UC DAVIS GRADUATE GROUP IN EPIDEMIOLOGY
WRITTEN PRE-QUALIFYING EXAMINATION
STUDY TOPICS 2022

This topic list is meant as a guide for studying and mastering key concepts in epidemiology and biostatistics but is not all-inclusive, so please use your judgement and discuss with the faculty any additional topics that may be relevant or core to the Graduate Group in Epidemiology.

**BASIC EPIDEMIOLOGY AND EPIDEMIOLOGIC STUDY DESIGN (EPI 205A & EPI 206)**

**Causation**
- Necessary, Sufficient
- Koch-Henle Criteria
- Bradford-Hill Criteria

**Measures of Accuracy**
- Precision
- Validity

**Bias and types of Bias**
- Selection
- Information/misclassification (differential/non-differential)
- Confounding

**Random Error/Variability**

**Measures of Disease Frequency**
- Prevalence
- Incidence (understand subject-time)
- Risk/probability
- Rate
- Ratio
- Incidence/disease odds (versus exposure odds)
- Crude and conditional measures

**Statistical Measures of Disease Association and Causal Effect Parameters**
- Risk Ratio ("relative risk")
- Incidence Rate Ratio
- Odds Ratio (including matched-pairs odds ratio, and the “rare disease assumption”)
- Attributable Risk
- Etiologic Fraction
- Population Attributable Risk

**Confounding**
- Methods for identifying/detecting confounding
- Methods for controlling confounding

**Interaction (effect measure modification)**
- Additive
Multiplicative
Absolute vs. Relative Measures of Effect

Standardized Rates
Directly standardized rates
Indirectly standardized rates / Standardized mortality (and morbidity) ratios

Outbreak Investigation

Diagnostic Test Evaluation and Screening Tests
Sensitivity and specificity
Likelihood ratios (binary, ordinal and quantitative tests)
Comparison of sensitivity and specificity of 2 tests
Predictive value positive and predictive value negative
Prevalence/apparent prevalence relationship
Sensitivity, specificity and predictive values of tests in series and parallel
Kappa for interobserver agreement
ROC curves

Study Design
Types of studies
Experimental
Clinical trials
Intervention trials
Prevention trials
Field trials
Observational
Cross-sectional studies
Cohort studies (retrospective and prospective)
Case-control studies (including “nested”)
Matched case-control studies
Ecological studies
Know advantages and disadvantages of each study type
Know biases of each study type
Know measures of association in each study type
Know how to analyze each study type
Know how to conduct sampling and select subjects for each study type

ADVANCED EPIDEMIOLOGIC METHODS (EPI 207)
Everything listed under basic epidemiology and epidemiologic study design PLUS:

Directed Acyclic Graphs (DAGs)
Conceptualize DAGS as representations of the relationships between variables in contingency tables
Using DAGs to identify confounding paths and selection of variables for statistical control
Distinguish confounders, colliders, and intermediates in DAGS
Understand direct, indirect and total effects with DAGS
Conditional and marginal independence versus association – statistical meaning and representation in a DAG
Be able to identify (and illustrate) selection bias using DAGs
Understand and illustrate the concepts of nondifferential versus differential misclassification and independent versus dependent misclassification using DAGS

Study Design:
Observational studies
  Case-control studies - Methods of control selection
  Cumulative incidence sampling
  Incidence density sampling

Proportionate Mortality Ratios and Mortality Odds Ratios

Potential outcomes model
  Identifiability/Non-identifiability
  Including doomed, immune, protective, causal

Causation/Causal Inference
  Selection of comparison groups
  Study base principles
  The counterfactual model
  The randomization assumption

Bias
  Confounding
    Effects of confounding
    Directionality of confounding
    Collapsibility/Simpson's Paradox
    Comparability
  Selection bias
    Differentiate between potential causes for selection bias in a follow-up design (cohort or experiment), case-control design, and cross-sectional design
  Information bias
    Understand how the concepts of sensitivity, specificity, false positive, and false negative can be applied to exposure and outcome misclassification

