Section 3.8 Formal Hypothesis Testing

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1.1 Section 3.8 Formal Hypothesis Testing

Notes:

Now let's review guidelines and steps involved in formal hypothesis testing including “null” and the alternative hypothesis
1.2 Learning Outcomes

List the concept, guidelines, and primary steps involved in hypothesis testing

Notes:

1. Here are the module learning objectives.
2. Remember, the course evaluation you get to fill out will ask whether the learning objectives were appropriately covered and presented.
1.3 Hypothesis Formulation

Notes:

1. At the simplest level, hypothesis formulation entails generating (formulating) a hypothesis, and the formally testing it.
2. This is classified under the scientific method of investigation.
1.4 Basic Strategy of Analytical Epidemiology

Notes:

1. These steps are used in hypothesis testing in the health sciences.
2. In the conventional sense, we specify an exposure and outcome of interest, and a hypothesis such as the exposure (e.g. lead paint exposure) being associated with a health outcome (e.g. cognitive difficulties).
3. We often compare the health outcome experience of the exposure groups (e.g. low versus high lead paint exposure). Keep in mind that there can be more than 2 exposure groups compared, such as low, medium, and high exposure.
1.5 Basic Strategy of Analytical Epidemiology

Notes:

1. In classical hypothesis testing, we consider 2 competing hypotheses known as the “null” hypothesis and the “alternative” hypothesis.
2. The “null” hypothesis typically (but not always) assumes no association between the exposure and outcome of interest.
3. Classical hypothesis testing is based on probability theory - in other words - making a judgment as to how likely the results align with the null versus alternative hypothesis.
1.6 Biostatisticians versus Epidemiologists

Notes:

1. At the broadest level, biostatisticians tend to focus on formal statistical testing of a hypothesis, including use of probability theory.

2. Epidemiologists tend to focus on the magnitude of a risk assessment (e.g., how much an exposure increases the risk of a health outcome), as opposed to formal testing of a null hypothesis versus alternative hypothesis.
1.7 Null and Alternative Hypothesis

Notes:
1. These are formal statements of the null ($H_0$) and alternative ($H_1$) hypotheses.

1.8 Epidemiology Risk Estimation

Notes:
1. What is the best estimate of the risk of disease in those who are exposed compared to those who are unexposed (i.e. exposed are at XX times higher risk of disease)?
2. This moves away from the simple dichotomy of yes or no for an exposure/disease association - to the estimated magnitude of effect irrespective of whether it differs from the null hypothesis.
1. This is an example of the focus of epidemiology - coming up with a best estimate of risk associated with an exposure, as opposed to formal testing in a yes/no fashion of a hypothesis.

1.9 Statistical Dependence - Association

Notes:

1. The term “association” means statistical “dependence” between 2 variables, such as an exposure and disease outcome.

2. The term “dependence” means that as the exposure goes up, the outcome tends to either go up or down in a systematic way.

3. For example, as exercise goes up, blood pressure tends to go down.
1.10 Strength of an Association

Notes:

1. The “strength” of an association is the degree to which the health outcome of interest occurs among persons with the exposure of interest compared to persons without the exposure.

1.11 Hypothesis Over Time

Notes:

Ways to Express Hypotheses:

- Suggest possible events...
- The incidence of tuberculosis will increase in the next decade
Notes:

1. When one expresses a hypothesis, there are multiple ways.
2. One way to express a hypothesis is occurrence of a health condition, such as tuberculosis, over time.
3. In this example, “time” is the predictor or exposure of interest, and tuberculosis is the outcome of interest.

1.12 Hypothesis Between Exposure and Outcome

Notes:

1. Another way to express a hypothesis is to suggest a specific relationship between the exposure and outcome of interest.
2. In this example, the hypothesis is that high cholesterol intake is associated with future risk of coronary heart disease.
1.13 Hypothesis as a Cause and Effect

Ways to Express Hypotheses:
Suggest cause-effect relationship...
Cigarette smoking is a cause of lung cancer

Notes:

1. A stringent way to express a hypothesis is to state a “cause and effect” relationship, rather than just an association.

2. In this example, the hypothesis is that smoking is a true cause of lung cancer.
1.14 One versus Two Sided Hypothesis

A one sided hypothesis specifies a direction between the exposure and outcome of interest. In this example, the hypothesis is that the *Helicobacter pylori* infection is associated with an "increased" risk of stomach ulcer (i.e. there is no mention of a possible decreased risk of stomach ulcer).

For a 2-sided hypothesis, the exposure of interest might be associated with either a lower or higher risk of the outcome of interest.
1.15 Guidelines for Developing Hypotheses

Guidelines for Developing Hypotheses:

State the exposure to be measured as:
- Specifically as possible

State the health outcome as:
- Specifically as possible
- Strive to explain the smallest amount of ignorance

Notes:

1. Here are some general guidelines for developing hypotheses - as a general rule, the hypothesis should be very specific.

1.16 Example Hypothesis

Example Hypothesis

Poor
Eating junk food is associated with the development of cancer

Good
The human papilloma virus (HPV) is associated with the development of cervical cancer
Notes:

1. As seen, the poor hypothesis is not specific enough since “junk food” is too vague and open to interpretation, and all types of “cancer” is too broad.
2. The “good” hypothesis has a very specific exposure (HPV 16 virus) and outcome (cervical cancer).

1.17 Conclusion