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Session 3

Sampling Design Alternatives

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Principles To Be Developed

- **Sample Statistics Differ from but Are Related to Population Parameters**
- **Difference Can Be Reduced by Obtaining Larger Sample of Data**
- **Some Sampling Designs for Obtaining These Data Are**
 - **More Informative**
 - **Less Costly**
 - **More Efficient**

Main Measures of Interest

Population
Parameter

Sample
Statistics

Continuous Variables

- Average: Arithmetic Mean
- Dispersion: Standard Deviation

μ

σ

\bar{X}

S

Discrete Variables

- Relative Frequency: Proportion

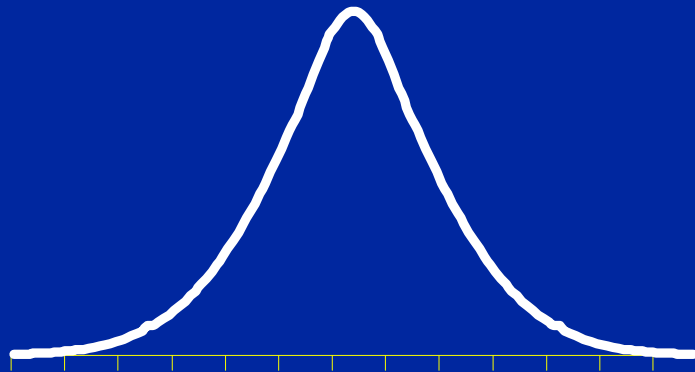
π

P

UNIVERSE



SAMPLE

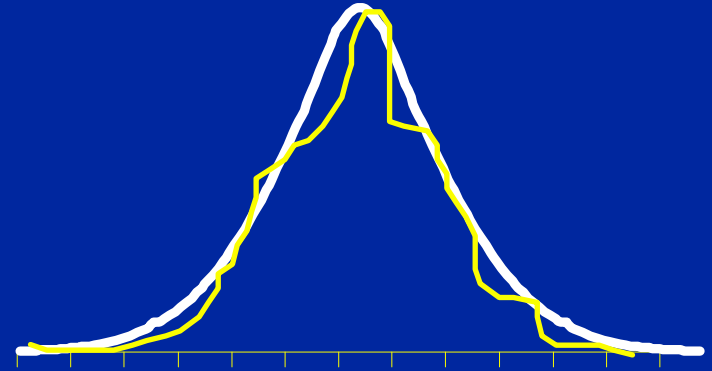


Parameters

μ

σ

π



Statistics

\bar{X}

S

P



Estimates

Hypothetical Sample Results

Three Populations

	A	B	C
	75	73	79
	75	76	79
	75	74	87
	75	78	72
	75	74	66
\bar{X}	75	75	75
μ	75	≈75	?

