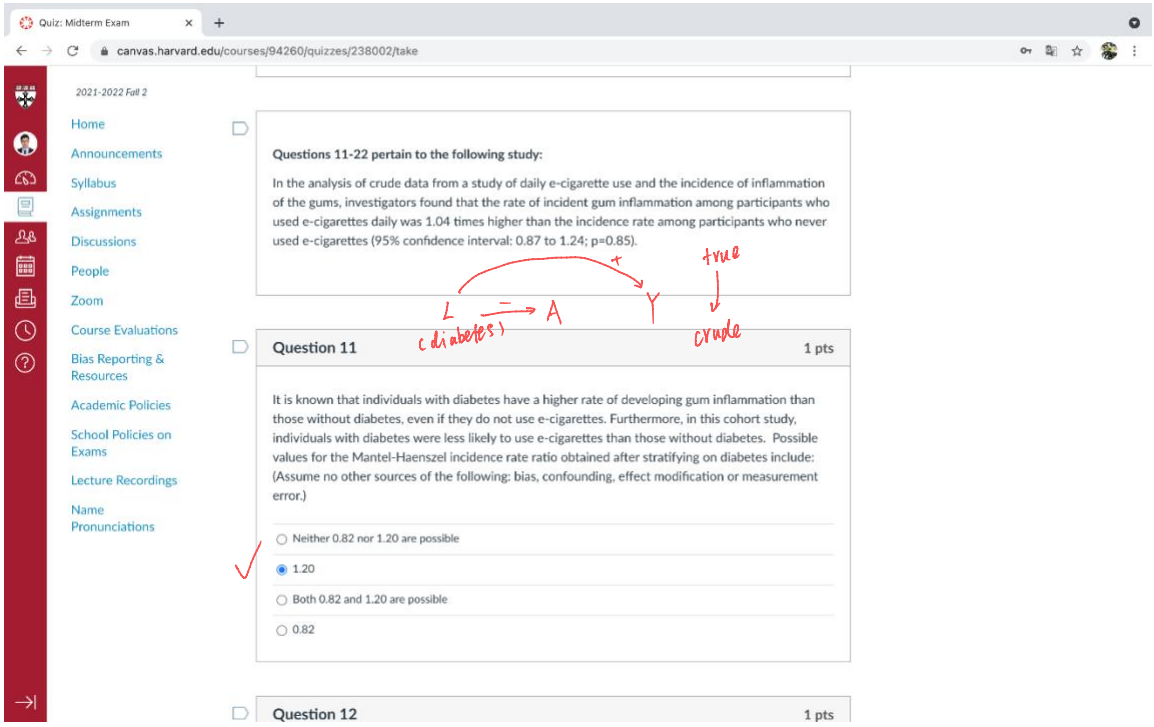
Question 9
1 pts
All else being equal (including the expected magnitude of the odds ratio), a case-control study designed with lower statistical power will produce:
(Assume no other sources of the following: bias, confounding, effect modification or measurement error.)
Narrower 95% confidence intervals for the odds ratio than a similar study with more power.
Wider 95% confidence intervals for the odds ratio than a similar study with more power.
Equal width 95% confidence intervals for the odds ratio than a similar study with more power.
Question 10
1 pts
One of the goals of stratification in observational studies is to strive to achieve:
Consistency
Conditional exchangeability
Marginal exchangeability
Positivity
All of the choices are correct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Questions 11-22 pertain to the following study:
In the analysis of crude data from a study of daily e-cigarette use and the incidence of inflammation of the gums, investigators found that the rate of incident gum inflammation among participants who used e-cigarettes daily was 1.04 times higher than the incidence rate among participants who never used e-cigarettes (95% confidence interval: 0.87 to 1.24; p=0.85).
Question 11
1 pts
It is known that individuals with diabetes have a higher rate of developing gum inflammation than those without diabetes, even if they do not use e-cigarettes. Furthermore, in this cohort study, individuals with diabetes were less likely to use e-cigarettes than those without diabetes. Possible values for the Mantel-Haenszel incidence rate ratio obtained after stratifying on diabetes include:
(Assume no other sources of the following: bias, confounding, effect modification or measurement error.)
Neither 0.82 nor 1.20 are possible
1.20
Both 0.82 and 1.20 are possible
0.82
Question 12
1 pts

