



Public Health

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وَقُلْ رَبِّ زِدْنِي عِلْمًا



Occurrence of disease Epidemiology (III)

L 8

why some individuals develop the disease and others don't?

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Learning objectives :

- to explain basic **models** of disease cause action.
- to understand the **etiology** or **causes** of disease and altered production.
- to understand the **theory** of disease causation

Models of disease causation

there is so many theories to describe the occurrence of the disease

1.

first one and the most important one

• Germ theory of disease (infection)

2.

• Epidemiological Triad not just the microbe is the causative agent also interaction between host, agent and environment

3.

• Epidemiological Tetrad نفس تعاون ال triad بس ضمنا ال Time
فصارت tetrad
cauz there is importance of the time in occurrence of the disease

4.

• Web of Causation theory multiple factors interact with each other in order to produce the disease

5.

• Wheel theory genetic factors in the occurrence of the disease
و يعتبرو اكثر سبب مهم ال occurrence of the disease

Germ Theory of Disease disease occur due to infection (viral, parasitic...)

- Proposed by **Robert Koch and Louis Pasteur.**
- Every human **disease is caused by a microbe or germ**, which is **specific for that disease**, and one must be **able to isolate the microbe** from the diseased human being.
- It is proposed mainly for infections.

for example TB we have to isolate mycobacterium tuberculosis from the lesion

Biological criteria (Koch's Postulates).

1. **Agent is regularly found** in the lesion of each case
2. Agent **is isolated** in pure **culture**.
3. Agent **causes similar disease** in **experimental animals**
4. Agent **is recovered from lesions** in **experimental animal**.

the microbe should present in the lesion like Tb we should isolate it from sputum or pharynx or lungs them self

we have to culture the micro-organism even if it takes long time

the organism may also infect animals and we can isolate it from them (for ex we have bovine mycobacterium bacilli that affect animals also plague can infect animals and transfer to human through flea)

Anthrax was the first disease demonstrated to meet these rules which have since proved useful with many other **infectious diseases and with chemical poisoning**.

the first time they proposed this postulate was for anthrax disease (affect both human and animal caused by bacillus anthrax and the spores are the infectious stage)

زي حالات الطب الشرعي التسمم بالزرنيخ او cyanide poisoning

Koch's postulates are of most value when :

- the specific cause is a **highly pathogenic infectious agent**.
- **chemical poison** or another specific factor, and
- there are **no healthy carriers of the pathogen**: a relatively uncommon occurrence

الnotes تعاون التلات نقط هداول كتبهم
بالصفحة التحت لحتى لا تتعجق الصفحه

1 = بالنسبة لkoch عشان تعتبر الorganism هاد هو السبب بالمرض لازم يكون highly pathogenic و رح نحكي معناها كمان شوي

2 = زي ما حكينا المحاضره قبل الماضيه.. we can postulate that chemical poisoning is related to the occurrence of the disease.. **methyl mercury poisoning** casuses minamata disease also **lead poisoning**

3 = حتى نطبق ال criteria of koch's postulate يجب انو ما يكون عنا carrier for the pathogen

↓
...**carrier**:an individual having the micro-organism but not showing signs and symptoms and they can excrete the micro-organism and transmit it to other people.. and there is multiple types of carriers we will discuss this later .. like in typhoid fever we have carriers

Epidemiological Triad (Triangle) the disease occur due to interaction between these three agents

• **Agent** the micro-organism

• **Host** factors in the host himself to develop the disease
certain people are more susceptible to have the disease

• **Environment** occurrence of الـبتشجع على الـ the disease



Agent

- Is an element or substance, animate or inanimate, the presence (or absence) of which may **initiate or effect a disease process**.
زيادة او نقصان بالاشي قد يسبب ال
occurrence of the disease
- A disease may have a **single agent**, several **independent** alternative agents or complex of two or more factors whose combined presence is essential for the development of the disease.
يعني يا بكون سبب واحد او اكثر من واحد عاملين combination مع بعض

