Table of Content

1. Introduction to Public Health

Public health is a field for people who care about the greater good of human beings. If that sounds self-important, consider this: Millions of people are alive today thanks to a handful of public health initiatives, such as vaccination programs, motor vehicle safety laws, restrictions on the use of tobacco, family planning, and clean air and water standards.

The field of public health is constantly evolving in response to the needs of communities and populations around the world. The underlying mission of public health is to improve the conditions and behaviors that affect health so that all people can attain it. That mission includes not only the practice of public health policy, but the research of public health issues and the education of future leaders who eventually will translate that research into practices and policies to improve the health of people regionally, nationally, and globally.

Public health...

- has a real and lasting positive effect on people.
- helps promote a healthy environment.
- is a moral and ethical imperative.

Importance of Public Health

The work of public health professionals is important because public health initiatives affect people every day in every part of the world. It addresses broad issues that can affect the health and well-being of individuals, families, communities, populations, and societies both now, and for generations to come.

Public health programs help keep people alive. These programs have led to...

- increased life expectancies.
- worldwide reductions in infant and child mortality.
- eradication or reduction of many communicable diseases.

Questions commonly addressed about Public Health:

- What is public health?
- What is a public health system?
- Why take a public health approach?

- Can public health make a difference?

What is Public Health?

- "The science and art of preventing disease, prolonging life and promoting health and efficiency through organized community efforts" (Winslow, 1920).
- "Fulfilling society's interest in assuring conditions in which people can be healthy" (IOM report, 1988).

Key terms

- Population health has been defined as "the health outcomes of a group of individuals, including the distribution of such outcomes within the group". It is an approach to health that aims to improve the health of an entire human population.
- Prevention is reserved for those interventions that occur before the initial onset of disorder.

Vision of Public Health

Healthy People in Healthy Communities.

Missions of Public Health

- Promote physical and mental health
- Prevent disease, injury, disability
- Prevents epidemics and the spread of disease
- Protects against environmental hazards
- Responds to disasters and assists communities in recovery
- Prevents injuries
- Promotes healthy behaviors
- Assures the quality and accessibility of health services

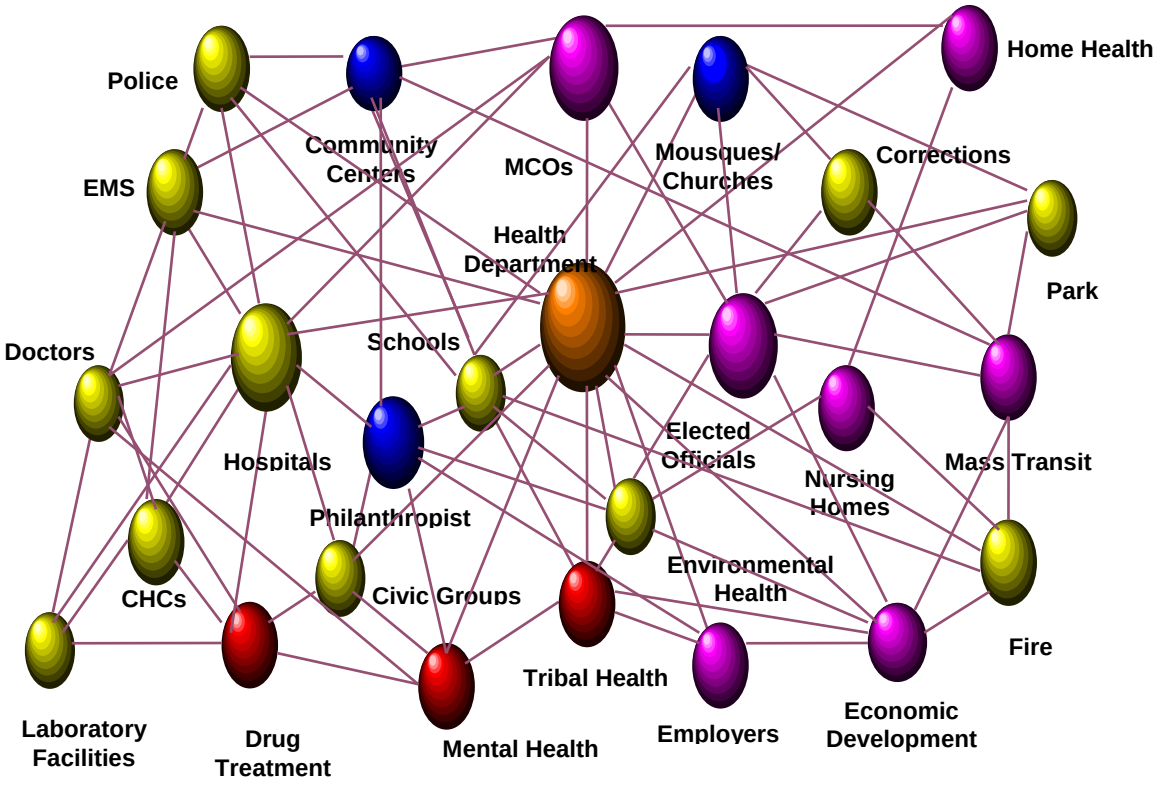
A Public Health System

WHO: All public, private, and voluntary entities that contribute to public health in a given area.

WHAT: A network of entities with differing roles, relationships, and interactions. All entities contribute to the health and well-being of the community.

NOTE: A public health system is more than the public health agency

Network of Public Health System

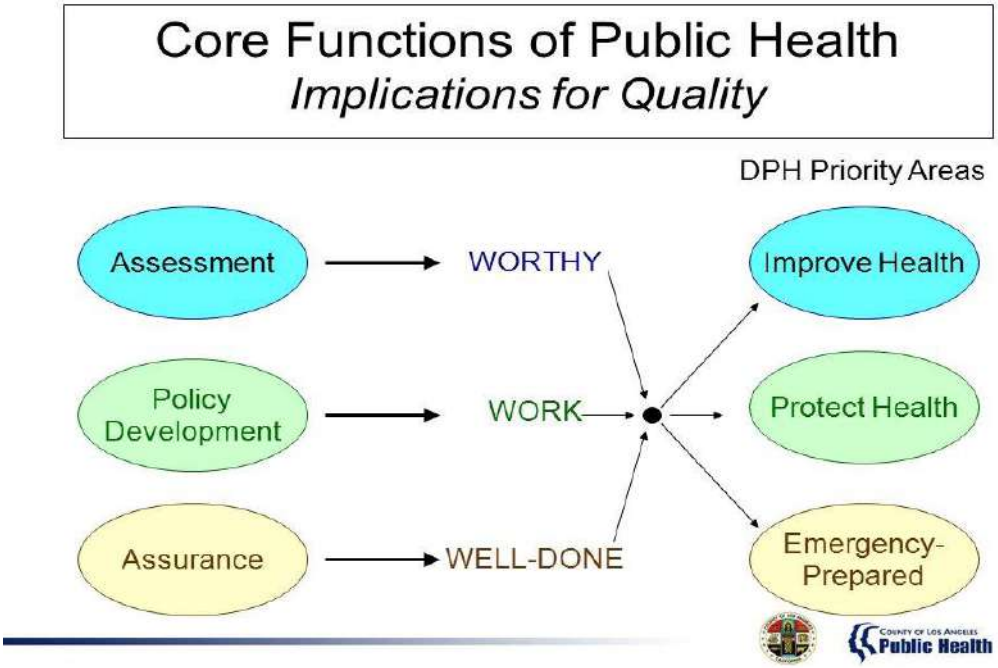


Workforce of Public Health

Public health professionals include, but are not limited to the following:

1. Administrators 2. Biostatisticians 3. Dieticians 4. Environmental health specialists 5. Epidemiologists 6. Health care providers 7. Health communication specialists 8. Health educators	9. Health law experts 10. Labratorians 11. Occupational health specialists 12. Public health nurses 13. Researchers 14. Sanitarians 15. Social scientists 16. Toxicologists 17. Others

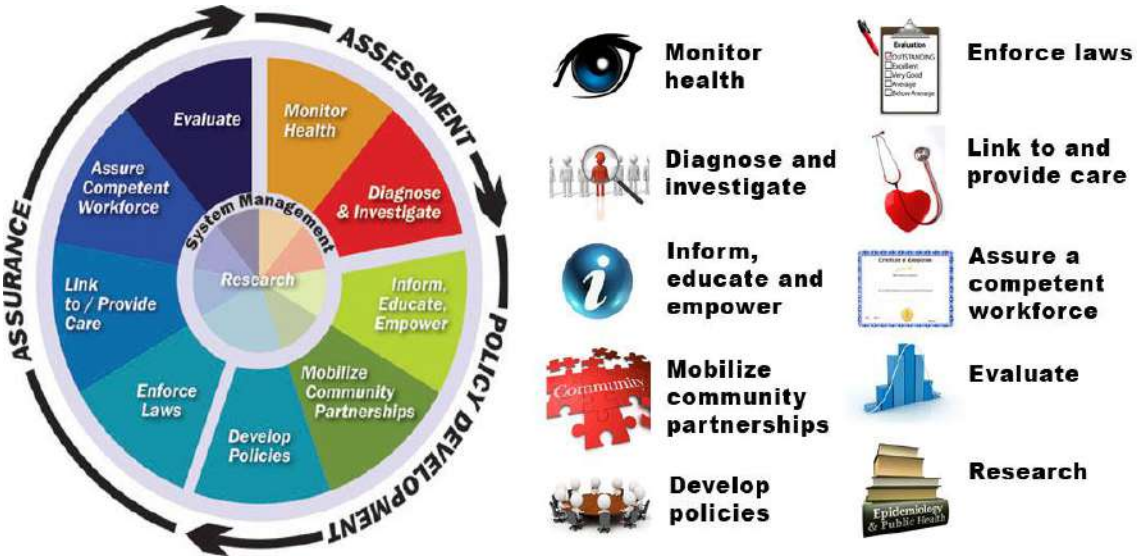
Core Components of Public Health



10 Essential Services of Public Health

1. Monitor health status to identify community health problems.
2. Diagnose and investigate health problems and health hazards in the community.
3. Inform, educate, and empower people about health issues.
4. Mobilize community partnerships to identify and solve health problems.
5. Develop policies and plans that support health efforts.
6. Enforce laws and regulations that protect health and ensure safety.
7. Link people to personnel health services and assure the provision of health care.
8. Assure a competent public health and health care workforce.

9. Evaluate the effectiveness, accessibility, and quality of services.
10. Research for new insights and innovative solutions to health problems.



Core Components &
10 Essential Public Health Services (EPHS)

Core Component	Essential Public Health Service	The EPHS "in English" (CDC)
Assessment	Monitor Health	Understand the health issues at the state and local level
	Diagnosis and Investigate	Identify and respond to public health problems and threats
Policy Development	Inform, Educate, & Empower	Keep people informed about healthy issues and healthy issues
	Mobilize Community Partnerships	Engage people and organizations in health issues
	Develop Policy	Plan and implement sound health policies
Assurance	Enforce Law	Enforce public health laws and regulations
	Link to/Provide Care	Make sure people receive the medical care they need
	Assure Competent Workforce	Maintain a competent public health and medical workforce
	Evaluate	Evaluate and improve programs
	Research	Support innovation and identify and use best practices

2. Public Health Approach

What is Public health?

- **C.E.A. Winslow in 1923** defined Public Health as the science and art of preventing disease, prolonging life, and promoting physical health and efficiency through organized community efforts for the sanitation of the environment, the control of community infections, the education of the individual in principles of personal hygiene, the organization of medical and nursing services for the early diagnosis and preventive treatment disease, and the development of the social machinery which will ensure to every individual in the community a standard of living adequate for the maintenance of health.

- **John M. Last's Dictionary of Public Health (2001) gives the following:**
  Public Health is one of the efforts organized by society to protect, promote, and restore the peoples' health.
- **Public health** is the combination of sciences, skills, and beliefs that is directed to the maintenance and improvement of the health of all the people through collective or social actions.
- The programs, services, and institutions involved emphasize the prevention of disease and the health needs of the population as a whole.
- Public health activities change with changing technology and social values, but the goals remain the same: to reduce the amount of disease, premature death, and disease-produced discomfort and disability in the population.
- Public health is thus a social institution, a discipline, and a practice.

What is Health?

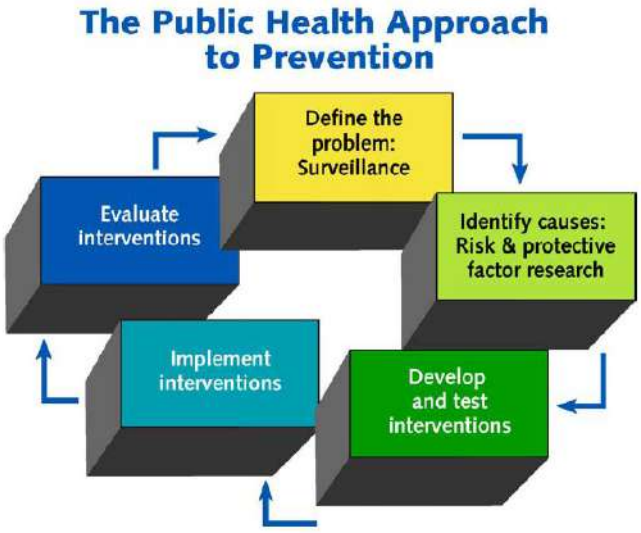
- The absence of Disease or Disability.
- The "complete physical, mental and social well being and not merely the absence of disease or infirmity". (W.H.O.)