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Question 12 1 pts

In the study described above, the prevalence of diabetes was 17% lower among the person-time contributed by daily e-cigarette users compared with non-users. However, this association did not reach statistical significance at the alpha=0.05 level (2-sided). Therefore, diabetes is not a confounder of the daily e-cigarette use - gum inflammation relationship in this study. (Assume no other sources of the following: bias, confounding, effect modification or measurement error.)

- ○ True
- ◉ False ✓

only DAG can detect confounding not statistical....

Question 13 1 pts

The Mantel-Haenszel incidence rate ratio for the relationship between daily e-cigarette use versus never using e-cigarettes and the incidence of gum inflammation after stratifying on diabetes status remained close to the null with relatively narrow confidence intervals and was not statistically significant. Because of this result, there is no need to assess whether the multiplicative relationship between daily e-cigarette use and the incidence of gum inflammation differs between those with and without diabetes.

- ○ True
- ◉ False ✓

Question 14 1 pts

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Question 14 1 pts

Which of the formulas below shows the test of the null hypothesis of no association between e-cigarette use and gum inflammation after adjusting for confounding as described above?

A $$\frac{\left(a-\frac{N_1M_1}{T}\right)^2}{\frac{N_1N_0M_1}{T^2}}$$

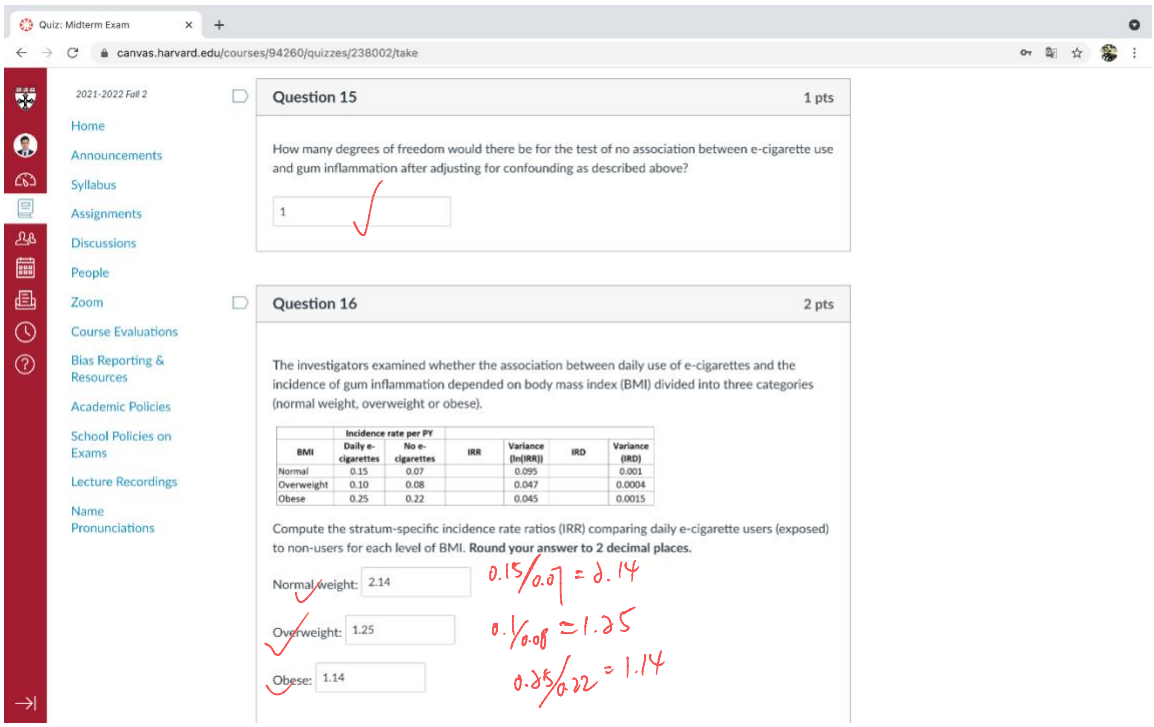
B ✓ $$\frac{\left(\sum a_i-\sum\frac{N_{1i}M_{1i}}{T_i}\right)^2}{\sum\frac{N_{1i}N_{0i}M_{1i}}{T_i^2}}$$

