# Epidemiology and Surveillance in Chronic Disease Prevention and Control

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# Objectives

- By the end of the presentation, the participant will be able to:
  - Describe the common tasks and role of epidemiology in chronic disease prevention and control
  - Discuss the functions of surveillance in chronic disease control and prevention
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#### **Basic Concepts**

- Epidemiology
  - Study the distribution and determinants of health problems
  - Apply the study results to prevention and control of health problems
    - Distribution
      - Study of frequency and pattern of health events in the population
      - Frequency number, and number in relation to the population
      - Pattern the health-related state or event by person, place, and time characteristics
    - Determinants
      - Search for causes and other factors of health-related states or events
  - Base on systematic and objective approach to data collection, analysis, and interpretation



# **Epidemiology Common Tasks**

- Identifying risk factors for disease, injury, and death
- Describing the natural history of disease
- Identifying individuals and populations at greatest risk for disease
- Identifying where the public health problem is greatest
- Monitoring diseases and other health-related events over time



- Evaluating the efficacy and effectiveness of prevention and treatment programs
- Providing information useful in health planning and decision making for establishing health programs with appropriate priorities
- Assisting in carrying out public health programs

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- Being a resource person
- Communicating public health information

## **Role of Epidemiology**

- Epidemiological findings contribute to
  - Preventing and controlling disease, injury, disability, death by
    - Providing information that leads to
      - informed public health policy and planning
      - individual health decision making
- Selected type of epidemiologic information
  - Public health assessment
  - Causes of disease
  - Completing the clinical picture
  - Program evaluation
    - Efficacy
    - Effectiveness



#### Epidemiology helps answer questions of

- Diagnosis:
  - Is there such a problem as myalgic encephalitis?
  - Is prostate specific antigen a good test for prostate cancer?
- Causes:
  - Why did this patient suffer from a stroke?
  - Is obesity the cause of metabolic syndrome?
- Treatment:
  - Is this the best treatment for Parkinson's disease?
  - Is my surgery as good as that of everyone else?
- Prognosis:
  - What are the chances of a recurrent heart attack?
  - How long will this knee joint prosthesis last?



#### • Health promotion and protection:

- Do current school meals harm children's future health?
- Will the Irish smoking ban in public places work better than the English policy?
- Health and disease surveillance:
  - Why are there tenfold international differences in suicide rates?
  - When will the next influenza pandemic occur?
- Health inequalities:
  - Why should life expectancy be nearly five years lower in unskilled manual workers?
    - Do health services reduce or increase health inequalities?



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## Surveillance

- Medical surveillance
  - Close observation of individuals exposed to a communicable disease
    - Detect early cases
    - Prompt isolation and control
- Public health surveillance
  - Systematic ongoing collection, analysis, interpretation, and dissemination of health data
    - Identify outbreaks: early warning => public health emergencies
    - Inform prevention and control measures



- Monitoring
  - Identify sudden changes in occurrence
  - Follow long-term trends and patterns
  - Identify changes in risk factors
  - Document program impact, progress
  - Help identify
    - Whether a health problem exists
    - Whether the problem is getting worse
  - Help set priorities
  - Help develop public health policy and strategies



- <u>An effective surveillance system has the following</u> <u>functions:</u>
  - detection and notification of health events
  - collection and consolidation of pertinent data
  - investigation and confirmation (epidemiological, clinical and/or laboratory) of cases or outbreaks
  - routine analysis and creation of reports
  - feedback of information to those providing the data
  - feed-forward (i.e. the forwarding of data to more central levels)
  - reporting data to the next administrative level



Detection and notification
Data collection and consolidation
Investigation and confirmation
(epidemiological, clinical, laboratory)
Data analysis and creation of reports
Feedback of info to persons providing data
Feed-forward
(forward report to central location)
Reporting data to next administrative level



http://www.who.int/immunization/monitoring\_surveillance/burden/vpd/en/

- Evaluation
  - Health programs may be aimed at
    - Increasing vaccination levels
    - Reducing smoking
    - Increasing fruit and vegetable consumption
    - Increasing physical activity
    - Decreasing obesity
    - Increasing screening



