Introduction to Epidemiology

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Outline

- Define
- History
- Basis of epidemiology
- Objectives of epidemiology
- Causal inference

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Epidemiology

- The study of the distribution and determinants of health-related states or events in specified populations and the application of this study to the control of health problems

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Epidemiology

- The study of how disease is distributed in a population and of the factors that influence or determine that distribution.

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History of epidemiology

- John Snow, 1854
  - Cholera outbreak in London
  - Snow had previously hypothesized cholera was transmitted via water.
  - Two water companies in London
  - One pulled water down stream from sewage, one from up stream
  - Deaths occurred around water pumps from the downstream company

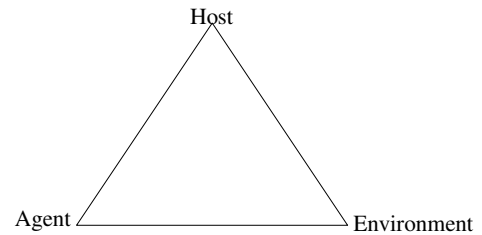Austin/Travis County Health and Human Services Department

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Basis of epidemiology

Disease, illness and ill-health are not randomly distributed in a population.

Determinants of disease

Host

Agent   Environment

Agent

- A necessary ingredient in the production of disease
- May be infectious (virus, bacteria) or noninfectious (chemical, radiation)
- May be a single agent or a complex of agents

Host

- The biological and behavioral qualities of an individual
- Factors can influence the exposure to disease causing agents and the occurrence of disease after exposure

Host

- Age
- Sex
- Race/ethnicity
- Occupation
- Immune status
- Alcohol / drug use
- Sexual activity

Environment

- External factors that affect the likelihood of disease occurrence
- Examples: weather, population density, geography

Objectives of epidemiology

1. Identify the causes of disease and the factors that increase a person's risk of disease
2. Describe the extent of disease found in a community
3. Describe the natural history and characteristics of a disease
4. Evaluate preventive/therapeutic measures
5. Guide policy decisions

1. Identify causes of disease

- Classic application of infectious disease epidemiology
- Outbreak or cluster investigations
- Medical detective

Examples of outbreak investigations

- Pneumonia associated with convention attendants discovered Legionnaires Disease
- SARS cases in Toronto traced back to exposures in Hong Kong
- Deaths due to E.coli from eating at fast food restaurants

Local outbreak examples

- A case of Hemolytic Uremic Syndrome caused by E.Coli from a church retreat
- Outbreak of shigella after a 21st birthday party caused by one of the guests

2. Describe the extent of disease

- Descriptive epidemiology
- Person – populations/communities affected
- Place – geographical locations
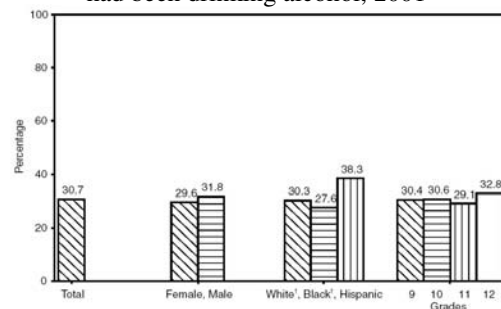- Time – seasonal patterns, trends over time

% of high school students who rode with a driver who had been drinking alcohol, 2001

YRBSS
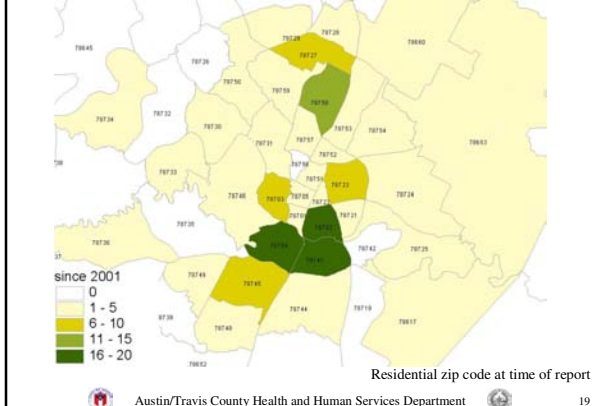
* ≥1 times during the 30 days preceding the survey.
† Non-Hispanic.