Interpretation of effect measures from longitudinal studies
  Equate incidence odds ratios to exposure odds ratios: be able to derive one from the other, provide appropriate interpretations

Concepts of Interaction
  Trend
  Homogeneity/heterogeneity on additive and multiplicative scales

Matching in Observational Studies
Direct standardization, indirect standardization, and Mantel-Haenszel methods
Be able to conduct direct and indirect standardization
Know the rates, weights, and estimated parameter outcome for each method
Be able to calculate a Mantel-Haenszel Odds Ratio

BASIC BIOSTATISTICS (EPI 202)
Probability:
Definition and properties
Exponential and logarithm functions
Conditional probability
Law of total probability
Bayes Theorem
Applications to epidemiology: sensitivity, specificity, predictive value +/-, prevalence

Random variables (RVs) and their distributions:
Discrete distribution models
Continuous distribution models
Applications to epidemiology: when are specific distributions appropriate
Marginal, conditional and joint distributions
Properties of RVs
Expectation and conditional expectation
Correlation and covariance
Variance and covariance of linear combination of RVs
Cumulative distribution function
Transformation methods
Applications and interpretations of all techniques in epidemiology

Large sample properties:
Limiting distributions
Convergence in probability
Law of large numbers
Central limit theorem
Asymptotic normal distribution
Standardization

BASIC STATISTICAL INFERENCE (EPI 203 AND PREREQUISITES)
Parametric Tests
z-statistic
t-statistic
ANOVA and general linear models
Linear regression

Non-parametric Tests
Mann-Whitney
Wilcoxon Rank
Kruskal-Wallis
Friedman
Tests of proportions (Chi-square statistic)
   Chi-square 2 x 2 contingency table
   McNemar's test for paired data

Types of Data (continuous or discrete (dichotomous/categorical/count, etc.)

Hypothesis testing
   P-value and type I error
   Confidence intervals
   Power and type II error
   Sample size calculations

ADVANCED BIOSTATISTICS
EPI 203
Sampling Distributions:
   Meaning
   Examples
   Large sample approximation

Point Estimation:
   Criteria for evaluating estimators--e.g. bias, variance, mean square error (MSE)
   Large sample properties
   Minimum variance
   Cramer-Rao lower bound
   Fisher Information (variance covariance matrix)
   Maximum likelihood (ML) estimation
      Likelihood
      Properties of ML estimators
   Method of moments estimators
   Delta method and Taylor series

Confidence interval (CI) estimation:
   Methods for CI construction
   Interpretation of confidence intervals
   Relationship with p-value

Hypothesis testing:
   Hypothesis testing framework
   Criteria for evaluating tests
   Neyman Pearson Lemma and Best Critical Region
   Level/size of tests
   Power of tests
   Likelihood Ratio Test

EPI 204
Know all assumptions for all general linear statistical models
Modeling binary outcomes: Logistic regression for binary outcome data in prospective and retrospective studies; models for matched and unmatched data; logits/log odds; logistic models for categorical (ordinal/nominal) outcomes.

- Model and model interpretation
- Assumptions and limitations
- Estimation of model parameters
- Model-based inference (CI, hypothesis testing)
- Model-building
- Interaction and confounding
- Model diagnostics and goodness of fit

Modeling count data: Poisson regression

- Model and model interpretation
- Assumptions and limitations
- Estimation of model parameters
- Model-based inference (CI, hypothesis testing)
- Model diagnostics (goodness of fit)

Modeling time to failure (censored) data (survival analysis): life tables, Kaplan-Meier, log-rank tests; Cox proportional hazards (PH) model, stratified Cox PH model

- Model and model interpretation
- Assumptions and limitations
- Estimation of model parameters
- Model-based inference (CI, hypothesis testing)
- Model-building
- Interaction and confounding
- Model diagnostics and goodness of fit