Epidemiology

Mercer University
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EVE 486
Public Health

What is epidemiology?

- Epidemiology is the study of the distribution and determinants of disease frequency in populations.
- Epidemiology seeks to identify the relationships between exposure and disease.

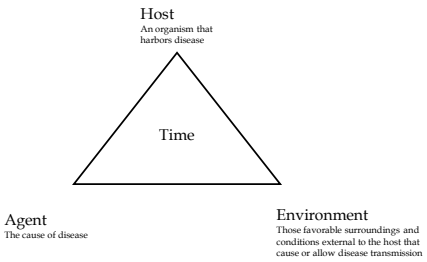
What is environmental epi.?

- Environmental epidemiology is the study of the effect on human health of physical, biologic, and chemical factors in the external environment…it seeks to clarify the relationship between these factors and human health (NRC, 1991).

Background definitions

- Endemic: the usual level of a disease within a given pop. or geographic area
  - Q: Why is this determination important?
- Epidemic: the occurrence of disease at a higher level than normally expected in a population
- Pandemic: an epidemic that is widespread (country, continent, world)

Epidemiologic framework



Some aims of epidemiology

- To elucidate causal mechanisms
- To explain local disease occurrence
- To describe the natural history of disease
- To determine control methods and preventive measures

The reality of epidemiology

- It proves NOTHING.
- At best, a relationship (association) between exposure and disease is demonstrated.
- Q: Why are we stuck with this reality?
  A:

Classic case study (J. Snow)

- Recognition: water supply & cholera
- Hypothesis: fecal contam. was agent
- Recognition: maybe other explanations
- Data collection
- Minimization of effects of other explan.
- Minimization of bias in data collection

Epidemiologic measures

- Measures of frequency
  - incidence
  - prevalence
- Measures of association
  - difference measures
  - ratio measures
- Measures of public health impact
  - etiologic fraction
  - preventive fraction

Measures of frequency

- These are measures that characterize a population in terms of demographic or risk factors, disease, and death
  - incidence: the number of new cases of disease that occur in a specified period of time

$$incidence\,rate = \frac{\#\,new\,cases}{pop.@\,risk} * k\ (often\ 100)$$

Example: incidence rate (freq.)

You are interested in the occurrence of anemia among children under 6 who live in homes containing lead-based paints.

You have information from a population of 2390 kids who were followed for 4 years (1996-1999); 482 of the kids lived in homes with Pb-based paint (1908 did not). Of the kids who lived in homes containing Pb-based paint, 27 developed a new case of anemia during the 4 years of follow up.

The incidence rate of anemia among kids who lived in homes with Pb-based paints is

$$IR = \frac{27\ new\,cases}{482\ kids\,at\,risk} * 100 = 5.6\ per\ 100\ over\ 4\ yrs$$

Attack rate (freq.)

An attack rate is a specific kind of incidence rate (applied to an outbreak investigation), expressed as a percentage

Example: There was a ASME cookout attended by 150 students, faculty, and friends. Thirty-five of these individuals got gastroenteritis from eating undercooked hamburgers.

The attack rate of gastroenteritis among cookout attendees was:

$$AR = \frac{35\ new\,cases}{150\ \ people\,at\,risk} * 100 = 23.3\%$$

Prevalence (freq.)

- There are two prevalence measures
  - Point prevalence: the # of existing cases of disease at a particular point in time
  - Period prevalence: the # of new cases and the # of existing cases of disease during a specified time period

Example: Point prevalence (freq.)

In March 2001, you performed an examination to determine decreased lung function on 2477 individuals 52-85 years of age. You identified 310 individuals with respiratory problems.

The point prevalence of decreased lung function in this population would be:

$$\frac{310\ existing\ cases}{2477\ \ pop.@\ risk} * 100 = 12.5\ per\ 100\ indiv.\ 52-85\ yrs$$

Example: Period prevalence (freq.)

The health department is concerned about the number of cases of conjunctivitis that are occurring in infant daycare centers. You decide to evaluate the health records during a 6-month period in 2001.

The number of infants in daycare during the period was 610. At the beginning of your 6-mo. period, 32 infants were identified with conjunctivitis; 48 infants developed new cases during the period.

