Chronic Disease Epidemiology

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RISKS

Attributable Risk

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Attributable Risk

Is the amount of risk that occurs because of the exposure

(Attributable risk is the **difference in the probability** of the event in exposed people and the probability of disease in unexposed people)

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Age:

Gender:

Income:

Occupation:

Working in a gas station: 1- Yes   2- No

X- ray chest: 1- Positive lung cancer

2- No lung cancer

Gas station	Chest x-ray
1.00	1.00
1.00	2.00
1.00	2.00
2.00	1.00
2.00	2.00
2.00	1.00
1.00	2.00
2.00	1.00
1.00	2.00
2.00	1.00
1.00	2.00
2.00	1.00

DANGER
CONTAINS
BENZENE
CANCER HAZARD

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Workers exposed to benzene vapours in gas stations

	Yes lung cancer	No lung cancer	Row Total
Yes Workers Exposed	**40**	**172**	**212**
No Workers Unexposed	**18**	**253**	**271**
Total	**58**	**425**	**483**

Calculate the incidence of lung cancer in both groups

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Calculate the attributable risk (fraction)

$$\frac{\text{Incidence exposed} - \text{Incidence unexposed}}{\text{Incidence exposed}}$$

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0.6481

# Multiply by 100

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64.81%

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Interpretation

This calculation tells us that, 64.81% of lung cancer in the exposed group (population) is ATTRIBUTED منسوب الى to benzene vapour exposure

Interpretation

It also tells us that, if were able to come up with preventive measures for those workers (e.g; wearing masks during their shift) then we would be able to prevent a fraction of 64.81% of the lung cancer cases in this population

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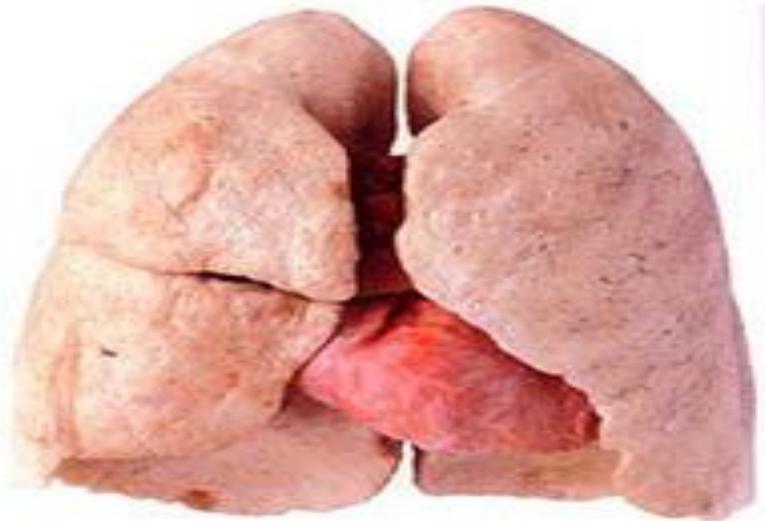
Example

- The incidence of lung cancer among smokers is 0.96/1000/yr.

- The incidence of lung cancer among non-smokers is 0.07/1000/yr.

- **Calculate the Relative Risk and interpret the result**

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- The relative risk associated with smoking in this population is 0.96/1000/yr divided by 0.07/1000/yr = **13.7**

- Therefore, smokers are ~14 times more likely to develop lung cancer than non-smokers

- The attributable risk associated with smoking is 0.96/1000/yr – 0.7/1000/yr = 0.89/1000/yr

- **The incidence of lung cancer attributed to smoking is 0.89/1000/yr**

- **The proportion of lung cancer cases that could be prevented in this population of smokers if they would quit smoking is 0.89/1000/yr divided by 0.96/1000/yr = 92.7%.**

Odds Ratio

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The odds ratio is one of a range of statistics used to assess the risk of a particular outcome (or disease) if a certain factor (or exposure) is present

The odds ratio is a relative measure of risk, telling us how much more likely it is that someone who is exposed to the factor under study will develop the outcome as compared to someone who is not exposed