C $$\frac{\left(\sum a_i-\sum\frac{N_{1i}M_{1i}}{T_i}\right)^2}{\sum\frac{M_{1i}M_{0i}N_{1i}N_{0i}}{T_i^3}}$$

D $$\frac{\left(\sum a_i-\sum\frac{N_{1i}M_{1i}}{T_i}\right)^2}{\sum\frac{M_{1i}M_{0i}N_{1i}N_{0i}}{T_i^2(T_i-1)}}$$

- ○ Equation C
- ○ Equation D
- ◉ Equation B ✓
- ○ Equation A

Question 15 1 pts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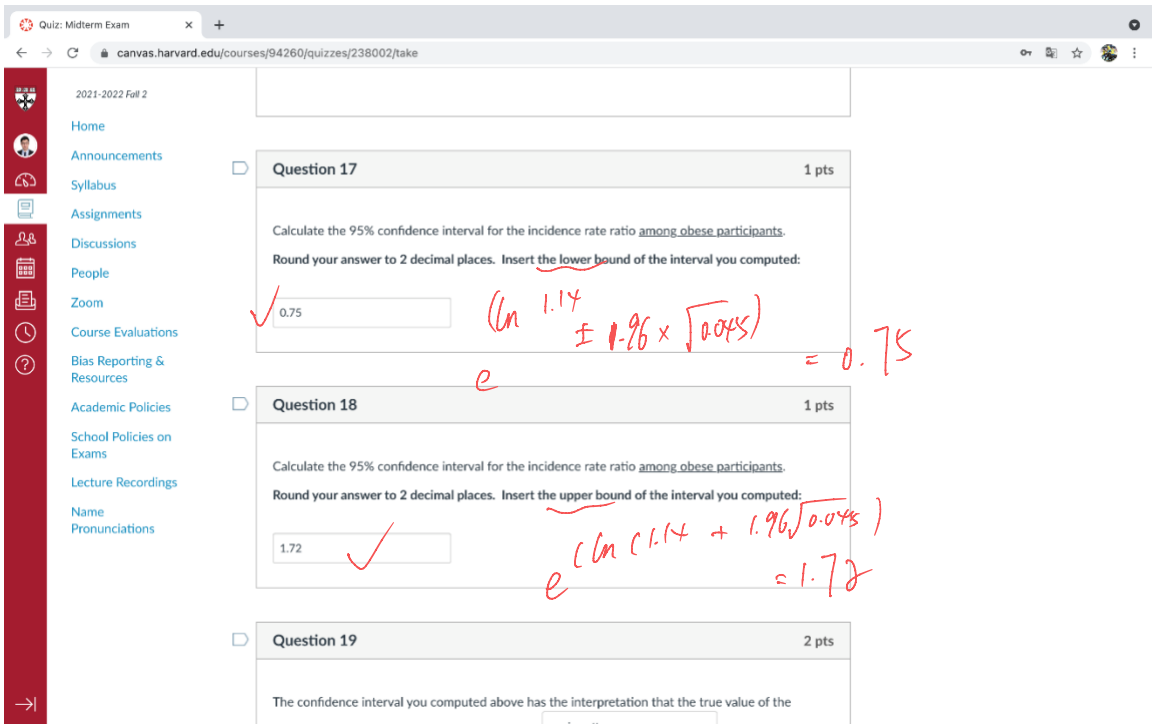
Question 15
1 pts
How many degrees of freedom would there be for the test of no association between e-cigarette use and gum inflammation after adjusting for confounding as described above?
1
Question 16
2 pts
The investigators examined whether the association between daily use of e-cigarettes and the incidence of gum inflammation depended on body mass index (BMI) divided into three categories (normal weight, overweight or obese).
Incidence rate per PY
BMI | Daily e-cigarettes | No e-cigarettes | IRR | Variance (ln(IRR)) | IRD | Variance (IRD)
Normal | 0.15 | 0.07 | | 0.095 | | 0.001
Overweight | 0.10 | 0.08 | | 0.047 | | 0.0004
Obese | 0.25 | 0.22 | | 0.045 | | 0.0015
Compute the stratum-specific incidence rate ratios (IRR) comparing daily e-cigarette users (exposed) to non-users for each level of BMI. Round your answer to 2 decimal places.
Normal weight: 2.14
Overweight: 1.25
Obese: 1.14
0.15/0.07 = 2.14
0.1/0.08 = 1.25
0.25/0.22 = 1.14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Question 17
1 pts
Calculate the 95% confidence interval for the incidence rate ratio among obese participants.
Round your answer to 2 decimal places. Insert the lower bound of the interval you computed:
0.75
(ln 1.14 ± 1.96 × √0.045)
= 0.75
e
Question 18
1 pts
Calculate the 95% confidence interval for the incidence rate ratio among obese participants.
Round your answer to 2 decimal places. Insert the upper bound of the interval you computed:
1.72
e^(ln(1.14 + 1.96√0.045))
= 1.72
Question 19
2 pts
The confidence interval you computed above has the interpretation that the true value of the