Classification of agents:

- Biological
- Nutrient
زيادة او نقصان في بعض الnutrients يسبب
occurrence of the disease ال
- Physical
- Chemical
- Mechanical
- Absence or insufficiency or excess of a factor necessary to health
مثلا زيادة او نقصان
بالفايتنمز
- Social

Agent factors

• Infectious agents:

Agent might be **microorganism**—virus, bacterium, parasite, prions, other microbes and others (poisonous creatures). *→ like some insects, snakes and scorpions* Generally, these agents must be present for disease to occur as essential causal factor.

• Nutritive:

Excesses or deficiencies (Cholesterol, vitamins, proteins), overnutrition. *(obesity) due to over uptake of carbohydrates*

goiter disease is due to iodine deficiency
excess cholesterol causes hypercholesterolemia
malnutrition is the most common cause of morbidity and mortality among children in developing countries like marasmus disease and kwashiorkor → deficiency of protein
like anemia due to iron or B12 deficiency
excess is called hypervitaminosis

• Chemical agents:

common in winter for people using coal and wood as an energy source
حساسيه من الزيتون بموسم القطف
(carbon monoxide, drugs, medications, Toxins and pollutants) Toxicity dose,

Penetrability, Stability, Half-life etc.

penetration of the toxin or drug to the tissue or the cell membrane
the resistance of a chemical to change in a chemical reaction.
هادي من جوجول مو من الدكتوراة عشان حسبتها مو مفهومه

large number of side effects that causes alot of diseases like allergies, over dose toxicity

نتيجته الحروق على سبيل المثال
radiologists radiation due to their occupation so they wear protective clothes
و عندهم جهاز بقيس نسبة ال radiation, people working in airports ear special headphones to protect them from noise

• Physical agents :

Ionizing radiation, sound, winds, floods, draughts, soil etc...

Agent characteristics صفات ال micro-organism

Infectivity refers to the proportion of **exposed** persons who become **infected**.
how many individual that got exposed to the agent become infected?
like in measles: اذا طفل بالروضة صار معو جدري ممكن ناس من اصحابو ينعديو و ناس لا

Pathogenicity refers to the proportion of **infected** persons who **develop clinical disease**. (signs and symptoms) ,cauz not all people who got infected will develop symptoms

Virulence refers to the proportion of persons with **clinical disease** who become **severely ill or die**. (the fatality of the disease)
like rabies is highly fatal so high virulence

Agent characteristics

هو انواع (a,b,c)

● **Hepatitis A** virus in children has **low pathogenicity and low virulence**, since many infected children remain **asymptomatic**, and few develop severe illness.

A is a mild one and u got the infection by ingestion then jaundice then they develop the symptoms but it's mild in children and sometimes they don't show symptoms, reveals without medication and rarely becomes chronic

● In persons with **good nutrition and health**, **measles virus has high pathogenicity but low virulence**, since almost all infected persons develop the characteristic rash and illness, but **few develop the life-threatening presentations of measles (pneumonia,**

encephalitis). in the past it used to have high pathogenicity and highly fatal so high virulence specially in **malnourished** people then it is called "severe measles"
also gastro-entritis

● In persons with **poor nutrition and health**, **measles is a more virulent** disease, with mortality as high as 5-10%.

● **Rabies virus is both highly pathogenic and virulent**, since virtually 100% of all infected persons (who do not receive treatment) progress to clinical disease and death

Associate Professor Dr.Eman A. Al-Kamil → post exposure vaccination.