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Geographical distribution of early Syphilis cases

since 2001
- 0
- 1 - 5
- 6 - 10
- 11 - 15
- 16 - 20

Residential zip code at time of report

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2. Describe the extent of disease

Epidemic

any disease that occurs at a greater than expected frequency

Endemic

any disease that does not fluctuate over time in a defined place

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3. Natural history & characteristics

Natural History
- Progression of disease

Biological Characteristics
- Biology
- Reservoir
- Transmission

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Natural History

1. *Appropriate exposure or accumulation of agent*
2. *Incubation period or latency period*

   How much time from the start of the disease process until disease?
   – All diseases have a defined period of time before symptoms occur.
   – Called subclinical disease.
   – Can be seconds, days, months or years depending on agent.

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Natural History

3. *Clinical disease*
   – Recovery
   – Persistent (Chronic) disease
   – Disability
   – Death
   – Chronic carriers
     - No evidence of active infection or clinical illness
     - Can still infect others
     - Most famous was Typhoid Mary

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Biological Characteristics

Infectivity

The ability of an agent to cause infection in a susceptible host.

Measured by % of exposed people who become ill.

Pathogenicity

Ability of agent to induce disease.

Measured by % of infected persons who develop clinically apparent disease.

Virulence

Severity of disease after infection occurs.

Measured by case-fatality rate.

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Biological Characteristics

Reservoir

The habitat in which the agent normally lives, grows and multiplies.
- Humans, Animals, Environment

Mode of transmission

How is the disease spread?
- Direct contact, airborne, vehicle-borne, vector-borne

4. Evaluation

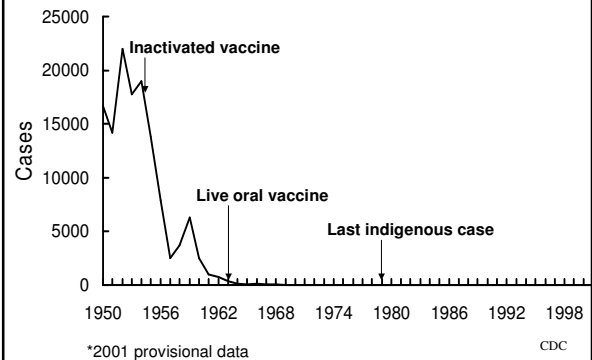- Determine the effectiveness of health programs and services in improving the health of the community

Evaluation of Health Study

Group	Pre-test	Intervention	Post-test
A	Measure BMI	Aerobics	Measure BMI
B	Measure BMI		Measure BMI

