How to select study subjects using Sampling Techniques

Dr. Shaik Shaffi Ahamed Ph.D.,

Professor

Department of Family & Community Medicine

College of Medicine

King Saud University

Objectives of this session:

To understand:

- Why we use sampling methods
- Definitions of few concepts
- Sampling and non-sampling methods
- And able to use sampling methods appropriately

Sampling

Sampling is the process or technique of selecting a study sample of appropriate characteristics and of adequate size.

Sampling in Epidemiology

- Why Sampling ?
  - Unable to study all members of a population
  - Reduce selection bias
  - Save time and money
  - Measurements may be better in sample than in entire population
  - Feasibility

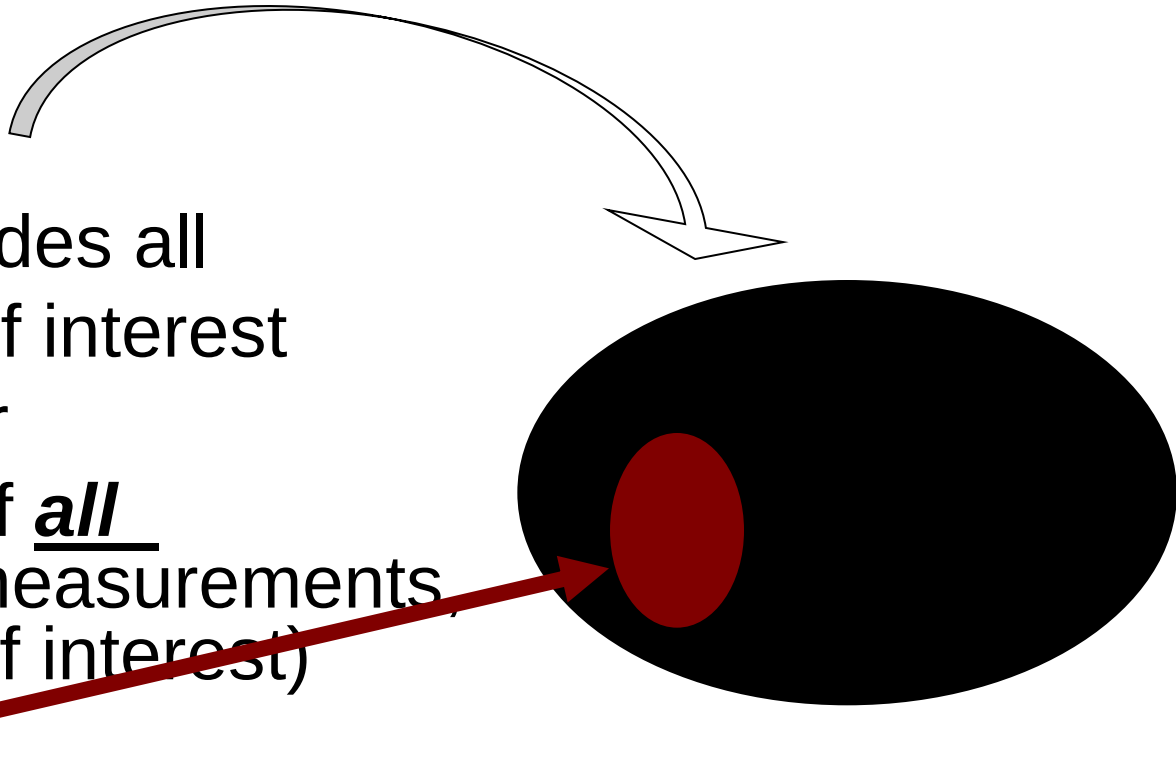
Definitions

- Population – group of things (people) having one or more common characteristics
- Sample – representative subgroup of the larger population
  - Used to estimate something about a population (generalize)
  - Must be similar to population on characteristic being investigated

Population:

a set which includes all measurements of interest to the researcher

(The collection of ***all*** responses, measurements, counts that are of interest)



Sample:

A subset of the population

Def. – Cont.

Sampling Frame

- This is the complete list of sampling units in the target population to be subjected to the sampling procedure.
- Completeness and accuracy of this list is essential for the success of the study.

Sampling Units

These are the individual units / entities that make up the frame just as elements are entities that make up the population.

Def. – Cont.

Sampling Error

This arises out of random sampling and is the discrepancies between sample values and the population value.

Sampling Variation

- Due to infinite variations among individuals and their surrounding conditions.
- Produce differences among samples from the population and is due to chance.

- **Example: In a clinical trail of 200 patients we find that the efficacy of a particular drug is 75%**

  If we repeat the study using the same drug in another group of similar 200 patients we will not get the same efficacy of 75%. It could be 78% or 71%.

  “Different results from different trails though all of them conducted under the same conditions”

Representativeness (validity)

A sample should accurately reflect distribution of relevant variable in population

- **Person** e.g. age, sex
- **Place** e.g. urban vs. rural
- **Time**

Representativeness essential to <u>generalise</u>

Ensure representativeness before starting,

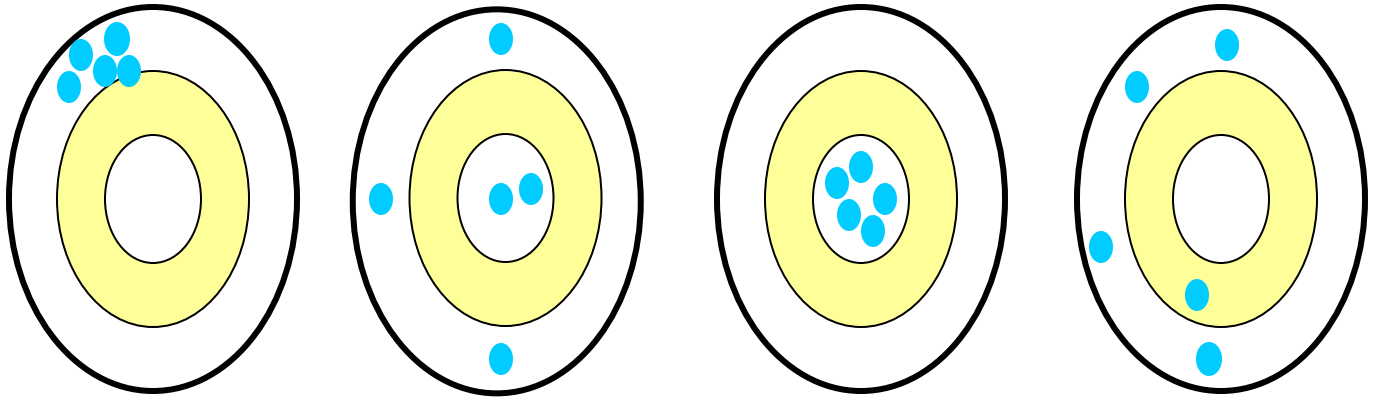
Confirm once completed

Validity of a Study

Two components of validity:

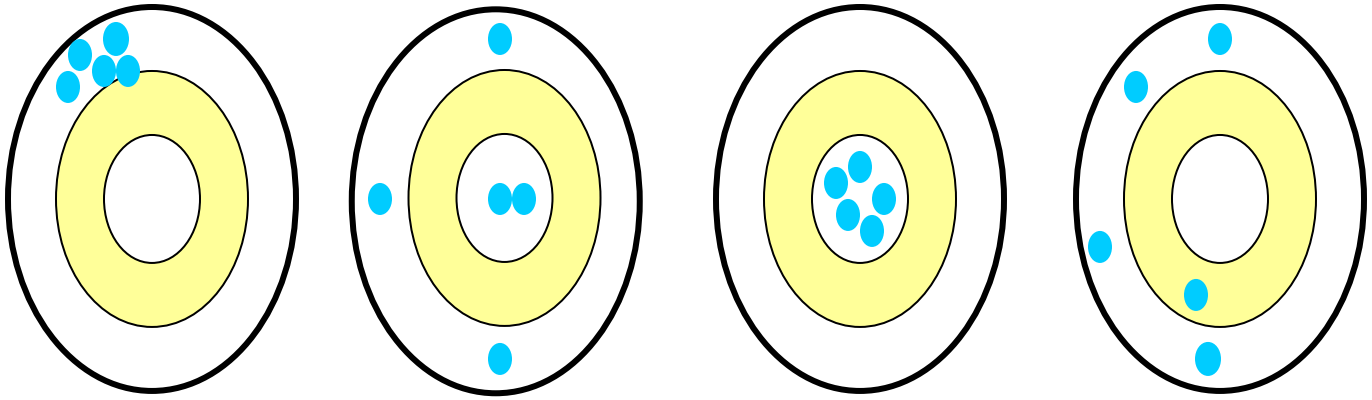
- **Internal validity**
- **External validity**

Illustration of the Difference Between Precision and Accuracy



Hulley & Cummings, *Designing Clinical Research*, 1988.

Illustration of the Difference Between Precision and Accuracy



Good Precision	Poor Precision	Good Precision	Poor Precision
Poor Accuracy	Good Accuracy	Good Accuracy	Poor Accuracy

Hulley & Cummings, *Designing Clinical Research*, 1988.

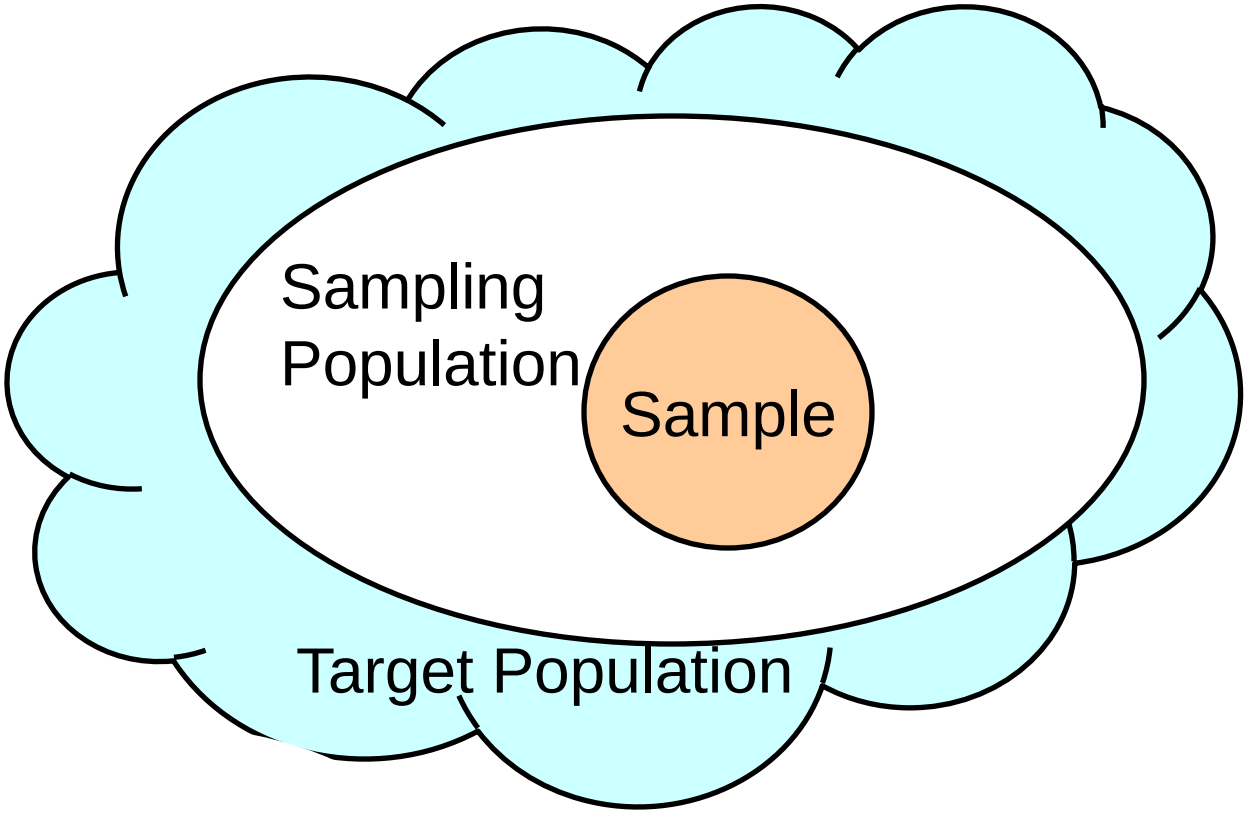
Internal validity

- A study is said to have internal validity when there have been proper selection of study group and a lack of error in measurement.
- For example, it is Concerned with the appropriate measurement of exposure, outcome, and association between exposure and disease.

External validity

- External validity implies the ability to generalize beyond a set of observations to some universal statement.

