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 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 be 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?