Poliomyelitis–US, 1950-2001*

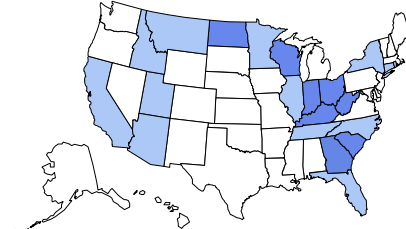*2001 provisional data

CDC

5. Policy

- Warnings on cigarettes
- Targeted community interventions
- Smallpox preparedness program
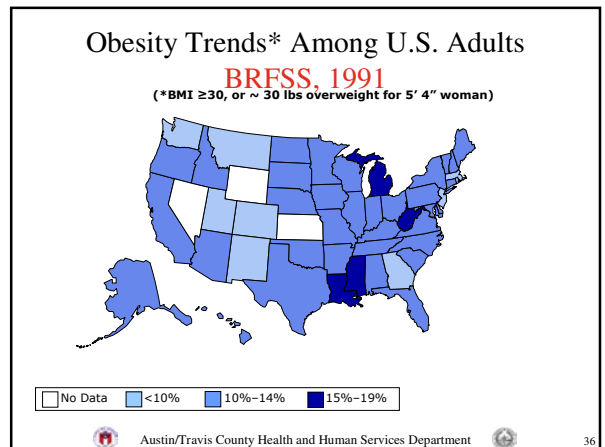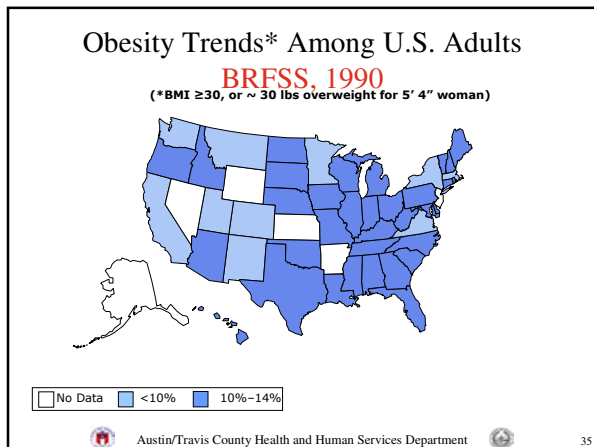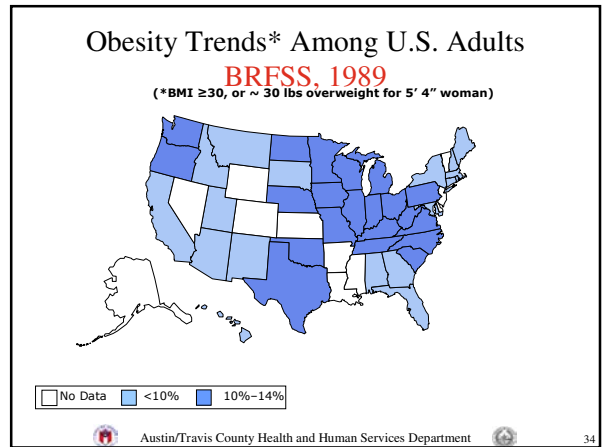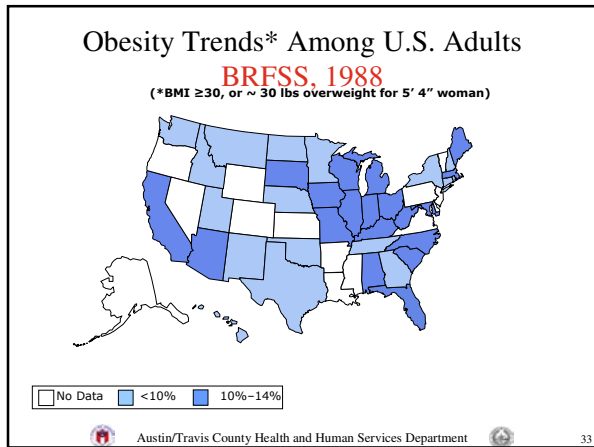- Polio eradication program

Obesity Trends* Among U.S. Adults
BRFSS, 1985
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data | <10% | 10%–14%

Obesity Trends* Among U.S. Adults
BRFSS, 1986
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data □   <10% ■   10%–14% ■

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Obesity Trends* Among U.S. Adults
BRFSS, 1987
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data □   <10% ■   10%–14% ■

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Obesity Trends* Among U.S. Adults
BRFSS, 1988
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data □   <10% ■   10%–14% ■

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Obesity Trends* Among U.S. Adults
BRFSS, 1989
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data □   <10% ■   10%–14% ■

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Obesity Trends* Among U.S. Adults
BRFSS, 1990
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data □   <10% ■   10%–14% ■

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Obesity Trends* Among U.S. Adults
BRFSS, 1991
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data □   <10% ■   10%–14% ■   15%–19% ■

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Obesity Trends* Among U.S. Adults
BRFSS, 1992
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data   <10%   10%–14%   15%–19%

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Obesity Trends* Among U.S. Adults
BRFSS, 1993
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data   <10%   10%–14%   15%–19%