Host

- In epidemiological terminology, the **human host** is referred to as “soil” and the disease agent as “seed”. الhost هو التربة الخصبة و الagent هو البذرة
- A person or other living animal, that affords **subsistence** or lodgment to an **infectious agent** under natural condition.
- Host factors: **Intrinsic factors** that influence an individual's:
 - **exposure**, in exposure they make them selfmore liable to have certain disease like doctors they are more liable for accidents, infection..
 - **susceptibility**, or some people are more susceptible to develop the disease because they have weak immunity
 - **response** to a causative agent. response of the body to the agent

Host factors

Demographic factors:

- Age
- Sex
- Ethnicity

Biological factors:

- Genetic factors
- Blood groups
- Enzymes
- Immunological factors

Socio-economic factors:

- Socio-economic status
- Education
- Occupation

Lifestyle factors:

- alcohol
- Drug abuse
- Smoking
- Nutrition
- Physical activity

Age: one of the important determinant factor for the occurrence of the disease.. الكبار و الصغار و يختلفو بين
chronic non-communicable diseases are more common in elderly people
infectious diseases are more common in children

Sex: women in productive age group are more liable to have many health problems which are related to pregnancy, delivery and family planning methods
men are more exposed to risk factors than women
breast cancer is more common in women than men due to anatomical differences

Ethnicity: certain ethnic groups develop certain diseases like hemoglobinopathies (Mediterranean region) بدول البحر الابيض المتوسط like thalassemia, G-6-PD ..

Blood groups: certain blood groups are protected from certain diseases like blood group O is protected from malaria
some blood groups increase risk of infection

Enzymes: like G-6-pd deficiency causes hemolytic anemia, phenyl ketonuria deficiency of certain enzyme causes problem in metabolism of a.a phenylalanine also cystic fibrosis

Education: increase in the awareness of the people how to protect them self and their family also how to utilize health care services and knowing the importance of vaccination

occupation: it could be the reason of hazard occurrence because of occupational exposure or on the positive way it helps the economic aspect in the family in order to improve their education and health

Environmental Factors

Physical environment

● Nonliving things and physical factors:

- air, pollution
- water, pollution
- soil,
- housing,
- heat,
- light,
- Radiation كنا عينا

Biological environment

- Microbial agents,
- insects,
- animals,
- plants and *could be poisoning*
- man himself.

Psychosocial environment

- Lifestyle,
- poverty,
- urbanization, *مدن + effect*
- community life, *- effect*
- income,
- education,
- stress etc.

Soil: like parasitic infection, *ancylostoma duodenale* it Penetrates the skin, anthrax: spores of anthrax are present in the soil
toxoplasmosis also is found in the soil and the source is cat feces it causes repeated abortion in women

Housing (indoor environment): painting, ventilation واحد اهم, overcrowding, indoor smoking, heating, molds, falls accidents

Heat (outside heat): high temperatures causes heat strokes

Light: affects on health.. special type of light should be in class rooms because inappropriate one cause vision problem for the students

Urbanization: pollution in cities \rightarrow , when moving to the city less percentage of animal to human transmitted diseases occur \uparrow , improvement of economic status of the individual sometime \uparrow , stress and psychological problems \rightarrow , better access to health care services \uparrow

Triangle of Epidemiology

In addition to agent, host and environment, **time factor** is added.

it is important to take time in consideration for occurrence of the disease

Time account for :

why is it important to know the incubational period of the disease? because some diseases during incubational period are infectious and can be transmitted, ex: measles, whooping cough so we can interrupt transmission of the disease by separating him+ helps in early detection of the disease

❖ **incubation period**, of micro-organism and radiation

↳ time from exposure or entering the organism to the body until signs symptoms appears

– hepatitis C during incubational period we can give him post exposure vaccination like rabies, cancer and HIV have long incubational period

❖ **Life expectancy** of the host or pathogen

– like half life of drugs specially in poisoning cases

– how many days does the organism stay in the body before it got eradicated by immune system?

