UNIT 1 EPIDEMIOLOGY

Contents

1.0 Introduction

1.1 History of Epidemiology

1.2 Type of Study Designs

- 1.2.1 Observational Studies
  - 1.2.1.1 Descriptive Studies
    - 1.2.1.1.1 Case Reports
    - 1.2.1.1.2 Case Series
  - 1.2.1.2 Analytical Studies
    - 1.2.1.2.1 Ecological Studies
    - 1.2.1.2.2 Case-control Studies
    - 1.2.1.2.3 Cross-sectional Studies
    - 1.2.1.2.4 Cohort Studies
- 1.2.2 Experimental Studies
  - 1.2.2.1 Randomized Studies
    - 1.2.2.1.1 Randomized Clinical Studies (trials)
    - 1.2.2.1.2 Field Trials
    - 1.2.2.1.3 Community Trials
  - 1.2.2.2 Non-randomized Studies (trials)
    - 1.2.2.2.1 Uncontrolled Trials (UTs)
    - 1.2.2.2.2 Natural Trials (NTs)
    - 1.2.2.2.3 Interventional Studies without Control (ISWC)
    - 1.2.2.2.4 Pre and Post Interventional Studies (trials) (PPIS)
    - 1.2.2.2.5 Cross Over Interventional Studies (trials) (COIS)

1.3 Risk Estimation

1.4 Casual Inferences

1.5 Summary

1.6 References

1.7 Answers to Check Your Progress

Learning Objectives

After reading this unit, you would be able to:

- Understand the definition of epidemiology;
- Learn the type of study designs of epidemiology;
- Appreciate how the risk is estimated is performed; and
- Gain knowledge on definition and criteria used for casual inference.

1.0 INTRODUCTION

The term ‘epidemiology’ is derived from three Greek words namely ‘epi’(upon), ‘demos’(people) and ‘logos’(study) collectively meaning ‘study upon people’. This branch of science studies all aspects of human health and diseases.

* Contributed by Dr. SAA Latheef, Department of Genetics and Biotechnology, Osmania University, Hyderabad

Epidemiology is defined as "the study of the distribution and determinants of health- related states or events in specified populations, and the application of this study to the prevention and control of health problems."

Check Your Progress

1) What is Epidemiology?

.....

.....

.....

.....

.....

1.1 HISTORY OF EPIDEMIOLOGY

History of epidemiology stretches from 400 B.C. to present day. In this Unit, an emphasis is given on Indian context. Historical milestones are described against each period/year.

Period/year	Milestone
400 B.C.	Hippocrates a Greek physician described the influence of environment on diseases. Defined the words "epidemic" and "endemic".
1334	Clinical trial concept was proposed by Petrach.
1543	Girolamo Fracastoro, a physician from Italy proposed that disease caused by live unseen small particles.
1546	Germ theory of disease was presented in the book titled "De Contagiosis Morbis" authored by Gerolamo Fracastoro.
1646	Rene Descartes, A French scientist, proposed reductionism that is studying one factor at a time and depending on the evidence than imagination.
1662	Individual deaths and their causes in London were discussed. by Johan Graunt in his book entitled "His Natural and Political Observations Upon the Bills of Mortality". He also used quantitative approach on the patterns of birth, death and disease prevalence and proposed Life tables.
1668	Thomas Sydenham from England described the concept of generic diseases.
1675	By developing microscope, Antonie von Leeuwenhoeck, a Dutch scientist showed an evidence for germ theory of disease.
1700	Bernardino Ramazzini, an Italian physician wrote an account on the occurrence of similar cases in workers sharing same space in his book titled "De Morbis Artificum Diatriba".

