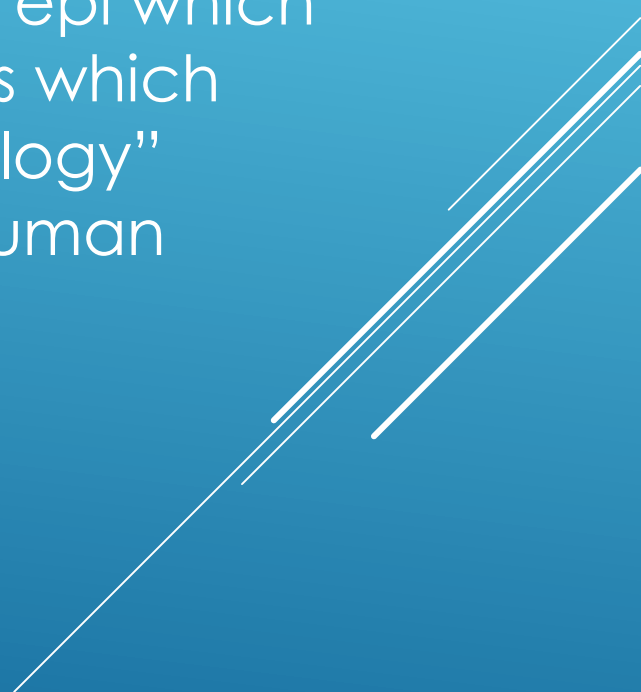


INTRODUCTION TO MATHEMATICAL EPIDEMIOLOGY



Epidemiology is the subject that studies the patterns of health and illness and associated factors at the population level.

The word “epidemiology” is derived from the Greek terms epi which means “upon”, demos which means “ people”, and logos which means “study”. That interpretation of the word “epidemiology” implies that the subject of epidemiology applies only to human populations.

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Until 20th century epidemiological studies were mostly concerned with infectious diseases. Nowadays, the leading causes of deaths worldwide are diseases such as stroke and coronary heart disease positioning diseases that do not transmit from one person to another as central concern of epidemiology.

Among infectious diseases dominate worldwide as cause of death lower respiratory infections (such as pneumonia) and HIV. We will be concerned with mathematical modeling of infectious diseases.

An *infectious disease* is a clinically evident illness resulting from the presence of pathogenic microbial agent. The microbial agent causing the disease can be bacterial, viral, fungal, parasitic or toxic proteins, called prions.

Infectious diseases caused by bacteria are tuberculosis and pneumonia, viral diseases include HIV and influenza, the most widespread fungal diseases are dermatomycoses, parasitic infections are caused by macroparasites such as protozoa, helminths, trematodes and cestodes. An example of a prion-caused disease is Creutzfeldt-Jakob disease.

Communicable diseases are infectious diseases that can be transmitted from one infectious person to another, directly or indirectly.

Often we do not make distinction between infectious diseases and communicable diseases, as many of the infectious diseases are in fact communicable diseases. However, there are diseases that are infectious but not communicable. Tetanus is an example of a disease that is infectious but not communicable.

Transmittable diseases are infectious diseases that can be transmitted from one person to another through unnatural routes. For instance, Creutzfeldt-Jakob disease can be passed from one patient to another through surgical instruments or transplants

Transmission of infectious diseases may occur through a variety of pathways. According to the means of transmission, infectious diseases are classified as follows:

- **Person-to-person** transmitted diseases are diseases that require direct or indirect contact. Direct contact includes touching or sexual contact. Diseases that are transmitted through a sexual contact are called *sexually transmitted diseases*. Sexually transmitted diseases include HIV, gonorrhea, syphilis and others. Indirect contact includes exchange of an infected object, blood or body fluids. Influenza can be transmitted through indirect contact.
- **Air-borne** transmission occurs upon inhalation of infected air. Air-borne transmitted diseases are influenza, smallpox, measles, chicken-pox and tuberculosis.

- **Food or water-borne** diseases are transmitted through ingestion of contaminated food or water. Cholera is a water-borne disease. Food-borne diseases include salmonella or stomach flu.
- **Vector-borne** diseases are transmitted by a vector, most often an arthropod such as mosquitos, ticks or snails. Examples of vector-borne diseases are malaria, dengue and West Nile Virus which are transmitted by mosquitos.
- **Vertical** transmission occurs when a disease is transmitted through the placenta from a mother to a child before or upon birth. Examples of such diseases are HIV, Hepatitis B, Syphyllis, rubella, and Herpes simplex virus.

For modeling purposes we distinguish four types of transmission: **direct**, when the causing pathogen is transmitted from one person to another, **vector transmitted** when the causative agent is transmitted from a vector to a human, **environmental transmission** when a human becomes infected through a contact with the pathogen, existing in the environment and **vertical** when the pathogen is transmitted from mother to child at birth.

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A **pathogen reservoir** is an ecological niche where a pathogen lives and multiplies, which plays a definite role in the spread of the pathogen. According to their reservoir the microbial agents are classified as **human, animal, and environmental**.

Human pathogens circulate mostly among humans, and humans play a role in their transmission.

Animal pathogens have vertebrate animals as a reservoir, and circulate primarily among animals. Epidemiologically this is significant because many adapt to infect humans through animal-to-human transmission. Infections that spread from vertebrate animals to humans are called **zoonoses**.

Environmental pathogens multiply primarily in the environment (typically water and soil) and spread from there to animal and human populations.