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Obesity Trends* Among U.S. Adults
BRFSS, 1994
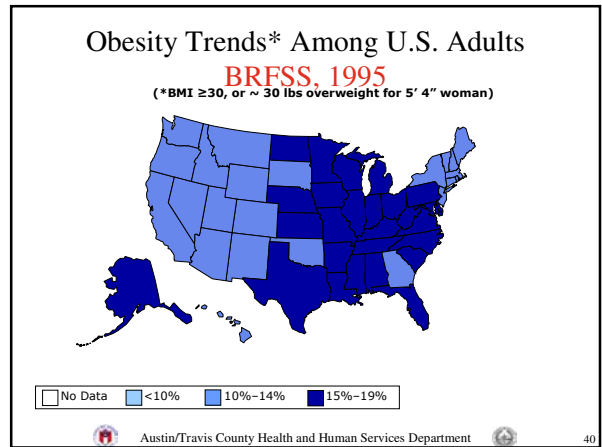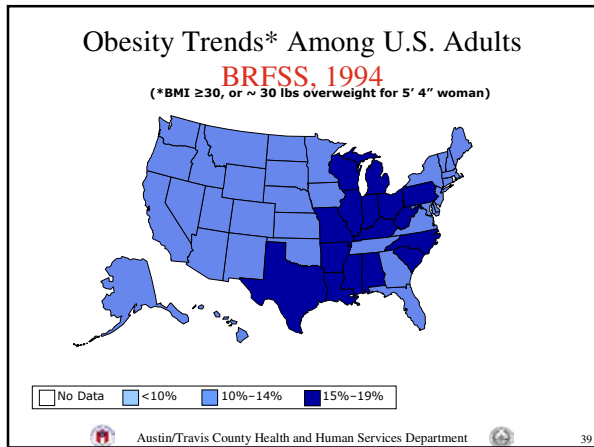(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data   <10%   10%–14%   15%–19%

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Obesity Trends* Among U.S. Adults
BRFSS, 1995
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data   <10%   10%–14%   15%–19%

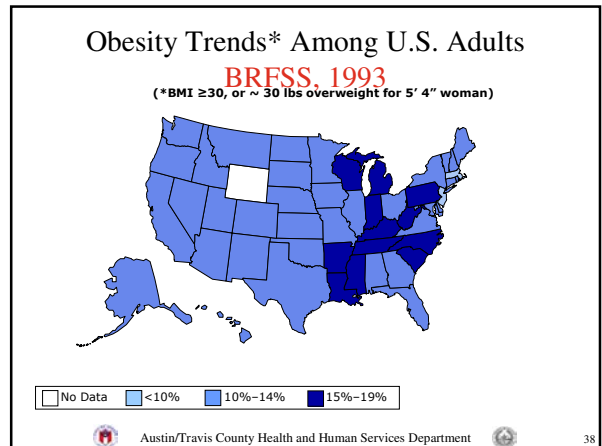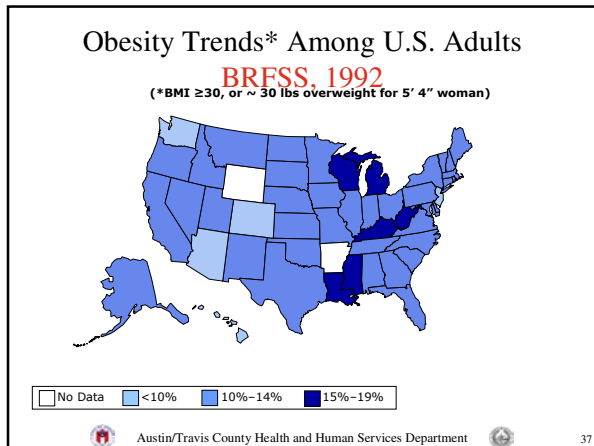Austin/Travis County Health and Human Services Department   40

Obesity Trends* Among U.S. Adults
BRFSS, 1996
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data   <10%   10%–14%   15%–19%

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Obesity Trends* Among U.S. Adults
BRFSS, 1997
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data   <10%   10%–14%   15%–19%   ≥20