## Surveillance Example

#### • Vaccine Preventable Disease

- State public health officials monitor vaccine preventable disease rates
- May signal that the vaccination program is not reaching specific at-risk populations
- Monitoring rates by racial/ethnic groups
  - E.g.: increasing rate exists among a given minority group
- Do barriers exist related to culture, language, and access to care?
- The vaccination program should then be altered to address these barriers



#### To set objectives of surveillance, ask:

- What is the **health-related event** under surveillance? What is its **case definition**?
- What is the purpose and what are the objectives of surveillance?
- What are the **planned uses** of the surveillance data?
- What is the **legal authority** for any data collection?
- Where is the **organizational home** of the surveillance?
- Is the system integrated with other surveillance and health information systems?
- What is the **population** under surveillance?



- What is the **frequency** of data collection (weekly, monthly, annually)?
- What data are collected and how? Would a sentinel approach or sampling be more effective?
- What are the data sources? What approach is used to obtain data?
- During what period should surveillance be conducted? Does it need to be continuous, or can it be intermittent or short-term?



- How are the data processed and managed? How are they routed, transferred, stored? Does the system comply with applicable standards for data formats and coding schemes? How is confidentiality maintained?
- How are the data analyzed? By whom? How often? How thoroughly?
- How is the information disseminated? How often are reports distributed? To whom? Does it get to all those who need to know, including the medical and public health communities and policymakers?

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https://www.cdc.gov/OPHSS/CSELS/DSEPD/SS1978/Lesson5/Section2.html#\_edn10 STATE UNIVERSITY

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#### **Epidemiology Triangle for Infectious Disease**



FIGURE 1-1 The triangle of epidemiology.



#### Advanced epidemiology triangle for chronic diseases and behavioral disorders



FIGURE 1-3 Advanced model of the triangle of epidemiology.



#### **Environment and Chronic Health Problems**

- The aggregate of external conditions and influences affecting the health status of people
  - Physical
  - Chemical
  - Biological
  - Social factors

*Merrill, R. M. 2017. Introduction to Epidemiology (7<sup>th</sup> Ed.) Sudbury, MA: Jones and Bartlett Publishers.* 

mental Risk Factors
Asbestos, radon, cigarette smoke, glues, carbon monoxide, lead, nitrogen dioxide, ozone, PM <sub>10</sub> , sulfur dioxide
Dioxin, nickel, arsenic, mercury, cement (chromium), polychlorinated biphenyls (PCBs), glues, rubber cement
Carbon tetrachloride, methylene chloride, vinyl chloride
Cadmium, lead, mercury, chlorinated hydrocarbon solvents
Chemicals, viruses, bacteria, radiation
Carbon monoxide, noise, tobacco smoke, physical stress, carbon disulfide, nitrates, methylene chloride
Methylmercury, carbon monoxide, lead, ethylene oxide
Arsenic, benzene, nitrates, radiation
Benzocaine, dapsone, nitrates
Tetrachloroethylene, mercury, arsenic, toluene, lead, methanol, noise, vinyl chloride
Extreme and prolonged noise events

Adapted from Centers for Disease Control and Prevention. Disease clusters: An overview evaluating a disease cluster. http://www.atsdr.cdc.gov/csem/csem.asp?csem=20&po=5. Accessed January 28, 2012.

## **Physical Stresses And Health**

- Excessive heat, cold, and noise
- Radiation (electromagnetic, ultrasound, microwave, xirradiation)
- Vehicular collisions
- Workplace injuries
- Climate change
- Ozone depletion
- Housing
- •

*Merrill, R. M. 2017. Introduction to Epidemiology (7<sup>th</sup> Ed.) Sudbury, MA: Jones and Bartlett Publishers.* 



Data from National Council on Radiation Protection and Measurements. Ionizing radiation exposure of the population of the United States, NCRP Report No. 93. Washington, DC: National Council on Radiation and Protection and Measurements; 1987.