1706-1777	François Bossier de Lacroix first attempted to classify the diseases.
1707	Pathological investigations of series of sudden deaths in the city of Rome, Italy were delineated in the book entitled "De Subitaneis Mortibus" authoured by Giovanni Maria Lancisi.
1713	Bernardino Ramazzini reported higher rate of breast cancer in nuns than married women.
1747	James Lind a Scottish physician in first clinical trial proved that consuming of citrus fruits cure the Scurvy disease.
1775	A causal association of exposure to suit with higher incidence of scrotal cancer was proposed by Percivall Pott, an English surgeon.
1780	First dengue like illness was reported in India from Chennai.
1798	Cow pox conferring protection on smallpox was proposed by Edward Jenner, a physician from England.
1801	Registration of deaths was introduced in England.
1802	Vaccination for smallpox was introduced in India.
1838	William Farr initiated the national system of death causes in England.
1842	Report on the Sanitary conditions of the Labouring population of Great Britain authored by Edwin Chadwik was published.
1842	Massachusetts system for registration of births, deaths and marriages were introduced in Massachusetts, United States.
1847	Ignaz Philipp Semmelweis, a Hungarian physician, proved that using of disinfected hands while treating pregnant women in obstetric clinics will prevent the occurrence of Puerparel fever.
1850	Report of Sanitary Commission of the State of Massachusetts was published by Lemuel Shattuck in United States 1853 John Snow, an English physician presented a paper on communicable diseases.
1854	John Snow reported source of Cholera outbreak in London.
1893	First International Classification of diseases was adopted by International statistical institute.
1894	Yersina Pestis was discovered by Alexander Yersin, a Swiss/ French bacteriologist.
1897	First vaccine in India was developed for plague by Dr.Waldemar Mordecai Haffkine.
1911	Indian Council of Medical Research was established.
1915	Application of Iodized salt for eradication of goitre was proposed in Switzerland.

1924	Iodine salt was introduced at community level in several countries
1939	AB Hill in England published a textbook entitled "Principles of Medical Statistics".
1948	World Health Organization was established.
1948	Framingham heart study was initiated in Framingham, Massachusetts, United States with a cohort of 5209 men and women aged 30-62 years to identify risk factors for cardiovascular diseases.
1950	Three case control studies on association of smoking and lung cancers were published by Morton L. Levin and co-workers, Ernest Ludwig Wynder and Evarts Ambrose Graham and Richard Shaboe Doll and Austin Bradford Hill.
1950	Methyl mercury poisoning of fish known as Minamata Disease was reported in Japan.
1950	Dengue was first discovered in Philippines and Thailand.
1951	British Doctors Cohort study was initiated by Richard Doll and Austin Broad Ford- Hill in England.
1952	Zika virus disease in humans was first reported in Uganda and United Republic of Tanzania.
1952	Primary Health Centres were started in India.
1953	United States Veteran's study on a cohort of 220000 males was commissioned by Harold Dorn.
1953	National malaria control programme was started in India.
1954	E.Culer Hammond and Daniel Horner initiated a study on the relationship of smoking and lung cancer in New York.
1954	Salk vaccine trial was initiated in United States to test the efficacy of Salk's killed virus to prevent poliomyeolitis.
1955	National Leprosy Control Programme was launched in India.
1957	Jerry Morris, a Scottish epidemiologist published first textbook on Non-communicable disease epidemiology textbook entitled "Uses of Epidemiology".
1957	Ancel Keys initiated Seven Countries Study to study the relationship of diet and coronary artery disease.
1962	National Tuberculosis Control Programme was initiated in India.
1963-1964	First clinically proved dengue case was reported in Kolkata, India.
1964	United States Surgeon General's report on smoking and health was submitted.

