Brief introduction to epidemiology and its application & significance in clinical research

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Abstract - Epidemiology is a branch of medical science that focuses on studying the patterns, causes, and effects of health-related conditions in a defined population. It plays a crucial role in understanding the distribution and determinants of diseases, as well as developing strategies to prevent and control them. By analyzing data and conducting research, epidemiologists aim to improve public health outcomes and address the health needs of communities.

Epidemiologists investigate various aspects of diseases, including their occurrence, distribution, and risk factors. They examine how diseases spread, identify patterns and trends, and seek to understand the factors that contribute to their development. Through their work, they provide valuable insights into the impact of diseases on individuals and populations, helping to inform public health policies and interventions. This article intents to discuss briefly about significance of epidemiology in clinical research and its advancements.

Key words – Epidemiology, Clinical research

Introduction

Epidemiology is the study of distribution and determinants of disease in human population.
The term derives from the word 'epidemic', a word used by Hippocrates when describing the disease that was '*visiting the people'*
Modern use of the term retains the restriction to human populations but has broadened the scope to include any type of disease, including those that are far from transient.
Thus epidemiologists study chronic diseases, such as Asthma, as well as such infectious diseases as cholera that might be inferred from the idea of an 'epidemic'
The distribution of disease studied is often a geographical one, but distribution of age, sex, social class, marital status, racial group and occupation are also often of interest. Some times the same geographical population is compared at different times to investigate trends in the disease. As an example, consider breast cancer as the disease of interest. This is one of the leading causes of death among women in industrial countries, but epidemiological studies have shown it to be much more common in northern latitudes than in other parts of the world.

"Epidemiology is usually regarded as a branch of medicine that deal with populations rather than individuals."
The clinician considers the best treatment and advise to give each individual patient, the epidemiologist considers what advice to give to the general population in order to lesson the overall burden of disease.
The fascinating history of epidemiology is illustrated by Stolly and Lasky (1995) in their nontechnical account of subject. Several of the pioneer works area reproduced in Buck et.al (1988), which gives a commentary on the development of epidemiology thinking. An alternative annotated collection of key papers is provided by Ashton (1994)

Importance of epidemiology in public health

Epidemiology plays a crucial role in public health by providing evidence-based insights into disease prevention and control. By studying the distribution and determinants of diseases, epidemiologists identify risk factors that contribute to their development. This knowledge allows public health officials to implement targeted interventions and policies to reduce the burden of diseases on communities.

One of the key contributions of epidemiology is its ability to identify disease outbreaks and monitor their progression. Epidemiologists work closely with public health agencies to detect and investigate outbreaks, enabling swift responses to contain the spread of diseases. Through their surveillance systems, epidemiologists can track disease trends, identify hotspots, and implement timely interventions to mitigate the impact of outbreaks.

Epidemiology also plays a crucial role in identifying risk factors for diseases. Researchers analyze data from population-based studies to identify associations between certain behaviours, exposures, or characteristics and the development of diseases. This information helps inform public health campaigns and interventions aimed at reducing the prevalence of risk factors and promoting healthier behaviours.

Furthermore, epidemiology contributes to the development of prevention strategies. By understanding the factors that contribute to the development of diseases, epidemiologists can design and implement interventions that target these specific risks. This may involve implementing vaccination programs, promoting healthy lifestyle choices, or improving environmental conditions to reduce disease transmission.

Overall, epidemiology is essential in guiding public health policies and interventions. It provides the evidence needed to make informed decisions and allocate resources effectively. By studying diseases and their impact on populations, epidemiologists contribute to improving health outcomes and reducing the burden of diseases on communities.

Epidemiology utilizes a range of methodologies and approaches to gather and analyze data. Researchers collect information through surveys, interviews, and medical examinations, among other methods. They then apply statistical techniques to analyze the data and draw meaningful conclusions. This data-driven approach allows epidemiologists to identify associations between risk factors and diseases, as well as evaluate the effectiveness of interventions.

Epidemiology is closely intertwined with other disciplines, such as biostatistics, environmental health, and social sciences. By integrating knowledge from these fields, epidemiologists gain a comprehensive understanding of the complex factors influencing health outcomes. This interdisciplinary approach enables them to take a holistic view of diseases and develop comprehensive strategies for prevention and control.

Discussion

Case studies: The work of Doll and Hill

In the period up to 1945 shortly after the second world war there was a huge increase in the number of deaths de to lung cancer in England and wales, as well as in another industrial countries.

For instance the lung cancer death rate amongst men aged 45 and over increased six fold between 1921-1930 and betweeen1921-1930and between 1940-1944 in England and wales (Doll and Hill, 1950)

Various factors could be explained the increase, including the possibility that it was an artifact for improved standards of diagnosis. Etiological explanations put forward included increases in atmosphere pollutions and smoking. Certainly pollution and smoking were known to have increased such that the corresponding increase in lung cancer mortality came later.