Precise Estimates are Possible If -

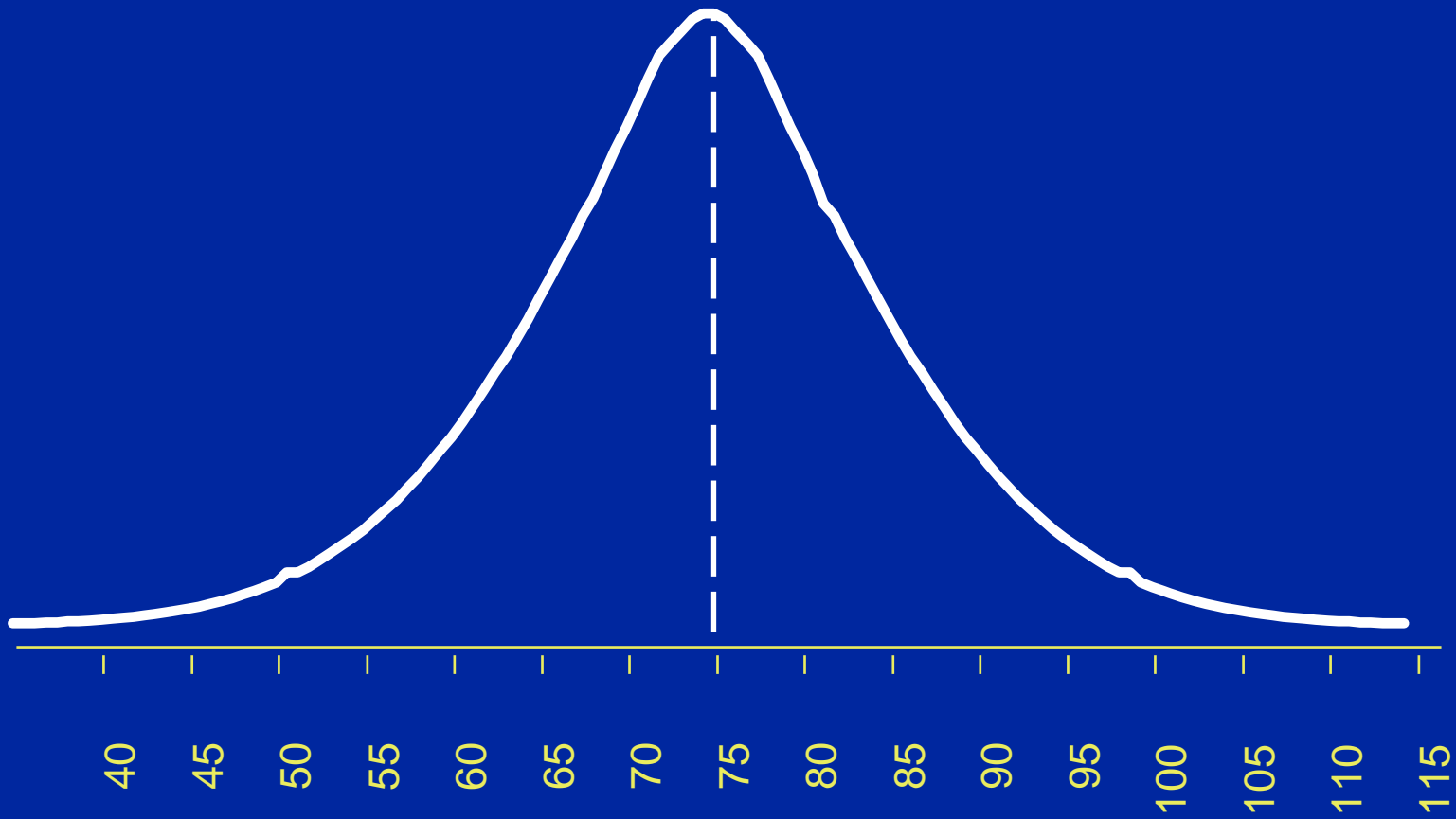
- There is Little Variation Among Sample Results
- The Sample Size is Sufficiently Large

