AMREF INTERNATIONAL UNIVERSITY

SCHOOL OF PUBLIC HEALTH

DEPARTMENT OF COMMUNITY HEALTH

MASTER OF PUBLIC HEALTH

END OF SEMESTER EXAMINATION DECEMBER 2025

UNIT CODE: MAP 717: STATISTICAL METHODS IN EPIDEMIOLOGY
DATE:
TIME: Three Hours **Start:** 1600 Hours **Finish** 1900 Hours

INSTRUCTIONS

1. This exam is marked out of 100 marks
2. This Examination comprises TWO Sections
   Section A: Compulsory Question (25 marks)
   Section B: Long Answer Questions (75 marks)

SECTION A: COMPULSORY (25 Marks)

Short Answer Questions

1. Researchers conduct a study to compare the risk of hypoglycemia (low blood sugar) among patients with diabetes who initiate long-acting versus short-acting insulin therapy. They recruit 15 patients who recently initiated insulin treatment and have no previous history of hypoglycemic episodes. Participants are followed for up to 2 years to assess occurrences of hypoglycemia. Results are shown below.

Participant number	Insulin type	Follow-up time (years)	Hypoglycemic episode
1	Long-acting	1.3	No
2	Long-acting	1.1	Yes
3	Long-acting	0.8	No
4	Long-acting	1.6	No
5	Long-acting	1.4	Yes
6	Long-acting	1.9	No
7	Long-acting	1.7	No
8	Short-acting	0.6	No
9	Short-acting	1.9	No
10	Short-acting	1.1	No

11	Short-acting	0.8	Yes
12	Short-acting	0.4	No
13	Short-acting	1.3	Yes
14	Short-acting	0.7	No
15	Short-acting	1.4	No

a) What is the study design? Give reasons for your answer. **(5 Marks)**
b) Calculate the cumulative incidence and incidence rate of hypoglycemia in this study. Provide a brief interpretation of the measures you have calculated above explaining how they differ. **(5 Marks)**
c) Calculate the relative risk and incidence rate ratio comparing hypoglycemic reaction among patients receiving long-acting insulin with those receiving short-acting insulin. Provide the interpretation of the measure you just calculated. **(10 Marks)**
d) How do measures of disease frequency differ from measures of association? **(5 Marks)**

SECTION B: Long Answer Questions

ANSWER <u>ANY THREE (3)</u> QUESTIONS (75 Marks)

2. A prospective cohort study examines the association of outdoor fine particulate air pollution with incident asthma in children living in urban populations. Investigators recruit 1,300 children aged 4–8 years from pediatric clinics in five large cities. All children are free of asthma at enrolment. Baseline ambient $PM_{2.5}$ exposure is assigned from monitors near each child's residence and categorized as **Low** (<15 µg/m³) or **High** (≥15 µg/m³). Children are followed annually; person-time and outcomes are summarized below:

Air pollution level	Asthma	No asthma	Person-time (years)
Low	200	800	3,300
High	100	200	780

a. Calculate the incidence rate of asthma (per 1,000 person-years) in each exposure group and calculate the incidence rate ratio (IRR) comparing high to low exposure.
b. Calculate the cumulative incidence (risk) of asthma in each group and the risk ratio (RR) and risk difference (RD), attributable fraction among the exposed (AF_e) and the population attributable fraction (PAF).
c. Provide interpretations of the measures you have calculated above.
d. Identify four potential sources of bias that could affected the estimated association in this study, briefly explaining the direction of bias (toward or away from null).

3.

a. Explain the difference between Type I and Type II errors in hypothesis testing.
b. Using appropriate public health examples, discuss the potential consequences of each type of error in epidemiologic research.
c. In your answer, highlight the balance between minimizing Type I and Type II errors, and explain how these balance will influence key aspects of study design, such as sample size determination, significance levels, and statistical power. **(25 Marks)**

4. Researchers conduct a case-control study to examine the association of paint exposure with pulmonary fibrosis, a serious disease that typically presents with shortness of breath and a nonproductive cough. The researchers identify 30 case individuals who have received a diagnosis of pulmonary fibrosis, confirmed by high-resolution computed tomography, and a comparison group of 90 healthy control individuals who are free of pulmonary symptoms. The researchers conduct in-person interviews with the case and control individuals to inquire about previous exposures to latex and oil-based paint products.

a. Discuss the potential sources of bias in this study
b. Describe the measures that can be taken to minimize them.

(25 Marks)

5. The data below are from a study conducted among adults in rural Kenya to assess the association between household air pollution and chronic cough.

Sex	Exposure to biomass fuel smoke	Chronic cough (Yes)	Chronic cough (No)	Total
Male	Exposed	180	420	600
	Not exposed	60	540	600
Female	Exposed	250	350	600
	Not exposed	40	160	200

a. Using the data provided, calculate the crude risk ratio for the association between exposure to biomass fuel and chronic cough.
b. Calculate the risk ratio separately for men and women.
c. Assess whether sex modifies the association between biomass exposure and chronic cough.
d. Discuss the public health significance of identifying effect modification in this context **(25 Marks)**.

6. The following is a two-by-two table summarizing the results of a longitudinal cohort study that investigated the impact of diabetes on all-cause mortality.

	Dead	Alive	Total
Diabetic	100	89	189
Non-diabetic	811	2340	3151
Total	911	2429	3340

a. Calculate relevant measures of public health impact (attributable risk, attributable risk percent, and population attributable risk percent) and
b. Provide an interpretation of each measure
c. Discuss how these measures can be used to guide public health interventions. **(25 Marks)**

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