Scope of Epidemiology: Historically, epidemiology was largely concerned with infectious diseases and mainly epidemics. But the concept is no longer today. The scope of Epidemiology has expanded to include both infectious and non-infectious diseases such as nutritional deficiency status mental disorders, hypertension, accidents, cancer and degenerative diseases.

Uses and purposes of Epidemiology:

1.**Diagnostic Purpose**: Just a doctor caring for an individual patient requires diagnosis so does the community health worker needs 'community diagnosis' or group diagnosis. The clinical dictum of diagnosis before treatment holds true for both clinical and community health practice. Epidemiological studies provide data for community diagnosis.

2.Identification of determinants of disease: on of the most important purposes of epidemiological studies is the identification of determinants of disease whose manipulation could lead to prevention and control of disease.

3.Evluation of Methods of disease control: Any programme designed to prevent and control a disease must be accompanied by methods for assessing whether the measures are effective in reducing frequency of disease. If the study reveals that the method being used is not effective the necessary alterations made accordingly.

4. Observation of natural history of disease: Knowledge of disease natural history is essential to make the likely outcome of patients illness.

5. classification of disease: The epidemiologist character tics of a disease are an integral part of its basic description by means of which it is defined and crcognised.

Epidemiological Concepts:

Basic Assumptions: There are two basic assumptions in Epidemiology.

1.Non-random distribution of disease: The distribution of disease is in human population is non random. Why certain individuals or groups get disease, while others does not, could be explained epidemiologically.

2. Human disease has casual and preventive factors that can be identified through systematic investigation of different populations or subgroups of individuals with in populations in different places or at different times.

Ecological approach to disease

In Epidemiology the occurrence and distribution of disease are studied against the background of various circumstances in man's total environment – physical, biological and social.. The Ecological approach to disease. More than one factor be present for disease to develop is referred to as 'multiple causation or multifactorial etiology'. Factors affecting the development of disease can be divided in to three groups: Agent, Host and environment.

1.Agent of disease – Etiological factors.

a. Nutritive Elements:

Defeciencies:example, Iron deficiency, marasmus

Excesses: example, Obesity.

b. Chemical Agents: Poisons: Example carbon monoxide

c. Physical Agents: Example Radiation.

d. Infectious Agents:

Metazoa	Example Ascaries
Protozoa	Example Ameba
Bacteria	example Mycobacterium tuberculosis
Fungi	example candiada albicans
Virus	example Rota virus.

2. Host Agents:

a. Genetic, b.Age, c.sex, d.Ethinic Group e.Physiologica state f. Immunologic stte g.preexisting disease h.human behavior.

3. Environmental Agents:

a. Biological Environment witch includes – Reservoirs infection-vectors that transmit disease – plants and animals.

b. Social environment: Socio-economic status- political organizations- culture.

c. Physical environment: Such as heat, light, air, water, radiation, gravity, atmosphere, pressure and chemical agents.

Hard Immunity: This is the level of immunity in a a community as a whole.

Spectrum of Disease: In infectious diseases this spectrum is , usually known as the 'gradient of infection', which reflects the sequence of manifestations of illness in the host reflecting his response to the infectious agent.

Clinical Trials

Single Blind Trial: In this study two group of patients were taken for study to see the efficacy of the drug. The clinician only know which group of patients get placebo and which group of patients get treatment.

Double Blind Trial: Under this trial neither the patient nor the clinician knows which group of patients gets placebo or treatment. Only Investigator knows about treatment group and placebo group.

Cross over Trial: In this each treatment is given, at different times of each subject, subjects are randomly assigned to one of the 3 groups.

Group- I	A	B	C
Group-II	B	C	A
Group-III	C	A	B

COHORT STUDIES

They are Longitudinal in which sample is cohort.

Cohort is a group of persons exposed to same sort of environment such as newborn, women between 15 to 45 years of age, or workers exposed to radiation, or other kinds of hazards in occupation. Cohort study could be prospective such as follow-up of morbidity and mortality in infants from birth to one year of age or it could be retrospective from birth to one yeara of age or it could be retrospective inquiry such as number of persons in the same population who suffered from Typhoid in the last 5 years.

Advantages: 1. Cohort studies gives direct information on the sequence of happenings. This is ideal for demonstrating causality.

2. Many disease can be studied simultaneously. We do this by ensuring that we record episodes of all required diseases during the follow-up.

Disadvantages: 1. Cohort studies are often expensive and time consuming.

2. They area not suitable for diseases with long latency because the time period for the study would then become unacceptability. For example young disease smokers and non-smokers were followed up to investigate lung cancer, we might at least to plan for 20 years time horizon, in order to give the Tumors to grow and be identified.

3. Cohort studies are not suitable for rare diseases.

4. There may study effect. During long course of time they may change their dietary habits example they patients of Coronary Heart Disease may change their dietary habits.