1965	A. Bradford-Hill in England proposed nine points to establish the casual association of disease.
1966	The last human plague case was reported in India.
1975	Eradication of smallpox was announced in India.
1976	Ebola virus disease was reported in Sudan and Democratic Republic of Congo.
1980	Eradication of smallpox was announced by World Health Organization.
1981	First case of human immune deficiency was reported in United States.
1983	First National Health Policy was proposed in India.
1984	Guinea worm eradication programme was initiated in India.
1985	Universal Immunization Programme was started in India.
1986	HIV case first reported in India.
1992	Centre for disease control and prevention, United States was Established.
1992-93	First national health family survey was conducted in India.
1993	Revised national tuberculosis control programme was launched in India.
1997	National polio surveillance programme was initiated in India.
1999	National Institute of Epidemiology was established in India.
2002	Severe acute respiratory syndrome was reported in two patients in South China.
2002	Second National Health Policy was proposed in India.
2005	National Rural Health Mission was initiated in India.
2010	National programme on prevention and control of cancer, diabetes, CVD and stroke were initiated in India.
2017	Third National Health Policy was presented in India.
2017	First outbreak of Zika virus disease reported in India from Gujarat and second outbreak in Tamil Nadu.
2018	International classification diseases version 11 was released.
2018	Ayushman Bharat, a national health protection scheme was launched.
2019	SARS Corona virus-2 discovered in Wuhan of Hubei Province.

1.2 TYPE OF STUDY DESIGNS

Epidemiological study designs can be broadly divided into two categories namely, Observational studies and Experimental studies.

1.2.1 Observational Studies

In observational studies, frequency and distribution of diseases or deaths are reported by time (year/month/week/day/hour/season), place (country/urban-rural/ institutions/hospitals/old age homes/ schools) and demographic characteristics (age/sex/income/education/occupation/marital status, religion/caste). Observational studies are categorised into two types – (i) Descriptive and (ii) Analytical studies. In descriptive studies, only description about the disease (case reports/case series) is made whereas in analytical studies (ecological/case-control/ cross-sectional/cohort) relationship of variables (causative factors) with diseases is described.

1.2.1.1 Descriptive Studies

Descriptive studies are again of two types, case reports and case series.

1.2.1.1.1 Case Reports

In case reports, cases with unusual symptoms, signs and characteristics or death observed during clinical practice are reported by the clinician's presentations which are helpful to define new clinical disease/entity. These case reports are useful in clinical practice, formulating hypothesis and explore in epidemiological studies. Example: coagulopathy in patient with renal failure.

1.2.1.1.2 Case Series

When new clinical entities/new cases or deaths with common characteristics, symptoms or signs are compiled by single or group of clinicians they can be called case series. They are useful for definition of new cases, to understand the spectrum of symptoms and signs, when followed till the death of patients which are useful to investigate the natural history of disease. The data are usually collected from clinicians and sometimes from populations in case of sudden deaths within a defined geographical area. Data of case series can be used to know the distribution of disease by place, time, religion, ethnicity, season and socio-economic status. Acquired immune deficiency syndrome is defined as new disease after publication of case series of young men contracted with *pneumocystis carinii pneumonia* and *Kaposi's sarcoma*. Case series data can be used to formulate hypothesis, easy to collect, cost effective and quickly available. Case-series data cannot be used to calculate rates of disease as no denominator is available, involve no comparison group, suffer from sampling variation and recruit only selective cases. Example case series on symmetrical acrokeratoderma (dermatosis).

1.2.1.2 Analytical Studies

Analytical studies are of four types**:**

1.2.1.2.1 Ecological Studies

In this type of studies, association between disease/outcome frequency and the level of exposure in groups of within or between populations is studied. Population not the individual is the unit in this kind of study. Grouping can be done based on the place (birthplace/residence/factory/school), socio-economic status, time or by mixing place and time. Ecological studies are used for generation of hypothesis.

Data from public/private sources, registries/death certifying organizations and earlier surveys can be used. For example, in this type of study, investigating the incidence of cancer in different countries can obtain the details on age distribution and disease status from census data and tumour registries. Example: spatial spread of leprosy in India.

