

# **The epidemiological concept of population**





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## The epidemiological concept of population: objectives



On completion of your studies you should understand:

- The meaning and applications of the idea that epidemiology is a population science.
- The profound influence of the characteristics of a population on its disease patterns.
- The potential and limitations of epidemiology in the absence of demographic population data.
- The expansion of possibilities in epidemiology which occurs when demographic population data are available.
- The impact of change in population size and characteristics on health

## Epidemiology as a population science



- Epidemiology is defined as a population science.
- Epidemiology compares the pattern of disease in populations over time, between places and in different types of people
- Populations are comprised of unique individuals.
- No epidemiological study can be done on one person
- Humans are social animals
- Epidemiology studies humans in the aggregate i.e. groups
- Epidemiology can be done on very small groups
- The classic experiment of Lind-12 people
- Study of adenocarcinoma of the vagina by Herbst and colleagues-8 cases and 32 controls

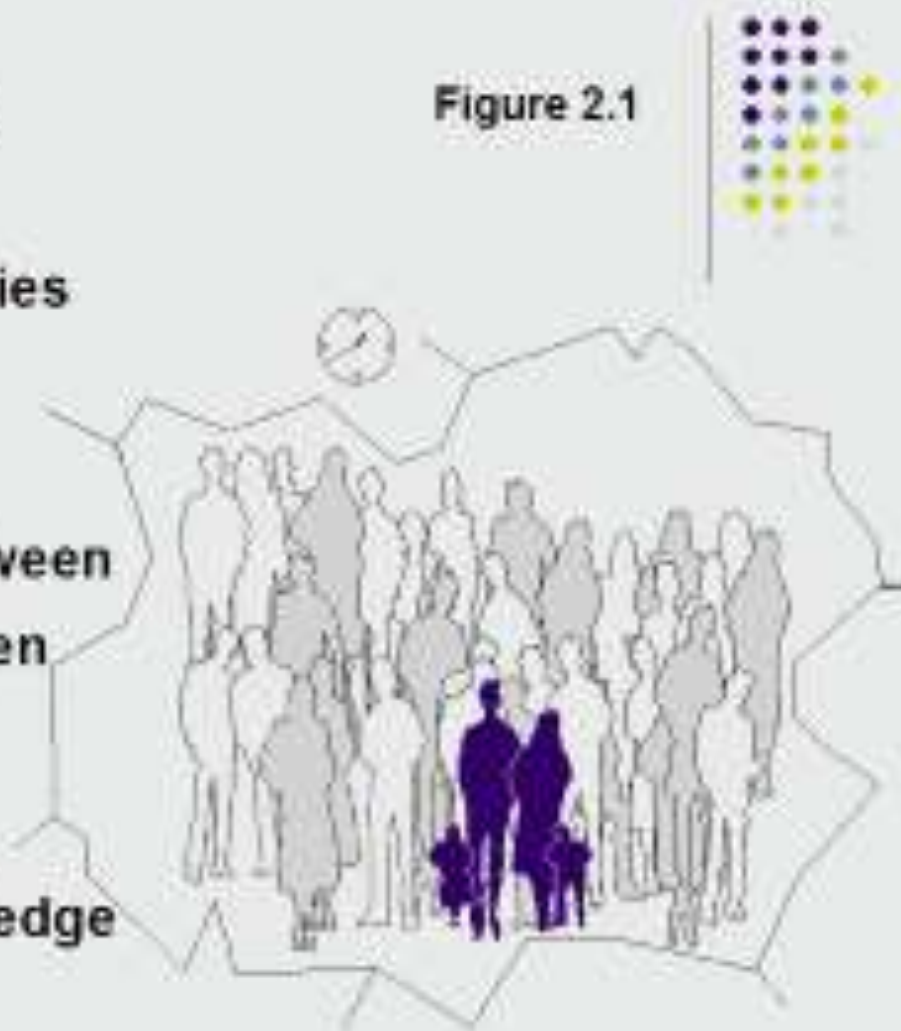
## The triad of epidemiological questions: time, place and person as exposure variables



- How does the pattern of this disease vary over time in this population?
- How does the place in which the population lives affect the disease pattern?
- How do the personal characteristics of the people in the population affect the disease pattern?