Essential Public Health Functions

- Monitor health status to identify community health problems.
- Diagnose and investigate health problems and health hazards in the community.
- Inform, educate, and empower people about health issues.
- Mobilize community partnerships to identify and solve health problems.
- Develop policies and plans that support individual and community health efforts.
- Enforce laws and regulations that protect health and ensure safety.
- Link people to needed personal health services and assure the provision of health care when otherwise unavailable.
- Assure a competent public health care workforce.
- Evaluate effectiveness, accessibility, and quality of personal and population-based health services.
- Research for new insights and innovative solutions to health problems.

Public Health Approaches

- Define the health problem.
- Identify risk factors associated with the problem.
- Develop and test community-level interventions to control or prevent the cause or the problem.
- Implement interventions to improve the health of the population.
- Monitor those interventions to assess their effectiveness.



The potential for prevention or control frequently requires:

Public Health Approach of Prevention

Requires the collection, analysis, and interpretation of data to define the problem and outline:

- What?
- Where?
- When?
- Who?
- How

Requires a determination of:

- Preventable or not preventable
- Controllable or not controllable
- Priority

The potential for prevention or control frequently requires:

- A plan
- A champion
- A strategy/method
- A method
- The will
- Funding

Do it

- After implementation the cycle begins again, but this time to evaluate the program results.
- Did the strategy work as intended?
- If yes, can you expand or replicate the program?

Public VS Medical

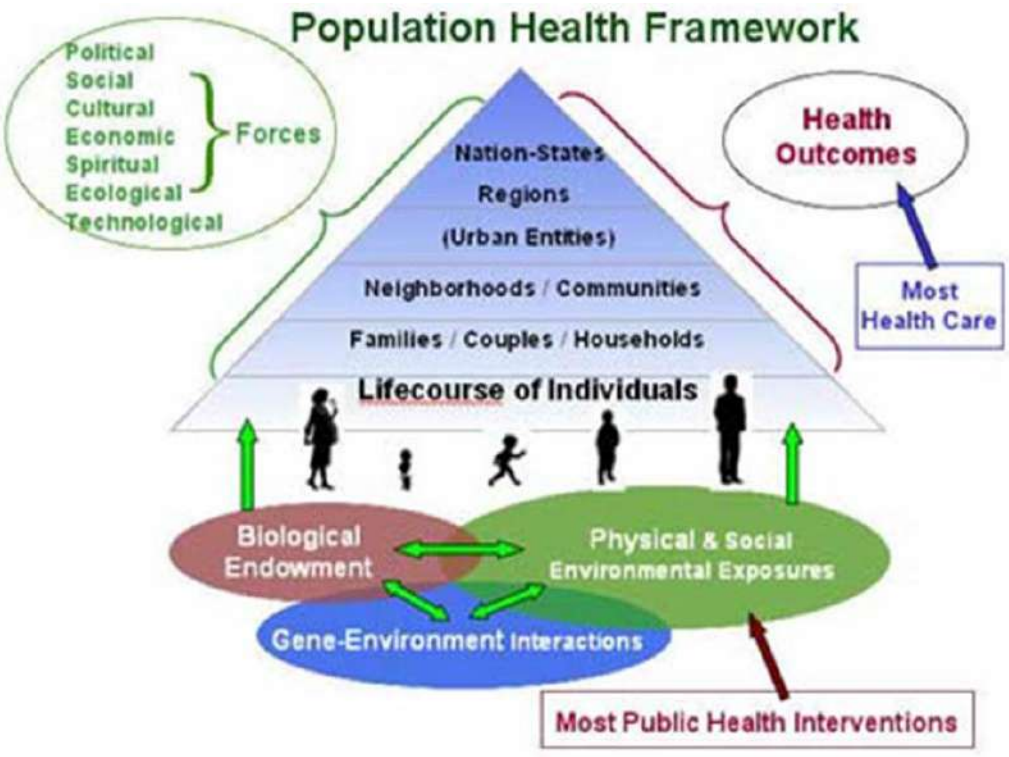
1. Public Health Approach Public Health Model

Population, Disease Prevention, Health Promotion, Interventions Environment Human behavior, Government (Some private)

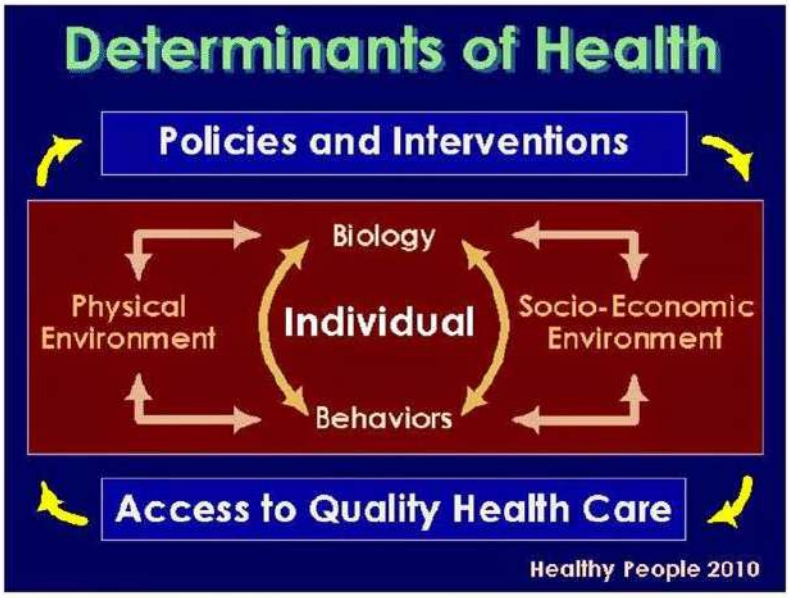
2. Medical Model

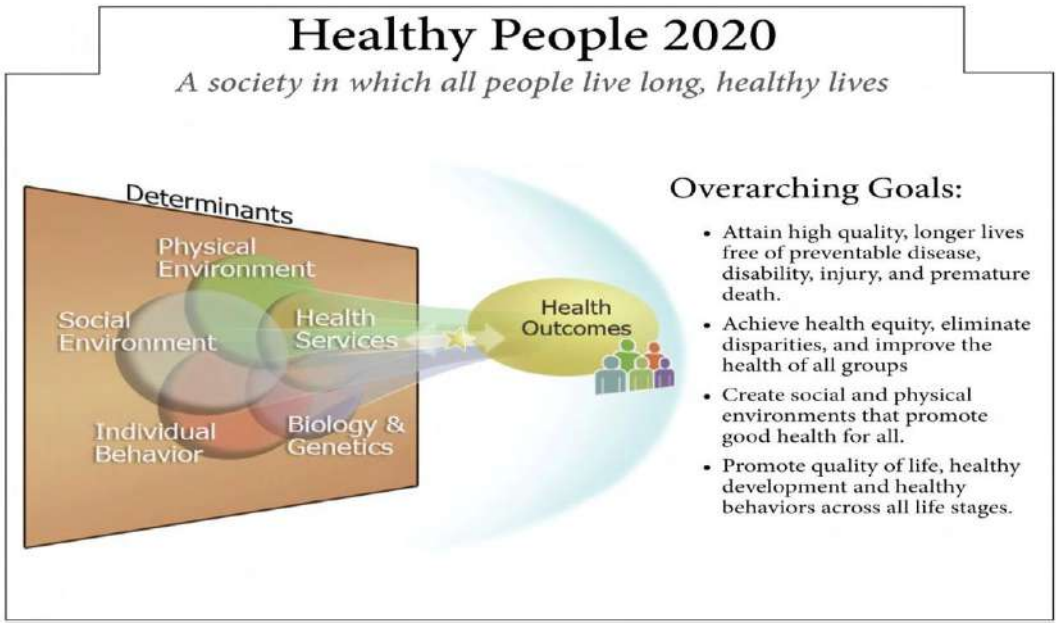
Individual , Diagnosis , Treatment, Intervention Medical care, Private (Some publi

Determinants of Health




Income and social status
Social support networks
Employment and working conditions
Physical environments
Education
Healthy child development
Biology and genetic endowment
Health services
Personal health practices and coping skills
Determinants of Health


Determinants of Health
Policies and Interventions
Biology
Physical Environment
Individual
Socio-Economic Environment
Behaviors
Access to Quality Health Care
Healthy People 2010



Achievements of Public Health

- Vaccination
- Safer Workplaces
- Safer & Healthier Food
- Motor Vehicle Safety
- Recognition of Tobacco Use as a Health Hazard
- Healthier Mothers and Babies
- Fluoridation of Drinking Water

3. Demography in Public Health

Demography is the scientific study of human population.

- Demography statistics is a very important information for any country.
- It describes the size population, its changes –increase or decrease- and its population and gender.
- It helps in planning and implementing short term and long term health programs for the community.
- Before we plan any health intervention or programmes for the community we should know the size and composition of the community.
- We also need to know the changes that will occur to the size and composition to the population.

Demography studies 3 aspects of a population

1. Changes in population size
2. Composition of population
3. Distribution of population in place

Demographic processes

The demographic processes that determine the size, composition and distribution of a population are:

- Fertility, Mortality, Marriage, Migration , and Social mobility

Sources of Demographic information

- Population census
- Vital statistics
- Migration
- Census- Census describes the population in the static stage
- Vital Statistics and Migration information gives the changes occurring to the population.

<u>Population Census</u>

- Population census is the total process of collecting, compiling and publishing of demographic, economic and social data pertaining to a specified time of all persons in a community.

Methods of conducting population census

- De facto method: In this method the total population of persons actually present in the area on the day of census is taken.
- De jure metho: In this method the total population of people is taken on the basis of their permanent residence.

Age pyramid

- Is a graphical representation of the population in various age groups of both sexes
- Age pyramid of Palestine has a broad base and a tapering top
- Broad base is due to the large population of children
- Narrow top is due to small population of elderly.

Median age

- Median age of population is that age which divides the population into two equal parts.
- The median age in developed countries like US and UK is higher than 30 years.
- The median age in Gaza is 18, compared with a world average of 28. In most European countries it's about 40, and it is 30 in Israel. Only in a dozen or so African countries is the median age lower, reaching 15 in Uganda.

Demographic characteristics of Palestinian Population

- Family size

– The average household size in the Palestinian Territory is 5.6 persons in 2012 compared with 6.4 in 1997: 5.3 persons in the West Bank and 6.1 persons in Gaza Strip.

- Education status – Literacy:
  - definition: age 15 and over can read and write
  - total population: 95.3%
  - male: 97.9%
  - female: 92.6%
  - note: estimates are for the Palestinian Territories

- Population density

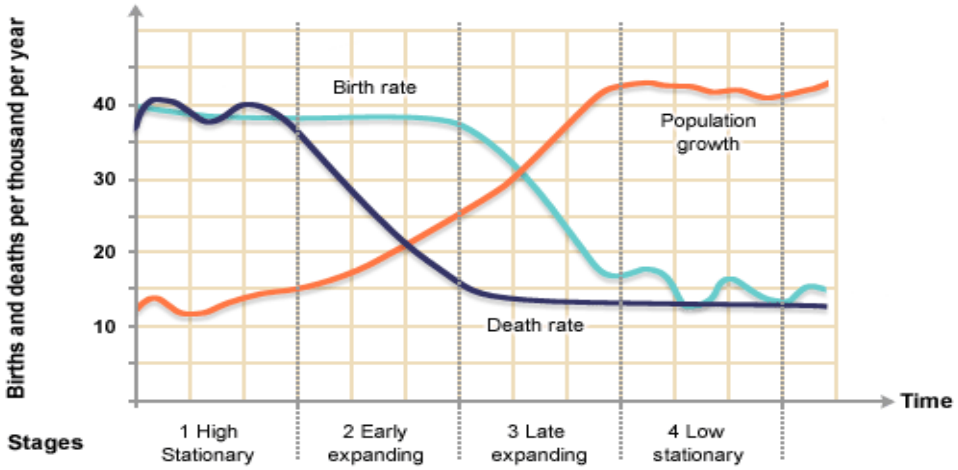
– Population density of Palestine is generally high at 756 persons/km2, particularly in Gaza Strip it is 4,822 persons/km2 compared to a lower population density in the West Bank of 493 persons/km2 at mid 2014.

– Population Density in Manila, Philippines is 42,857 persons/km2 "The Highest population density in the World"

– Population Density in Cairo, Egypt is 18,071 persons/km2.

Demographic Transition Model

The changes in these rates and the effect on population can be shown on the Demographic Transition Model (Population Cycle) - see diagram below:



This can be divided into four, and possibly five, stages:

Stage 1 - High Stationary

Birth Rate and Death rate are both high. Population growth is slow and fluctuating.