#### **Chemicals and Health**

- Several chemicals in the environment are capable of causing chronic disease and adverse health conditions
  - Drugs
  - Acids
  - Alkali
  - Heavy metals (e.g., lead)
  - Poisons
  - Some enzymes

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Table 11-3	Selected Carcinogens in the Workplace				
Carcinogen	Occupation	Type of Cancer			
Aromatic amines, solvents	Rubber industry	Bladder, leukemia, stomach, lung, skin, colon, lymphoma			
Asbestos	Construction workers	Lung, larynx, gastrointestinal tract			
Benzene	Boot and shoe manufacture and repair	Leukemia, lymphoma			
Nickel	Nickel refining	Lung, nasal sinuses			
Radon	Underground mining	Lung			
Soot, tars, oils	Coal, gas, petroleum workers	Skin, lung, bladder			
Vinyl chloride	Rubber workers, polyvinyl chloride manufacturing	Liver			
Wood dust	Furniture manufacturing	Nasal cavity			

Data from National Institute for Occupational Safety and Health—Occupational Cancer. (2003). http://www.cdc.gov /niosh/topics/cancer/. Accessed December 13, 2008.

## **Biologic Agents and Health**

Table 11-4	Viruses and Cancer					
Virus		Type of Cancer				
Epstein-Barr v	virus	Burkitt's lymphoma				
Human papillo	omavirus (HPV)	Cancers of the cervix, anus, vagina, vulva, penis, orophayrnx				
Hepatitis B an	d C viruses	Liver cancer				
Human T-cell (	ymphotrophic virus	Adult T-cell leukemia				
Kaposi's sarco Herpes virus	ma-associated	Kaposi's sarcoma				

Data from Viruses that can lead to cancer, American Cancer Society. Last Revised 04/27/2015. Available at: http://www.cancer .org/cancer/cancercauses/othercarcinogens/infectiousagents /infectiousagentsandcancer/infectious-agents-and-cancer-viruses.





## Social Environment And Health

- War Mental and physical disabilities
- Families and households Dietary behaviors
- Social networks and social supports foster the ability to deal with and survive chronic health problems
- Neighborhoods and communities may include environments that facilitate physical activity (e.g., parks and recreational centers, bike paths, and safe walking areas), which in turn reduces the risk of certain chronic conditions
- Public health policy (e.g., no smoking in public places) may reduce exposure to individuals of risk factors for certain chronic diseases



#### **Behavior and Chronic Health Problems**

- Many of the diseases and conditions today are influenced by lifestyles of modern populations
  - Career pressures
  - Sedentary lifestyles
  - High density population living
  - Poor diet
  - Crime
  - Drugs

- Gangs
- Poverty
- Pollution
- Fear
- Stress
- Economic struggles



#### Multifactorial etiology in chronic disease epidemiology

- Prevention and control of noninfectious diseases and conditions is often much more complicated than that of infectious diseases
  - The interaction between behavior, environment, genetic, and social risk factors often make prevention efforts complex and sometimes infeasible
  - Prevention programs need to be specifically tailored to given societies and cultures
  - Despite the complexities of primary prevention, it provides the greatest potential for minimizing public suffering and health-care costs



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McKenzie, J.F., Neiger, B.L., Thackeray, R. (2012) (6th ed) Planning, Implementing, and Evaluating Health Promotion Programs: A Primer. San Francisco, CA: Pearson Education, Inc.