- Populations comprise individuals, families, groups and communities
- Epidemiology seeks variation in disease pattern over time, between subgroups and between places
- Understanding such variation yields knowledge on causation and prevention of disease

Figure 2.1



## Sickness X

A sickness of unknown type, which appears as outbreaks, sometimes affecting whole communities, is spreading across a large part of continental Europe. Years later it will emerge in the USA. It will be shown to be present in many countries, though it may remain unrecognised in normal medical practice, for it may occur as solitary cases or in small numbers and not outbreaks. Sick people have a wide range of symptoms and signs on examination. Their many symptoms include simply feeling unwell, with loss of appetite and abdominal pain, disturbances of the gastrointestinal tract including diarrhoea, a skin rash on parts of the body exposed to the sun, and mental disturbances. It leads to progressive physical and mental deterioration. People who contract the sickness are likely to die, with the mortality rate as high as 60 percent in some outbreaks. If a sufferer recovers the sickness can recur.

The sickness clusters in families, and it affects the poor living in rural areas more than any other group. Sharecropping and growing of corn are common in areas where the disease occurs. The problem is greatest in spring though the early symptoms occur in winter. The sickness is common in prisoners and patients in asylums. It does not affect staff in the institutions.



## **Class exercise on sickness X: applying the triad**



**Apply the questions in the triad to disease X.**

- **Now, does this information help you understand the causes of the disease?**
- **How might you use this information to begin more detailed scientific investigation**  
**and**
- **to plan the control or prevention of disease?**

## Sickness X: outcome of analysis by the epidemiological triad.



The questions applied to sickness X

- The sickness is a new, emergent problem
- It sometimes occurs as outbreaks
- It is seasonal
- It follows times of economic hardship
  
- It is worst in people living in low grounds
- It affects people in institutions more, but only the inmates, not staff
  
- Living in poverty and sharecropping increased risk
- Being related to a person with the disease increases the risk
- It affects all ages, and both men and women

## **Sickness X: interpretation of analysis by the triad.**

- **The great variation in disease over time, between places and by personal characteristics the evidence points to an environmental rather than a genetic cause.**
- **The various associations eg emergence in the spring, the link to poverty, the effect on those living in institutions etc permit hypotheses to be developed and tested.**
- **These observations direct us to populations for study eg those living in institutions.**
- **At this stage no specific control or preventive actions are compelling but the disease seems to be preventable**
- **People can be advised on their risk e.g. health care professionals**

## **Class exercise: Epidemiology for the individual and the population: prognosis**



- **How would you assess the prognosis for a patient with a terminal illness who asks, how long have I got to live?**
- **How would you advise a parent of a 5-year old son with asthma who asks will my child have asthma for the rest of his life?**
- **And, will my child have an asthmatic attack this weekend?**
- **How could you predict for a developing country that is rapidly becoming rich the health problems to come?**

## Class exercise: epidemiology and heterogeneity



- How would epidemiology study the link between tobacco and lung cancer in a society where every adult smoked 20 cigarettes per day?
- How would one investigate epidemiologically the effect of the gas nitrogen on human health? What about oxygen?
- In what ways might health risk factors such as tobacco and alcohol consumption have varying effects upon individuals and populations?

## **Class exercise: Disease as a manifestation of individuals in social groups**

- **Imagine a world in the future where humans lived an isolated lifestyle, using technologies to communicate, and using physical barriers to reduce contact. Imagine that the physical environment remained similar to that we experience now i.e. people lived in housing of equal quality and used similar cars etc.**
- **What would be the effect on disease patterns?**
- **Which diseases would be more common and which less so?**
- **What would the influences be on lifestyles?**

## Disease as a manifestation of individuals in social groups



- Diseases are expressed biologically in individuals.
- Many diseases, however, are caused only by the interaction of individuals within and between populations
- Suicide is hugely influenced by social conventions
- Durkheim, a French sociologist, held that loss of common social values leads to social and individual instability and suicide.
- Economically unequal societies have more mental and physical health problems than expected including murder and accidents, and cardiovascular diseases.
- Down's Syndrome, a genetic disorder called Trisomy 21, shows how social expectations and behaviours alter disease patterns.