Sampling and representativeness



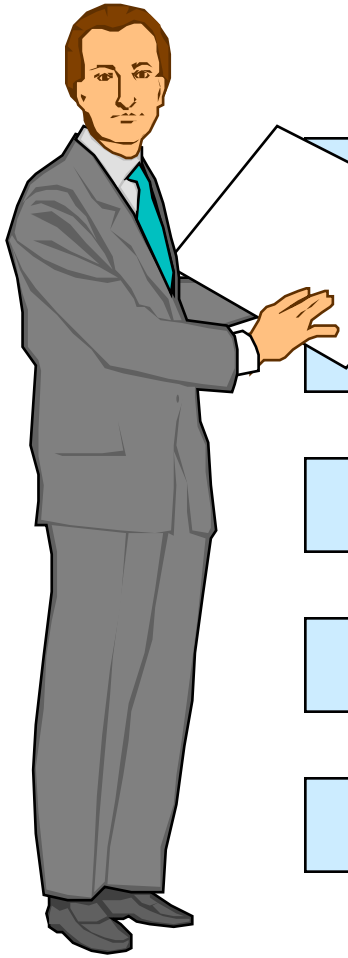
Target Population ➔ Sampling Population ➔ Sample

How to sample ?

In general, 2 requirements

1. *Sampling frame* must be available, otherwise develop a sampling frame.
2. Choose an appropriate *sampling method* to draw a sample from the sampling frame.

The Sampling Design Process



Define the Population

↓

Determine the Sampling Frame

↓

Select Sampling Technique(s)

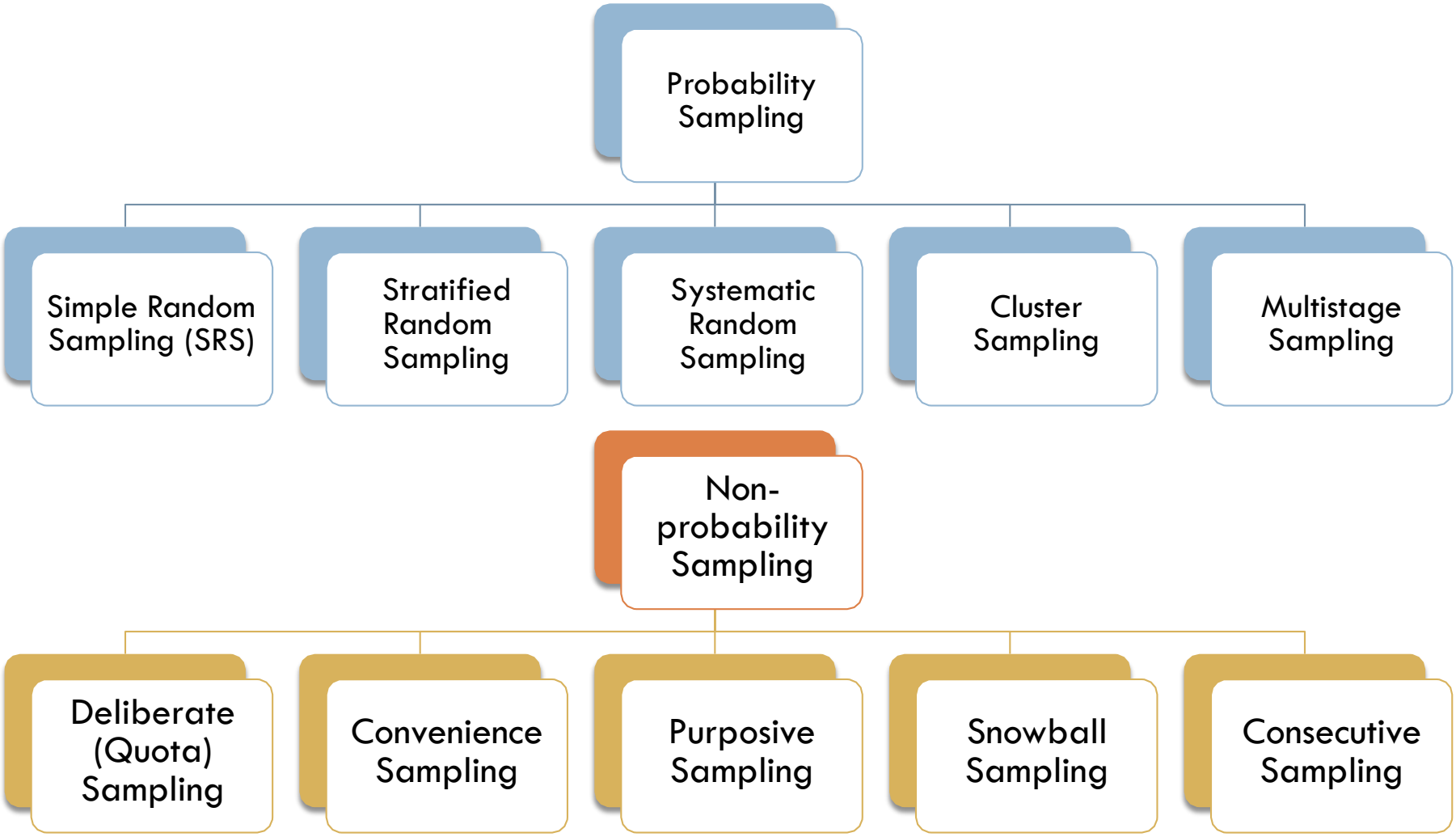
↓

Determine the Sample Size

↓

Execute the Sampling Process

Types of Sampling Methods



Simple Random Sampling

- Equal probability
- Techniques
  - Lottery method
  - Table of random numbers
- Advantage
  - Most representative group
- Disadvantage
  - Difficult to identify every member of a population

Table of random numbers

6 8 4 2 5 7 9 5 4 1 2 5 6 3 2 1 4 0

5 8 2 0 3 2 1 5 4 7 8 5 9 6 2 0 2 4

3 6 2 3 3 3 2 5 4 7 8 9 1 2 0 3 2 5

9 8 5 2 6 3 0 1 7 4 2 4 5 0 3 6 8 6

Random Number table

1	2	3	4	5
49486	93775	88744	80091	92732
94860	36746	04571	13150	65383
10169	95685	47585	53247	60900
12018	45351	15671	23026	55344
45611	71585	61487	87434	07498
89137	30984	18842	69619	53872
94541	12057	30771	19598	96069
89920	28843	87599	30181	26839
32472	32796	15255	39636	90819

How to select a simple random sample

1. Define the population
2. Determine the desired sample size
3. List all members of the population or the potential subjects

- For example:
  - 4^{th} grade boys who have demonstrated problem behaviors
  - Lets select 10 boys from the list

Potential Subject Pool

1. Ahamed
2. Munir
3. Khalid
4. Ameer
5. Junaid
6. Khadeer
7. Shaffi
8. Rafi
9. Ghayas
10. Fayaz

11. Riyaz
12. Yaseen
13. Jaffar
14. Sattar
15. Ghouse
16. Imran
17. Khaleel
18. Shabu
19. Shanu
20. Javid

21. Fahad
22. Iqbal
23. Jabbar
24. Aziz
25. Anwar
26. Shohail
27. Shohaib
28. Rehaman
29. Naeem
30. Rahim

So our selected subjects are with numbers 10, 22, 24, 15, 6, 1, 25, 11, 13, & 16.