The odds of an event happening is the probability that the event will happen divided by the probability that the event will not happen

$$p / (1-p)$$

ALWAYS WEAR SUNSCREEN

Example: Melanoma

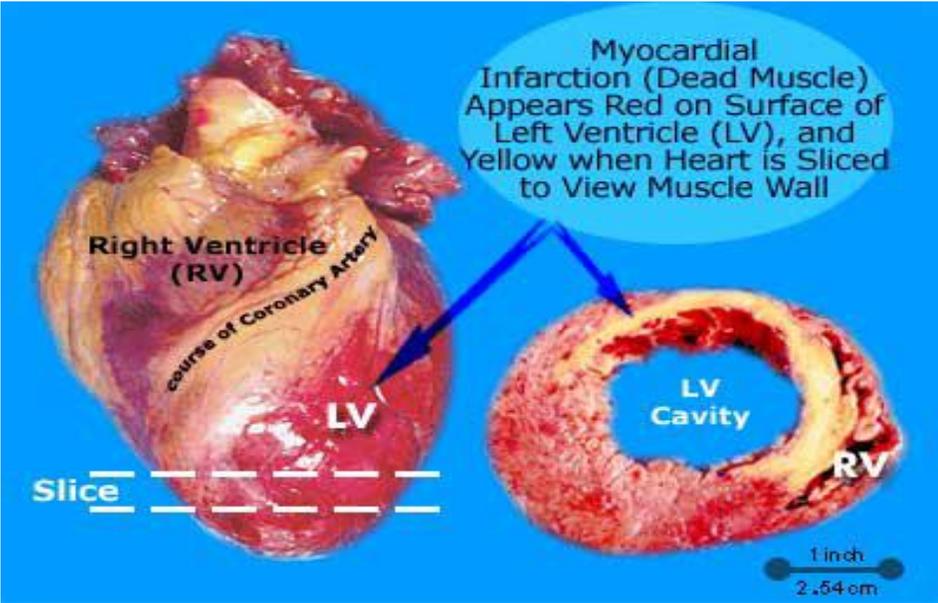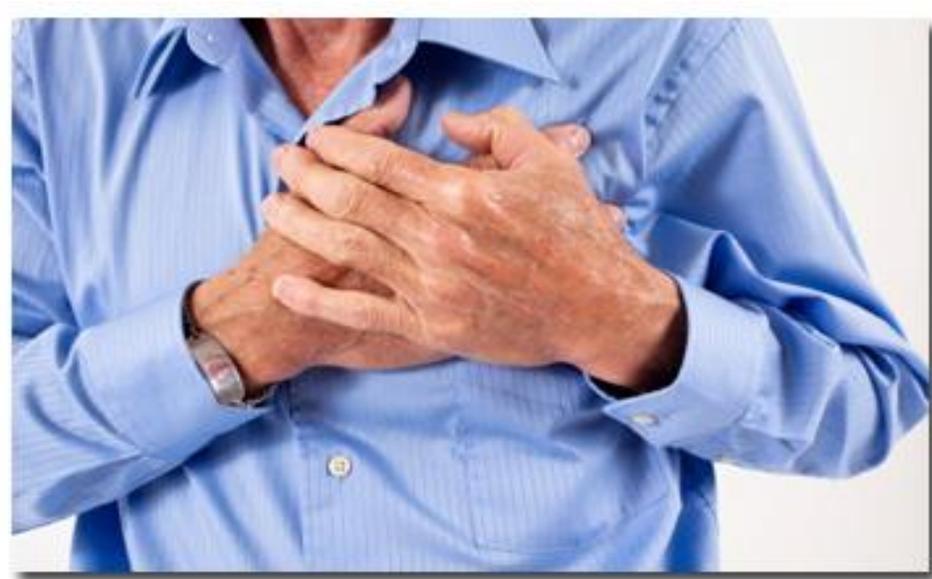- 1000 persons **observed for 1 year**; 1 acquires melanoma