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Question 18 1 pts

Calculate the 95% confidence interval for the incidence rate ratio among obese participants.

Round your answer to 2 decimal places. Insert the upper bound of the interval you computed:

1.72

Question 19 2 pts

The confidence interval you computed above has the interpretation that the true value of the incidence rate ratio for the association between e-cigarette use and gum inflammation lies between the lower and upper bound computed above with 95 % confidence, assuming that exchangeability holds and that there are no other sources of bias.

Question 20 1 pts

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Question 20 1 pts

Which of the following formulas is the correct test statistic to evaluate whether there is evidence of statistically significant effect measure modification on the additive scale?

a. $\sum \frac{[ln(IRD_i) - ln(IRD_{summary})]^2}{var(ln(IRD_i))}$

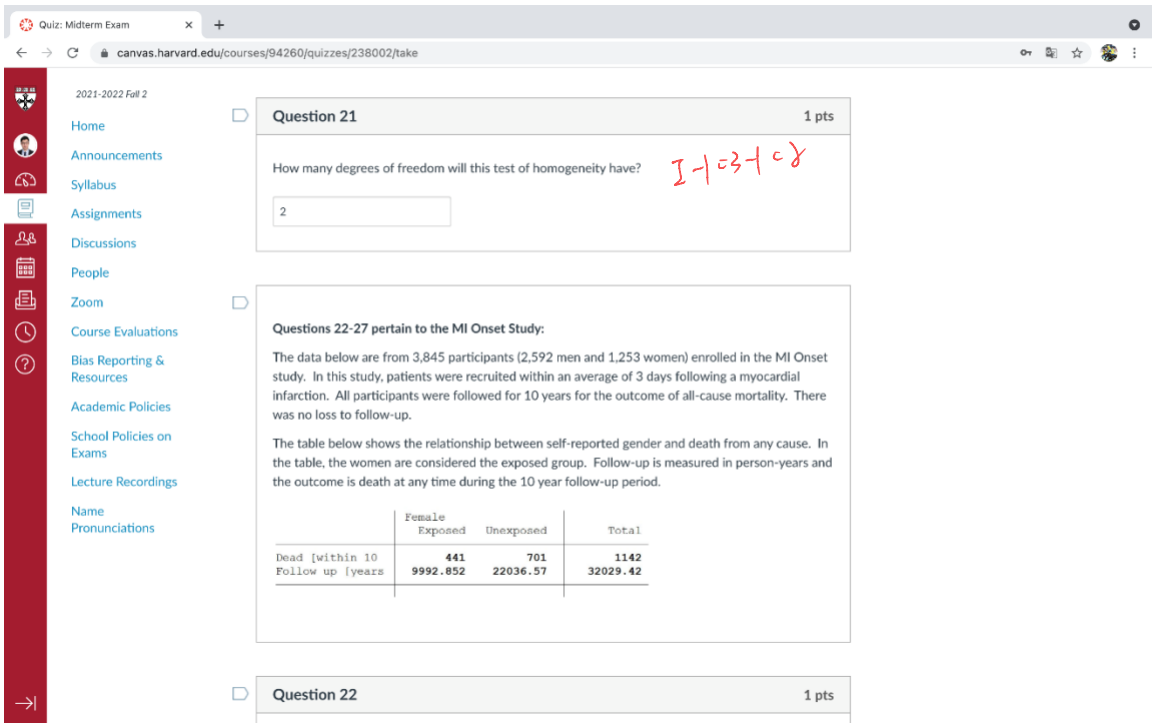
b. $\sum \frac{[IRD_i - IRD_{summary}]^2}{var(IRD_{summary})}$