Reasons

Birth Rate is high as a result of:

- Lack of family planning
- High Infant Mortality Rate
- Need for workers in agriculture
- Religious beliefs

Death Rate is high because of:

- High levels of disease
- Famine
- Lack of clean water and sanitation
- Lack of health care
- War
- Competition for food from predators such as rats

Typical of Britain in the 18th century and the Least Economically Developed Countries (LEDC's) today.

Stage 2 - Early Expanding

Birth Rate remains high. Death Rate is falling. Population begins to rise steadily.

Reasons

Death Rate is falling as a result of:

- Improved health care (e.g. Smallpox Vaccine)
- Improved Hygiene (Water for drinking boiled)
- Improved sanitation
- Improved food production and storage
- Improved transport for food

- Decreased Infant Mortality Rates

Typical of Britain in 19th century; Bangladesh; Nigeria

Stage 3 - Late Expanding

Birth Rate starts to fall. Death Rate continues to fall. Population rising.

Reasons:

- Family planning available
- Lower Infant Mortality Rate
- Increased mechanization reduces need for workers.
- Increased standard of living
- Changing status of women

Typical of Britain in late 19th and early 20th century; China; Brazil

Stage 4 - Low Stationary

Birth Rate and Death Rate both low. Population steady. Typical of USA; Sweden; Japan; Britain

Stage 5 - Declining Population

Birth Rate remains low. Death rate begins to rise slightly, resulting in a declining population

Death rate rises slightly due to lifestyle choices such as a poor diet and smoking

Examples: Germany, Scotland

The Infant Mortality Rate is the number of children who die before their first birthday.

These changes are reflected in the population structure.

World population

- Total population of the world about 2000 years ago was 250 million.
- In 1800 the world population became 1000 million (1 billion).
- In 1987 the world population became 5 billion.
- In 1999 the world population became 6 billion.
- Expected to become 8 billion by 2025.
- About ¾th of world population lives in the developing countries.
- China and India are the two most populous countries in the world.
- The world population growth rate was at the peak in 1970.
- About 95% of the population growth is occurring in the developing countries.

Life expectancy

- Life expectancy is the average number of years which a person of a particular age may expect to live.

- It is one of the best indicators of a country's level of development and overall health status.
- The life expectancy of people all over the world has been increasing.

Life expectancy at birth

- In most countries the life expectancy of women is more than that of men.
- In Monaco is 89.52 years (2015) "The Highest in the World"
- In Japan is 84.74 years (2015)
- In Israel is 81.38 years (2015)
- In Jordan is 81 years (2015)
- In USA is 75.90 52 years (2015) ♀ 80 years & ♂ 76 years
- In Palestine is 75.01 years (2015), ♂ 72.97 years & ♀ 77.17 years
- In Egypt is 73.7 years (2015)
- In South Africa is 49.72 years (2015) "The Lowest in the World"

Fertility

- Fertility – Is the actual bearing of children by a woman.
- The reproductive age of a woman is between 15 – 45 years.
- Some factors affecting fertility are:
  - Age at marriage
  - Duration of married life
  - Spacing of children
  - Education
  - Socioeconomic status
- Birth rate =

$$\frac{\text{Number of live births during the year}}{\text{Estimated mid-year population}} \times 1000$$

- Growth rate = Crude birth rate – Crude death rate

The Palestinian Central Bureau of Statistics (PCBS) presents the following information about Palestinians at the end of 2014, There is an increase in population of Palestinian in the world.

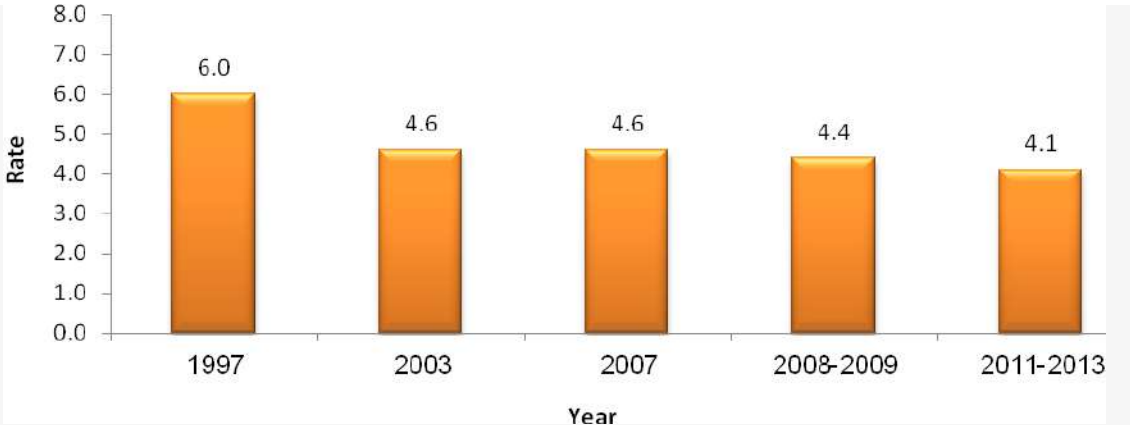
- The projected number of Palestinians in the world is 12.10 million, of whom 4.62 million are in State of Palestine, 1.46 million in Israel, 5.34 million in Arab countries and around 675 thousand in foreign countries.
- More than one-third of population in Gaza Strip.

- The projected number of Palestinians living in State of Palestine at the end of 2014 is 4.62 million: around 2.83 million reside in the West Bank and 1.79 million in Gaza Strip. Palestinian refugees make up 43.1% of the Palestinian population in Palestine: 38.8% of them in the West Bank and 61.2% in Gaza Strip.

Decline in fertility rate

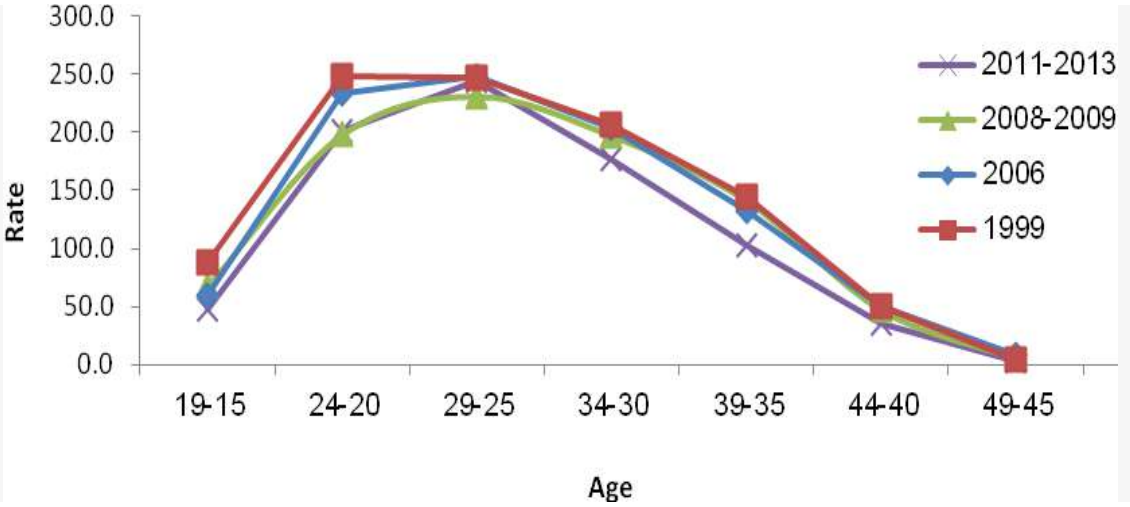
The total fertility rate declined during 2011-2013 to 4.1 births compared with 6.0 births in 1997. In Gaza Strip the rate was 4.5 births compared to 3.7 births in the West Bank during 2011-2013.

Total Fertility Rate in State of Palestine, Selected Years



There has been a decline in the specific fertility rate, particularly in the early reproductive years (15-24 years).

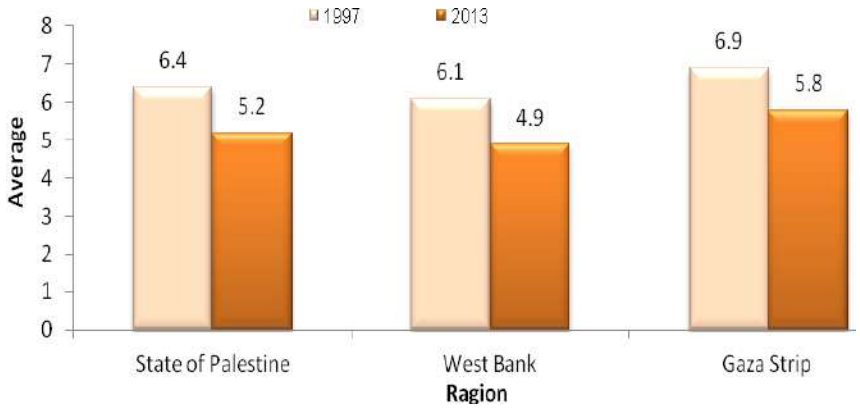
Age-Specific Fertility Rates in State of Palestine, Selected Years



Decrease in average household size

The average household size in Palestine was 5.2 persons in 2013 compared to 6.4 in 1997: 4.9 persons in the West Bank and 5.8 persons in Gaza Strip.

Average Household Size in State of Palestine by Region, 1997, 2013



Decreasing crude birth and death rate

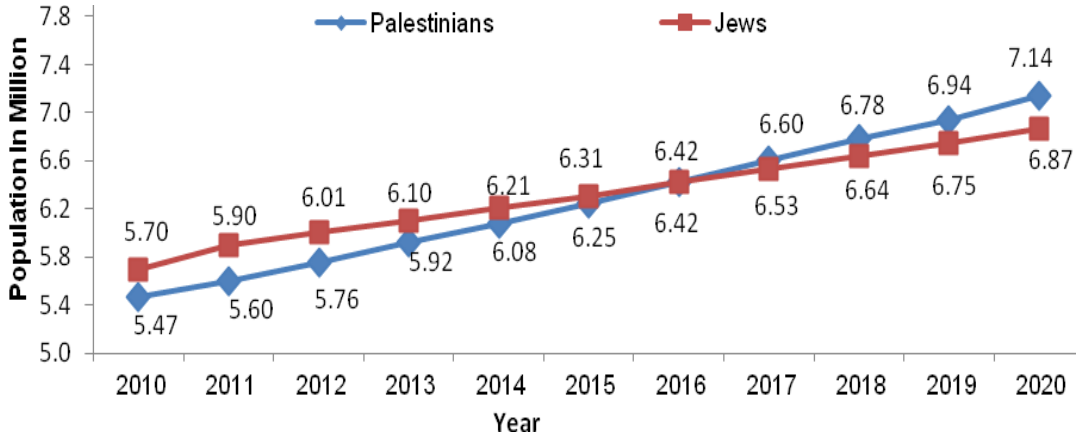
- The crude birth rate is 32.3 births for every 1000 of population: 29.4 in the West Bank compared to 36.8 in Gaza Strip. The rate is expected to decline to 29.0 by 2020. The crude death rate is 3.7 deaths for every 1000 of population: 3.8 in the West Bank compared to 3.5 in Gaza Strip. The rate is expected to decline to 3.4 by 2020.
- High fertility rate among Palestinians in Jordan
- The total fertility rate for Palestinian woman living in Jordan was 3.3 births in 2010 compared to 2.5 in Syria in 2010 and 2.8 in Lebanon in 2011.