The Mathematical Relationship is -

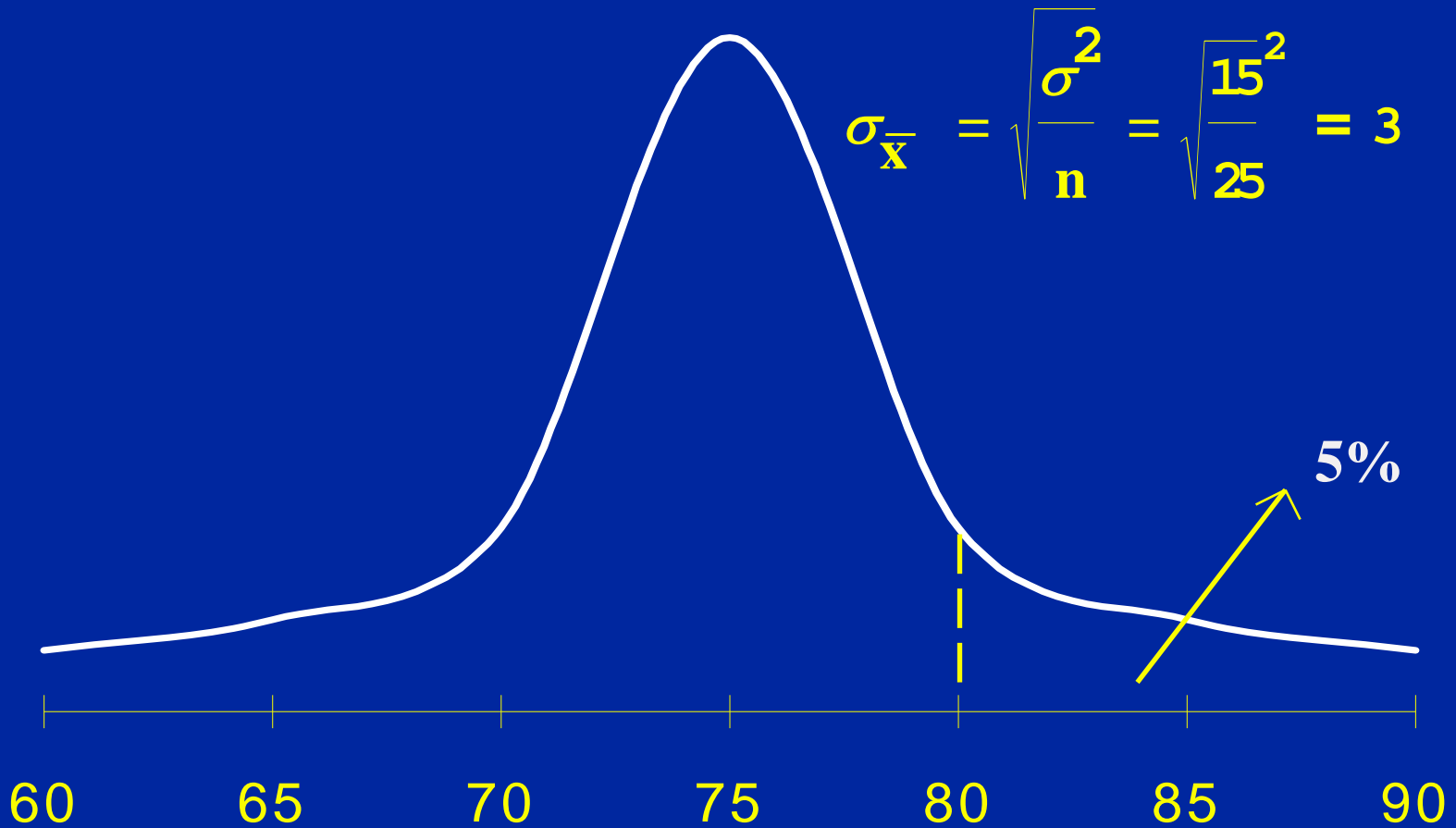
$$\text{Standard Error} = \sqrt{\frac{\text{Variance}}{\text{Sample Size}}}$$