#### **Primary Prevention**

- Active Primary Prevention
  - Requires behavior change on part of subject
    - Wearing protective devices
    - Health promotion
    - Lifestyle changes
    - Community health education
    - Ensuring healthy conditions at home, school, and workplace

#### Passive Primary Prevention

- Does not require behavior change
  - Vitamin-fortified foods
  - Fluoridation of public water supplies



### **Secondary Prevention**

- Occurs to reduce the progress of disease
- The disease already exists in the person
  - Cancer screening Cancer already present; the goal is to detect the cancer before clinical symptoms arise in order to improve prognosis and prevent conditions from progressing and from spreading



#### **Tertiary Prevention**

- To reduce the limitation of disability from disease
- The disease has already occurred
  - Physical therapy for stroke victims
  - Halfway houses for recovering alcoholics
  - Shelter homes for the developmentally disabled
  - Fitness programs for heart attack patients



#### **EXAMPLES**



#### **British Doctors Study**

- Doll R, Hill AB (1954). "The mortality of doctors in relation to their smoking habits". BMJ. 328 (7455): 1529–1533.
- Doll, R; Hill AB (November 1956). "Lung cancer and other causes of death in relation to smoking; a second report on the mortality of British doctors". British Medical Journal. 2 (5001): 1071–1081.
- Doll R, Peto R, Boreham J, Sutherland I (2004). "Mortality in relation to smoking: 50 years' observation on male British doctors". BMJ. 328 (7455): 1519.



#### Age-adjusted lung cancer death rates and per capita consumption of males and females in the US





## Framingham Heart Study

#### **Research Milestones** (selected)

Cigarette smoking found to increase the risk of heart disease 1960 Cholesterol level, blood pressure, and electrocardiogram abnormalities found to 1961 increase the risk of heart disease Physical activity found to reduce the risk of heart disease and obesity to increase the 1967 risk of heart disease 1970 High blood pressure found to increase the risk of stroke Atrial fibrillation increases stroke risk 5-fold 1988 High levels of HDL cholesterol found to reduce risk of death 1998 Atrial fibrillation is associated with an increased risk of all-cause mortality Lifetime risk at age 40 years of developing coronary heart disease is one in two for 1999 men and one in three for women High-normal blood pressure is associated with an increased risk of cardiovascular 2001 disease

#### **Research Milestones** (selected)

- **2002** Obesity is a risk factor for heart failure Network phenomena appear to be relevant to the biologic and behavioral
- **2007** trait of obesity Obesity appears to spread through social ties
- 2008 Social networks exert key influences on decision to quit smoking
- **2009** Parental dementia may lead to poor memory in middle-aged adults

High leptin levels may protect against Alzheimer's disease and dementia

2010 Sleep apnea tied to increased risk of stroke Fat around the abdomen associated with smaller, older brains in middleaged adults Occurrence of stroke by age 65 years in a parent increased risk of stroke in offspring by 3-fold

## Nurses' Health Study

- The largest, longest running investigations of women's health
- Starting with the original Nurses' Health Study in 1976
- Now in the third generation with Nurses' Health Study 3 (which is still enrolling male and female nurses) and count more than 275,000 participants
- <u>Key research findings</u>



#### Key research findings from the Nurses' Health Studies



	Breast cancer	Coronary heart disease (CHD) & stroke	Colon cancer	Hip fracture	Cognitive function	Eye disease
Cigarette smoking	No relation with past or current smoking	Increases risk of CHD and stroke; risk reduced within 2-4 years of smoking cessation	Increases risk of colon cancer	Increases risk of hip fracture for current smokers	Not examined	Increases risk of cataracts and "wet" AMD (a severe form of Age- related Macular Degeneration)
Oral contra- ceptives	Current use increases risk; past use no association	Current use increases risk; past use no association	Reduces risk of colon cancer	Not examined	Not examined	Reduces risk of "wet" AMD
Post- menopausal hormone therapy	<ul> <li>&gt;5 years of estrogen plus progestin use increases risk;</li> <li>&gt;10 years of estrogen only use increases risk</li> </ul>	Current use increases risk of stroke, and among recently menopausal women may reduce the risk of CHD	Reduces risk of colon cancer	Current use reduces risk of hip fracture	No relation to cognitive function	Current use reduces risk of high-tension glaucoma and "wet" AMD

