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# Epidemiology and the Cancer Problem

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# Epidemiology and the Cancer Problem

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## Summary and Key Points

1. Epidemiology analyzes the risk factors, potential treatments and prevention of cancer.
2. Observational studies do not manipulate variables and are used to generate hypotheses.
3. Descriptive studies examine a disease.
4. Analytic studies examine determinates of disease and test hypotheses.
5. Cohort studies are a fundamental study design in epidemiology.
6. Most epidemiologic cancer studies have been case control studies.
7. Experimental studies ideally evaluate one intervention, and are best if randomized between study and control groups.

## Introduction

Epidemiology is the study of populations using defined research methods to confirm the patterns and causes of disease and applying this information to improve the health of the populations. This branch of science is the basis for understanding the spread of diseases in a defined area or group of people. Epidemiologic studies have been instrumental in improving outcomes by establishing preventive and therapeutic measures for the incidence, prevalence and mortality from cancers. The incidence of malignancy in a country or in our world defines the magnitude of the cancer problem. For example, the total incidence of all cancers, excluding non-melanoma skin cancers, in the United States in 2013 will be over 1,600,000 and the total number of deaths will be over 580,000 (Cancer Facts & Figures, American Cancer Society) Epidemiological studies can be broadly divided into Observational or Experimental studies.

## Observational Studies

The observer or investigator does not manipulate the environment or possible causal factors of the study population. Either the disease itself is studied (descriptive studies) or determinants of the disease are studied (analytic studies). Prevalence (total number of cases at a specified time or over periods of time), incidence (new cases in a population over a specified time interval, usually one year) and mortality (number of people dying with disease) are all part of descriptive studies. Observational studies are descriptive and generate hypotheses. The Surveillance, Epidemiology and End Results (SEER), a program of the National Cancer Institute, maintains these data for the USA, based on tumor registries that include approximately 28% of the US population. Cancer Facts and Figures is an annual report from the American Cancer Society**,** whereas the World Health Organization publishes a yearly report through the International Agency for Research on Cancer (IARC) for the world. These reports demonstrate the scope of the cancer problem.

Analytic studies are used to test hypotheses. Ecological studies (studies of groups of people so the results cannot be individualized) help shape policies for regions and governments, etc. Cross-sectional, cohort and case control studies have individuals as the unit participant. In a cross sectional study, the data are collected during a specified period of time. Exposures and disease status are studied together and thus there is limited ability to show causal relationship.

In cohort studies, people who are free of a disease at baseline are followed over a specified period of time. Those individuals who develop a disease are compared with those who do not in the cohort to determine if certain exposures are associated with the disease. In other words, the rate of exposure to a (presumed) risk factor in the affected group is compared to the rate in the unaffected group. These data can reflect cause and effect relationships in real life and so cohort studies are a

fundamental study design in epidemiology. The difference between disease incidence in exposed and unexposed is reported as risk ratio. Both relative and absolute risk can be assessed. Multiple diseases can be studied in relationship to an exposure and information on the natural history of a disease is also ascertainable. Generally, cohort studies need to have a very large at risk population, are costly and need to have long follow up time. A classic example of a cohort study is the analysis of lung cancer risk in British physicians which clearly established a link between cigarette smoking and lung cancer.[1]

In contrast to cohort studies, case control studies are retrospective analyses. In a case control study, patients with a disease (cases) are compared with an unaffected sample (controls) population. The analysis of the characteristics of the cases and controls attempts to find one or more characteristics that are associated with the cases. This is a less costly, less time consuming way to reach the same conclusion that a cohort study would have shown in the larger population. Exposure odds ratio, the odds of exposure in cases divided by the odds of exposure in controls is calculated. Case control studies start with the presence or absence of a disease, and work backward to look for exposures (usually to presumed possible risk factors).

Incidence risk or rate cannot be measured in case control studies, because the total number of potential individuals at risk, the population from which the cases arose, or the denominator, is unknown. However, if the disease in question is rare, the odds ratios would approximate the relative risk. Most cancer related epidemiological studies have been case control studies as many cancers are not common and take a long time to develop. As an example, a case control study was used to establish a link between human papillomavirus and head and neck cancer.[2]

### Experimental Studies

An experimental epidemiological study tries to show a causal relationship of an exposure to an effect. At the same time, removal of an exposure can be related to an outcome. This type of a study can be shown to improve an outcome or to prevent an occurrence. Usually, the hypothesis is generated from an observational study or a previous experiment. Experimental studies are playing an increasing role in understanding the genetic nature of cancer. An experiment can be done at an individual level or in a community. The best experiments are considered to be the ones with a control sample and all other factors or exposures the same as the experimental sample except for the pre-specified intervention. To prevent any obvious treatment biases, the subjects of the experiment are randomized to control arm vs. intervention arm via remote computer and placebo is given to the control sample. Statistical methods are employed to set a sample size; audits and interim analyses are planned to assess compliance and prevent harm to study subjects. An example of an experimental study that pointed to a causal relationship between an exposure and a cancer is the Women's Health Initiative study of post-menopausal hormone replacement. [3]

### Conclusion

Epidemiology is one of the core basic sciences of modern medicine. It is especially important in the advancement of oncologic knowledge; most advances today are proven by the use of randomized controlled trials. Understanding of the differences between types of studies is a critical component of life-long learning for all physicians.

**Thought Questions**

1. A number of case control studies conducted in the last decades of the 20th century suggested that hormone replacement therapy (HRT) with estrogen and progesterone in women after menopause could lower the risk of heart attack. However, the Women's Health Initiative (WHI) study, a prospective, randomized, placebo controlled trial of HRT, subsequently showed that neither estrogen plus progesterone nor estrogen alone (for women who had a hysterectomy), affected the risk of heart attack. Importantly, the WHI also showed that the use of estrogen and progesterone as HRT significantly increased the risk of breast cancer. Why would case control studies have shown a cardiac benefit from HRT? To state the question differently, what characteristics of case control studies could introduce bias that would produce results different from a prospective, randomized trial?

   Your answer

   Expert Answer

2. The emergence of the human immunodeficiency virus (HIV) in the 1980's led to a host of epidemiologic studies designed to understand the effects of the virus. Imagine that you wanted to see what effect HIV had on the risk of developing cancer. Describe the differences between observation, cohort, and case control studies in patients with HIV where the goal of the studies is to determine the risk of cancer in HIV infected individuals.

   Your answer

   Expert Answer

3. A particular form of bladder cancer is quite common in Egypt and very rare anywhere else in the world. What type of epidemiologic study would be best to attempt to figure out why?

   Your answer

   Expert Answer

**Glossary**

Absolute risk- The probability that a specific event will occur in a population

Analytic studies- A type of observation study where the determinants of the disease are studied through testing a hypothesis.

Control sample- In a study, the group not exposed to the trial intervention.

Experimental sample- In a study, the group that is exposed to the trial intervention

Incidence- The number of new cases in a population in a specified time period

Intervention- Removal of an exposure

Mortality- The number of people dying with disease

Odds ratio- The rate of an event in cases. The rate of an event in the controls where event = exposure to an agent or a disease.

Prevalence- Total number of cases at a specified time or over period of time

Relative risk- The ratio of the risk (of a disease) in one population to the risk in another population

Risk ratio- A synonym for “relative risk”

**References**

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