c. $\sum \frac{[IRD_i - IRD_{summary}]^2}{var(IRD_i)}$

d. $\sum \frac{[ln(IRD_i)^2 - ln(IRD_{summary})^2]}{var(ln(IRD_i))}$

- (●) Formula c
- ( ) Formula a
- ( ) Formula b
- ( ) Formula d

Question 21 1 pts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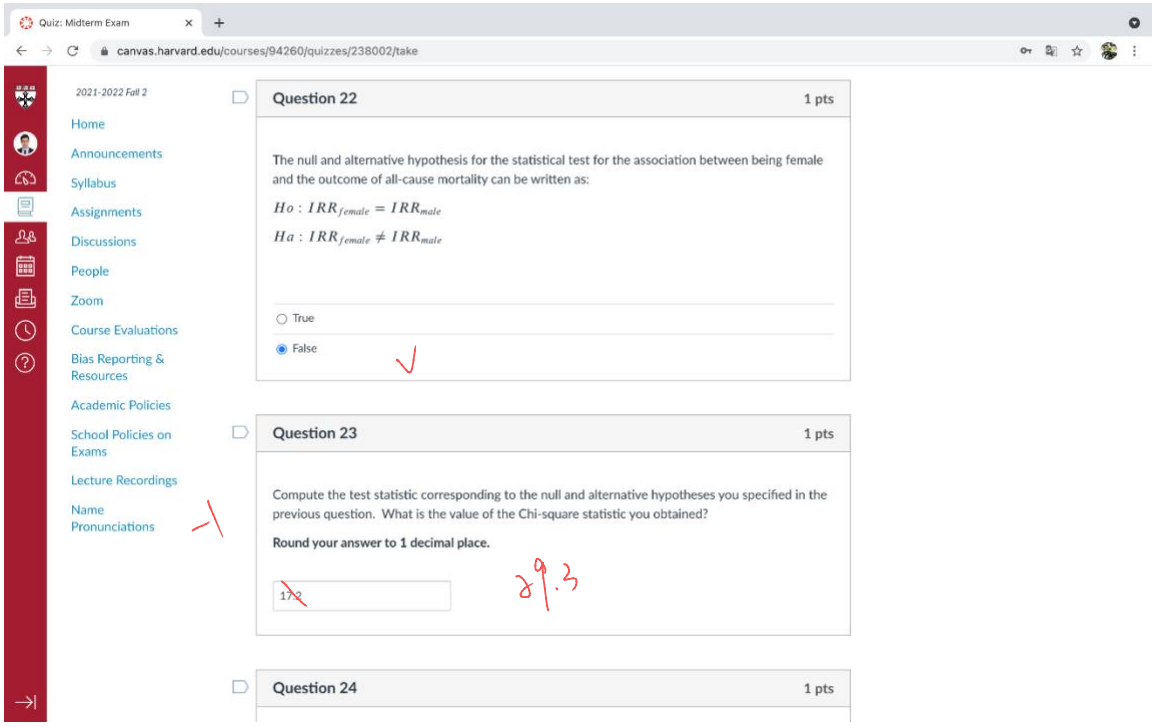
Question 21
1 pts
How many degrees of freedom will this test of homogeneity have?
I-1=3-1=2
2
Questions 22-27 pertain to the MI Onset Study:
The data below are from 3,845 participants (2,592 men and 1,253 women) enrolled in the MI Onset study. In this study, patients were recruited within an average of 3 days following a myocardial infarction. All participants were followed for 10 years for the outcome of all-cause mortality. There was no loss to follow-up.
The table below shows the relationship between self-reported gender and death from any cause. In the table, the women are considered the exposed group. Follow-up is measured in person-years and the outcome is death at any time during the 10 year follow-up period.
Female
Exposed
Unexposed
Total
Dead [within 10
441
701
1142
Follow up [years
9992.852
22036.57
32029.42
Question 22
1 pts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Question 22
1 pts
The null and alternative hypothesis for the statistical test for the association between being female and the outcome of all-cause mortality can be written as:
$Ho: IRR_{female} = IRR_{male}$
$Ha: IRR_{female} \neq IRR_{male}$
True
False
Question 23
1 pts
Compute the test statistic corresponding to the null and alternative hypotheses you specified in the previous question. What is the value of the Chi-square statistic you obtained?
Round your answer to 1 decimal place.
17.2
29.3
Question 24
1 pts