1. Ahamed
2. Munir
3. Khalid
4. Ameer
5. Junaid
6. Khadeer
7. Shaffi
8. Rafi
9. Ghayas
10. Fayaz

11. Riyaz
12. Yaseen
13. Jaffar
14. Sattar
15. Ghouse
16. Imran
17. Khaleel
18. Shabu
19. Shanu
20. Javid

21. Fahad
22. Iqbal
23. Jabbar
24. Aziz
25. Anwar
26. Shohail
27. Shohaib
28. Rehaman
29. Naeem
30. Rahim

- Simple random sampling
  - Estimate hemoglobin levels in patients with sickle cell anemia

1. Determine sample size
2. Obtain a list of all patients with sickle cell anemia in a hospital or clinic
3. Patient is the sampling unit
4. Use a table of random numbers to select units from the sampling frame
5. Measure hemoglobin in all patients
6. Estimate the levels (normal & abnormal) of hemoglobin

Systematic random Sampling

- Technique
  - Use “system” to select sample (e.g., every 5th item in alphabetized list, every 10th name in phone book)
- Advantage
  - Quick, efficient, saves time and energy
- Disadvantage
  - Not entirely bias free; each item does not have equal chance to be selected
  - System for selecting subjects may introduce systematic error
  - Cannot generalize beyond population actually sampled

Example

- If a systematic sample of 500 students were to be carried out in a university with an enrolled population of 10,000, the sampling interval would be:
- I = N/n = 10,000/500 =20
- All students would be assigned sequential numbers. The starting point would be chosen by selecting a random number between 1 and 20. If this number was 9, then the 9th student on the list of students would be selected along with every following 20th student. The sample of students would be those corresponding to student numbers 9, 29, 49, 69, ... 9929, 9949, 9969 and 9989.

Systematic sampling

Systematic random sampling

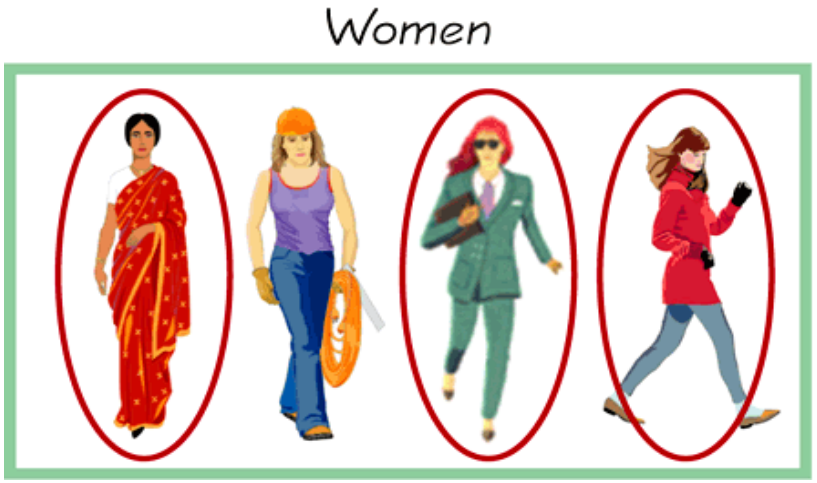
- Select a random starting point and then select every k^{th} subject in the population

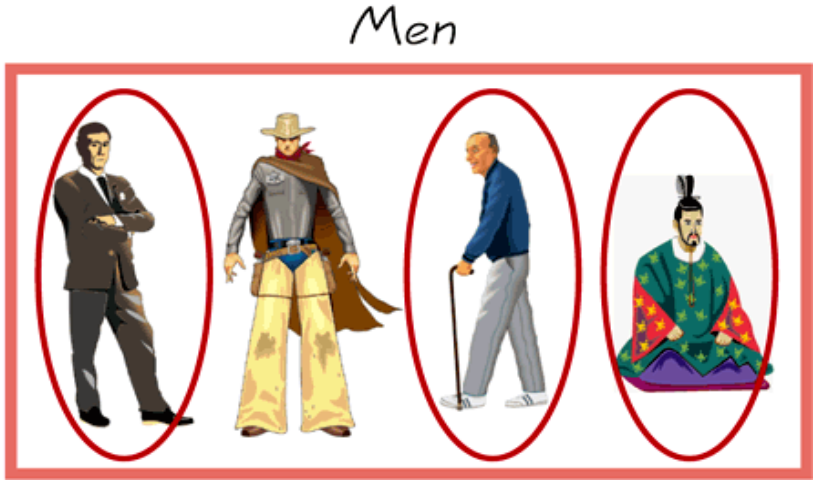
Stratified Random Sampling

- Technique
  - Divide population into various strata
  - Randomly sample within each strata
  - Sample from each strata should be proportional
- Advantage
  - Better in achieving representativeness on control variable
- Disadvantage
  - Difficult to pick appropriate strata
  - Difficult to Identify every member in population

Stratified random Sampling

- Divide the population into at least two different groups with common characteristic(s), then draw subjects randomly from each group (group is called strata or stratum)