Selected Demographic Indicators by Country of Residence, Selected Years

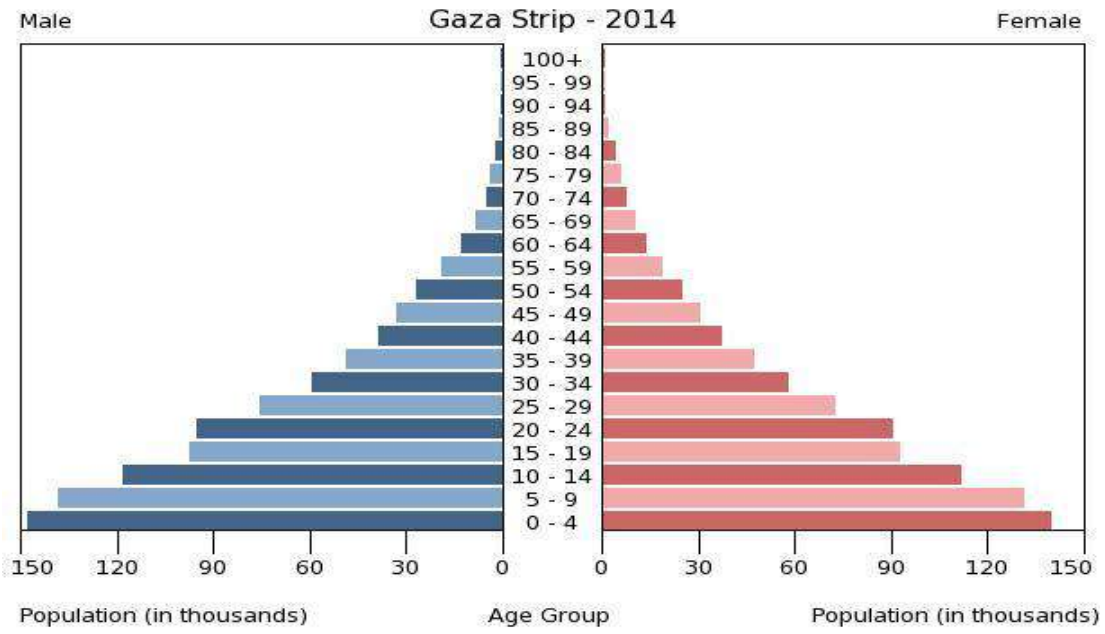
Country of Residence	Average Household Size	Total Fertility Rate
Jordan *	4.8	3.3
Syria *	٤.١	٢.٥
Lebanon**	4.4	2.8

- The youthful Palestinian population in Israel
- The number of Palestinians living in Israel is 1.46 million, of whom about 35.4% are aged below 15 years compared to 4.3% aged 65 years and over.
- Higher fertility rate among Palestinians in Israel than among Jews
- The total fertility rate in 2013 among Palestinian women living in Israel was 3.4 births compared to 3.1 births among women Jews. The average Palestinian household size in Israel is 4.8 persons. The crude birth rate of Palestinians in Israel exceeded 23.5 births for every 1000 of population.
- The number of Palestinians in historical Palestine will exceed the number of Jews over time
- The number of Palestinians in historical Palestine totaled 6.08 million at the end of 2014. There were 6.10 million Jews at the end of 2013 according to estimates by the Israeli Central Bureau of Statistics and the number is expected to reach 6.21 million Jews by the end of 2014.
- The number of Palestinians and Jews will total about 6.42 million each by the end of 2016 provided that current growth rates remain constant. However, the number of Palestinians in historical Palestine will total 7.14 million compared to 6.87 million Jews by the end of 2020.

Number of Palestinian and Jews living in Historical Palestine



- Population in the Gaza Strip: 1,816,379



Age Structure of Population in the Gaza Strip:

- 0-14 years: 43.2% (male 402,848/female 381,155)
- 15-24 years: 20.6% (male 191,710/female 182,405)
- 25-54 years: 30.1% (male 280,551/female 266,756)
- 55-64 years: 3.5% (male 31,711/female 31,515)
- 65 years and over: 2.6% (male 19,617/female 28,111)

Sex ratio:

- at birth: 1.06 male(s)/female
- 0-14 years: 1.06 male(s)/female
- 15-24 years: 1.05 male(s)/female
- 25-54 years: 1.05 male(s)/female
- 55-64 years: 1.04 male(s)/female
- 65 years and over: 0.68 male(s)/female
- total population: 1.04 male(s)/female

4. Health Indicators

Quantifiable characteristics of specific populations which researcher use as supporting evidence for describing the health of a population are called **Health indicators**. Health indicators which used to measure health of a community.

- Health indicators which used to measure health of a community.
- Health indicators can be used to compare health of two communities.
- It can be used to assess the health needs of a community.
- It is useful for monitoring and evaluation of health programs.

Qualities of an 'indicator'

- Validity – The indicator should measure what it is supposed to measure.
- Reliability – It should give the same value when measured by different people.
- Sensitivity – It should show the changes in the situation.

Health indicators

- Mortality indicators
- Morbidity indicators
- Disability rates
- Nutritional status indicators
- Health care delivery indicators
- Socio-economic indicators
- Indicators of quality of life

Health Indicators in Palestine (1997-2002)

1	Indicator	2002	2000	1997
2	Population Growth Rate	3.7%	3%	3.1%
3	Crude Birth Rate	27.2/1000	33.2/1000	34.5/1000
4	Crude Death Rate	3.1/1000 birth	3.2 / 1000 birth	3.5
5	Life Expectancy Rate	71.9	71.8	71.5
6	Infant Mortality Rate	23.3	22.7 /1000 birth	24
7	Maternal Mortality Rate (per 100,000)	13.8 (reported)	37.3 (reported)	77(Estimated)
8	Total Fertility Rate	4.31	4.31	5.58

Mortality indicators

- Crude death rate
- Specific death rate
- Case fatality rate
- Expectation of life
- Infant mortality rate
- Maternal mortality rate

1. **Crude death rate** : 'is the number of deaths (from all causes) per 1000 estimated mid-year population in one year, in a given place'

$$\frac{\text{Number of deaths during a year}}{\text{Mid-year population}} \times 1000$$

2. **Specific death rate** : Is the death rate due to a specific disease, or in a specific age or sex group etc.

$$\frac{\text{Number of deaths due to Tuberculosis during a year}}{\text{Mid-year population}} \times 1000$$

Example: Specific death rate due to Tuberculosis

3. Case fatality rate

- It is the number of people dying due to a specific disease.
- It shows the severity of the disease

$$\frac{\text{Number of deaths due to a disease}}{\text{Total number of cases due to the disease}} \times 100$$

4. Infant Mortality Rate (IMR)

- Number of infant deaths in a year per 1000 live births

$$\frac{\text{Number of deaths of children less than 1 year of age in a year}}{\text{Number of live births in the same year}} \times 1000$$

Measurements of Morbidity

- Incidence
- Prevalence

1. Incidence

- There are 500 new cases of Hepatitis in a city with a population of 30,000 in 2008
- Incidence of hepatitis =

$$\frac{500}{30{,}000} \times 1000 = 16.7 \text{ per 1000 per year}$$

- The Incidence rate MUST contain the time period

2. Prevalence

- Prevalence is defined as all cases (old and new) present at a given point of time or a period of time in a given population.
- Prevalence is of <u>two types</u>:
  - Point prevalence
  - Period prevalence

Point Prevalence

- Point prevalence refers to the total number of cases (old and new) present at given point of time, usually a day.
- Prevalence of Cutaneous leishmaniasis in a city <u>on</u> 5th May, 2009
- Normally when we say prevalence it is <u>Point Prevalence</u>

- Is the total number of cases (old and new) existing during a defined period of time in a defined population.
- Prevalence of Pulmonary Tuberculosis in a city in year 2008.

Physical Quality of Life Index

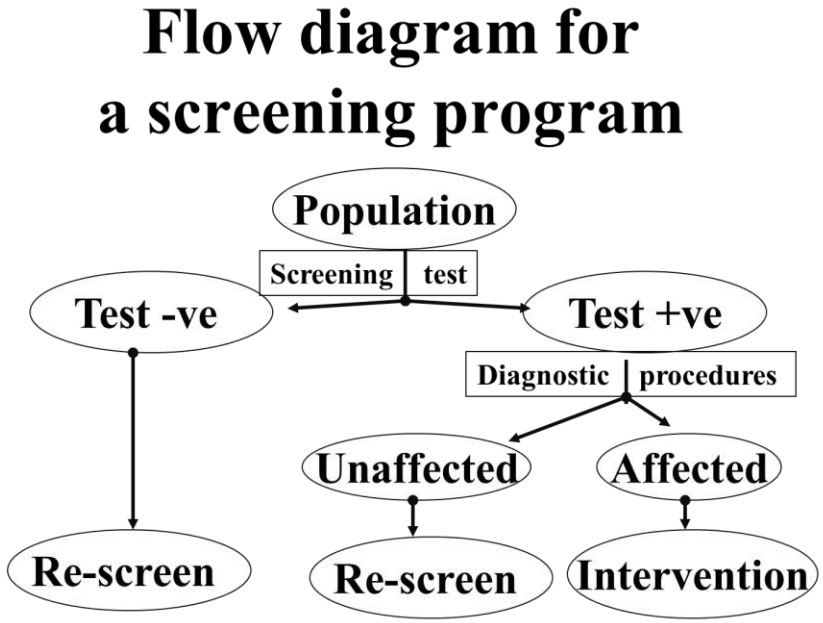
- Quality of life is difficult to define and measure.
- One method is to combine three indicators – Infant Mortality rate, Life expectancy at 1 year of age and Literacy
- The index is calculated for each country
- The maximum is 100 and minimum 0

Human Development Index

- Human Development Index is calculated from Longevity (life expectancy at birth), Knowledge (adult literacy rate and mean years of schooling) and Income (Gross Domestic Product per capita)
- Maximum is 1 and minimum 0.

5. Screening and Epidemiology

Screening is the testing of apparently healthy populations to identify previously undiagnosed diseases or people at high risk of developing a disease. Screening aims to detect early disease before it becomes symptomatic. It is an important aspect of prevention, but not all diseases are suitable for screening.



The Principles of Screening

- The choice of disease for which to screen;
- The nature of the screening test or tests to be used;
- The availability of a treatment for those found to have the disease;
- The relative costs of the screening.

Types of screening

- Mass
- Multiple or multiphasic
- Targeted
- Case-finding or opportunistic

Factors appropriate for screening

- Important health problem
- High prevalence
- Natural history understood
- Long latent period
- Early detection improves prognosis

Evaluation of a screening program

- Reliability
- Feasibility
- Validity
- Performance
- Effectiveness

Reliability

- Biological variation
- Program method
- Intraobserver variability
- Interobserver variability

Feasibility

- **Acceptability**
  - Quick
  - Easy
  - Safe
- **Cost effectiveness**
  - Screening
  - Diagnosis
  - Follow-up
  - Intervention

Validity

- **Sensitivity:** Probability to test positive among truly affected
- **Specificity:** Probability to test negative among truly unaffected

Performance

- **PV+:-** Probability to be affected among test positives
- **PV-:-** Probability to be unaffected among test negatives
- **PCC:-** Probability to be correctly classified

Effectiveness

- **Outcome measures:**
  - Morbidity
  - Disability
  - Mortality
- **Bias**
  - Patient self-selection
  - Lead time
  - Length

Study designs for screening

1. Correlation Studies

- **Use:** Description of population
- **Strength:** Suggest possibility of benefit
- **Limitation:** Can't test hypothesis

2. Analytical Studies

- **Types:** Case-control and Cohorts
- **Use:** Comparison of rates
- **Advantage:** Test hypothesis
- **Limitation:** Selection, Lead time and length

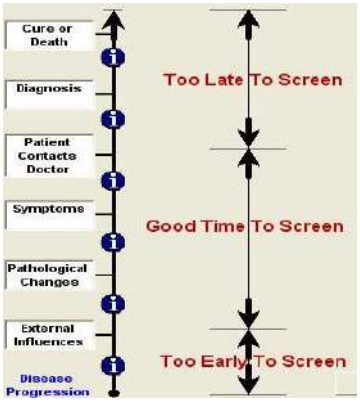
3. Randomized Trials

- **Use:** Comparison of rates
- **Strength:** Most valid test of hypothesis
- **Limitation:** Cost, ethics & feasibility

Disease : The disease must be an important health problem.

- There should be a recognizable latent or early symptomatic stage.
- The natural history of the disease, including latent to declared disease, should be adequately understood.

When to screen for disease?



Test :

- There should be a suitable test or examination.
- The test should be acceptable to the population.
- **Outcomes of a Screening Test**