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Question 24 — 1 pts

Based on the p-value associated with the Chi-square statistic you computed above, in a Neyman-Pearson hypothesis testing paradigm with alpha pre-specified at 0.05, you would:

- (●) Reject the null hypothesis ✓
- ( ) Not reject the null hypothesis
- ( ) There is not enough information to decide whether or not to reject the null hypothesis

Question 25 — 3 pts

The table below shows the relationship between age and gender in these data:

Age Category	Female Male	Female	Total
< 50 years	598 23.07	161 12.85	759 19.74
50 to < 65 years	1,095 42.25	343 27.37	1,438 37.40
>= 65 years	899 34.68	749 59.78	1,648 42.86
Total	2,592 100.00	1,253 100.00	3,845 100.00

The Kaplan-Meier curves show the relationship between age and death from any cause separately for men and women:

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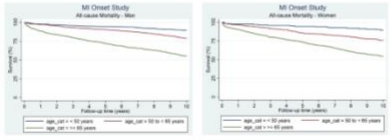
The Kaplan-Meier curves show the relationship between age and death from any cause separately for men and women:



Does age possess the three derived properties of a confounder of the association between gender and all-cause mortality? In your response, list the three derived properties and describe how age does or does not fulfill each of the properties.

Specific calculations are not required to get full credit for this question.