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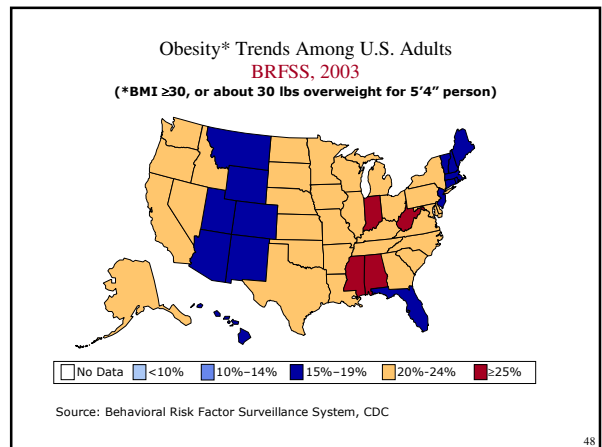Obesity Trends* Among U.S. Adults
BRFSS, 1998
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data   <10%   10%–14%   15%–19%   ≥20

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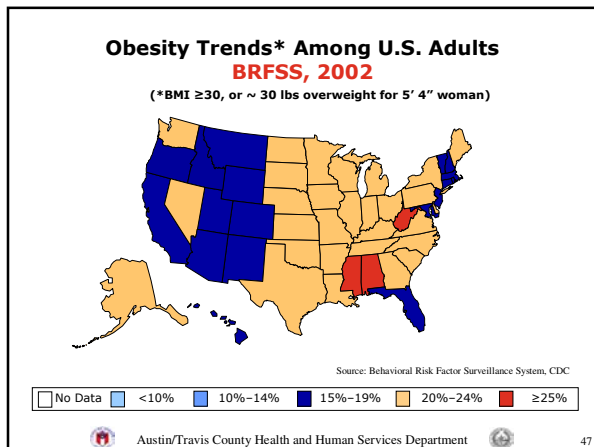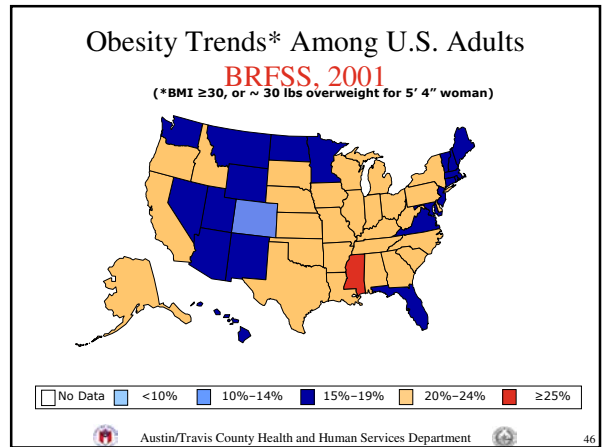Obesity Trends* Among U.S. Adults
BRFSS, 1999
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data   <10%   10%–14%   15%–19%   ≥20

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Obesity Trends* Among U.S. Adults
BRFSS, 2000
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data   <10%   10%–14%   15%–19%   ≥20

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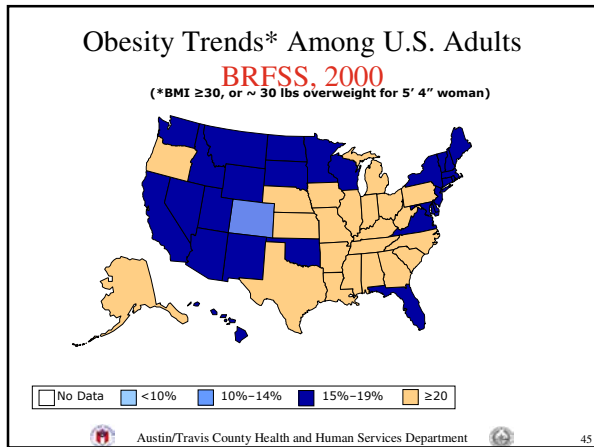Obesity Trends* Among U.S. Adults
BRFSS, 2001
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

No Data   <10%   10%–14%   15%–19%   20%–24%   ≥25%

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Obesity Trends* Among U.S. Adults
BRFSS, 2002
(*BMI ≥30, or ~ 30 lbs overweight for 5' 4" woman)

Source: Behavioral Risk Factor Surveillance System, CDC

No Data   <10%   10%–14%   15%–19%   20%–24%   ≥25%

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Obesity* Trends Among U.S. Adults
BRFSS, 2003
(*BMI ≥30, or about 30 lbs overweight for 5'4" person)