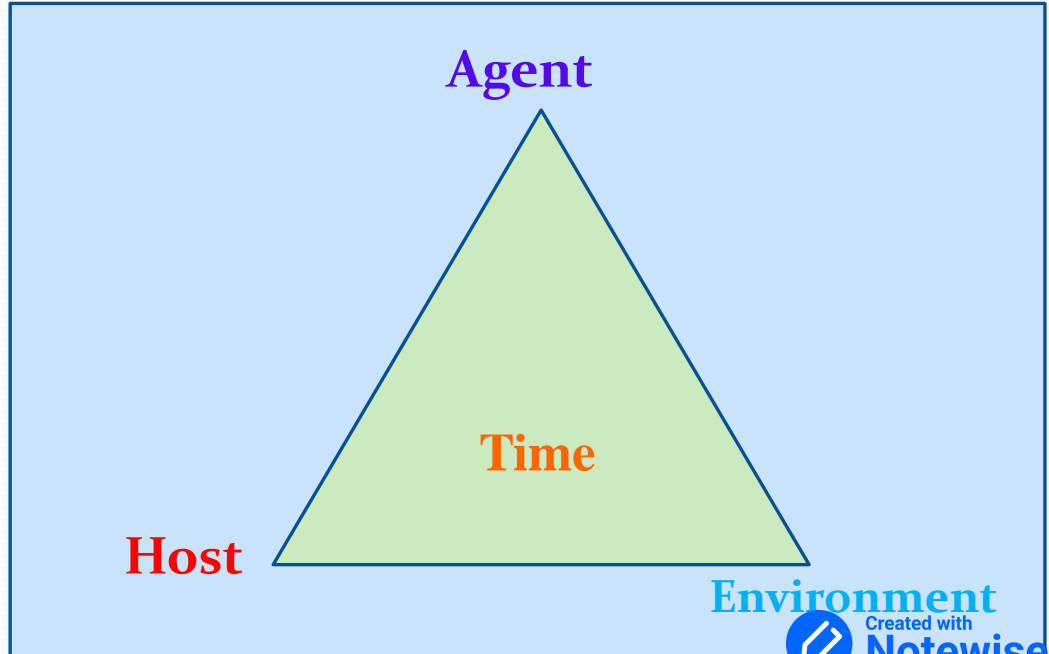
❖ **duration** of the course of illness

Is it chronic or acute?

**Epidemiological
Tetrad**

Epidemiological Tetrad

- Agent
- Host
- Environment
- Time



Disease Occurrence

- Different diseases, in different communities, show different **patterns** of expected occurrence:
 - not just acute infectious diseases are prevalence diseases also chronic diseases like diabetes, hypertension..
- **Endemic**: **habitual or constant presence** of a disease or pathogen within a given geographic area, measured by the **prevalence rate**.
 - continuous existence of the disease
 - when infections occur at first like **hepatitis B** yes firstly it's an acute infection then it becomes chronic and we can transmit the for others and this causes accumulation of cases, also like **malaria** the micro-organism موجود and the vector (الناموسة) موجود so from time to time an epidemic occur, also **salmonella**
 - اولها يتكون incidence rate
- **Hyperendemic**: A disease or pathogen that is constantly present at a **high incidence and/or prevalence rate** and affects **all age groups** equally, or a **persistently high level** of occurrence, **high prevalence rate**, Malaria in Africa.
 - تستند على ال prevalence
 - في رقم محدد لل prevalence اذا كان اعلى منو يكون hyperendemic.. اقل منو hypoenidemic
 - اffect all age groups even animals. like common cold in winter or certain infection in a school, poisoning from a specific restaurant
- **Sporadic**: an **irregular pattern** of occurrence, with occasional cases occurring at irregular intervals (prevalence is zero).
 - small epidemics
 - here we prefer the incidence
 - specific time, acute cases
 - ببشرفى بسرعة

increase in incidence rate more than usual

Epidemic: occurrence in a community or region of a group of illnesses of similar nature, clearly **in excess of normal expectancy** and derived from a **common** or from a **propagated** source.

