Methodological issues in the measurement of chronic disease

The importance of measurement error

- Measurement error is one of the main constraints on our ability to measure the frequency of chronic diseases and identify risk factors for them
- Is often not considered properly either in the planning of data collection or in the interpretation of published research

Measurement error - overview of the session

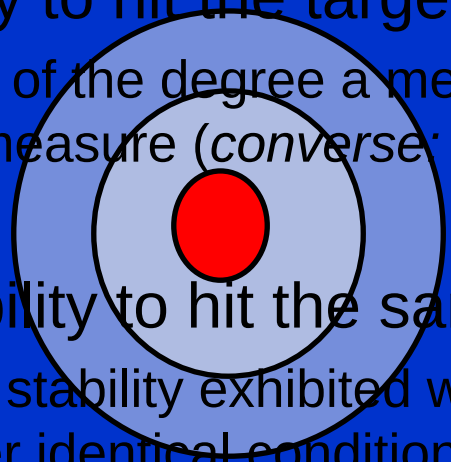
- Sources of error
- Validity and reliability and their assessment
- Influence of of measurement error on:
  - » Summary estimates
  - » Estimates of associations between two variables
  - » Controlling for confounding

Sources of Measurement Variation

- Subject
- Observer
- Environment
- Instrument/method of data collection
- Assay/analysis

Validity and Reliability

- **Validity** - ability to hit the target
  - » An expression of the degree a measurement measures what it purports to measure (*converse:* ***measurement*** *bias*)



- **Reliability** - ability to hit the same spot
  - » The degree of stability exhibited when a measurement is repeated under identical conditions (*converse:* ***measurement*** *imprecision*)

- A reliable measure may biased and a valid measure imprecise

Assessment of and types of validity

- Face
- Content
- Consensual
- Construct
- Criterion
  - » Concurrent
  - » Predictive

Measurement of reliability

- Reliability is measured by performing two or more independent measurements and comparing the findings using an appropriate statistical test

Examples of approaches to the measurement of reliability

- Test-retest reliability - within and between observers, subjects, machines, assays
- Random allocation of subjects to observers

- Exercises 1 to 3

Effects of measurement error

- On estimates of population parameters
  - » Bias e.g. estimate of population mean is wrong
  - » Imprecision e.g. estimate of population variance is wrong
- On identification of associations, such as between a chronic disease and possible risk factors - need to consider whether the error is related to, or independent of, the value of the other variable.

- **Error related** - the error with respect to exposure (or disease) is dependent on the individual's disease (or exposure) status.
- **Error unrelated** - the error with respect to exposure (or disease) is *independent* of the individual's disease (or exposure) status.

Effects of measurement error in identifying associations

- Unrelated error - almost always tend towards the null value.
  - » Thus if an association is found it is likely to be stronger than measured.
- Related error - can work towards the null value **or** to suggest an association when none is there

Bias and imprecision in the measurement of confounders

- Imprecision reduces the ability to control for the effects of a confounder
- Bias in the measurement of a confounder may distort an association between two variables towards or away from unity

Beware of claims of "independent" associations!

Examples

- Work through scenarios 1 to 3

In the measurement of any chronic disease or risk factor consider

- **Sources of measurement error:**
  - » Subject/Observer/Instrument/Assay/ Environment
  - » Validity and reliability

- **The influence of bias and imprecision on:**
  - » Summary estimates for populations/groups

- **The influence of bias and imprecision on**:
  - » Estimates of associations between two variables
    - – the importance of knowing whether assessing whether the measurement error is related to the other variable
  - » Estimates of associations while “controlling” for confounders - if independent relationships are claimed is this justified?