1.2.1.2.2 Case-control Studies

These studies investigate the aetiology of disease, suitable for studying rare and longer duration of (chronic) diseases, cost effective, require less number of subjects, easy to perform, no risk is done to subjects, multiple risk factors can be studied at the same time, no dropout of subjects is observed, has minimal ethical problems and can be completed within short duration. The unit of study is individual. Newly diagnosed cases are compared with subjects without disease. Exposure to potential risk factors in both cases and controls is evaluated by examining case sheets/enquiry of patients or patient relatives/controls or by performing biochemical tests. These studies are called retrospective (as the study deals backwards from outcome/disease to cause) and prospective (if the data collection is still in progress).

Cases are recruited from hospitals/patient registries/cross sectional study/case-series/cohort study. Controls are drawn from same geographic area/spouses/ friends, from same office/factory/institute or patients diagnosed with other disease from same hospital. Cases and control can be matched for age, sex, and ethnicity, social class (income, education and occupation) to reduce selection bias. The association between exposure (causative agent/risk factor) and disease/outcome is evaluated by Odds ratio. Demerits of case-control are difficulty in finding suitable controls, subjects may not be representative of population, prevalence/ incidence or attributable risk cannot be estimated, efficacy of therapeutics cannot be evaluated, not possible to distinguish between causative or accompanying factors, suffers from confounding(due not mismatching of subjects), recall (cases more likely recall the presence of events), selection (subjects not recruited as per standard criteria), Berkesonian (recruitment of subjects from sub population than general population) and interviewer bias. Example: Utility of anthropometric traits and indices in case-control study.

1.2.1.2.3 Cross-sectional Studies

In these studies, both exposure and outcome (disease) are investigated at the same time. No temporal associations between exposure (risk factors) and outcome can be explained. The unit of the study is individual. These studies are useful for investigating chronic diseases and fixed exposures such age, gender, ethnicity and genotype, to study multiple risk factors simultaneously. These studies are easy to conduct, give inputs on burden of disease which can be used for planning health infrastructure, allocating resources and manpower. It is inexpensive and can be completed within a short period of time. If cross sectional study is repeated on the same population it can serve as cohort study and if repeated on independent sample, it is useful to investigate the trends of the disease. For variable exposure, data on past and present exposures are recorded.

The target population is studied using representative population and the results are extrapolated to this population. These studies are also called prevalence

studies. If prevalence is standardized using the data of standard populations, the prevalence can be compared with other populations. Both disease and determinants can be studied in this type of studies. To avoid sample bias, random sampling techniques are used such as simple, systematic, clustered, stratified, multistage and mixed. The denominator is usually the population at risk or total population studied. Prevalence is presented a per cent or per 1000 subjects. Prevalence studies are of three types depending on the time involved. They are point, period and lifetime prevalence.

Prevalence studies are not suitable for studying the natural history of disease and to estimate the incidence. Subjects deceased or with severe disease are missed out in these studies. It is not possible to distinguish whether risk factor or exposure precedes the outcome/disease or exposure is resulted from the outcome. If investigator fail to gain the confidence of subjects which results in high non-response rate resulting leading to selection bias. This type of study design is not suitable for rare diseases. A statistical technique called Logistic regression analysis can be used to find the association between risk factors and disease. Example: Prevalence of coronary artery disease and coronary risk factors in Tirupati urban population.