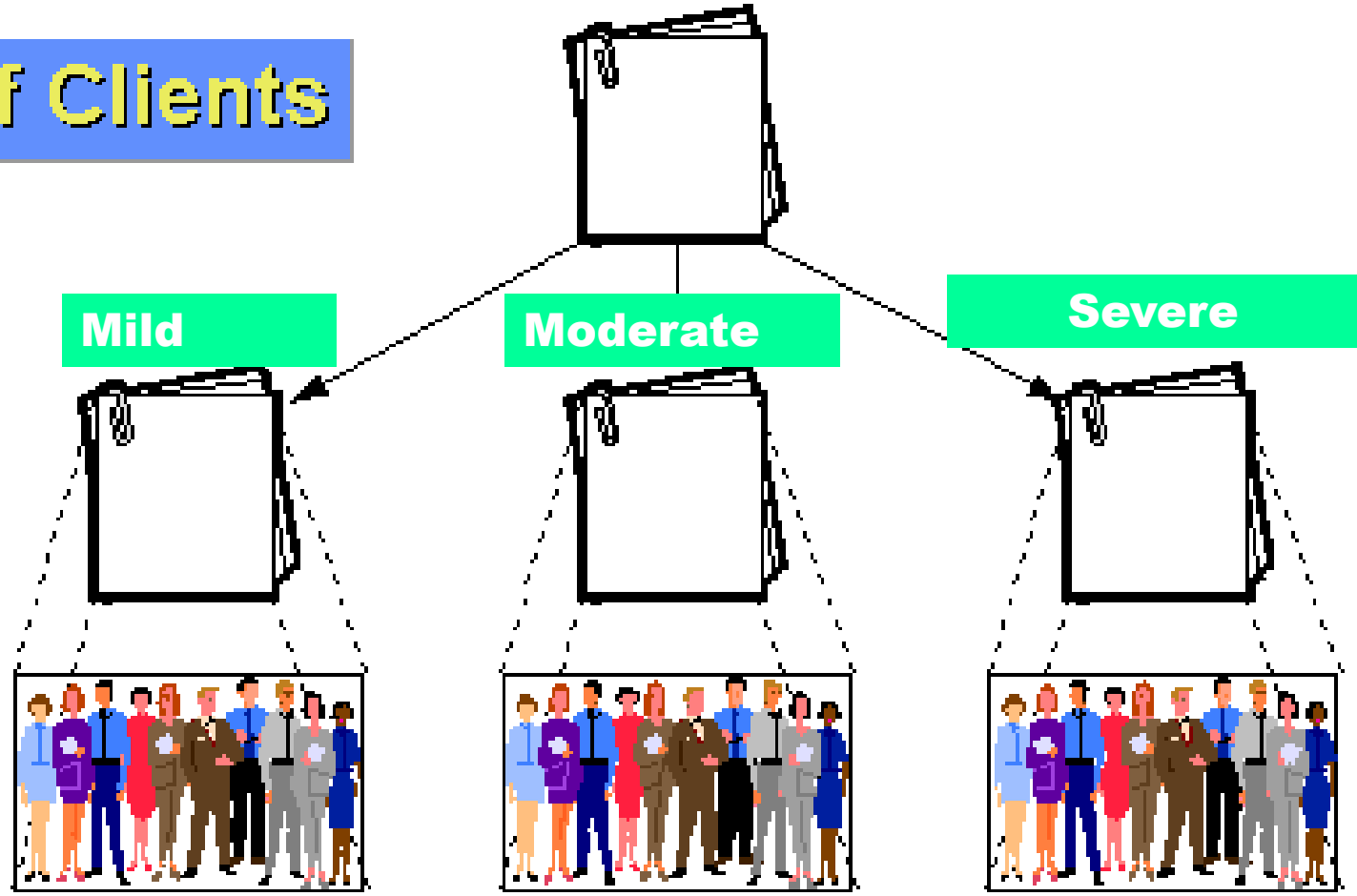




Stratified Random selection for drug trail in hypertension

List of Clients

Strata



Random Subsamples of n/N

Sampling in Epidemiology

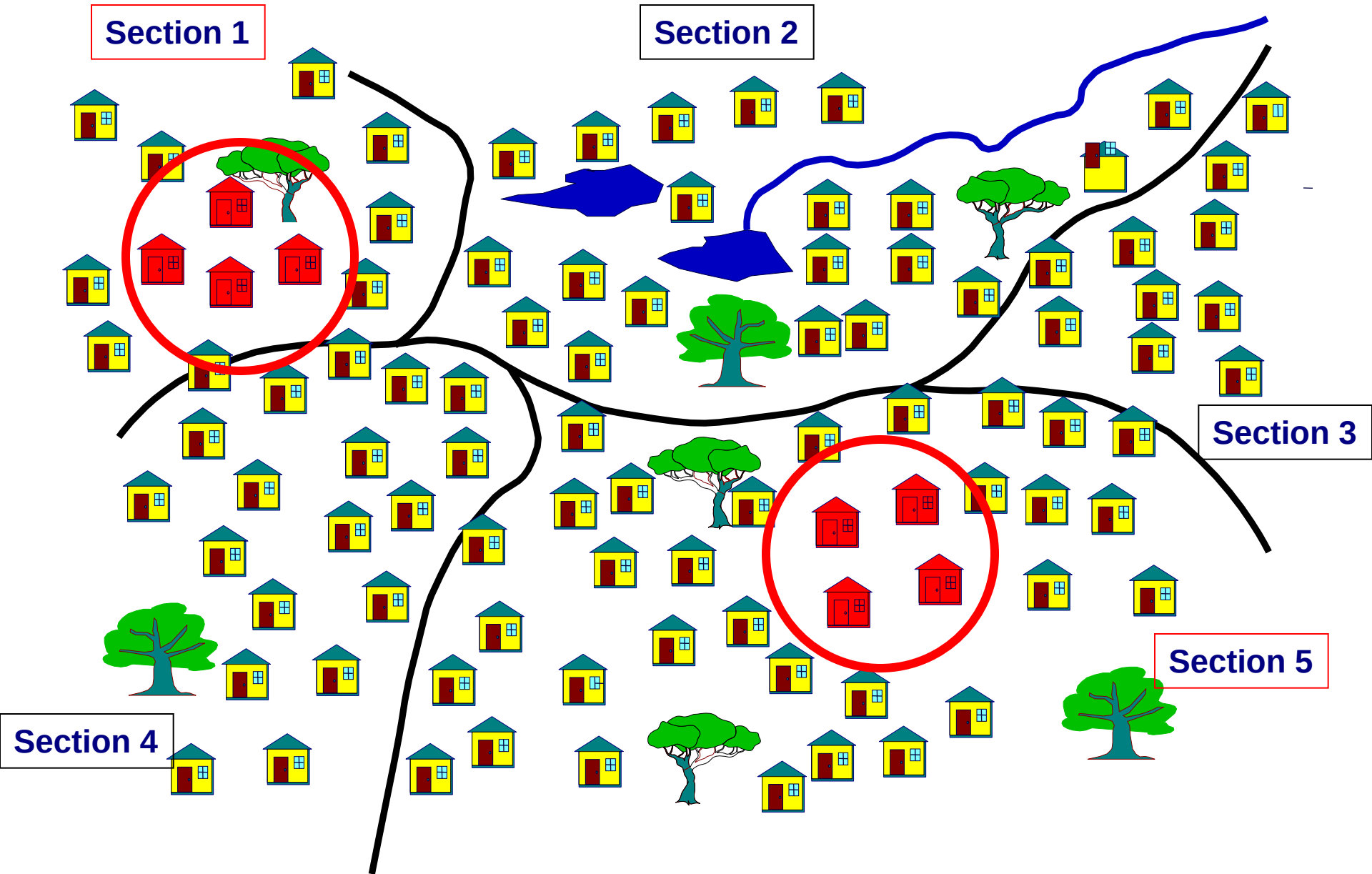
- **Stratified random sample**
  - **Assess dietary intake in adolescents**