Common source: one person transmitted the disease to a group of people then stopped

propagation: after this person transmitted the disease to a group, this group continued transmitting the disease

اذا حكينا طفل صار معو جدري بالروضة و عدى اصحابو و هم مو ماخدين ال vaccine هيك الصف كلو صار معو جدري... what determines if it is excess?
last month cases where much less than this month

• Public health officials often use the term **outbreak**, which means the same, because it is **less provocative to the public**.

لفترة معينة و اختفى زي مدرسه، روضة short epidemic

measured by incidence rate some time they call it attack rate

• When an epidemic **spreads over several countries or continents**, affecting a large number of people, it is called a **pandemic** (worldwide epidemic).

like Corona

The Theory of “Web of Causation”

- The “epidemiological triad theory” was very effectively used by Leavel and Clark in explaining the **natural history of disease and levels of prevention** for avoiding such departures from the state of health.

we always take causation of communicable disease only but here they said that we should consider non-communicable diseases also

- But it could **not explain the causation of non communicable diseases** like IHD or road accidents.

↪ what are factors of

- ↪ individual causes for ex he is drunk, معو صار ischemia
- ↪ environmental causes it's raining or snowing
- ↪ mechanical causes سيارتو خرابانة

Web of causation

- McMahan and Pugh forwarded the theory of “**epidemiological web of causation**”, wherein the **various factors** (e.g. hypercholesterolemia, smoking, hypertension) are like an **interacting web of a spider**.
↳ genetic factor, lifestyle, alcohol abuse

- **Each factor has its own relative importance** in causing the final departure from the state of health, as well as **interacts with others**, **modifying** the effect of each other.
كل عامل الو دور
↳ triggering, increasing or decreasing..

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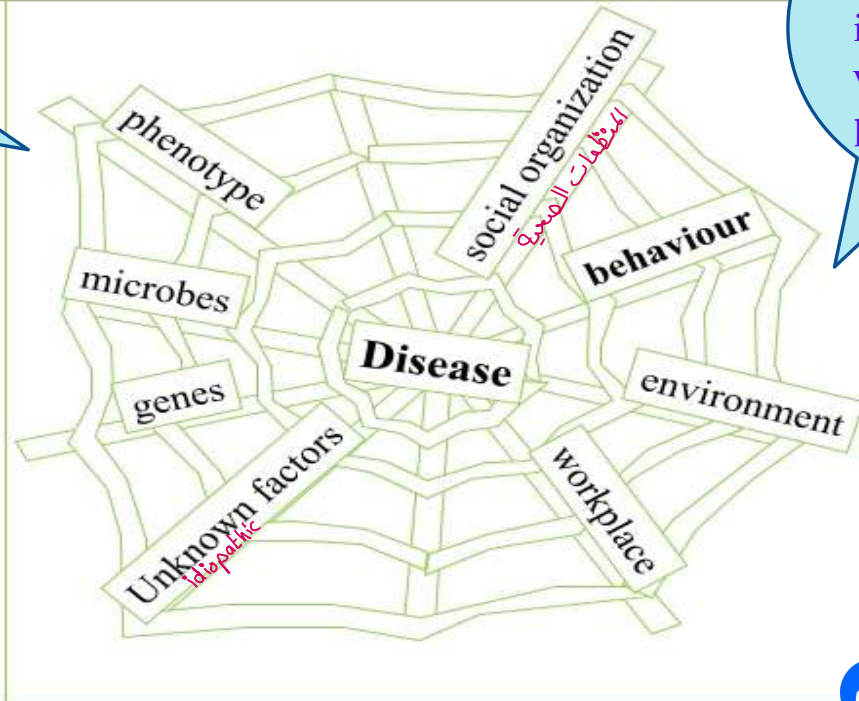
In summary:

- ❖ The epidemiologic triad is enhanced to understand communicable diseases.
- ❖ Web causation can be used for non- communicable diseases as well as communicable diseases..