The period prevalence of conjunctivitis would be

$$\frac{32\ existing\ cases + 48\ new\ cases}{610\ babies\ at\ risk} * 100 = 13\ cases\ \ per\ 100\ babies$$

Factors affecting prevalence (freq.)

Factors that increase prevalence	Factors that decrease prevalence
Individuals w/ disease move into the population	Individuals w/ disease move out of the population
Individuals w/o disease move out of the population	Individuals w/o disease move into the population
Treatment prolongs life w/o a cure	Treatment cures more people
There is an increase in the number of indiv. susceptible to the disease	There is an decrease in the number of indiv. susceptible to the disease

Mortality rates (frequency meas.)

If we want to measure the frequency of death in a population, we can discuss

- crude death rate = total deaths/ total population
- cause-specific death rate = # deaths due to cause/ # at risk
- case-fatality rate = # deaths due to cause/# new cases during time

Measures of association

Measures of association assess the strength of the statistical relationship between a given study factor (i.e., exposure) and disease or death

- What is the magnitude of association between exposure and disease?

Difference measure (association)

Attributable risk (AR): the number of new cases of disease among the exposed that can be attributed to the exposure (the number of new cases that would not have occurred if the individuals had not been exposed)

$$AR = IR_{exposed} - IR_{unexposed}$$

Attributable risk example

Referring back to the problem of anemia in young children…

- Incidence of anemia among exposed group:
  (27/482)100 = 5.6 cases per 100
- Incidence of anemia among unexposed group:
  (77/1908)100 = 4.0 cases per 100
- Attributable risk
  5.6 cases/100 - 4.0 cases/100 = 1.6 cases per 100

Therefore, 1.6 cases of anemia for every 100 kids who live in houses with Pb-based paint would be eliminated if the families moved (or if the exposure was somehow otherwise removed).

Ratio measure of association

Relative Risk (RR): the ratio of the incidence of disease among the exposed, divided by the incidence of disease among the unexposed

$$RR = \frac{IR_{exposed}}{IR_{unexposed}}$$

Relative risk example

Using the Pb-based paint example again…

- Incidence in the exposed group: 5.6 per 100
- Incidence in the unexposed group: 4.0 per 100

$$RR = \frac{5.6/100}{4.0/100} = 1.4$$

- Therefore, the incidence of anemia among children in homes with Pb-based paint is 1.4 times higher than the incidence among children in homes without Pb-based paint.
- RR < 1 implies a "protective" effect
  RR > 1 implies a "hazardous" effect

Measures of public health impact

Measures that reflect the expected effect of changing the distribution of one or more risk factors in a particular population.

What proportion of cases is due to a specific cause?

Measures of public health impact

- Etiologic fraction: The proportion that the incidence rate of the outcome among the exposed would be reduced if the exposure was eliminated (attributable risk %)

$$EF = \frac{IR_{\text{exposed}} - IR_{\text{unexposed}}}{IR_{\text{exposed}}}(100\%)$$

Example: Etiologic fraction

- Pb-based paint example…
  - Incidence of anemia among exposed group: (27/482)100 = 5.6 cases per 100
  - Incidence of anemia among unexposed group: (77/1908)100 = 4.0 cases per 100

$$EF = \frac{5.6/100 - 4.0/100}{5.6/100}(100\%) = 28.6\%$$

The incidence rate of anemia could be reduced by 28.6% if children who lived in houses with Pb-based paints would move.

Measures of public health impact

- Preventive fraction: The proportion by which the incidence rate of the outcome among the exposed is reduced because of the exposure

$$PF = \frac{IR_{\text{exposed}} - IR_{\text{unexposed}}}{IR_{\text{exposed}}}(100\%)$$

Note: This metric is used if the exposure is protective, i.e., a vaccine.

Example: Preventive fraction

- You are evaluating a program to reduce the incidence of measles among college freshmen…
  - The incidence rate among freshmen who **were** vaccinated
    - 30 measles cases/150 vaccinated freshmen = 20 per 100 vacc.
  - The incidence rate among freshmen who **were not** vaccinated
    - 45 measles cases/150 unvaccinated freshman = 30 per 100 unvac.

The preventive fraction comparing unvaccinated to vaccinated freshmen:

$$EF = \frac{30/100 - 45/100}{30/100}(100\%) = -50.0\%$$

The incidence rate of measles was reduced 50% among the vaccinated freshmen.