1. **Define three age groups: 11-13, 14-16, 17-19**
2. **Stratify age groups by sex**
3. **Obtain list of children in this age range from schools**
4. **Randomly select children from each of the 6 strata until sample size is obtained**
5. **Measure dietary intake**

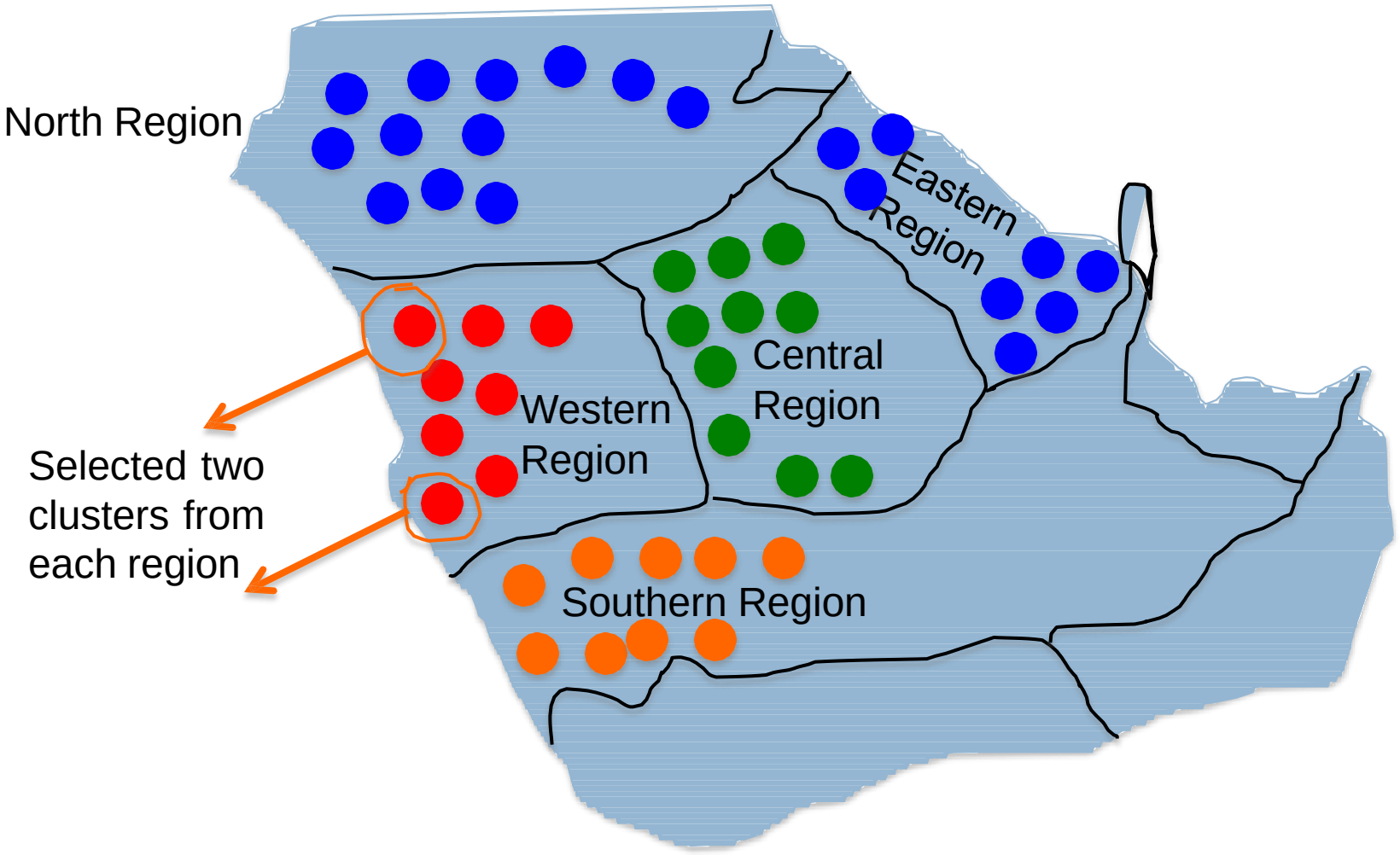
Cluster (Area) random sampling

- Randomly select groups (cluster) – all members of groups are subjects
- Appropriate when
  - you can't obtain a list of the members of the population
  - have little knowledge of population characteristics
  - Population is scattered over large geographic area

Cluster sampling



Cluster Sampling



Cluster (Area) Sampling

- Advantage
  - More practical, less costly
- Conclusions should be stated in terms of cluster (sample unit – school)
- Sample size is number of clusters

Multistage random sampling

- Stage 1

  --randomly sample clusters (schools)

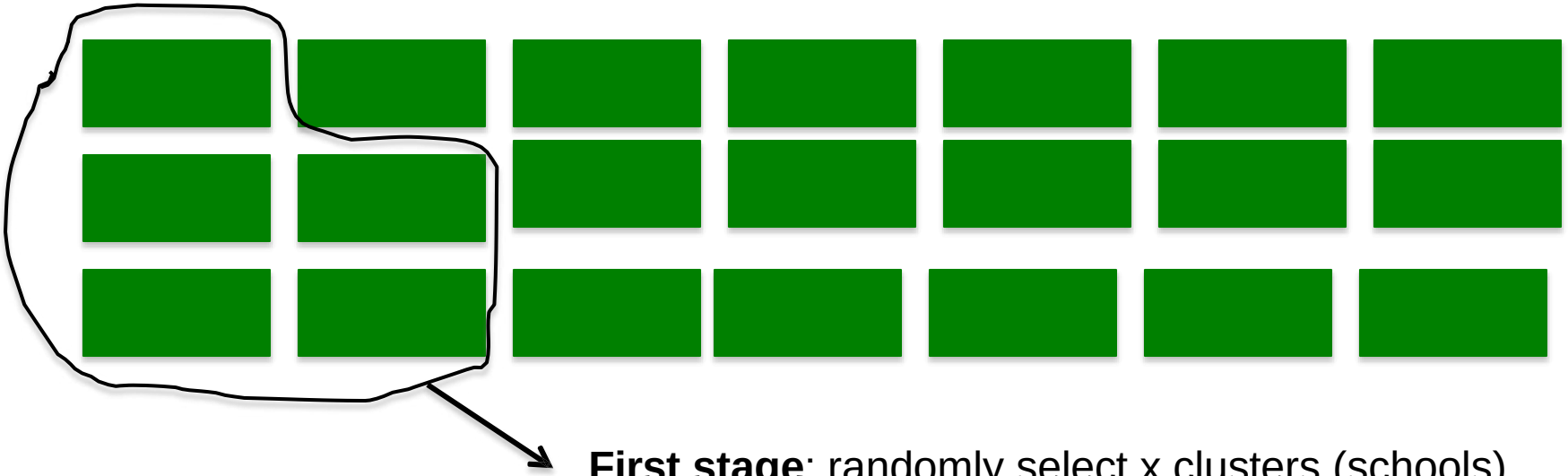
- Stage 2

  --randomly sample class rooms from the schools selected

- Stage 3

  --random sample of students from class rooms

Multi-stage Sampling



First stage: randomly select x clusters (schools)