There is no single cause /
multi-factorial
causes

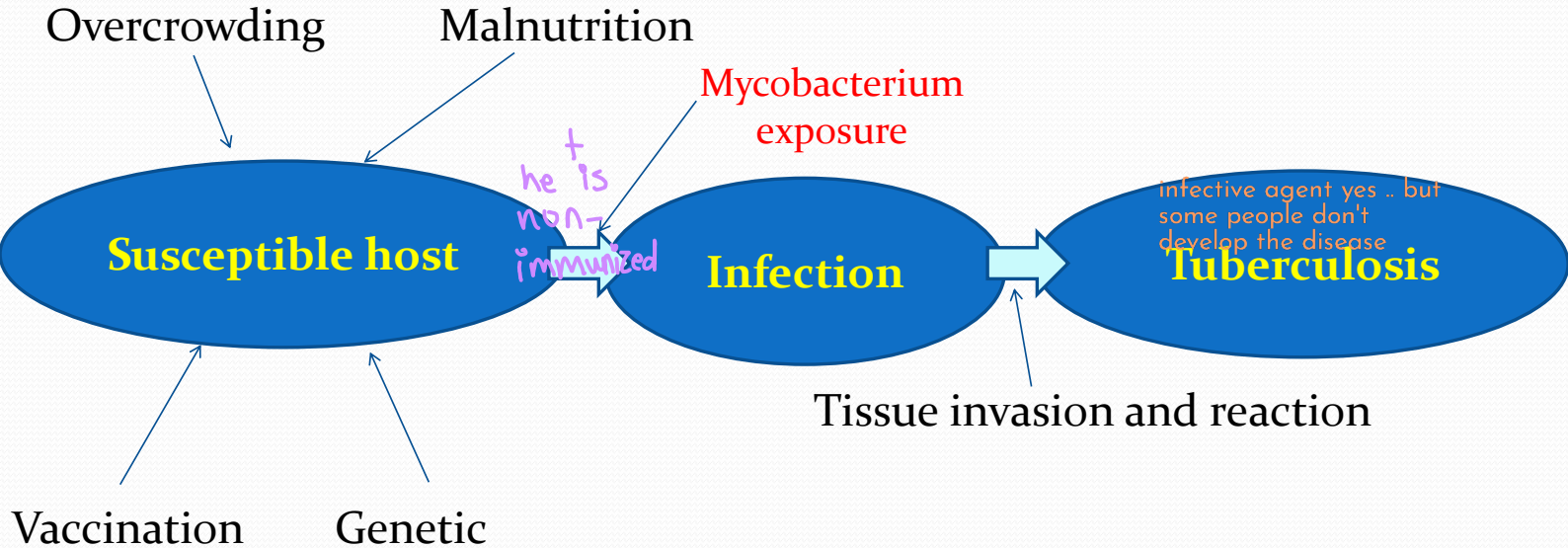
اكثر من عامل
interacting
مع بعض

Web of Causation

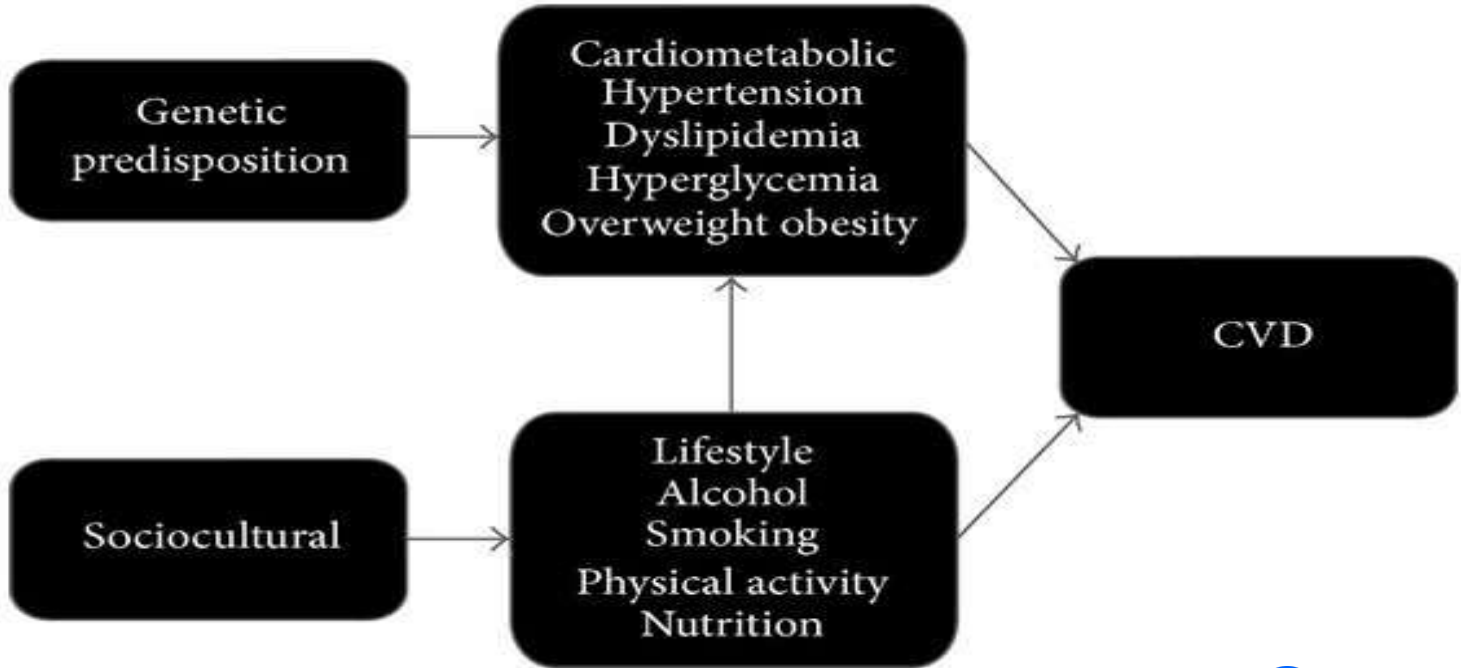


Causes of disease are interacting in various pathways

Example on Web of causation



Example on Web of causation CVD



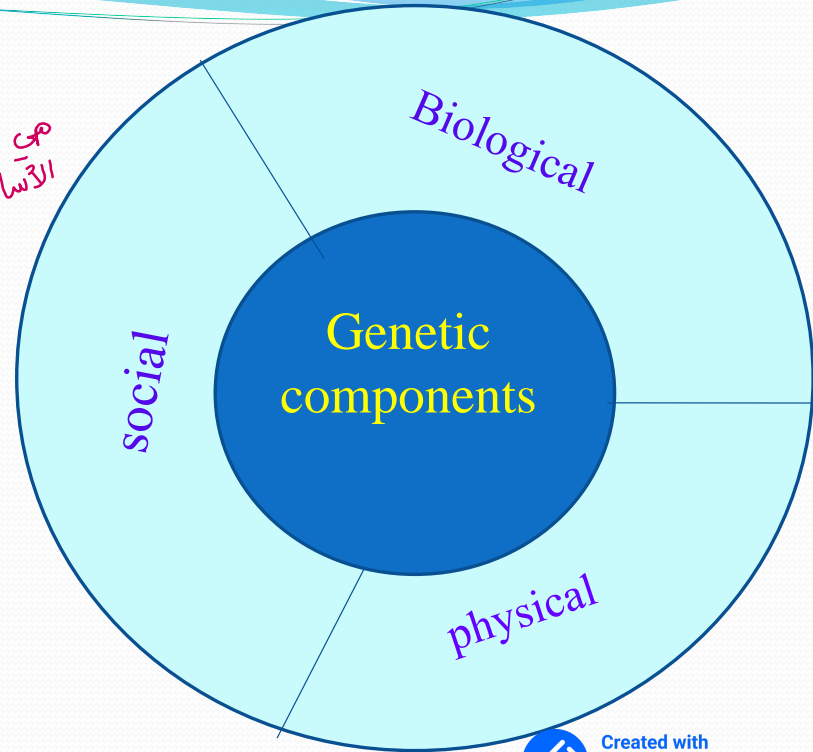
Wheel theory

اعطينا دورا كبر لـ
genetic and environmental factors

- As medical knowledge advanced, an additional aspect of interest that came into play is the comparative **role of “genetic”** and the **“environmental”** (i.e. **extrinsic factors outside the host**) factors in causation of disease.
- The “triad” as well as the “web” theory does not adequately cover up this differential.
- To explain such relative **contribution of genetic and environmental factors**, the “wheel” theory has been postulated.

Wheel theory

- The theory visualizes human disease in the form of a wheel, which has a **central hub representing the genetic components** ^{مركز الأساس} and the **peripheral portion representing the environmental component**.
- Like any wheel, the outer part (**environmental component**) has spokes (3 in this model) and the environmental component is thus divided into 3 subcomponents, representing the **social, biological and physical** components of the environment.



Necessary Vs Sufficient