1.2.1.2.4 Cohort Studies

These studies are called incidence/longitudinal studies. Cohort means group of population. Groups can be formed based on the date of birth (birth cohort), date of marriage (marriage cohort), decade (decade cohort), occupation (doctors/ lawyers/engineers/teachers), city population (Example: Delhi) etc. Subjects of cohorts have common characteristics/experience/condition. A group is assigned for the study, and exposed and non-exposed cohorts within the same group are identified and followed for particular period. If exposure is rare, this cohort is compared with external cohort matching all characteristics except exposure. Same cohort can be divided into subgroups based on level of exposure and outcome. Diagnostic criteria for outcome of interest are decided at the beginning of the study. Baseline data is collected from cross sectional studies, census and birth registries. Data on exposure are collected by conducting interviews, contacting subjects on mobile/through e-mail, examination of case sheets, conducting of diagnostic tests and environmental surveys such as air or water quality. Subjects with disease are excluded from this study. Both exposed and non-exposed cohort subjects are evaluated periodically on clinical status, performing diagnostic tests, reviewing cash sheets and visiting the subjects for examining the end points (outcome/disease/death) of study. Presence of outcome/disease/death is compared between exposed and non-exposed cohorts. Incidence rates, relative risk (measure of evaluating the strength of association between exposure and outcome), attributable risk (what extent disease is due to exposure) and population attributable risk (suggest to what extent disease is reduced if the exposure is eliminated) are determined and compared between both cohorts. Cohort studies are of three types namely prospective (outcome occur after initiation of the study), retrospective (outcome occurred before the initiation of the study) and mixed (outcome occurred before the initiation of study which is further assessed prospectively). If the newly identified cases in the cohort study if compared with control of the same cohort, it is called nested case-control study. Example for Prospective cohort study of overweight and obesity in rural population of West

Bengal, India and for retrospective cohort study example is maternal and neonatal outcome of gestational diabetes in the subjects of Kerala; Mixed cohort study example is retrospective and prospective cohort study on HIV sero status and incident pneumonia.

1.2.2 Experimental Studies

The experimental type of study designs is employed to find the aetiology of disease, to evaluate the effect of interventions/services and to investigate the cost and benefit analysis of the interventions. Hypotheses are tested using experimental studies. They are broadly divided into randomized or non-randomized studies.

1.2.2.1 Randomized Studies

Randomized studies are classified into randomized clinical trials, field trials and community trials.

1.2.2.1.1 Randomized Clinical Studies (Trials)

In randomized clinical trials, efficacy of medications/new treatments/new devices are investigated. This kind of study design is useful to study the effect of single intervention on multiple outcomes. Randomized clinical trials are performed in hospitals or contract research organizations. Subjects are randomized into treatment or control groups. This randomized can be done using simple (computer generated random numbers, random number tables, flipping coin, throwing dice and schuffling deck of cards), block, stratified, covariate adaptive randomization procedures and online software tools (Suresh, 2011). Randomization reduces the selection bias and ensures that both arms of subjects are equal and comparable except the intervention which causes difference in the outcome. To avoid subject's variation (subjects if knew that change is occurring because of treatment they receive would report favourably on the treatment to the investigator) and investigator bias (if investigator knows who is receiving what type of treatment may give the report on treatment outcome positively), *blinding* is done. Blinding is done in three ways i.e. single (patients not aware of treatment group he/she belongs), double (both patient and investigator not aware of the treatment group) and triple (patient, investigator and external evaluator are not aware of the treatment group). If no standard treatment is available before planning the interventional trial, placebo group is included. Placebo group receive biologically and therapeutically inert material, but they have only psychological satisfaction of receiving treatment. Randomized clinical trials are done in four phases. In Phase I trial, the tolerated dose is identified in either healthy subjects or patients; in phase II, the mechanism of action of drug, absorption, diffusion, metabolism and excretion details of drug are studied in small group patients; in phase III, the efficacy of drug in large number of patients is investigated and in the phase IV, adverse effects of drug after the release of drug in the market are evaluated (Umscheid et al. 2011). RCT meets the requirement of protocol agreed at the time clearance of ethics committee. RCT is performed when there is no information on the intervention intended for the study. RCT requires that subjects enrolled in the study are not deprived of standard treatment and the planned interventions should be best in the light of the present knowledge. At the end of

RCT, clinical endpoints such as death, decrease in the risk /improvement in clinical condition and possible adverse effects are evaluated after completion of the trial. Incidence of outcome is calculated; incidence rate is compared using relative risk and attributable risk between treated and control subjects. Statistical tools such as linear regression for continuous variables, logistic regression for dichotomous outcomes, poission regression for number of events and cox regression for survival analysis are used. RCT can be employed in evaluating the efficiency of health services. For example, in Burlington trial it was showed that nurses and paramedical staff can perform the health care delivery duties on par with physicians (Sackett et al.1974) and impact of training on informal health care providers in correct case management in rural areas of west Bengal is an example in Indian context.

