

Bonus Exhibit

How Do Epidemiologists Determine Causality?

Epidemiology is the branch of medical science that studies the incidence, distribution, cause, and control of disease in a population. You often hear the results of epidemiological research on the six o'clock news. Although epidemiologists prefer to conduct strong experimental research when possible, oftentimes their research questions and variables do not lend themselves to experimental research. It is constructive to look at epidemiology to learn how to conduct high quality nonexperimental research.

Perhaps the single most important individual in the development of research methods and analysis in Epidemiology is Sir Austin Bradford Hill (1897-1991). Bradford Hill developed a list of criteria that continues to be used today. When using them, don't forget Hill's advice:

“None of these nine viewpoints can bring indisputable evidence for or against a cause and effect hypothesis What they can do, with greater or less strength, is to help answer the fundamental question—is there any other way of explaining the set of facts before us, is there any other answer equally, or more, likely than cause and effect?” (Cited in Doll, 1991).

The Bradford Hill Criteria

- 1: Strength of Association.** The stronger the relationship between the independent variable and the dependent variable, the less likely it is that the relationship is due to an extraneous variable.
- 2: Temporality.** It is logically necessary for a cause to precede an effect in time.
- 3: Consistency.** Multiple observations, of an association, with different people under different circumstances and with different measurement instruments increase the credibility of a finding.
- 4: Theoretical Plausibility.** It is easier to accept an association as causal when there is a rational and theoretical basis for such a conclusion.
- 5: Coherence.** A cause-and-effect interpretation for an association is clearest when it does not conflict with what is known about the variables under study and when there are no plausible competing theories or rival hypotheses. In other words, the association must be coherent with other knowledge.
- 6: Specificity in the causes.** In the ideal situation, the effect has only one cause. In other words, showing that an outcome is best predicted by one primary factor adds credibility to a causal claim.
- 7: Dose Response Relationship.** There should be a direct relationship between the risk factor (i.e., the independent variable) and people's status on the disease variable (i.e., the dependent variable).
- 8: Experimental Evidence.** Any related research that is based on experiments will make a causal inference more plausible.
- 9: Analogy.** Sometimes a commonly accepted phenomenon in one area can be applied to another area.

In the following example, we apply Hill's criteria to the classic case of smoking and lung cancer.

1. *Strength of Association*. The lung cancer rate for smokers was quite a bit higher than for nonsmokers (e.g., one study estimated that smokers are about 35% more likely than nonsmokers to get lung cancer).
2. *Temporality*. Smoking in the vast majority of cases preceded the onset of lung cancer.
3. *Consistency*. Different methods (e.g., prospective and retrospective studies) produced the same result. The relationship also appeared for different kinds of people (e.g., males and females)
4. *Theoretical Plausibility*. Biological theory of smoking causing tissue damage which over time results in cancer in the cells was a highly plausible explanation.
5. *Coherence*. The conclusion (that smoking causes lung cancer) "made sense" given the current knowledge about the biology and history of the disease.
6. *Specificity in the causes*. Lung cancer is best predicted from the incidence of smoking.
7. *Dose Response Relationship*. Data showed a positive, linear relationship between the amount smoked and the incidence of lung cancer.
8. *Experimental Evidence*. Tar painted on laboratory rabbits' ears was shown to produce cancer in the ear tissue over time. Hence, it was clear that carcinogens were present in tobacco tar.
9. *Analogy*. Induced smoking with laboratory rats showed a causal relationship. It, therefore, was not a great jump for scientists to apply this to humans.

References

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