- In the imaginary future world of isolated people diseases which are transmitted from person to person would occur rarely.
- The pattern of mental health problems would be profoundly different

## Disease as a manifestation of individuals in social groups



- For most of their history humans have lived as small groups of hunter-gatherers and not in large settled communities.
- British colonised the Andaman Islands (East of India, West of Thailand) in 1857 when 5,000 people comprised the tribe Great Andamanese. In 1988, 28 were left. Measles and influenza took their toll.
- The Jarawa tribe remains isolated on the Andaman Islands. They are now making contact with the outside world. The result is predictable.
- Disease patterns are generated in and by populations and need to be described, explained and predicted in a population setting.

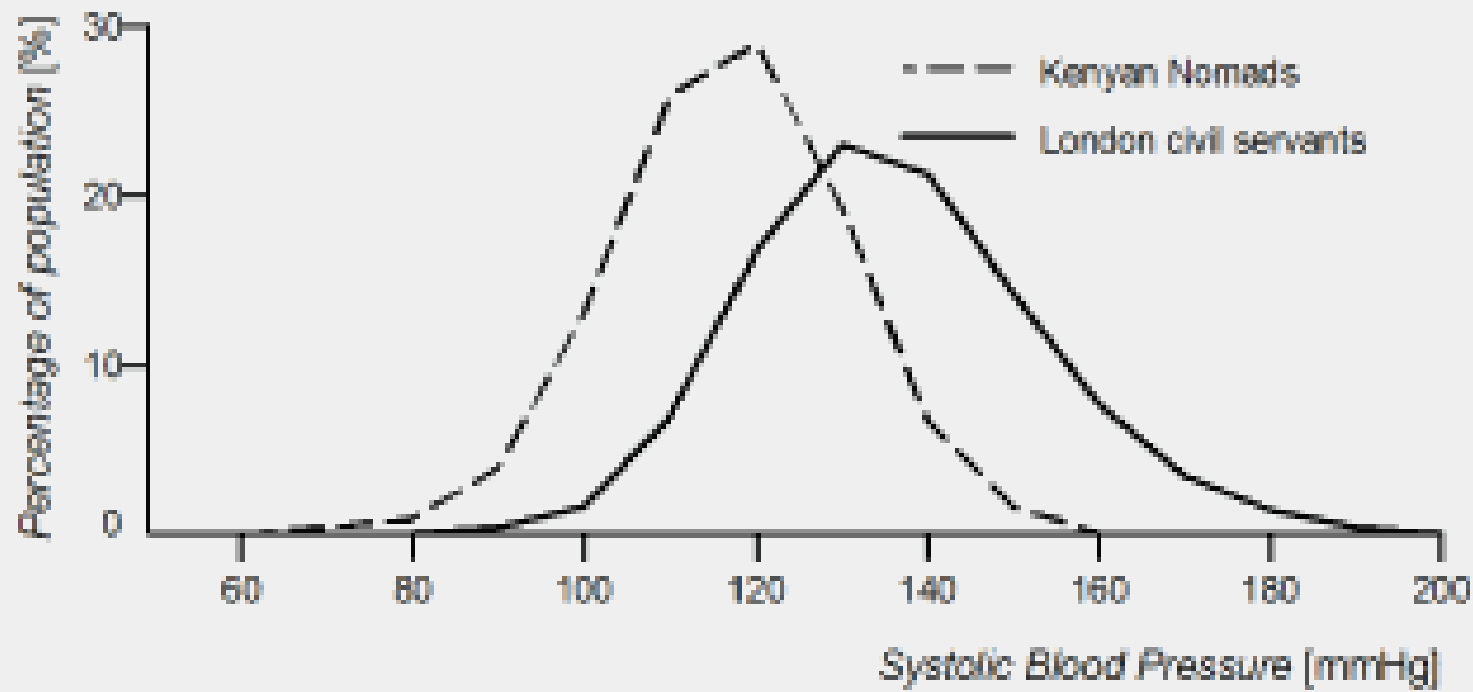


## Geoffrey Rose on sick individuals and sick populations



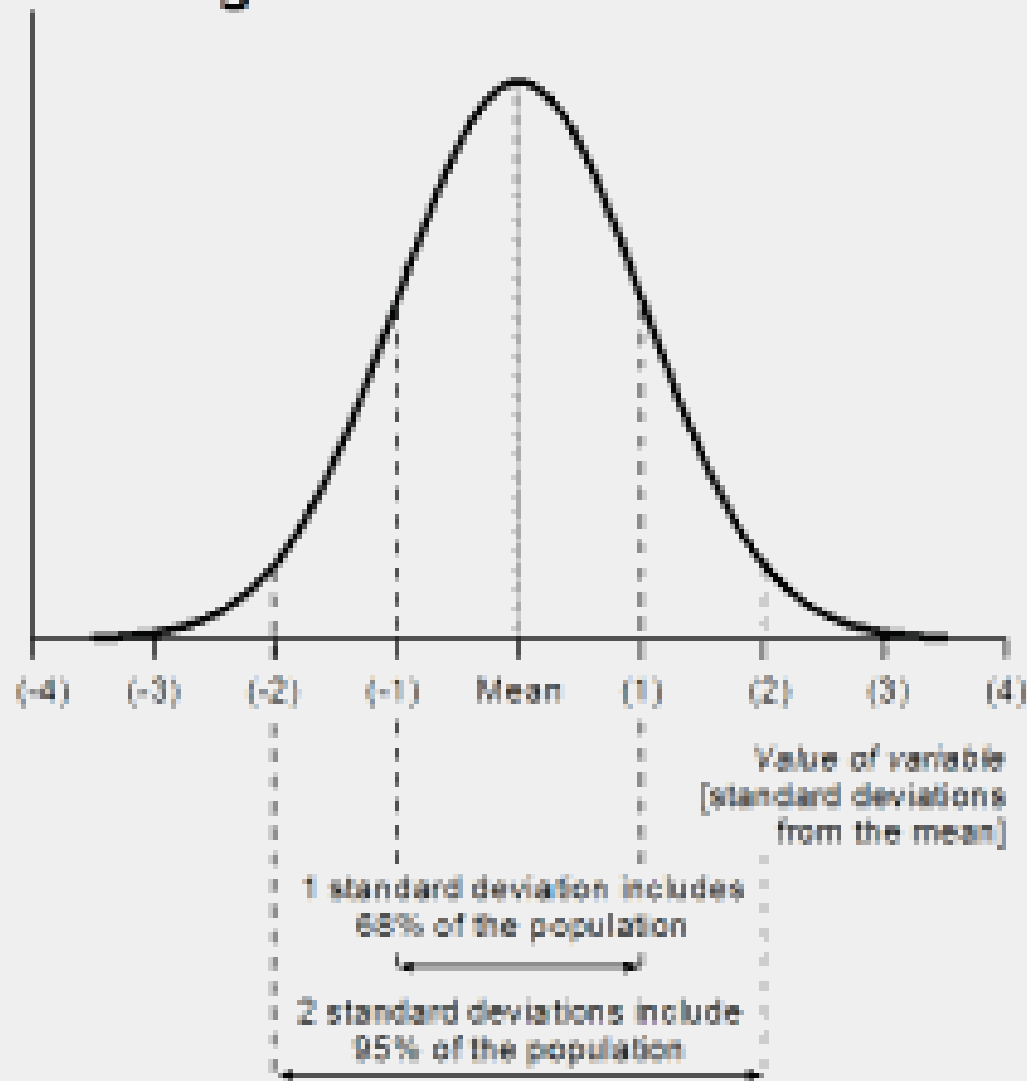
- Rose proposed a radical and still controversial vision of health in his book, "The Strategy of Preventative Medicine".
- His central proposition was that people with overt diseases and health problems - whether people with hypertension, alcohol problems or obesity - were simply at one end of the spectrum, or distribution, i.e., they are not deviant, merely an integral part of the whole.