Demerits of RCT includes ethical constraints, cost intensive, require adequate sample size, inference drawn in select population may not be generalised to the general population. These studies are useful to gain understanding on the cause and effect only, not useful for studying disease mechanisms leading to improvement in clinical condition/decrease in the risk, multiple observers are needed, risk of dropout of subjects may happen due to the death, change of residence/job and loss of interest to continue in the study, only single factor can be studied at a time, subjects may not be representative of the reference population, suffers from information bias (result from the way information is collected), volunteer bias (resulting from eligibility criteria and subjective judgments of investigator) and employ surrogate than primary endpoints to enhance efficiency of the study resulting in false negative results.

1.2.2.1.2 Field Trials

This type of trials is conducted in the field i.e. general population and involves healthy subjects or groups. Effect of intervention on the multiple outcomes can be studied in this study design. Randomization is ideal choice but in practice implementing it in the field trials (FTs) is challenging. In FTs, risk factor/exposure or procedures is modified or terminated or stopped to reduce the risk of developing disease. Examples for these trials include vaccine/smoking cessation/chemo prophylactic trials. FTs are used for investigating the common or serious diseases. If the disease is rare then high risk groups are involved. FTs are cost intensive, require large number of subjects and longer period of follow-up. Example: Effect of home-based neonatal care and management of sepsis on neonatal mortality in rural areas of Gadchiroli district, Maharashtra.

1.2.2.1.3 Community Trials

The unit of these trials are communities. In the selected communities, some communities are assigned to exposure and others not. Community trials (CTs) are done for diseases which are influenced by socio-economic status such coronary artery disease (CAD). A risk factor/exposure or behaviour is interrupted in those who have it to prevent the development of the disease. CTs investigate single or multiple risk factors. Example: community trial on prevention and reduction oral diseases among children done in Chandigarh and Cuttack.

1.2.2.2 Non-randomized Studies (trials)

Ethical, financial and administrative constraints, requirement of large manpower, larger sample size and applicability of some interventions to groups than individual limits the use of RCTs and necessitates the employing of non randomized studies (trials). Owing to sampling bias, the interventional and non-interventional groups are not comparable, and the validity of the results may be doubtful. Non-randomized trials are of five types: (1) Uncontrolled trials, (2) Natural studies, (3) Interventional studies without control, (4) Pre and post interventional studies, (5) Cross over interventional studies.

1.2.2.2.1 Uncontrolled Trials (UTs)

These are useful to know the effect of intervention, dose of therapeutic agent and adverse reactions. UTs on using Pap smear test for diagnosis of cervical cancer showed reduction in mortality of cervical cancer. Example: Effect of tacrolimus ointment in Vitiligo conducted in Kolar, Karntaka.

1.2.2.2.2 Natural Trials (NTs)

When observations mimic the experiment those can be used to test the hypothesis of relation between exposure and outcome. Effect of acute stress conditions such earthquake showed higher rates of mortality from cardiac and external cause than other reasons in 1981in Athens, Greece (Trichopolous et al.1983, Park, 2013). Example: Epidemiology of injuries after earthquake in Kutch district, Gujarat.

1.2.2.2.3 Interventional Studies without Control (ISWC)

In ISWC, intervention is assigned to one human group and compared with non-interventional past group. This non-interventional past group is called historical control. Interventional group can also compare with natural population which has similar frequency and characteristics of the disease/outcome to be controlled/ prevented. Example: Study done in Hyderabad evaluating the effect of cyclosporine restriction on incidence of extended spectrum betalactamase gram negative infections in neonates compared with historical control.