Necessary

- The presence of this factor always result in disease.
- Example: Rabies virus for rabies

Sufficient

- is not a single factor, but a minimum set of factors and circumstances that, if present in a given individual, will produce the disease.
- Example: Mycobacterium TB for TB

yes it is sufficient ←
ليس لها سكن ما تدري → I need more factors

Necessary Causes vs. Sufficient Causes

✚ If someone says that A (cause) causes B (disease):

✚ If A is necessary for B (**necessary cause**) that means you will never have B if you don't have A. In other words, if one thing is a **necessary** cause of another, then it means that the **outcome can never happen without the cause.**

However, sometimes the cause occurs without the outcome.

✚ If A is sufficient for B (**sufficient cause**), that means that if you have A, you will ALWAYS have B. In other words, if something is a **sufficient** cause, then every time it happens the outcome will follow. The **outcome always follows the cause.** **However, the outcome may occur without the cause.**

there is other factors that affect the occurrence of the disease even if the sufficient cause doesn't exist

✚ If A is *neither necessary nor sufficient* for B then **sometimes** when A happens B will happen. **B can also happen without A**. The cause sometimes leads to the outcome, and sometimes the outcome can happen without the cause.

✚ If A is *both sufficient and necessary* for B, B will never happen without A. Furthermore, B will **ALWAYS** happen after A. The cause always leads to the outcome, and the outcome never happens without the cause.

Examples

All four circumstances are types of causality that occur in the real world. Some examples are:

❖ **Necessary but Not Sufficient:** Thus , tubercle bacillus is a necessary, not a sufficient cause. This true for most the infectious causes. *لازم تكون في اسباب تانية معو زي ال malnutrition, overcrowding*

❖ **Sufficient but Not Necessary:** ^{قطع الرأس} Decapitation is sufficient to cause death; however, people can die in many other ways. Therefore, decapitation is not necessary to cause death. *قطع الرأس بسبب الموت لكن هناك اسباب تانية برضو بتسبب الموت*

❖ **Neither Necessary nor Sufficient:** ^{Sexually transmitted disease} Gonorrhea is neither necessary nor sufficient to cause pelvic inflammatory disease. A person can have gonorrhea without ever developing PID. They can also have PID without ever having been infected with gonorrhea.

❖ **Both Necessary and Sufficient:** A **gene mutation** is both necessary and sufficient for the development of the disease. Everyone with the mutation will eventually develop the disease. No one without the mutation will ever have it.

