1. Lecture 2 - Slide 1

2. The Science of Public Health: Epidemiology and Biostatistics

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2. Epidemiology and Biostatistics

The Science of Public Health

- **Epidemiology:** What...Where...Who...When...?
  - The basic science of public health
  - The study of the distribution and determinants of the frequency of diseases and conditions in specified populations during specified time periods

- **Biostatistics:** How...
  - The basic science of public health
  - The study of measurement of biological or health data

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5. The Science of Public Health

![Graph showing the well-designed study]

6. Lecture 2 - Slide 8

![Graph comparing pain relief over time for different medications]

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The Science of Public Health

Mean - the arithmetic average of a set of values
Median - the middle value(s) in the ordered set
Mode - the value in a frequency distribution that occurs most often

Edentulous Patients Screened

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Total = 200
Mean = 200/20 = 10.00
Median = (9+18)/2 = 13.50
Mode = Bimodal = 9 and 18

The Science of Public Health: Normal (Gaussian) Distribution...

Mean = Median = Mode

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9. Epidemiology and Biostatistics: Ratio, Proportion, Rate, Frequency

- **Ratio** - the relationship between two measures expressed as \( \frac{a}{b} \)

- **Proportion** - a type of ratio in which the numerator is included in the denominator, expressed as a percentage:
  \[
  \left( \frac{X}{X+Y} \right) \times 100
  \]

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10. Epidemiology and Biostatistics: Ratio, Proportion, Rate, Frequency

- **Rate** - a time-specific proportion; the basic measure of disease occurrence; expresses the probability of risk of a disease in a defined population over a period of time

- **Frequency** = Rate
  \[
  \text{Numerator} / \text{Denominator}
  \]
  during a specified **time** period

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11. Epidemiology and Biostatistics: Incidence and Prevalence Rates

- **Incidence Rates**
  - Direct measure of risk (probability) that healthy people will develop a disease or condition during a specified period of time
  - Tells us the rate at which new disease occurs in a defined, previously disease-free group of people
  - Basic tool to study causality (etiology) of disease

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12. Epidemiology and Biostatistics: Incidence and Prevalence Rates

- **Incidence Rates (IR)**

\[
\text{# of new cases of a disease or condition} \quad \frac{\text{Total # in population at risk for the disease or condition}}{\text{over a period of time}}
\]

Types of study: Cohort, Prospective

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13. Epidemiology and Biostatistics: Incidence and Prevalence Rates

- **Prevalence Rates**
  - Measure the disease burden: the number of people in the total general population who have the disease at a given time.
  - Tells us the point prevalence: the probability of people having a disease at a given point in time, or over a short period of time – the period prevalence.

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14. Epidemiology and Biostatistics: Incidence and Prevalence Rates

- **Prevalence Rates**
  - # of existing cases of a disease or condition
  - # in the total population
  - At a point in time

Types of Studies: Cross-Sectional, Retrospective, Survey

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15. Epidemiology and Biostatistics: Incidence and Prevalence Rates

- High or low prevalence is **not** a measure of risk or causality
  - **Low Prevalence:**
    - Low incidence?
    - High cure rate?
    - Short course of disease?
    - High virulence, rapidly fatal?
  - **High Prevalence:**
    - Increase survival rate?
    - Improved detection?

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16. Epidemiology and Biostatistics: Relative Risk, Odds Ratio, Attributable Risk

- Relative Risk = Risk Ratio (RR)
  - Critical measure for determining strength of association, for assessing the causal (etiological) role of a risk factor for disease

\[
\frac{IR_{disease\ positive,\ risk\ positive}}{IR_{disease\ positive,\ risk\ negative}}
\]

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17. Epidemiology and Biostatistics: Incidence and Prevalence Rates

**Odds Ratio (OR)**
- Calculated as the **RR** when **IR** is very low

Odds that risk **positive** are disease positive

Odds that risk **negative** are disease positive

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18. Epidemiology and Biostatistics: Incidence and Prevalence Rates

**Attributable Risk (AR)**
- The risk of disease in individuals **exposed** to the risk factor, vs. those who are **not** exposed
- Provides an estimate of the number of cases of disease that might be prevented if exposure to the risk factor is eliminated

\[
AR = \text{Incidence rate of disease and risk factors positive} - \text{Incidence rate of disease and risk factors negative}
\]

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19. Epidemiology and Biostatistics: Evaluating Outcomes: Risk a...

![Epidemiology and Biostatistics: Evaluating Outcomes: Risk and Causality](image1)

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20. Epidemiology and Biostatistics: Evaluating Outcomes: Risk a...

![Epidemiology and Biostatistics: Evaluating Outcomes: Risk and Causality](image2)

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21. Epidemiology and Biostatistics: Evaluating Outcomes: Association and Causality

- **Spurious** – from chance or bias

- **Indirect** – RF(A) appears to → Outcome (C)
  Actually, RF(A) associated w/ RF (B) → Outcome (C)

- **Causal** – RF(A) → Outcome (C) …IF
  1. (A) precedes (C)
  2. Changes in (A) → changes in (C)
  3. (A) does NOT → (C) because of (B)

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22. Epidemiology and Biostatistics: Evaluating Outcomes: Association and Causality

- **Strength of association**
  - measured by RR

- **Dose-response association**

- **Consistency of association**
  - correlating studies: replication of findings by different methods, multiple testing
  - many lines of converging evidence

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23. Epidemiology and Biostatistics: Evaluating Outcomes: Association and Causality

Temporal association
Specificity of association
  - How tight does RF predict outcome
  - Ideally, 1:1
Plausibility
  - Coherence with scientific knowledge

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24. Epidemiology and Biostatistics: Evaluating Outcomes: Association and Causality

Impediments to etiologic investigation
  - No known etiologic agent
  - Multifactorial agents
  - Long latency
  - Indefinite onset
  - Different effects of factors on onset and progress of disease
  - Confounding and bias

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Epidemiology and Biostatistics: Describing the performance of a test

Positive and negative test results
- True positive (TP)
- False positive (FP)
- True negative (TP)
- False negative (FP)

Sensitivity
- The probability that diseased individuals will have a positive test result
  \[ = \text{TPR} = \frac{TP}{TP + FN} \text{ (all disease positive)} \]

Specificity
- The probability that disease-free individual will have a negative test result
  \[ = \text{TNR} = \frac{TN}{TN + FP} \text{ (all disease negative)} \]
27. Epidemiology and Biostatistics: Describing the performance of a test

- **Predictive value positive**
  - The probability that individuals with a positive test have the disease
  - \( PVP = \frac{TP}{TP + FP} \) (all with positive test)

- **Predictive value negative**
  - The probability that individuals with a negative test do not have the disease
  - \( PVN = \frac{TN}{TN + FN} \) (all negative test)

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28. Epidemiology and Biostatistics: Describing the performance of a test

- **Reliability (Precision)**
  - Test gives consistent results (standard spread of two frequency distributions), random error may not be accurate
  - Improved by replication and standardization

- **Accuracy**
  - Two frequency distributions true to positivity criteria, systemic error
  - Not improved by replication and standardization

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29. Epidemiology and Biostatistics: Evaluating Outcomes

![Epidemiology and Biostatistics: Evaluating Outcomes](image)

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