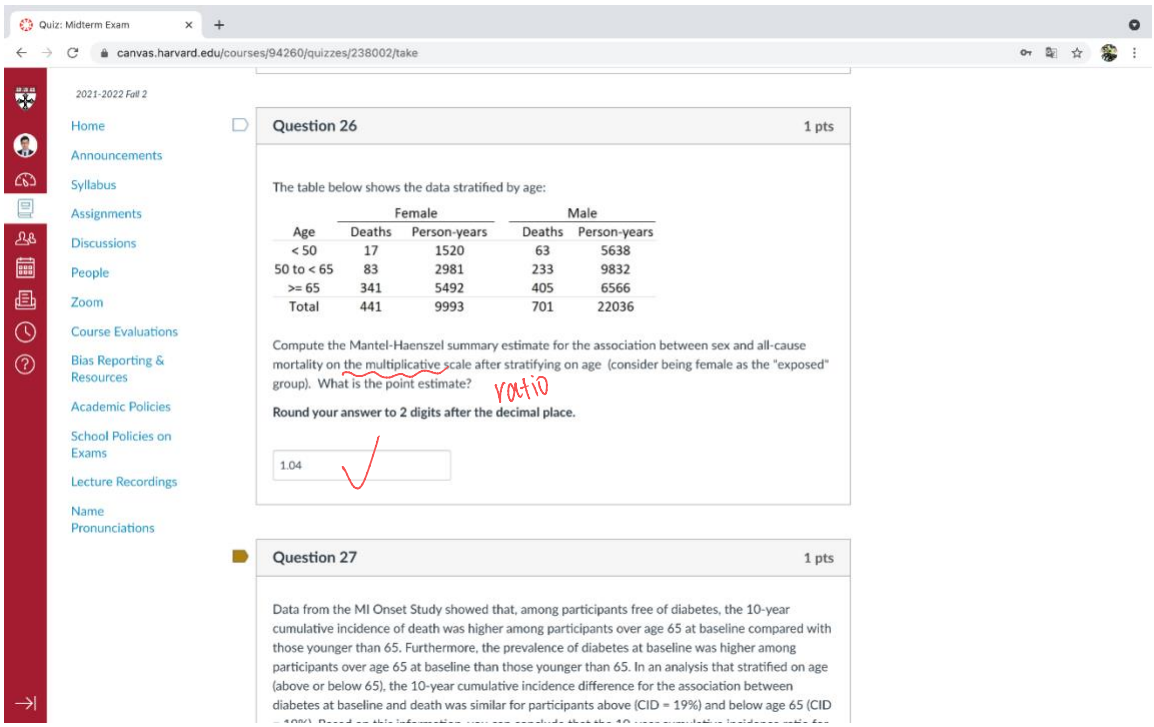
Edit View Insert Format Tools Table

12pt Paragraph B I U

The 3 derived properties of a confounder is associated with exposure, associated with outcome and not in a downstream pathway from exposure to outcome.

The age is both associated with gender and all-cause mortality, and it is not through the downstream pathway from gender to all-cause mortality. Thus, age possess the three derived properties of a confounder.

1. Age & female ✓
2. Age & death among male ✓
3. ... ✓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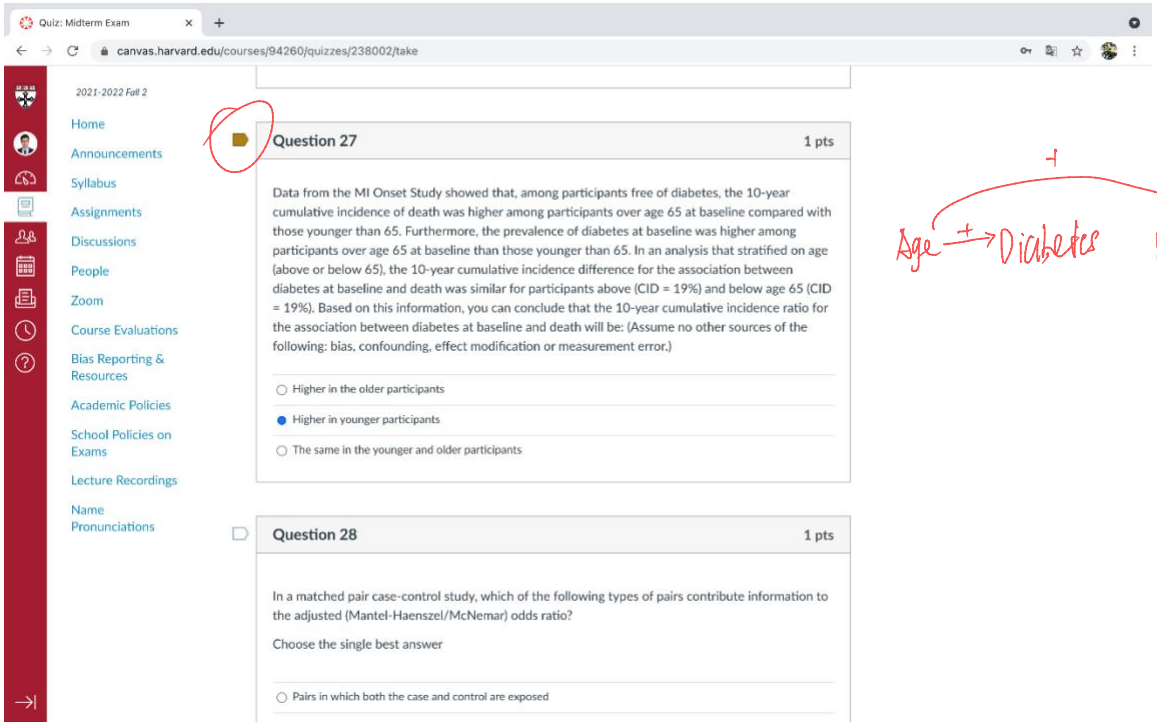
Question 26
1 pts
The table below shows the data stratified by age:
Female
Male
Age
Deaths
Person-years
Deaths
Person-years
< 50
17
1520
63
5638
50 to < 65
83
2981
233
9832
>= 65
341
5492
405
6566
Total
441
9993
701
22036
Compute the Mantel-Haenszel summary estimate for the association between sex and all-cause mortality on the multiplicative scale after stratifying on age (consider being female as the "exposed" group). What is the point estimate?
ratio
Round your answer to 2 digits after the decimal place.
1.04
Question 27
1 pts
Data from the MI Onset Study showed that, among participants free of diabetes, the 10-year cumulative incidence of death was higher among participants over age 65 at baseline compared with those younger than 65. Furthermore, the prevalence of diabetes at baseline was higher among participants over age 65 at baseline than those younger than 65. In an analysis that stratified on age (above or below 65), the 10-year cumulative incidence difference for the association between diabetes at baseline and death was similar for participants above (CID = 19%) and below age 65 (CID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Question 27
1 pts
Data from the MI Onset Study showed that, among participants free of diabetes, the 10-year cumulative incidence of death was higher among participants over age 65 at baseline compared with those younger than 65. Furthermore, the prevalence of diabetes at baseline was higher among participants over age 65 at baseline than those younger than 65. In an analysis that stratified on age (above or below 65), the 10-year cumulative incidence difference for the association between diabetes at baseline and death was similar for participants above (CID = 19%) and below age 65 (CID = 19%). Based on this information, you can conclude that the 10-year cumulative incidence ratio for the association between diabetes at baseline and death will be: (Assume no other sources of the following: bias, confounding, effect modification or measurement error.)
Higher in the older participants
Higher in younger participants
The same in the younger and older participants
Question 28
1 pts
In a matched pair case-control study, which of the following types of pairs contribute information to the adjusted (Mantel-Haenszel/McNemar) odds ratio?
Choose the single best answer
Pairs in which both the case and control are exposed