5. Exposure to the factor of interest may change . For instance smokers may quit with in a few weeks of the base line study and yet continue to be counted among the smokers in subsequent analysis.

6. Withdrawals may occur.

Alternative Design with Economic advantages:

1. Omission of the nonfactor Group. This is not recommended because with out parallel study of the control group, we can not judge the effects seen are due to the factor.
2. Use of external comparison group rather than a nonfactor group.
3. Mortality, rather then Morbidity, is the outcome recorded.
4. Event notification arises from routine statistics, rather than special observation.

COHORT LIFE TABLE

Time (t)	No. of free of disease (n)	No. of events (e)	Interval Risk(q)	Interval survival (p)	Cumulative survival (s)
0	1000	5	0.0050	0.9950	0.9950
1	995	10	0.0100	0.9899	0.9850
2	985	20	0.0203	0.9797	0.9650
3	965	35	0.0363	0.9637	0.9300
4	930	50	0.0538	0.9462	0.8800
5	880				

$Q=e/n$, $p=1-q$, $s_t=p_0\ p_1\ p_2\ldots\ldots p_t$

MEASURING DISEASE

Morbidity: Deals with disease pattern (being sick with disease)

Mortality: Deals with death (death due to disease)

Incidence : is the number of new cases of the disease within a specified period of time.

Prevalence: is the number of existing cases at a particular point of time.

P = ID , where as P= prevalence, I = incidence, D= average duration.

$$\text{Prevalence Rate at mid – year} = \frac{\text{No.of people with disease at mid year}}{\text{Mid year population}}$$

$$\text{Incidence Rate for the year} = \frac{Number\ of\ new\ cases\ of\ disease\ in\ the\ year}{mid-year\ population}$$

Ecological data:When ever we have grouped data that data is called ecological data. Example patients suffering from lung cancer dot to smoking cigarettes.

Study Designs:

An epidemiological study could be designed in several ways so as to collect new data. The basic principle should be always be followed: A study should be comparative and should seek to avoid all positional causes of bias.

Doll and Hill included controls as well as cases .Example:

	Cancer affected	Cancer not affected	Total
smokers	30	70	100
Non smokers	10	90	100
Total	40	160	200

The main classes of study type may be identified.

1.Observational:In this data are collected simply to see what is happening. Example given below.

Table showing Tobacco consumption by case control study by sex for patients

No. of cigarettes/day	Males		Females	
	Cases	Controls	Cases	Controls
Never-smokers	2	27	19	32
1-4	33	55	7	12
5-14	250	293	19	10
15-24	196	190	9	6
25-49	136	71	6	0
50 OR MORE	32	13	0	0
TOTAL	649	649	60	60

2.Interventioal Study: is an experiment that things are made to happen.
In Interventional study we should take a large group of people who had never smoked and had no evidence of disease, and to ask a randomly selected haft to smoke heavily and the rest to continue abstain. After several years, the disease experience would be compared between, between the two groups, smokers and non smokers. Results from such a study would give very strong evidence of a casual effect of smoking.

3. Survey Study:
In this study usually a sample are observed or questioned to seek information on risk factor exposure on disease status.

4.Case control studies:
In this design first step is a case-control, we detect a number of people with the disease under study it., first group of patients having some particular ailment, in the 2nd group of cases free from ailment. The cases and the controls are then investigated to see the risk factors difference between them.
Group-I- cases with ailment
Group-II controls- free from disease.
Advantages:1. Case contdrol studies are quicker and cheaper than follow up studies.
2.Many risk factors can be studied symaltaniously.
3.case controls studies are particularly well suited to investigations of risk factors for rare diseases.
4.this study requires small sample size than other studies.
5.Case control studies are usually more equally balanced with equal sample size.
6. Transient risk factors, such as contaminated food, pollution caused through industrial accidents are ideally studied through this.

Disadvantages:
1.Case control study do not involve time sequence and are not able to demonstrate causality
2.Being a case might reflect survival rather than morbidity.
3.Case control studies can investigate only one disease.
4.case control studies can not provide valid estimate risk
5.Case control studies are very likely to suffer from bias error but this can be over come by single blind study.

Conclusion:

The Impact of Epidemiology on Public Health
In conclusion, epidemiology plays a vital role in public health by providing valuable insights into disease occurrence, risk factors, and patterns. Through rigorous data collection and analysis, epidemiologists inform evidence-based policies, develop targeted interventions, and contribute to disease prevention and control efforts.

While there are limitations and challenges in epidemiological research, recent advancements in technology and interdisciplinary collaborations have opened new avenues for progress. Precision epidemiology, real-time data collection, and the integration of social determinants of health are expected to shape the future of the field.

As we continue to face new health challenges, epidemiology will remain essential in our efforts to improve population health outcomes. By combining statistical analysis, research methodologies, and a multidisciplinary approach, epidemiologists will continue to shape our understanding of disease prevention and control, ultimately leading to healthier communities.

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