- Probability of melanoma occurring

  (p) = 1/1000 = 0.001

- Probability of melanoma not occurring

  (1-p) = 1 – p = 0.999

- Odds of melanoma occurring is p/1-p = 0.001/0.999 = 0.001

Odds ratio used in **case-control** and sometimes in **cross-sectional** studies

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- Range: 0 to + ∞

- **OR** = 1:<u>No association</u>, no relationship

- **OR > 1**: <u>Positive association</u>, direct relationship, disease is more likely in exposed than in non-exposed-possible risk factor

- **OR < 1**: <u>Negative association</u>, indirect relationship, disease is less likely in exposed than in non-exposed-possible protective factor

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$$= \frac{\text{Odds of disease in exposed}}{\text{Odds of disease in non-exposed}}$$

$$= \frac{\{a/(a+b)\}/\{b/(a+b)\}}{\{c/(c+d)\}/\{d/(c+d)\}}$$

$$= \frac{a/b}{c/d} = \frac{ad}{bc}$$

Myocardial Infarction (Dead Muscle) Appears Red on Surface of Left Ventricle (LV), and Yellow when Heart is Sliced to View Muscle Wall

Right Ventricle (RV)

course of Coronary Artery

LV

Slice

LV Cavity

RV

1 inch

2.54 cm

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Exposure	Myocardial Infarction					
	Present		Absent		Total	
Smoke	100	a	900	b	1000	a+b
Do not smoke	25	c	975	d	1000	c+d
Total	125	a+c	1875	b+d	2000	

- Disease odds ratio: odds of MI in smokers/odds of MI in non-smokers

  = (a/b)/(c/d) = (100/900)/(25/975) = 4.3

- Is there an association between smoking and MI? How strong? Positive or negative

- Is smoking a risk factor or a protective factor?

There is a positive association between smoking and MI. Smokers are 4.3 times as likely to have MI compared with non-smokers

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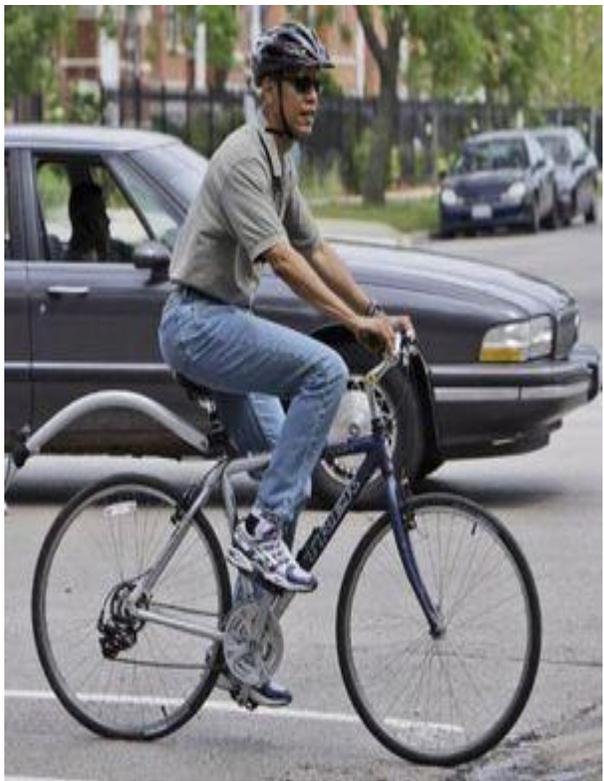
A case–control study of bicycle helmets and head injury

	Cases	Controls	Total
No helmet (exposed)	67	140	207
Wearing a helmet (unexposed)	31	126	157
Total	98	266	364

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History

- Originally, epidemiology focused on a single pathogen, a single cause of disease. The epidemiologist's challenge was to isolate a single bacteria, virus, or parasite.

- As improvements were made in nutrition, housing conditions, sanitation, the water supply, antibiotics, and immunization programs, control of infectious disease was paralleled by the emergence of chronic diseases

Noninfectious Disease

- Noninfectious acute conditions; e.g., accidents, suicide, stroke

- Noninfectious chronic disease; e.g., heart disease, cancer (typically), diabetes
  - **Characterized by latency periods of 10 to 20 or more years**

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Chronic Disease Epidemiology

- Involves the study of the **distribution** and **determinants** of chronic disease and conditions in human populations and the **application of the study for preventing and controlling** chronic health problems

- William Farr promoted the idea that some diseases, especially chronic diseases, have a **multifactorial etiology**

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Top 5 chronic problems

Ischemic heart disease, or coronary artery disease. …

Stroke. …

Cancers …

Chronic obstructive pulmonary disease. …

Trachea, bronchus, and lung cancers. …

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Major risk factors

1- tobacco use.