No Data   <10%   10%–14%   15%–19%   20%–24%   ≥25%
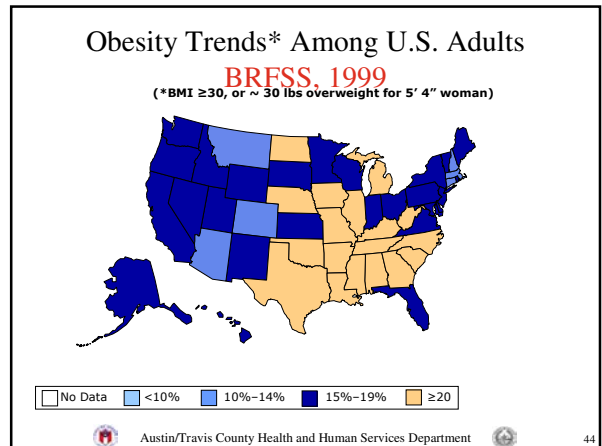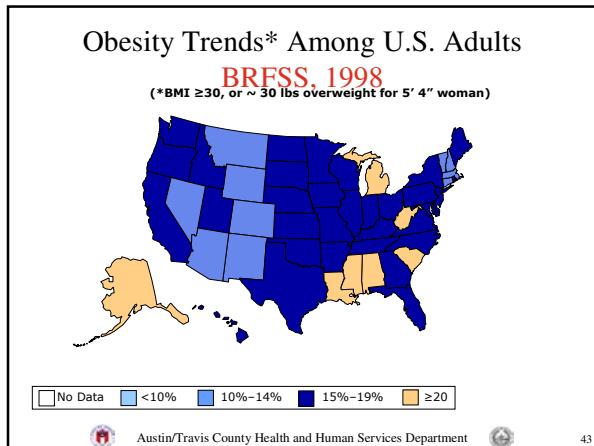
Source: Behavioral Risk Factor Surveillance System, CDC

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Applications of epidemiology

- Clinical
- Genetic
- Social
- Infectious Disease
- Chronic Disease
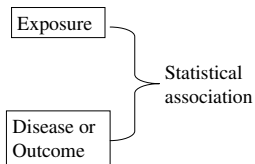- Pharmacoepidemiology
- HIV/AIDS
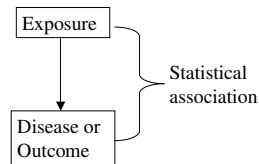- Maternal & child

Causal Inference

- Does an exposure or factor cause disease?
- More than is a factor statistically associated with disease.

Association   Causal Association

Exposure — Statistical association — Disease or Outcome

Exposure → Disease or Outcome — Statistical association

Criteria for causal association

- Temporal relationship
- Strength of relationship
- Dose-response relationship
- Biologic plausibility
- Consistency of results

Causal inference

- Temporal association
  – Does the exposure precede the disease?

Causal inference

- Strength of relationship
  – The stronger the association, the more likely it is that the exposure-disease relationship is causal
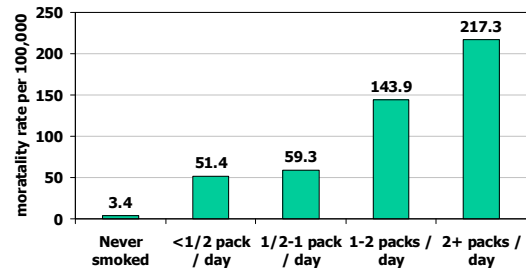 – Strong associations are not as likely as weak association to be due to different types of study bias

Causal inference

- Dose-response relationship
  - Is the association stronger with increased intensity or duration of exposure?

Dose-response relationship

From: Hammond & Horn, JAMA 166:194-1308; 1958

Causal inference

- Biologic plausibility
  - Results consistent with current knowledge of biology?
  - Are there any known or suspected biological mechanisms that help explain the exposure-disease association?

Causal inference

- Consistency of results
  - Do other studies with different populations and methods report the same results?

More information

For more information on epidemiology

Epidemiology Supercourse
http://www.pitt.edu/~super1/

Contact information

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