	Breast cancer	Coronary heart diseas (CHD) & strol		er Hip fractu	ure Cognitiv function	
Obesity	Increases risk for menopausal women; weight loss after menopause is associated with reduced risk	Increases risk of CHD and stroke; weight gain after age 18 increases risk of stroke and CHD	Increases risk of colon cancer	Reduces risk of hip fracture, in large part due to extra padding around the hips	Not examined	Increases risk of cataracts and AMD
Alcohol	One or more drinks per day increases risk	Moderate alcohol intake reduces the risk of CHD	≥2 drinks per day increases risk	High consumption increases risk of hip fracture	Moderate intake reduces risk of cognitive impairment	No relation to age-related eye diseases
Diet	Higher intake of red meat increases risk of premenopausal breast cancer	Mediterranean diet reduces risk of CHD and stroke; fish intake reduces risk of stroke; nuts and whole grains reduce risk of CHD; refined carbohydrates and trans fats increase risk	Folate, vitamin B6, calcium, and vitamin D intake reduce risk; red and processed meat intake increase risk	Reduced risk with calcium supplement use among women with low- calcium diets; higher dietary calcium intake has no effect; vitamin D intake reduces risk and retinol increases risk	Higher vegetable intake, especially green leafy vegetables, reduces risk of cognitive impairment	Some antioxidants reduce risk of cataracts and AMD; higher intake of fish reduces risk of cataracts and AMD

	Breast cancer	Coronary heart disease (CHD) & stroke	Colon cancer	Hip fracture	Cognitive function	Eye disease
Physical activity	Moderate physical activity reduces risk and improves survival in breast cancer patients	Physical activity, including walking, reduces risk of CHD and stroke	Physical activity reduces risk	Physical activity, including walking, reduces risk of hip fracture	Moderate physical activity reduces risk of cognitive impairment	No relation to age-related eye diseases
Other exposures	Family history of breast cancer, high breast density, high circulating hormone levels, and shift work all increase risk	Snoring is associated with a modest but significantly increased risk of CHD and stroke	>10 years of aspirin use reduces risk; family history increases risk	Diabetes and increasing years spent working rotating night shifts increase risk	Type 2 diabetes and higher insulin, even in women without diabetes, increase risk	Diabetes increases risk of glaucoma and cataracts; positive family history and African heritage increases risk of glaucoma
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#### **Cancer Prevention Studies**

- Conducted by <u>American Cancer Society</u>
- Hammond-Horn Study: 1952-1955
  - helped to establish cigarette smoking as a cause of death from lung cancer and coronary heart disease
- CPS-1: 1959-1972
  - demonstrated sharp increase in lung cancer death rates among US women between 1959 and 1972 occurred only in smokers
  - First study to show a relationship between obesity and shortened overall survival
- CPS-2: 1982- last survey questionnaire sent in 2007
- CPS-3: 2006-current



### Other key findings from CPS studies

- Cigarettes with reduced yield of tar and nicotine do not reduce the risk of lung cancer.
- Obesity is associated with increased death rates from at least ten cancer sites, including colon and post-menopausal breast cancer.
- Discovery of the link between aspirin use and lower risk of colon cancer opened the door to research on chronic inflammation and cancer.
- Relationships of other potentially modifiable factors such as physical inactivity, prolonged hormone use and certain dietary factors with cancer risk.
- Air pollution, especially small particulates and ozone, increase death rates from heart and lung conditions. CPS-II findings helped to motivate the Environmental Protection Agency to propose more stringent limits on air pollution.



#### GA Chronic Disease Prevention Programs (selected)

- Georgia Asthma Control Program (GACP)
- <u>Georgia Comprehensive Cancer Control Program</u> (CCCP)
- <u>Hypertension Management and Outreach Program</u> (<u>HMOP</u>)
- <u>Georgia Stroke and Heart Attack Prevention Program</u> (Georgia SHAPP)
- Georgia Tobacco Use Prevention Program (GTUPP)
- Georgia Tobacco Quit Line (GTQL)



# Questions? Thank you! KENNESAW STATE UNIVERSITY