2- the harmful use of alcohol.

3- raised blood pressure (or hypertension)

4- physical inactivity.

5- raised cholesterol.

6- overweight/obesity.

7- unhealthy diet.

8- raised blood glucose.

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Environment and Chronic Health Problems

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The environment reflects the aggregate of those external conditions and influences affecting the health status of people

- Physical
- Chemical
- Biological
- Social factors that can influence the health status of people

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Example

Table 11-2	Selected Chronic Conditions and Their Environmental Risk Factors
Respiratory	Asbestos, radon, cigarette smoke, glues, carbon monoxide, lead, nitrogen dioxide, ozone, PM_{10}, sulfur dioxide
Dermatologic	Dioxin, nickel, arsenic, mercury, cement (chromium), polychlorinated biphenyls (PCBs), glues, rubber cement
Liver	Carbon tetrachloride, methylene chloride, vinyl chloride
Kidney	Cadmium, lead, mercury, chlorinated hydrocarbon solvents
Cancer	Chemicals, viruses, bacteria, radiation
Cardiovascular	Carbon monoxide, noise, tobacco smoke, physical stress, carbon disulfide, nitrates, methylene chloride
Reproductive	Methylmercury, carbon monoxide, lead, ethylene oxide
Hematologic	Arsenic, benzene, nitrates, radiation
Methemoglobinemia	Benzocaine, dapsone, nitrates
Neuropsychologic	Tetrachloroethylene, mercury, arsenic, toluene, lead, methanol, noise, vinyl chloride
Noise-induced hearing loss	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, x-irradiation)
- Vehicular collisions
- Workplace injuries
- Climate change
- Ozone depletion
- Housing
- Etc.

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Cause Acute and Chronic Conditions

- Radiation exposure can cause severe, intense results such as radiation burn, nausea, fatigue, vomiting, and diarrhea

- On the other hand, several chronic conditions may result from radiation exposure such as damage to the central nervous system and cancer

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Exposure to Radiation

- The **three basic pathways** through which people are exposed to radiation are

  1. Inhalation – breathing radioactive materials into the lungs
  2. Ingestion – swallowing radioactive material
  3. Direct (external) exposure

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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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e.g; Major sources of lead

- Metal processing (52%)
- Non-road engines and vehicles (13%)
- Fuel combustion (13%)
- Waste disposal (16%)
- Other (6%)

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In many places of the world, leaded gasoline poses a major source of lead exposure

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Lead and Health

- Lead can accumulate in various parts of the body (i.e., in the blood, bones, muscles, and fat)

- Infants and children are most sensitive to lead; even low levels, especially before 72 months of life

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Lead and Health

- Lead exposure may damage organs including kidneys, liver, brain and nerves, and other organs

- Leads to osteoporosis, affects the brain and nerves, which can cause seizures, mental retardation, behavioral disorders, memory problems, and mood changes

- Affect the heart and blood, such as causing high blood pressure and increased heart disease or anemia

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Toxicokinetics

- Study of how a chemical substance enters the body and the course it takes while in the body

- The processes of toxicokinetics are
  - Absorption (entrance of the substance into the body), distribution (movement of the substance from where it enters the body to other sites in the body such as liver, blood and lymph circulation, kidney, and lungs)

  - Biotransformation (transformation produced by the body of the substance into new chemicals)

  - Excretion (ejection of the substance or metabolites from the body)

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Example

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.

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Biologic Agents and Health
Cancer

Table 11-4	Viruses and Cancer
Virus	**Type of Cancer**
Epstein-Barr virus	Burkitt's lymphoma
Human papillomavirus (HPV)	Cancers of the cervix, anus, vagina, vulva, penis, orophayrnx
Hepatitis B and C viruses	Liver cancer
Human T-cell lymphotrophic virus	Adult T-cell leukemia
Kaposi's sarcoma-associated Herpes virus	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.