1.2.2.2.4 Pre and Post Interventional Studies (trials) (PPIS)

A clinical variable of interest is chosen for this study and measured before and after the intervention in the same group. For example, measurement of blood pressure before and after administering of the antihypertensive drugs. As there is no control group, the change observed is assumed to be due to the intervention. The change in blood pressure may also be due to the reduced salt intake, involvement in physical activity or practising of meditation. Using the same study design, incidence can be compared before and after introducing of interventions in the same group under study. Example: Effect of awareness on the reduction of hypertension prevalence in Kumarokom village of Kottayam district, Kerala.

1.2.2.2.5 Cross Over Interventional Studies (trials) (COIS)

In this design same subjects receive intervention, undergo washout period to reach baseline level and then subjected to second intervention. This design reduces

inter individual variation and requires a smaller number of subjects. COIS is suitable for chronic disease patients where interventions only alleviate the suffering but not cure. Ex. Protective effect of walnut on cardiometabolism in obese.

Check Your Progress

2) Describe the types of epidemiological studies.

.....

.....

.....

.....

.....

1.3 RISK ESTIMATION

The aim of risk estimation is to gain knowledge, to reduce health risks due to chemical exposure and to set standards for the control of exposures. Risk is estimated in four steps and they are: (1) Hazard identification, (2) Dose-response assessment, (3) Exposure assessment and (4) Risk characterisation. Hazard identification investigate what type of harm or risk happen due to the exposure, characterisation and measurement of exposure and validation of methods is done for this purpose. Dose-response deals with the relationship of exposure to the adverse events. The exposure levels are reported as low, medium and high categories and this facilitates the comparison of results between the studies and extrapolation of results. Identification of bias in risk estimation improves the validity of results. In exposure assessment step, both qualitative and quantitative investigation of agents, source of exposure, frequency and duration and determinants of exposures is done in exposed population. This information is used for controlling or prevention of exposure in the exposed population. Risk characterisation involves combined approach which uses both exposure assessment and dose response assessment data to predict the health risk to the population. Identification of bias and measurement errors can be useful for evaluating their impact on risk characterisation. Advantages of epidemiological than animal data in risk characterisation includes less error in exposure information; give importance to the context and exposure patterns in predicting the health effects; genetic variation and better representation of host factors and generalizable than animal data.

Check Your Progress

3) Describe the steps in risk estimation?

.....

.....

.....

.....

1.4 CASUAL INFERENCES

Casual inference may be defined as a measurement of an effect than deciding whether effect is existing or not (Rothman et al.2005). Austin Broadford Hill in 1965 proposed nine-point criteria for deciding the observed epidemiological associations are casual or not. They are: (1) Strength: If the association between exposure and disease is stronger it is more likely to be causal, (2) Consistency: If the observed association between exposure and disease is consistent across populations and usage of different methods then it can be considered as casual, (3) Specificity: If the exposure causes single than multiple diseases it is assumed to be casual association, (4) Temporality: An association is deemed casual when the exposure precedes the occurrence of the disease, (5) Biological gradient: The dose-response relationship when observed between exposure and disease, the association can be termed as casual i.e. more the exposure to the agent the greater will be the severity of the disease, (6) Plausibility: The relationship between exposure and disease if conforms to the evidence of existing scientific literature on aetiology and mechanism of action it is considered as biologically plausible, (7) Coherence: Coherence indicates that exposure and disease association should agree with natural history and biology of the disease, (8) Experiment: Decreased risk of disease due to the modification or prevention of exposure suggests proof of casual association between exposure and disease, (9) Analogy: Analogy should be used to interpret causality for weaker association between exposure and disease. Hill criteria can aid health researchers for drawing casual association between exposure and disease. Integration of epidemiological data with data obtained from using omic tools such genomics, transcriptomics, metabolomics and proteomics may enhance the application of Hill criteria for better characterisation on the casual associations between exposure and disease.