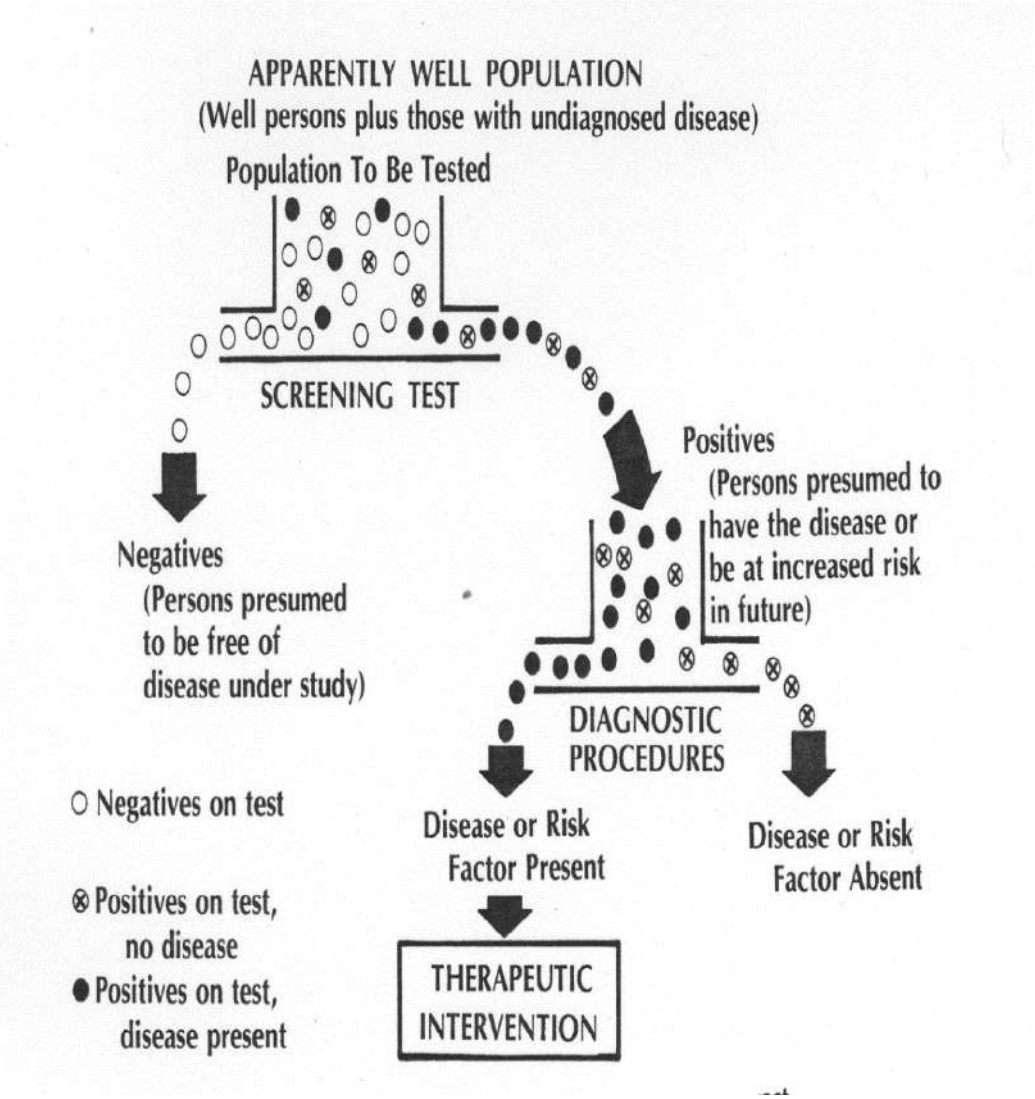
	True Disease Status		
Screening Test	Positive	Negative	Total
Positive	True Positives (TP)	False Positives (FP)	TP+FP
Negative	False Negatives (FN)	True Negatives (TN)	FN+TN
Total	TP+FN	FP+TN	TP+FP+FN+TN

Treatment:

- There should be an acceptable treatment for the patients with recognized disease.
- There should be facilities for diagnosis and treatment should be available.
- There should be an agreed policy on whom to treat as patients.

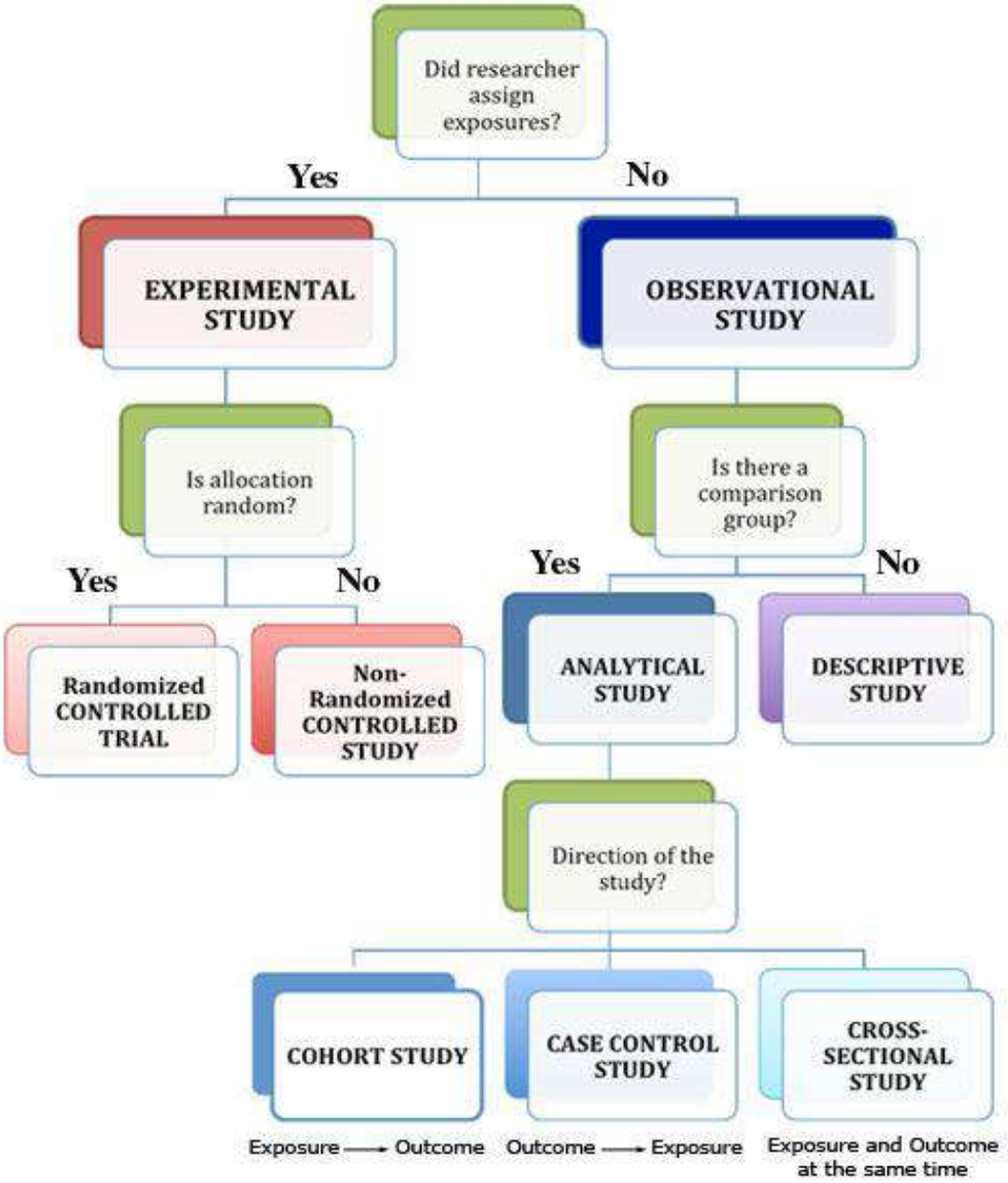
Costs:

- The cost of case finding (including diagnosis and treatment of patients diagnosed) should be economically balanced in relation to possible expenditure on medical care as a whole.


APPARENTLY WELL POPULATION
(Well persons plus those with undiagnosed disease)
Population To Be Tested
SCREENING TEST
Negatives
(Persons presumed to be free of disease under study)
Positives
(Persons presumed to have the disease or be at increased risk in future)
DIAGNOSTIC PROCEDURES
Disease or Risk Factor Present
Disease or Risk Factor Absent
THERAPEUTIC INTERVENTION
○ Negatives on test
⊗ Positives on test, no disease
● Positives on test, disease present

Epidemiology is the study of the distribution and determinants of health-related states. or events (diseases) in specified populations and the application of this study to the control of health problems.

Types of Epidemiological Studies:



Observational Studies: Descriptive & Analytical Types

Observational studies involve no intervention other than asking questions and carrying out medical examinations and simple laboratory tests or X-ray examinations. In epidemiology, observational studies are more common than experimental ones, particularly if an investigator wants to determine whether an agent or exposure causes cancer in humans.

Descriptive Studies

Descriptive studies tend to be simpler and easier to conduct than analytical or experimental studies but they are nonetheless quite important. Descriptive studies can provide the background from which analytical studies emerge. They help to generate hypotheses, as opposed to testing them.

Advantages:

- A large range of outcomes because no subgroups are studied
- A large range of potential predictors again because no subgroups are studied

Disadvantages:

- Not possible to study subgroups
- No control for confounding as data is in aggregate form
- Not able to reproduce/replicate results as data was not collected in an experiment with defined perimeters.

1. Cross-Sectional Comparison Studies: "Am I like my neighbors?"

Cross-sectional studies compare data that are combined from smaller groups as opposed to very large descriptive studies. These studies focus on observations made at only one point in time so they are quickly completed and relatively inexpensive. But they cannot reveal a sequence of events over time since they sample data only once.

Cross-sectional studies often simply compare the rate of a particular cancer in one place versus another place.

2. Correlation (Ecologic) Studies: "What if I am exposed to this?"

Ecologic studies look at diet and cancer at the population level, think of this as the view from 30,000 feet. These types of studies represent a transition to analytical studies since they compare cancer rates of populations in relation to risk factors. They do not include outcome so they aren't considered analytical.

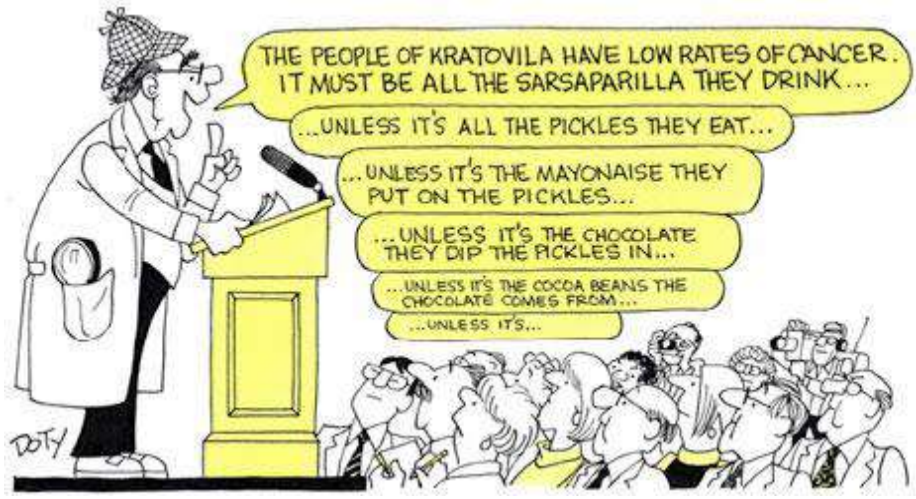
Examples:

- The diet-cancer correlation
- Following populations as they migrate to compare cancer rates

Advantages:

Ecologic studies can provide powerful clues pointing in a particular direction, especially when they compare large populations with different diets.

Disadvantages:



Ecologic studies can't prove cause and effect.

Scientists need more evidence from other studies to help prove the connection that ecologic studies point to.

Analytical Studies

Analytical studies measure both disease-related outcomes and risk factors. The vast majority (>99%) of all epidemiological studies in the medical literature fall into this category. The advantages and disadvantages of these types of studies are the converse of those listed for descriptive studies.

Advantages:

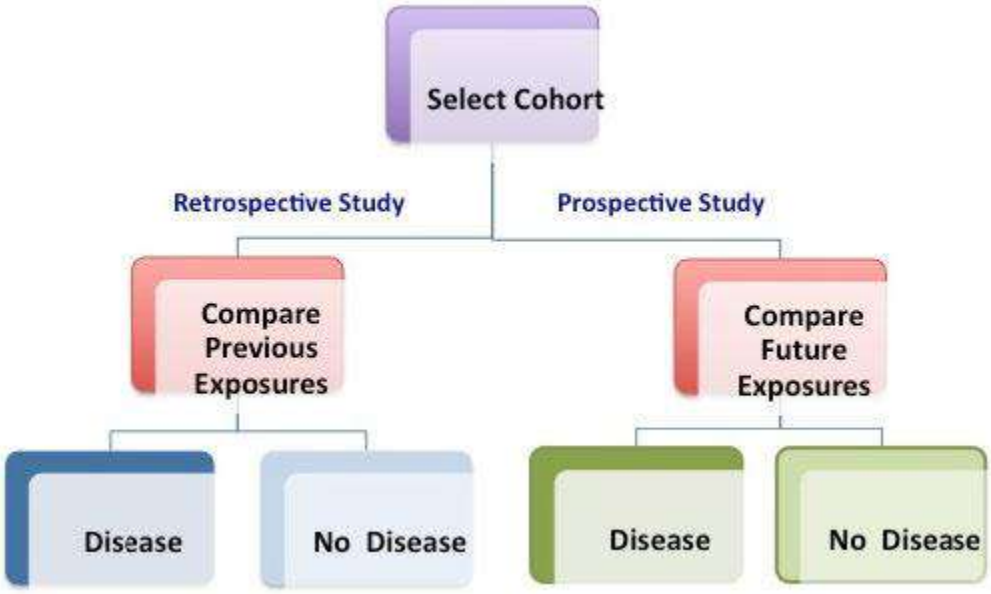
- The ability to focus on subgroups
- The ability to control for confounding
- Possible to reproduce/replicate results

Disadvantages:

- Limited variability in disease rates
- Narrow range of potential predictors

1. Cohort Studies: "What will happen to me"?

In cohort studies investigators compare populations that are assumed to be similar except that they have different exposures to factors of interest (e.g., diet, exercise, sun, asbestos, cigarette smoke), and determine whether or not the prevalence (likelihood) of getting the disease varies with exposure.



- Prospective studies begin prior to the exposure and study the population over time.

An example is the Nurses' Health Study in which thousands of nurses kept records of lifestyle factors that may have been related to disease. Overtime, some of the nurses developed specific diseases, while others didn't.