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Helicobacter pylori

- A **bacterium** that can cause chronic conditions such as

  - Dyspepsia – heartburn, bloating, and nausea
  - Gastritis – stomach inflammation
  - Ulcers in the stomach and duodenum, as well as stomach cancer and lymphoma

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

Behaviour 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

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Smoking and Chronic Disease

- **Cancer** – lip and oropharyngeal cancer, esophageal cancer, stomach cancer, anal cancer, pancreatic cancer, laryngeal cancer, lung cancer, cervical cancer, vulvar cancer, penile cancer, bladder cancer, renal cancer

- Ischemic heart disease, pulmonary circulatory disease, cardiac dysrhythmias, heart failure, stroke, arterial disease, pneumonia and influenza, chronic obstructive pulmonary disease, ulcers, Crohn's disease, ulcerative colitis, pregnancy complications, stillbirths, neonatal conditions, sudden infant death syndrome, and accidents by fire and flames

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Body Weight and Chronic Disease

Several health complications associated with excessive weight

- High blood pressure
- Stroke
- Heart disease
- Diabetes mellitus
- Osteoarthritis
- Impaired functioning of the heart and lungs

- Gallbladder disease
- Hyper-lipidemia
- Obstructive sleep apnea
- Injuries
- Cancer (e.g., colon, rectum, breast)

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Prevention and Control

- With shift from infectious acute diseases to noninfectious chronic diseases globally, public health prevention and control efforts have also changed emphasis

- As **risk factors** for disease are identified and the extent of these risk factors made known through epidemiologic study, the potential for effective prevention and control efforts exist

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Selected Disease Prevention Behaviors

- Maintaining a healthy weight
- Eating no more than two or three servings of red meat per week
- Taking a multivitamin with folate every day
- Eating five or more servings of fruits and vegetables per day
- Eating more high fiber foods, such as whole grains, wheat cereals, bread, and pasta

Selected Disease Prevention Behaviors

- Including cruciferous vegetables in the diet (e.g., broccoli, cabbage, etc.)
- Not smoking
- Getting adequate sleep
- Protecting one's self from the sun
- Avoiding certain workplace exposures
- Exercising regularly

Heredity and Chronic Health Problems

What influence does heredity play in cancer?

10-20%

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Breast Cancer Risk Factors

- Risk increases with age
- Mammography – most effective method of screening
- Treatable if detected early

Risk factors include

- Family history of breast cancer (explains 5-10% of cases)
- History of certain benign breast diseases
- Early age of menarche
- Late age of menopause
- Exposure to ionizing radiation
- Obesity

- Being white
- Having the first child at a late age
- Not breastfeeding
- Nodular densities on a mammogram
- Higher socioeconomic status

Multifactorial etiology in chronic disease epidemiology

Prevention and control of noninfectious diseases and conditions is often much more complicated than that of infectious diseases

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Complexities of Prevention Programs

- 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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Disease Prevention and Control

Priorities in disease prevention and control may be determined by the following questions

- **Which disease, disorder, or condition has the greatest impact** on illness, disability, injury, lost work time or school time, unnecessarily using up health resources, rehabilitation costs, causing family disruption, economic impact, and costs?
- **Are special populations or groups of people suffering** from exposures to diseases, agents, risk factors, or hazards?
- **Which susceptible populations are most likely to respond** to prevention, intervention, and control measures?
- **Which risk factors**, diseases, agents, or hazards are most likely to respond to control measures?

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Disease Prevention and Control

(*questions continued*)

- Are there diseases, disabilities, injuries, disorders, or **conditions that need to be investigated, that are being overlooked**, or are not being responded to by other organizations or agencies?

- Of the many risk factors, diseases, agents or hazards, **which would yield the greatest improved health status, social impact, and economic benefit to the target population?**

- Of the many risk factors, diseases, agents, or hazards, **which are of national, regional, state, or local concern and of major priority for an epidemiological investigation?**

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