Box 1.1: Epidemiological Study Types

I) **Observational Studies**
- A) *Descriptive study types*
  - i) Case report
  - ii) Case series
- B) *Analytical studies*
  - i) Ecological studies
  - ii) Cross-sectional studies
  - iii) Case-control studies
  - iv) Cohort studies

II) **Experimental Studies**
- A) *Randomized studies*
  - i) Randomized clinical trials
  - ii) Field trials
  - iii) Community trials
- B) *Non-randomized studies*
  - i) Uncontrolled trials
  - ii) Natural studies

iii) Interventional studies without control
iv) Pre and post interventional studies
v) Cross over interventional studies

1.5 SUMMARY

Epidemiology is the study of the distribution and determinants of health-related states or events in specified populations, and the application of this study to the prevention and control of health problems. Information collected using epidemiological methods is used to improve public health.

Epidemiological study designs can be broadly divided into Observational and Experimental. In observational studies, frequency and distribution of diseases/ deaths are reported by time, place and personal characteristics. Observational studies are of two types and they are descriptive and analytical. In descriptive studies, only description about the disease (case reports/case series) is made whereas in analytical studies (ecological/case-control/cross-sectional/cohort), relationship of variables (causative factors) with diseases is described. The other two components, risk estimation and causal inference are also discussed in the unit.

1.6 REFERENCES

Aggarwal, R. & Ranganathan, P. (2009). Study designs: Part 4–Interventional studies. *Perspect Clin Res*, 10:137-139.

Beaglehole, R. & Bonita, R. (2004). *Public Health at the Crossroads: Achievements and Prospects*. Cambridge: Cambridge University Press.

Bonita R, Beaglehole R., & Kjellstrom T. (2006). *Basic Epidemiology,* 2nd edition, Geneva: World Health Organization.

Bhopal, RS. (2002). *Concepts of Epidemiology: An Integrated Introduction to the Ideas, Theories, Principles and Methods of Epidemiology*. Oxford: Oxford University Press.

Gouda, HN& Powles, JW. (2014). The science of epidemiology and the methods needed for public health assessments: a review of epidemiology textbooks. *BMC Public Health*. 14:139.

Last, JM Spasoff RA & Harris SS, eds. (2000). A dictionary of epidemiology. 4th ed. New York, NY: Oxford University Press.

Morgenstern H. (1995). Ecologic studies in epidemiology: concepts, principles, and methods. *Annu. Rev. Public Health*, 16:61-81.

Park, K. (2013) Park's textbook of Preventive and Social Medicine. Jabalpur: Bhanot Publishers.

World Health Organization (WHO). (2005) *Preventing chronic diseases: a vital investment*. Geneva.

Sackett, DL, Spitzer WO, Gent M, et al. (1974). The Burlington Randomized Trial of the Nurse Practitioner: Health Outcomes of Patients. *Ann Intern Med,* 80:137–142.

Trichopoulos D, Katsouyanni K, Zavitsanos X, Tzonou A., &Dalla-Vorgia P. (1981). Psychological stress and fatal heart attack: the Athens. earthquake natural experiment. *Lancet*,26:441-4.

Umscheid C, Margolis DJ, & Grossman CE. (2011). Concepts of Clinical Trials: A Narrative Review. *Postgraduate Med*, 123: 194-204.

1.7 ANSWERS TO CHECK YOUR PROGRESS

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

2) Epidemiological Study designs can be broadly divided into Observational and Experimental. Observational studies are of two types, Descriptive and Analytical. Experimental studies are broadly divided in to randomized or non-randomized experimental studies.

3) There are four steps in risk estimation, and they are: (1) Hazard identification, (2) Dose-response assessment, (3) Exposure assessment, and (4) Risk characterisation.