Epidemiologists then looked at the lifestyle data gathered to determine whether there were any factors that were different among those who did versus did not develop the disease.

- Historical or retrospective studies look back in time for patterns of exposure that may have differed among the groups.

These studies look at groups of people who have or have not developed a disease and compare them. When these studies rely on health or occupational records they can be very useful. However, when they are based on subjects' memories, they may be less reliable.

Advantages:

- Cancer doesn't just suddenly appear in a person. Cohort studies allow researchers to study people over the long period of time that it takes for cancer to develop.
- Cohort studies have an advantage over case-control studies because they ask people to.

Disadvantages:

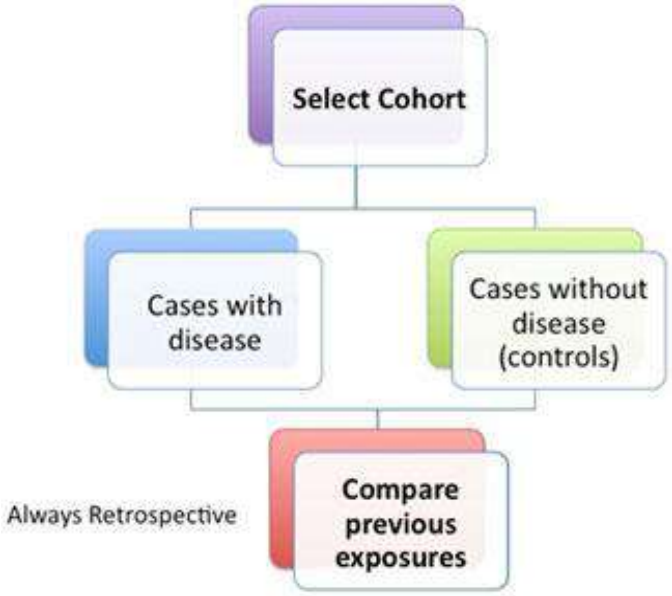
- As in any kind of dietary investigation, cohort studies need to be extremely large and follow participants over a long period of time in order to pack real scientific and statistical punch.
- Keep track of what they're eating while they're still healthy, rather than waiting until they develop cancer and then asking what they ate in the past (pre-diagnosis).
- Many different types of cancer (or other diseases) can be studied using the same cohort.
  Source: American Institute of Cancer Research

2. Case Control Studies: "Why me" study.

In *case control studies* investigators begin with people who have been diagnosed as having a disease (cases) and compare them to people without the disease (controls).

Using data from a variety of sources - personal interviews, medical and hospital records - cases and controls are compared with regard to past exposures in an attempt to identify differentiating factors.

- Similarities with historical cohort studies and Both types of studies take a look backward in time for exposures that may be related to disease.
- Differences with historical cohort studies
- Sample size



- In case-control studies, a relatively small group of cases is identified, and compared to an equal-sized group of matched controls.
- In historical cohort studies, a large cohort is divided among those who do versus do not have the disease.

Advantages of case controlled studies:

With enough subjects in the study and careful selection of controls, case-control studies provide a cost-effective way to study cancer.

Disadvantages:

As in eyewitness testimony in a courtroom, case-control studies depend on our often unreliable memories.

In case-control studies, cases and/or controls may remember their past diets differently. This is called 'recall bias'.

Honesty in reporting is also an issue.

New scientific developments may help avoid this problem. Biomarkers of dietary intake, which act like fingerprints of the foods we eat regularly, can be utilized vs. relying on faulty memories.

"Well, if I recall correctly, on April 17 , 1991, at 6:37 p.m. Eastern Time, I ate 6 ounces of grilled salmon steak, farm raised, 2/3 cup of rice, 1/2 cup steamed broccoli, 1 cup of mixed salad greens with 2 tablespoons of French dressing, a 12 ounce glass of unsweetened iced tea and 3 scoops of Tin Roof ice cream for dessert."

Summary of Analytical Study Designs

Most epidemiological studies are described as "hypothesis generating." That is, they identify trends in the general population that then confirm them in carefully controlled experimental settings.

The choice among the three types of epidemiological studies always reflects a trade-off among the goals (e.g., explore a single disease or multiple diseases) and the constraints (e.g., time and costs).

This chart shows strengths and weaknesses of several types of studies.

	Prospective Cohort	Historical Cohort	Case Control
Strengths	• Time relationships are known • Multiple diseases can be studied • Suitable for rare exposure situations • Presence of disease can be verified	• Multiple diseases can be studied • Relatively inexpensive • Relatively fast	• Good for rare diseases • High drop-out rate • Can be used to study multiple exposures • Relatively inexpensive • Relatively fast
Weaknesses	• Large cohort required • High drop-out • Long time-frame • Most expensive • Definitions of exposure and disease can vary over time	• Large cohort required • Reliance on non-reliable recall and/or historical data of exposure • Comparability of exposed and non-exposed is problematic	• Reliance on non-reliable recall and/or historical data of exposure • Time course can be difficult to verify • Comparability of cases and controls is problematic

Experimental Epidemiology Studies

Experimental (laboratory) studies involve more than observing and gathering data. Scientists make small, defined changes in one or more sets of the test subjects - cells, tissues, animals or people. Then they compare the various outcomes. These studies can be done in two basic ways: in vitro (test tubes) and in vivo (living organisms-mice or people)

In Vitro

In vitro studies are experiments performed in test tubes. These studies help researchers figure out for instance precisely how and why certain foods or food substances might protect against cancer. Seeking clues as to the complicated array of chain reactions that happen after we consume a particular nutrient, researchers examine animal or human cells or tissues removed from the body.

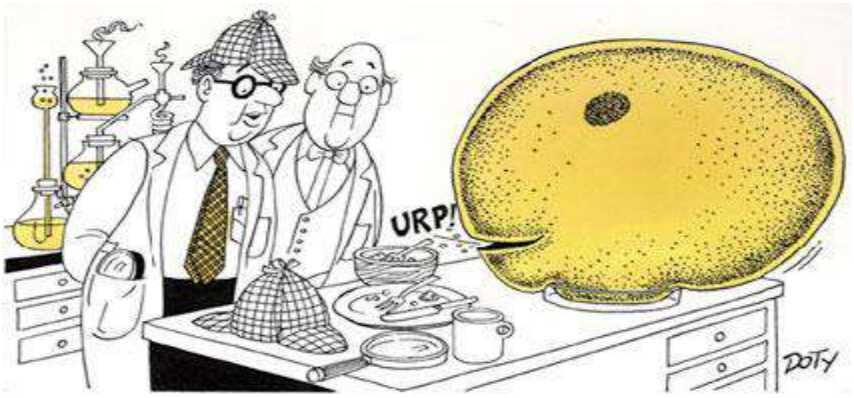
For example, an epidemiological study can suggest that eating green beans protects against cancer. But that's only an association. Using in vitro studies, scientists can look at the chain of events that happens when nutrients and cancer cells meet. Put those two types of studies together, and you're closer to solving the mystery than with either type of study alone.

Advantages:

In vitro studies are tightly structured, which means that scientists can control for many confounding variables. Once an in vitro study finds a "suspect" - a biological mechanism that might protect against or add to your risk of cancer - researchers can then test their hypotheses in an animal model.

Disadvantages:

In vitro studies can't tell us if an anti-cancer effect that happens at the cell level also occurs in the "real world" of the complex human body. In vitro does not mimic physiological conditions of a living organism like a mouse model or human.



"Looks like Carstairs finally got a single cell to eat a whole meal. By the way, have you seen Carstairs lately?"

They also can't tell us how much we might have to eat of any substance to reap anti-cancer benefits, and they can only involve food components, not whole foods, since one can't feed a cell an apple.

In Vivo

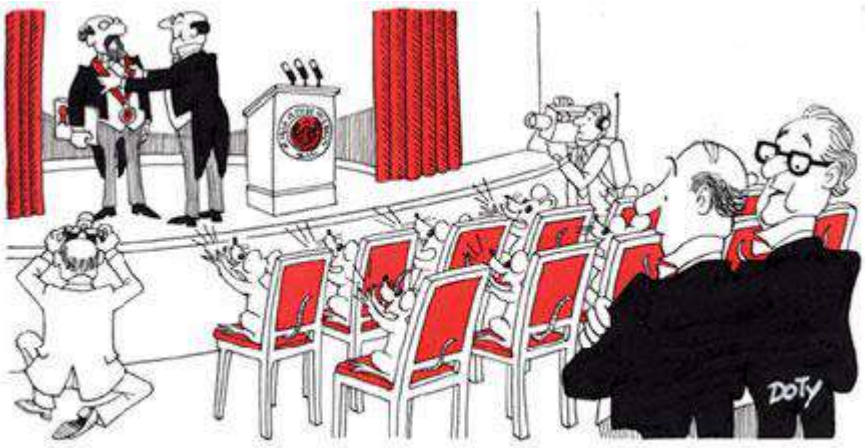
In vivo studies can put hypothesis to the test in complex living organisms. If cell or tissue studies (in vitro) provide evidence that intervention X protects against cancer, an in vivo study can give researchers the next clue.

Advantages:

Testing interventions in animal models allows scientists much stricter control than with humans. Unless they lock you in the lab, you're probably going to eat those Oreos, but a mouse eats what he's fed - so researchers know exactly what's going in and what's going out.

Disadvantages:

Humans aren't mice. While the fast majority of our biological processes are similar - especially the cancer process - many things that happen in mice don't happen the same way in humans, and vice versa.

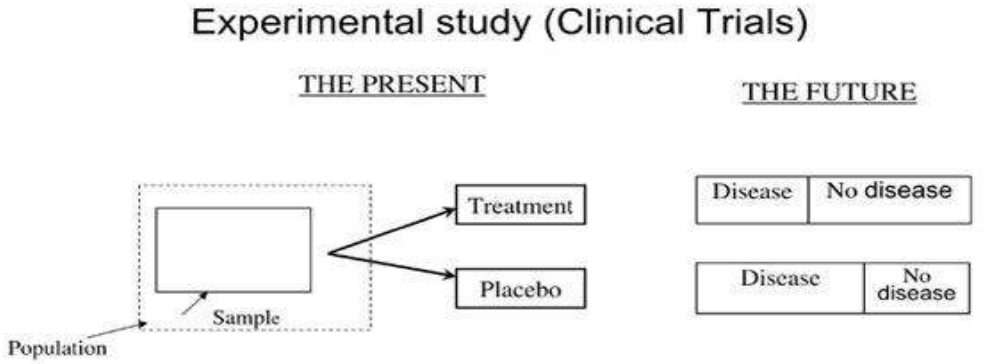


"It's an award for a cancer cure, but it only works on mice."

Image courtesy of American Institute of Cancer Research

Clinical Trials - The next step

If an animal experiment is successful, usually the next usual formal epidemiological experiment is a randomized controlled clinical trial, conducted to test a preventive or therapeutic regimen or diagnostic procedure. In controlled trials, scientists don't just observe what happens to study subjects as they live their lives. Rather, they make specific changes to their lives to see how those changes affect them.



Steps:

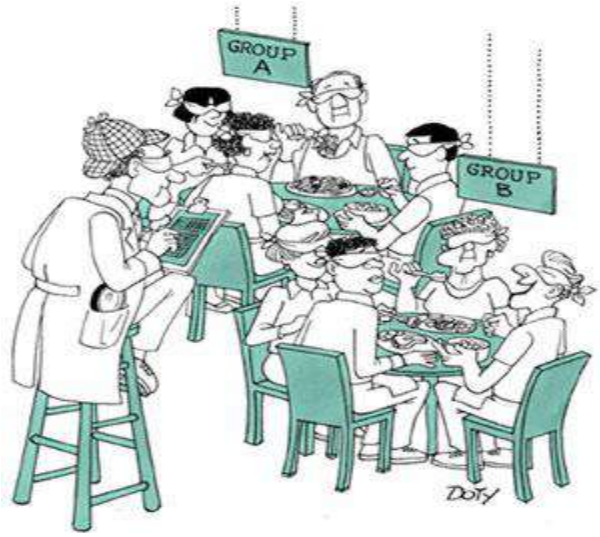
1. Select a sample from the population
2. Measure baseline variables
3. Randomize
4. Apply interventions (one should be a blinded placebo, if possible)
5. Follow-up the cohort
6. Measure outcome variables (blindly, if possible)

Chart courtesy of the National Cancer Institute (NCI)

One group of study participants, the "intervention group", consumes foods or nutrients scientists think may protect against cancer. Other participants, the "control group," get a different "food prescription" - often just a placebo.

Advantages:

Controlled trials avoid many of the types of bias that can be found in other studies. They also let scientists keep tight control over the enormous complexity of our daily lives.



"Anyone for a game of Blind Man's Bluff after dinner?"

Disadvantages:

Controlled trials are often called the scientific "gold standard." This can be true in many situations, but for unraveling the mystery of linkages between diet and cancer prevention, this investigation method may not be perfect.

It's hard to "blind" people to dietary modifications because you know what you're eating, and you'll be aware if someone changes it.