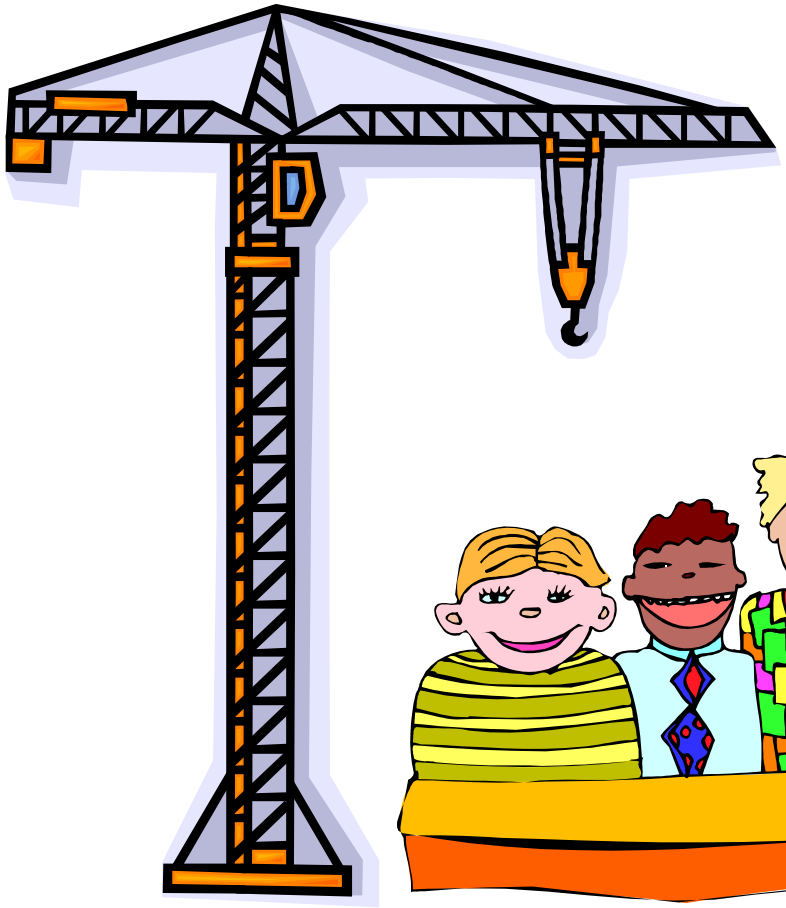
Second stage: within each school, randomly select y clusters (class rooms)

Third stage: randomly select x number of people from the class room

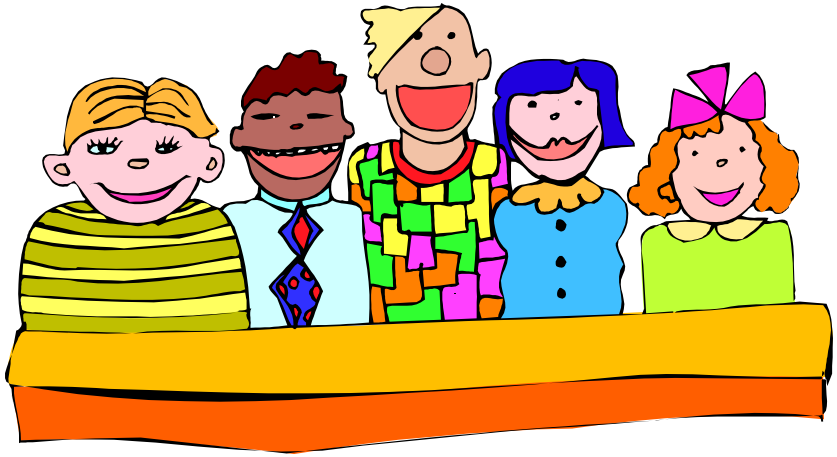
Random . . .

- **Random Selection vs. Random Assignment**
  - Random Selection = every member of the population has an equal chance of being selected for the sample.
  - Random Assignment = every member of the sample (however chosen) has an equal chance of being placed in the experimental group or the control group.
    - Random assignment allows for individual differences among test participants to be averaged out.

Subject Selection (Random Selection)

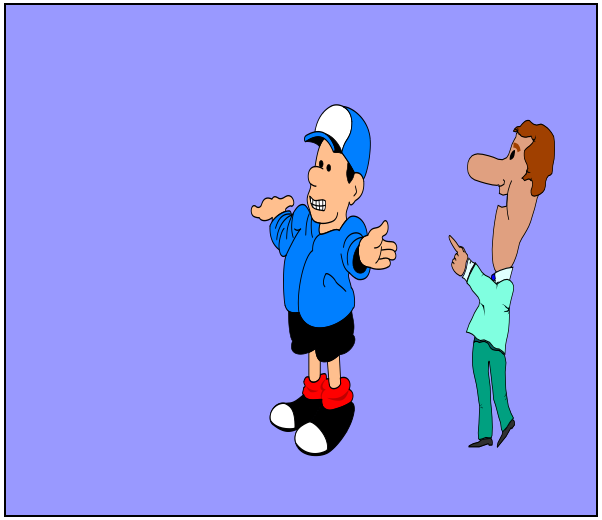


Choosing which potential subjects will actually participate in the study

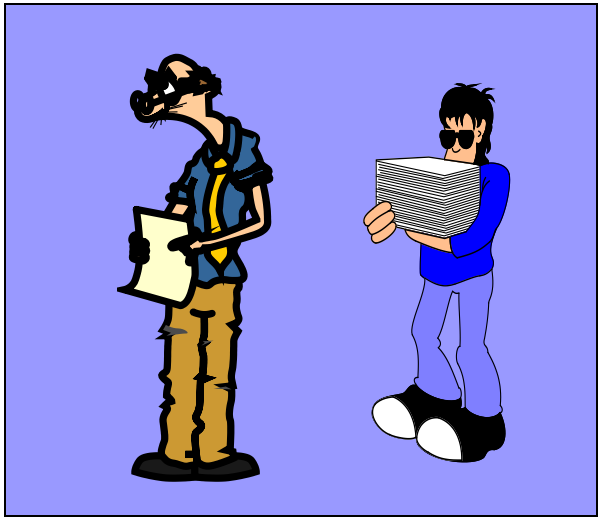


Subject Assignment (Random Assignment)