**Figure 2.2 BP distributions in Kenyan nomads and London civil servants**



Probability

## Figure 2.3 A normal distribution



## **Class exercise: Sick populations and sick individuals**



- **In what ways do the shapes of the distributions differ in the two populations?**
- **Roughly, what percentage of Kenyans and London Civil Servants have hypertension?**
- **Is there any suggestion from figure 3 that the cause of high blood pressure in an individual Kenyan nomad and a London civil servant likely to differ?**
- **What is the cause of the different distribution of blood pressure in the two populations?**
- **Are the causes of sickness in the population different from the sickness in the individual?**

## Sick populations and sick individuals



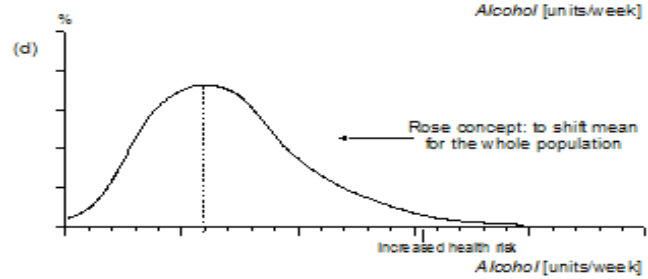
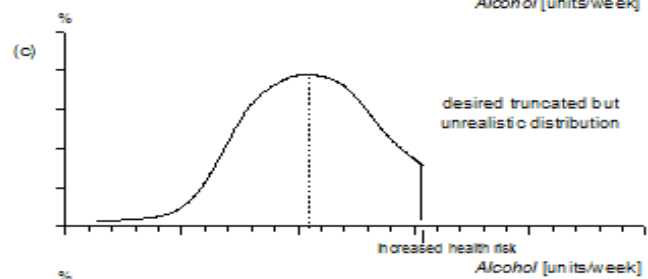
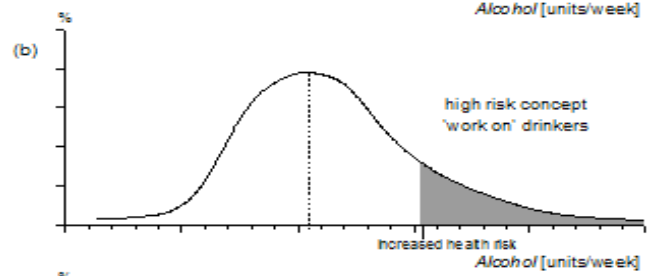
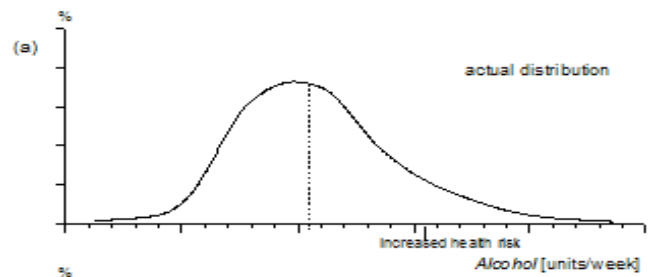
- The shape of the distributions of blood pressure is similar-normal (or Gaussian)
- The distribution in civil servants is to the right of Kenyan nomads.
- The cause of high blood pressure in individuals is usually not pinpointed
- the shape of the distributions suggests similarities in the forces that shape them
- causes of hypertension in nomads and civil servants may be the same genetic, environmental and behavioural factors
- difference in the average blood pressures indicate powerful forces are operating
- nomads are closer to the normal pattern and the Londoners' distribution has shifted rightwards

## Sick populations and sick individuals



- the causes of the rightward shift probably include dietary factors, obesity, insufficient exercise, stress and genetic factors
- these factors are acting on the entire population
- the causes of sickness in the population of London civil servants are conceptually different from the causes of sickness in the individual
- The individual may be an alcoholic as a response to anxiety, depression, unemployment or simply a fondness for alcoholic beverages that led to addiction. Populations, however, have high and low consumption for different reasons including religion, tradition, customs of hospitality, availability, income, taxes, etc.