Image courtesy of American Institute of Cancer Research

That's why many controlled trials involving diet and cancer give the nutrients in the form of a supplement. One group gets the supplement being tested and the control group get a "placebo".

It's important to remember that even if scientists show that an isolated supplement produces no anti-cancer effects, this won't tell us anything conclusive about how whole foods or diets made up of many different foods affect cancer risk.

And since cancer can take decades to develop, it's hard to know if a study has lasted long enough to influence cancer development and/or prevention. Nevertheless, a positive result from a controlled trial can provide strong

evidence that a particular nutrient has a protective effect against cancer so further testing or observational studies can be undertaken.

Meta-Analysis

Meta-analysis is a structured literature review technique that attempts to combine similar studies to determine the average effect size for a particular treatment under comparable circumstances with comparable participants. Meta-analysis is all about putting the different pieces of the puzzle together in a scientific way. It combines the findings of many different studies using statistical methods. These studies offer a real, quantifiable sense of where the evidence is leading.

Cumulative Evidence

Cumulative evidence is another method used to look at the big picture. Rather than using a complex mathematical model, though, cumulative evidence simply means stacking up all the related studies and figuring out what they say overall. Think of a fictional detective looking at fingerprints, eyewitness testimony, DNA evidence, and circumstantial evidence, and putting them all together to see what kind of case they build.

Image courtesy of American Institute of Cancer Research

<u>Meta-analysis can be used as a guide to answer the question:</u>

'Does what we are doing make a difference to X' even if 'X' has been measured using different instruments across a range of different people?

Meta-analysis provides a systematic overview of

quantitative research that has examined a particular question.

Advantages of meta-analysis:

It combines all the research on one topic into one large study with many participants.

Disadvantage: The danger is that in combining a large set of different studies the construct definitions can become imprecise and the results difficult to interpret meaningfully.

Steps in a meta-analysis

1. Search of literature

2. Selection of studies ('incorporation criteria')

- Based on quality criteria, e.g. the requirement of randomization and blinding in a clinical trial.
- Selection of specific studies on a well-defined subject, e.g. the treatment of breast cancer.
- Decide whether unpublished studies can be included to avoid publication bias.

3. Decide which dependent variables or summary measures are allowed in the comparison.

4. Statistical model selection

5. Reporting

How do you describe a disease?

- Symptoms and Signs
- Symptoms - High grade fever, Redness of eyes and Rash.
- Signs - Rash, Koplick's spots.
- Ex. Measles.
- We can describe the disease in a community in a scientific way – Descriptive epidemiology.

Descriptive Epidemiology

- Is the method by which Epidemiologists describe an epidemiological / health related event.
- Descriptive Epidemiology describes the distribution of cases/events in X3
    - Time, Place and Person

What purpose does Descriptive Epidemiology serve?

1. Epidemiologist becomes familiar with the data and thereby the problem.
2. Epidemiologist learns the extent/size of the problem.
3. Epidemiologist creates a detailed description which can be communicated.

4. Identify high risk group(s) and get a clue into the causation of disease (Hypothesis).

Time distribution

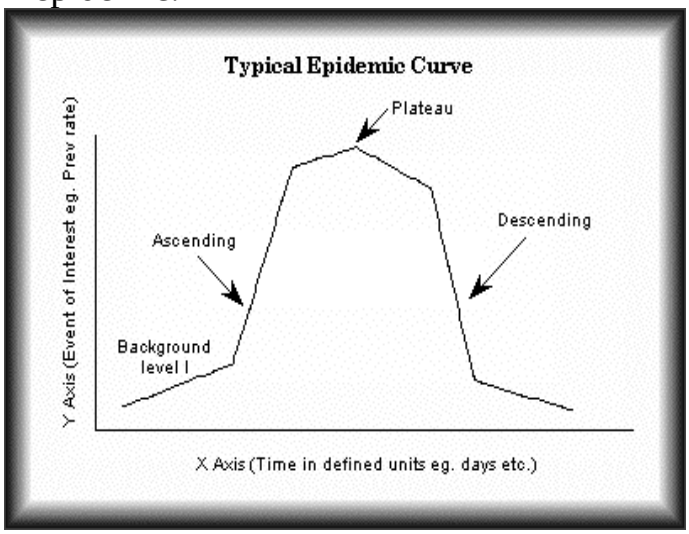
- The occurrence of disease changes over time.
- In Time distribution epidemiologist tries to describe the changes in the disease occurrence.
- There are three kinds of time trends or fluctuation
    - Short-term fluctuations.
    - Periodic fluctuations.
    - Long-term or secular trends.

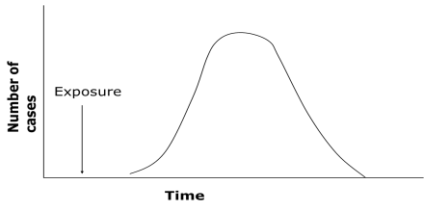
Short-term fluctuations

- These are epidemics/outbreaks
- There are three types of epidemics
    - Common-source epidemic
        - Single exposure or point source epidemic
        - Continuous or multiple exposure epidemic
    - Propagated epidemics
        - Person to person
        - Arthropod vector
        - Animal reservoir
    - Slow (modern) epidemics

Epidemic curve

- A graph of the time distribution of epidemic cases is called the 'epidemic curve'.
- The shape & size of the epidemic curve will help us know the type of epidemic.





Common-source: Single exposure epidemic (point source epidemic)

The main features of a 'point-source' epidemic are

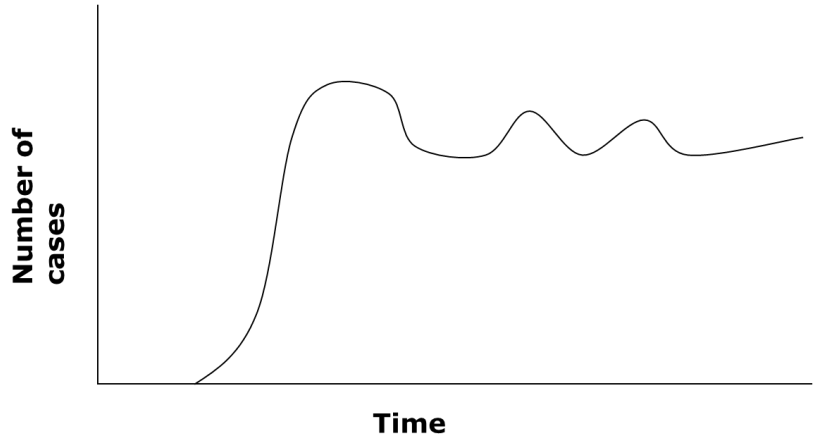
- The epidemic curve rises and falls rapidly.
- No secondary curves.
- All cases occur in ONE incubation period.

- Commonly seen in food poisoning, industrial pollution.

Common-source: Continuous or repeated exposure

- Exposure from the same source may be continuous or repeated.
- The cases occur for more than one incubation period.
- The epidemic curve will have more than one peak.

Single source continuous exposure epidemic



Propagated epidemics

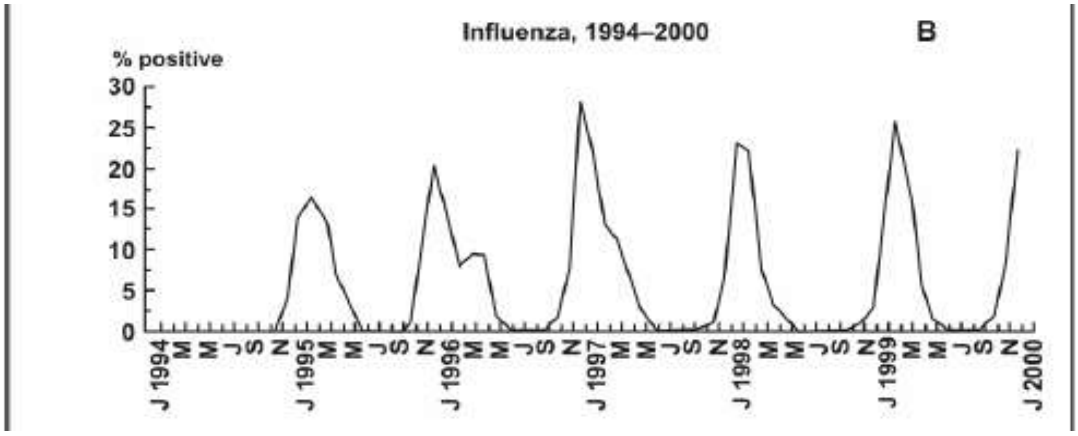
- Propagated epidemic is mainly due to person-to-person transmission.
  - E.g. Hepatitis
- Transmission continues till susceptible individuals are depleted.

Periodic fluctuation

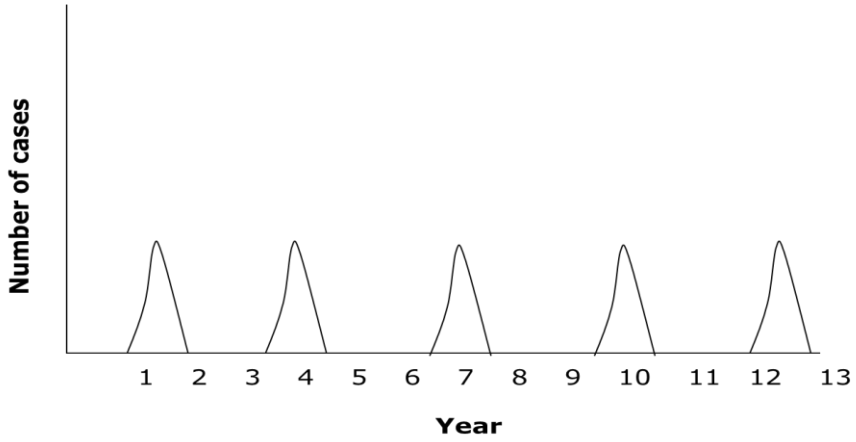
- Seasonal trend
  - Some occur more during certain seasons. E.g. respiratory diseases are more common during winter months.
- Cyclic trend
  - Some diseases show an increase every few years. E.g. measles show an increase every 2-3 years.

Time distribution-seasonal trend

Seasonal pattern of Influenza



Cyclic trend



Long term or Secular trend

- Secular trend means changes in the occurrence of disease over a long period of time, generally several years or decades.
- Example: Tuberculosis and Leprosy cases, Libya 1972-2005

Tuberculosis and Leprosy cases, Libya 1972-2005

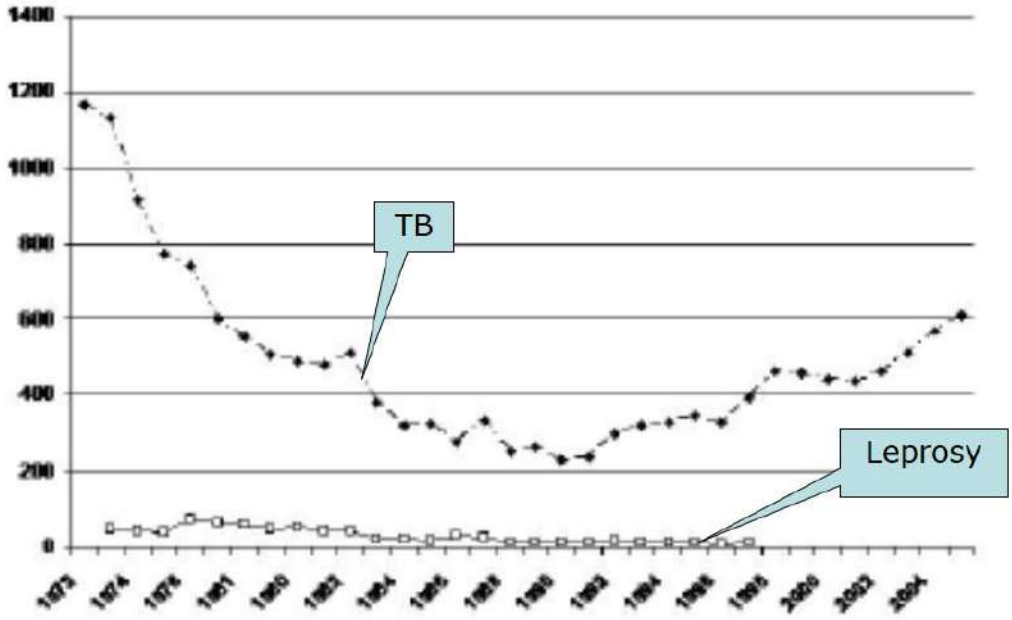
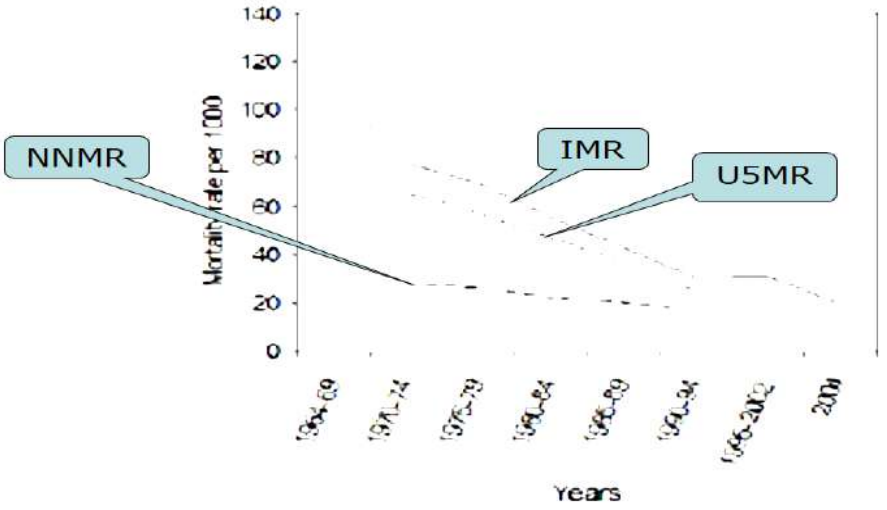


Figure 2: Secular trend in notified cases of tuberculosis and leprosy in Libya during the period 1972-2005.