+
Age
+
Diabetes
Death

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Question 28 1 pts

In a matched pair case-control study, which of the following types of pairs contribute information to the adjusted (Mantel-Haenszel/McNemar) odds ratio?

Choose the single best answer

- ○ Pairs in which both the case and control are exposed
- ○ None of the other answers
- ○ All pairs contribute information equally
- ◉ Pairs in which only the case or the control, but not both, are exposed ✓

Question 29 1 pts

Matching on a true confounder in a case-control study removes any potential effect modification by the confounder. (Assume no other sources of: bias, confounding, effect modification or measurement error.)

- ○ True
- ◉ False ✓

Question 30 1 pts

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Question 30 1 pts

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In a case-control study with a fixed number of cases, adding more controls per case generally decreases the amount of information in the study because the optimal ratio of the number of cases to controls is 1:1.

- ◉ True ✓
- ○ False

Question 31 1 pts

In a recent study, Ashrafioun et al (2019) evaluated the association between opioid use disorders, psychiatric comorbidities, including alcohol use disorder and risk for suicide attempts among veterans seeking pain care. After adjusting for confounding, they found that compared to veterans who did not have opioid use disorder or alcohol use disorder, the rate of suicide attempts was 1.98 times higher among those who had opioid use disorder alone, 2.09 times higher among those who had alcohol use disorder alone and 4.43 times higher among those who had both opioid use disorder and alcohol use disorder.

Based on the data presented above, calculate the relative excess risk due to interaction (RERI) for the associations between opioid use disorder, alcohol use disorder and the outcome of suicide attempts.

1.36 ✓

$R_{11} - R_{10} - R_{01} + 1$
$= 4.43 - 1.98 - 2.09 + 1$
$= 1.36$