- the population distribution of risk factors, and the shape of the risk factor - disease relationship is vital to public health.
- leads to a radically different population based strategy for disease control based on both the causes, and the causes of the causes
- This thinking is at the heart of the controversy over high risk and population approaches as indicated in the example of alcohol



## **Class exercise- Sickness X as a disease of individuals and populations**



- **Was sickness X, a disease of sick individuals or of sick population?**
- **What might have been the causes of the causes in sickness?**



## **Sickness X: as a population disease**

- **Never occurred in humans free to choose their own way of life**
- **Occurred after populations were thrown into poverty**
- **Did not decline even after its specific cause was well understood in biological terms**
- **Continued to occur, in hundreds of thousands of people every year, in some extremely rich countries which would not accept that the cause had been discovered even though other countries virtually eliminated the problem by acting upon available knowledge**
- **Declined when a war led to a change in the mode of life in the USA**
- **Declined when economic disaster led to a marked change in the mode of living and working in rural areas.**
- **Was virtually defeated by government action.**

## Individual and population level variables in epidemiology



- Under what circumstances might individual measures be meaningfully applied to populations and vice versa?
- Reflect on such measures as age, sex, blood pressure, household size, population density, gross national product.

## Individual measures with no meaningful interpretation in populations



- Fingerprint patterns
- Personality
- Eye colour
- Loneliness

## Some variables with no direct and meaningful individual counterpart



- Population density
- Air quality measure such as particular matter or sulphur dioxide
- Income and wealth
- Inequality index
- Road traffic density
- % of population unemployed
- Indexes of socio-economic deprivation
- Gross national product
- Ambient temperature
- Land use

## Population variables based on individual data



- **Individual attributes such as age, age at death, blood pressure and serum cholesterol can usually be aggregated meaningfully and described in the population as a whole.**
- **To provide a meaningful picture the data must be from either the whole population or from a characteristic (representative) sample.**
- **Paradoxically some data collected from individuals when used in aggregate cease to be meaningful at the individual level.**
- **While social variables are usually measured in individuals, environmental variables are usually not so measured.**

Social characteristics including cohesion in society, teamwork, and the state of economic transition, are likely to have profound effects on health and yet be incompletely captured and described through individualised approaches to measurement.

# Demography and epidemiology



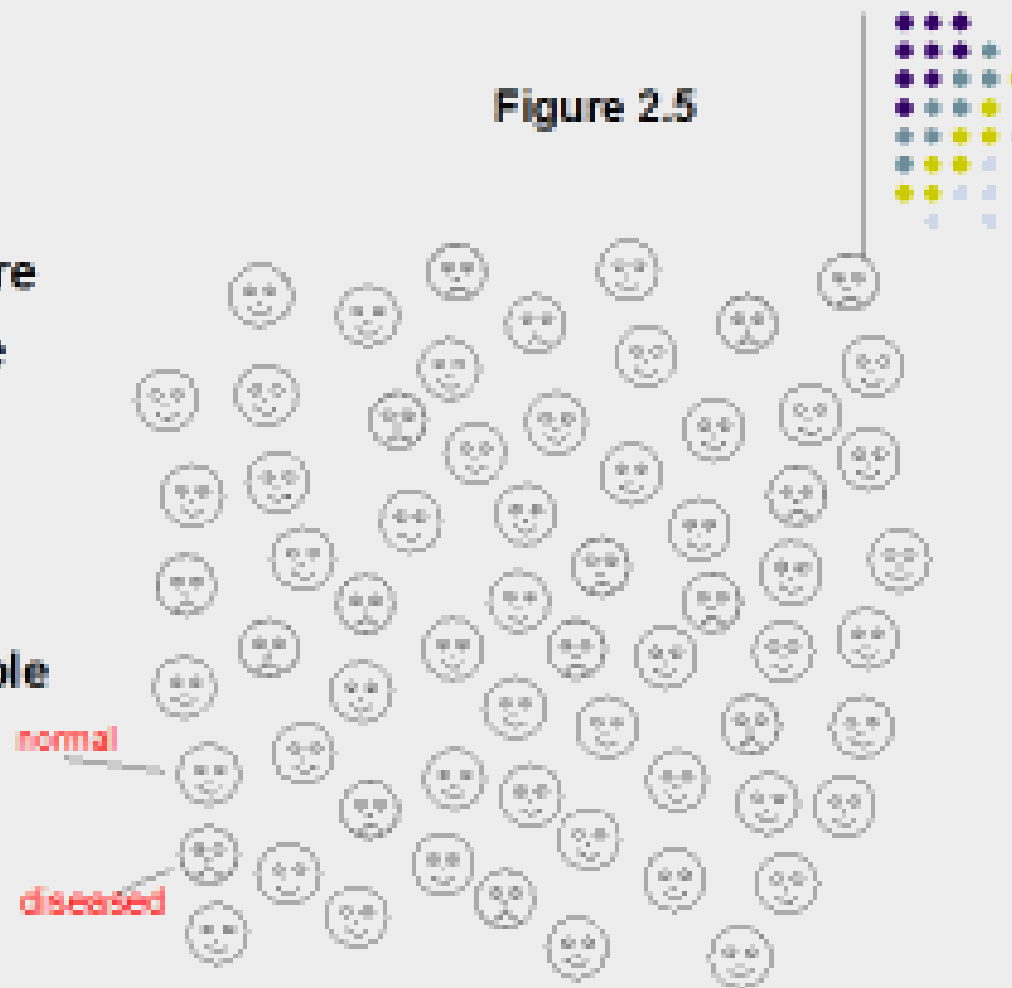
- **Demography is the study of population, including the impact of birth, death, fertility, marriage, migration and other social factors on population structure and trends.**
- **Epidemiology is hugely dependent on demography**