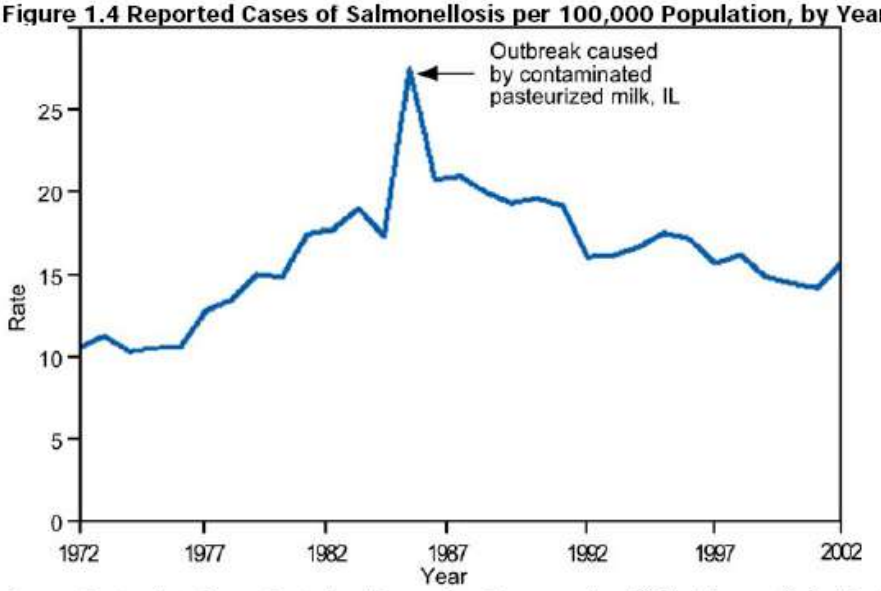
Health indicators of Libya 1964-2004



U5MR – Under 5 Mortality Rate; NN – NeoNatal; I - Infant

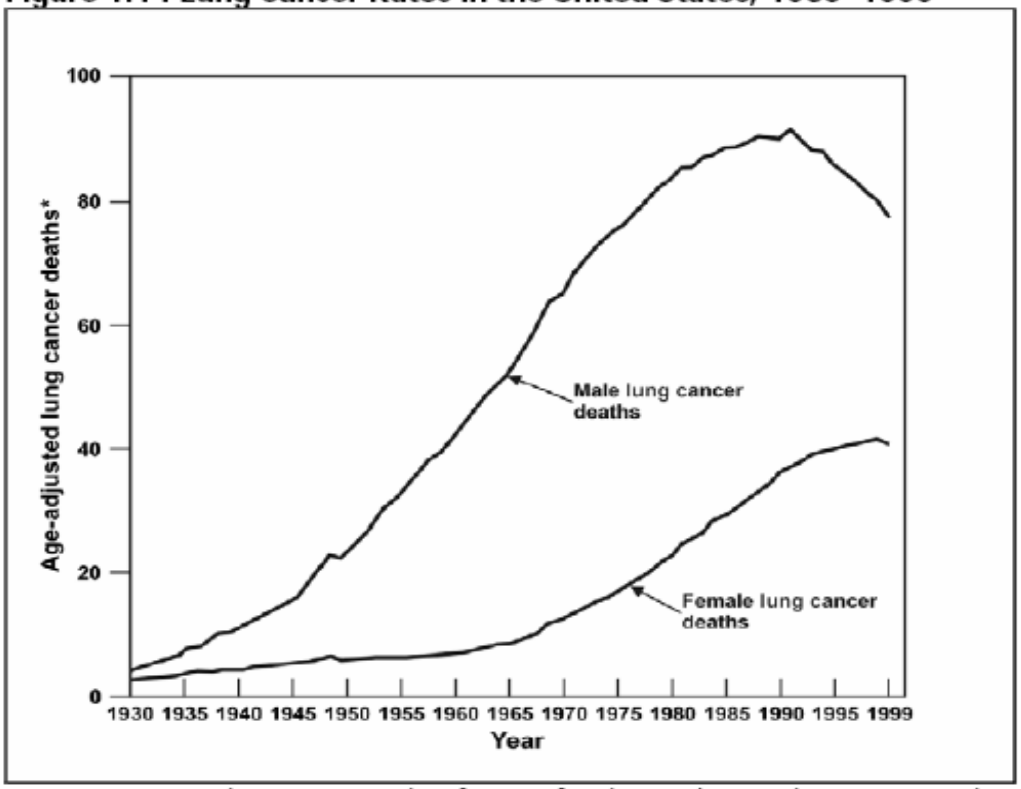
Time distribution

Figure 1.4 Reported Cases of Salmonellosis per 100,000 Population, by Year– United States, 1972-2002



Source: Centers for Disease Control and Prevention. Summary of notifiable diseases–United States, 2002. Published April 30, 2004, for MMWR 2002;51(No. 53): p. 59.

Figure 1.14 Lung Cancer Rates in the United States, 1930–1999



Data Source: American Cancer Society [Internet]. Atlanta: The American Cancer Society, Inc. Available from: http://www.cancer.org/docroot/PRO/content/PRO_1_1_ Cancer_ Statistics_2005_Presentation.asp.

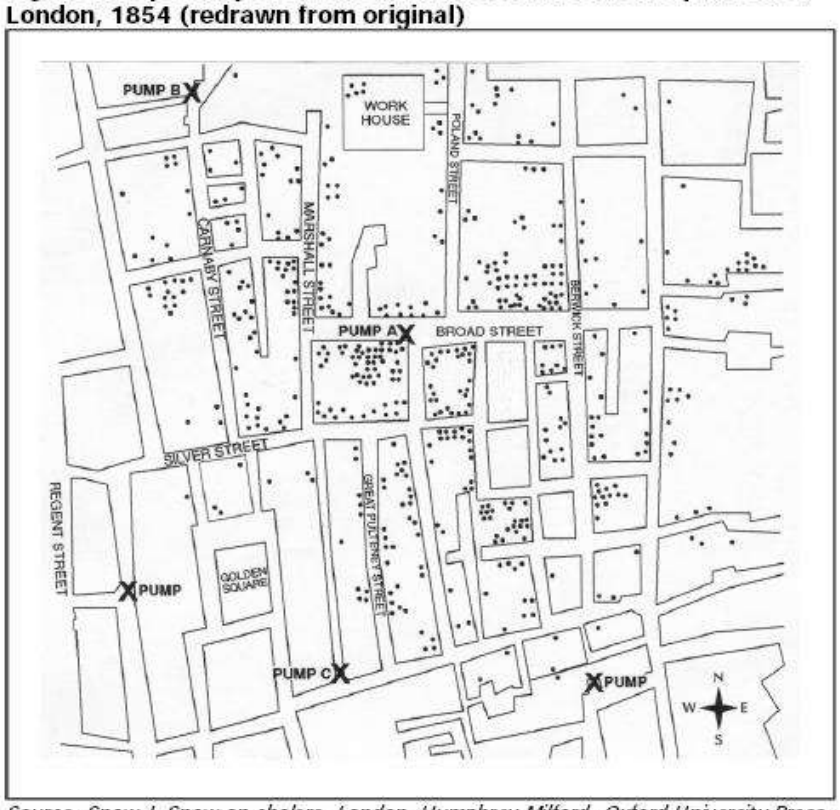
Time distribution – Uses

- Take appropriate action
- Know whether interventions are effective.
- Develop hypothesis regarding the source or cause of outbreak.

Place distribution

- Describes the distribution of cases in a geographic area.
- The distribution can be based on place of residence, place of work, place of recreation, place of travel etc. depending on the disease.
- We may have to try more than one distribution to learn more about the disease
- Two types of maps - Spot map and Area map.

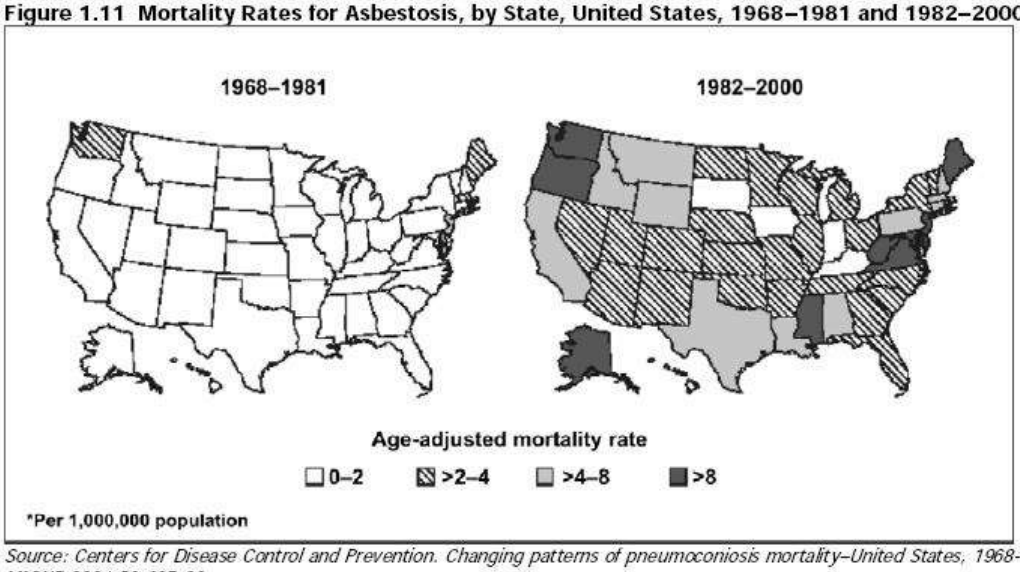
Figure 1.1 Spot map of deaths from cholera in Golden Square area, London, 1854 (redrawn from original)



Source: Snow J. Snow on cholera. London: Humphrey Milford: Oxford University Press; 1936.

Place distribution (Area map)

Figure 1.11 Mortality Rates for Asbestosis, by State, United States, 1968–1981 and 1982–2000



Source: Centers for Disease Control and Prevention. Changing patterns of pneumoconiosis mortality–United States, 1968-2000. MMWR 2004;53:627-32.

Spot map vs Area map

- Spot map gives an idea of the number and distribution of cases in an area.
- Area map describes the rate of occurrence of cases by taking into account the population of the area.

Place distribution – uses

- Know the geographical extent of disease.
- Identify the source of infection or causative agent.
- To plan control or preventive measures.

Person distribution

- Personal characteristics like age, sex etc. almost invariably affect disease occurrence.
- So distribution of disease or health event among these categories help the epidemiologist in knowing more about the disease.

<u>Person distribution – age</u>

- Almost every health related event vary with age
    - Measles
    - Cancer
    - Hypertension

Person distribution (age)

Figure 1.13a Pertussis by 5-Year Age Groups

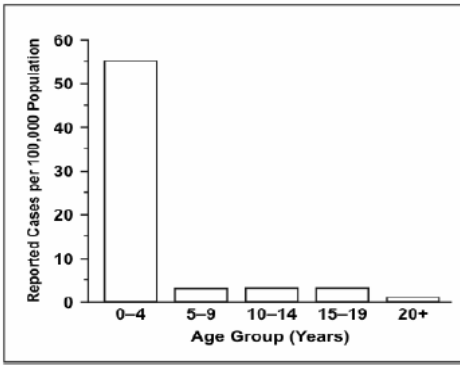
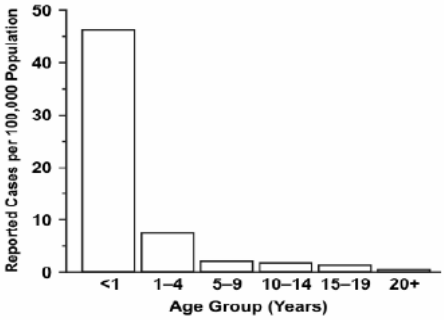


Figure 1.13b Pertussis by <1, 4-Year, Then 5-Year Age Groups



Person distribution (sex)

- Distribution of disease varies between males and females.

Person distribution – other attributes

- Race
- Ethnicity
- Nationality
- Behavior
- Socioeconomic groups