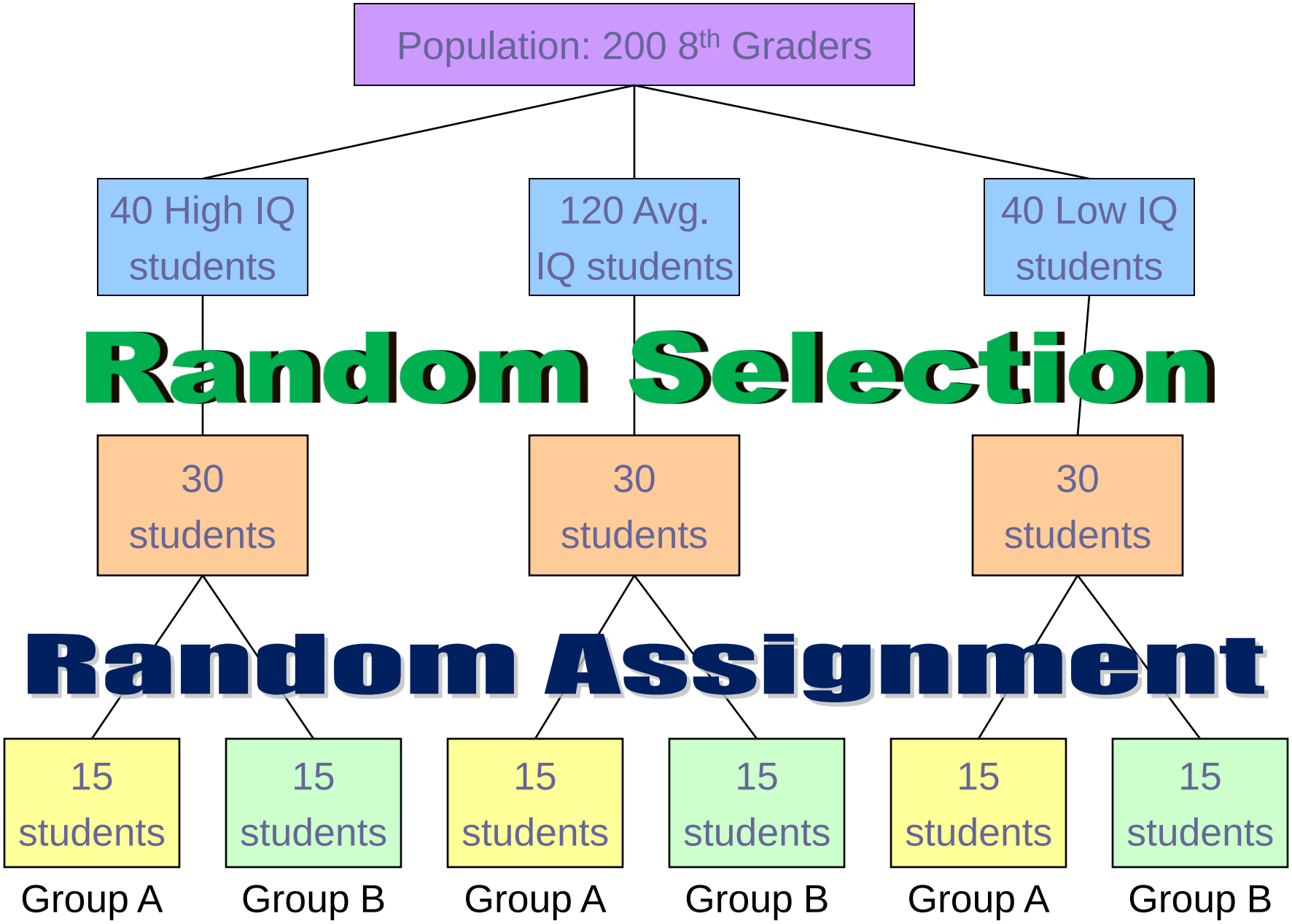
Deciding which group or condition each subject will be part of



Group A



Group B


Population: 200 8th Graders
40 High IQ students
120 Avg. IQ students
40 Low IQ students
Random Selection
30 students
30 students
30 students
Random Assignment
15 students
15 students
15 students
15 students
15 students
15 students
Group A
Group B
Group A
Group B
Group A
Group B

Sampling Methods

Probability Sampling

- Simple random sampling
- Stratified random sampling
- Systematic random sampling
- Cluster (area) random sampling
- Multistage random sampling

Non-Probability Sampling

- Deliberate (quota) sampling
- Convenience sampling
- Purposive sampling
- Snowball sampling
- Consecutive sampling

Deliberate (Quota) Sampling

- Similar to stratified random sampling
- Technique
  - Quotas set using some characteristic of the population thought to be relevant
  - Subjects selected non-randomly to meet quotas (usu. convenience sampling)
- Disadvantage
  - selection bias
  - Cannot set quotas for all characteristics important to study

Convenience Sampling

- “Take them where you find them” - nonrandom
- Intact classes, volunteers, survey respondents (low return), a typical group, a typical person
- Disadvantage: Selection bias

Purposive Sampling

- Purposive sampling (criterion-based sampling)
  - Establish criteria necessary for being included in study and find sample to meet criteria.
- Solution: Screening
  - Obtain a sample of larger population and then those subjects that are not members of the desired population are screened or filtered out.

    EX: want to study smokers but can't identify all smokers

Snowball Sampling

In **snowball sampling**, an initial group of respondents is selected.

- After being interviewed, these respondents are asked to identify others who belong to the target population of interest.
- Subsequent respondents are selected based on the referrals.

Consecutive sampling

- Outcome of 1000 consecutive patients presenting to the emergency room with chest pain
- Natural history of all 125 patients with HIV-associated TB during 5 year period

Explicit efforts must be made to identify and recruit ALL persons with the condition of interest

Choosing probability vs. non-probability sampling method

Probability sampling	Evaluation Criteria	Non-probability sampling
Conclusive	*Nature of research*	Exploratory
Larger sampling errors	*Relative magnitude sampling vs. non-sampling error*	Larger non-sampling error
High [Heterogeneous]	*Population variability*	Low [Homogeneous]
Favorable	*Statistical Considerations*	Unfavorable
High	*Sophistication Needed*	Low
Relatively Longer	*Time*	Relatively shorter
High	*Budget Needed*	Low

In Conclusion,

For any research, based on its study design and objectives an appropriate random sampling technique should be used.