## **Exercise: demography and epidemiology**

- **Imagine a country or region where there was no demographic data, so the number of people and the age and sex composition of the population were unknown.**
- **Imagine also that an epidemic (of pneumonia, food poisoning, depression or attempted suicide) is suspected.**
- **You are asked to develop a plan to prevent and control the epidemic in the area.**
- **Imagine that accurate information on the age and sex composition of the inhabitants is to be collected. How will this be done?**
- **Which questions do you need to answer to bring to bear a rational control strategy and to declare the problem controlled? Which epidemiological data do you need, in general terms, to answer the questions? How does the census help you?**

- **Count of cases possible**
- **Limited health care planning possible on case count**
- **Trends in case counts useful if population is stable**
- **Changes in case count cannot be interpreted easily if population is unstable**

Figure 2.5





**Figure 2.6**



- Set a boundary
- Decision about those on the boundary
- Define a time
- Count the population
- Describe the population
- Count migrations, births and deaths
- Link population counts to health data to calculate birth and death rates, and disease specific rates
- Surveillance by time, place and person
- Monitoring
- Design of studies to understand the burden and causes of disease

## Epidemiological and public health questions



### a) Frequency and pattern

- How common is this problem?
- Is the problem increasing, decreasing or about the same?
- Where does it occur most?
- Who is affected most?

### b) Understanding cause

- What are the causes of the problem?

### c) Control

- What strategy is needed to prevent or control the problem?
- Are control measures working?

## Overview of the applications of the population concept



- Health policy
- Traditional health care systems
- Modern health care systems
- Health promotion
- Clinical practice based on demand
- Clinician practice based upon a population list
- Biomedical science

## Epidemiological theory on population health



- population patterns of disease are highly dynamic, driven by demographic and environmental change
- disease patterns in individuals and societies are profoundly influenced by the mode of interaction of individuals with each other, animals and the wider environment
- the pattern of disease in society is more than the sum of disease in individuals
- the causes of disease lie in populations and their societies as much as in individuals and their biology

## Summary



- **Epidemiology is a population science because it studies disease patterns in communities, builds upon demographic population data, and applies the findings to improve the health of population groups.**
- **Epidemiological studies do not work well without an understanding of the composition, structure and culture of the population under study.**
- **The focus on population is the defining feature of epidemiology, which distinguishes it from clinical research, and the other medical sciences, which primarily study the individual, the organ and the cell.**