$$= \sqrt{\frac{\sigma^2}{n}} \quad \text{or} \quad \sqrt{\frac{\pi(1-\pi)}{n}}$$

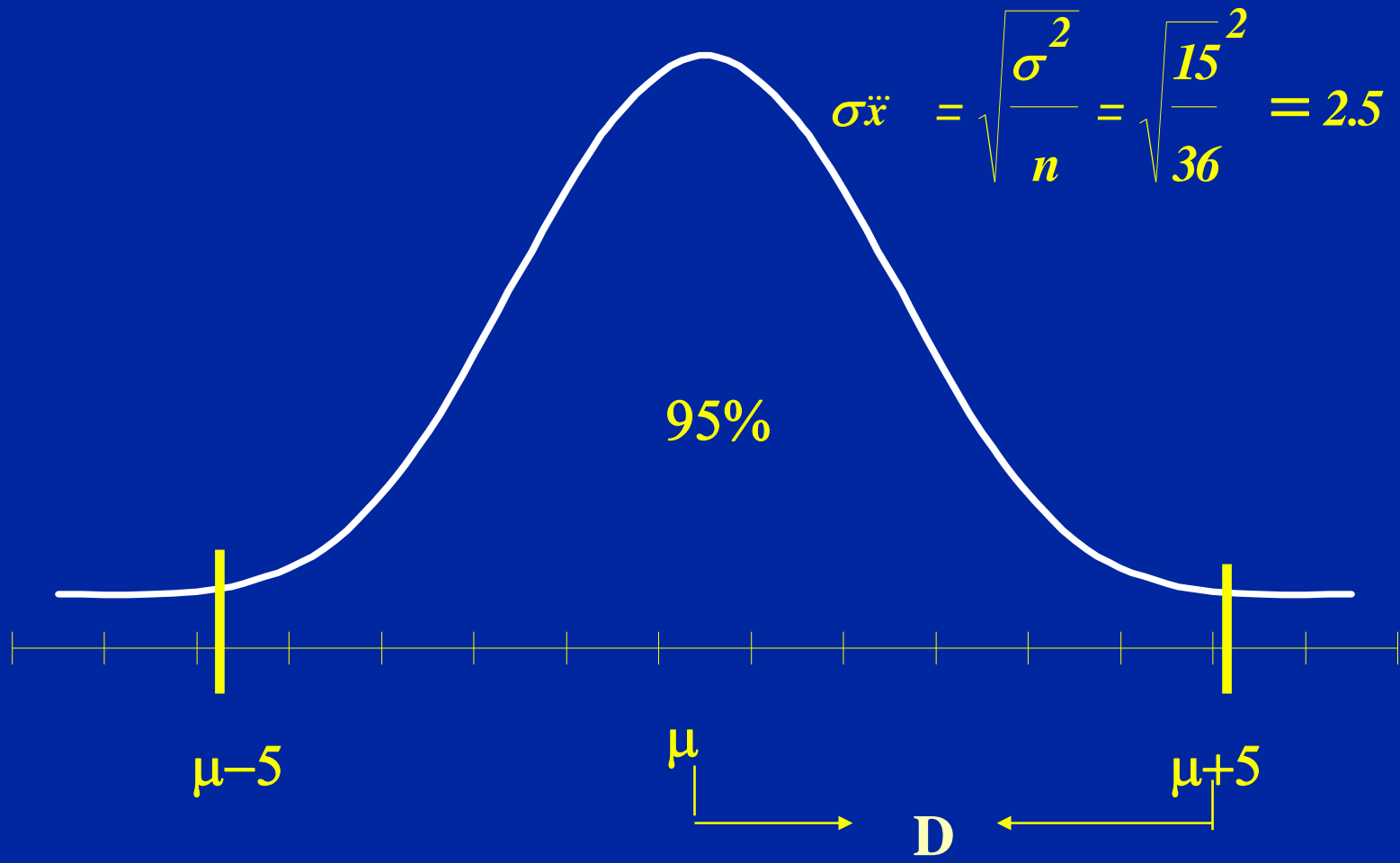
$$\sigma_{\bar{x}} = 15$$



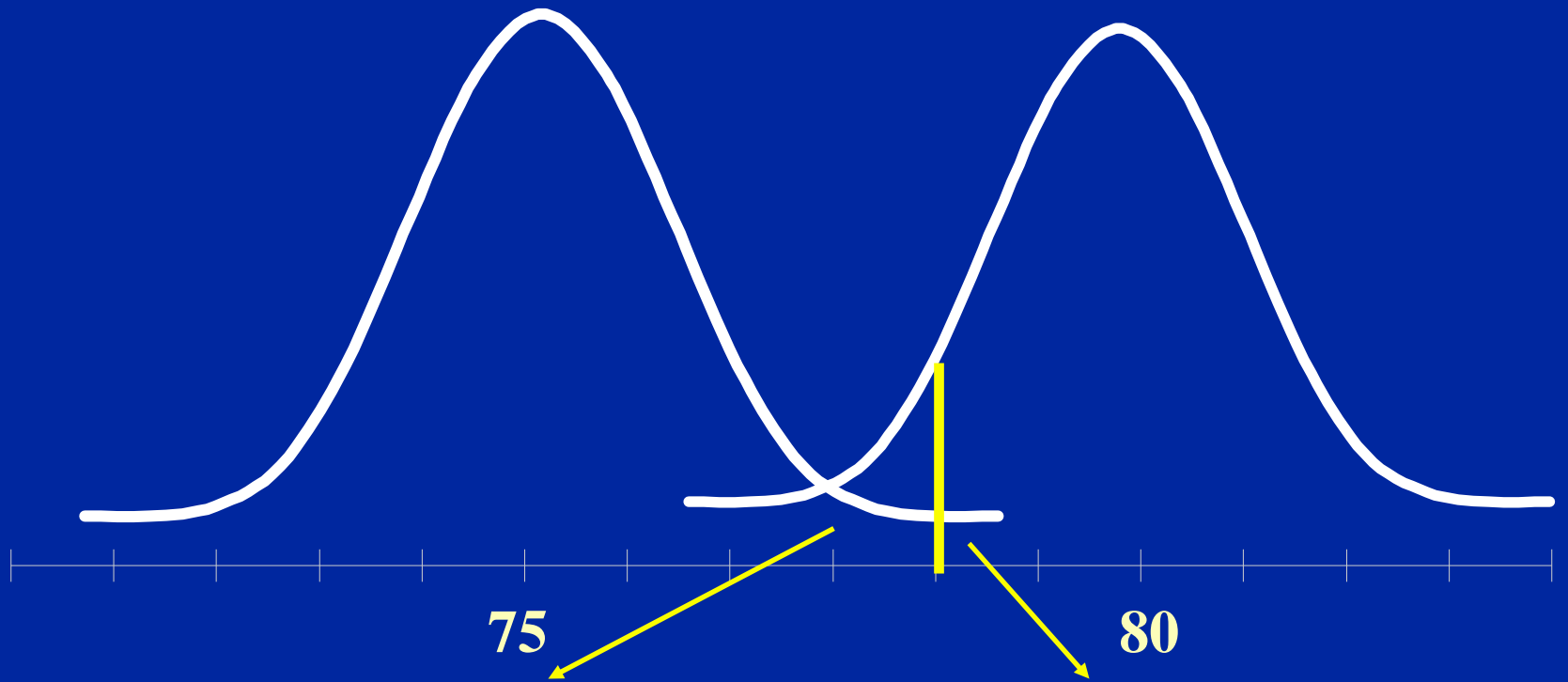
Daily Attendance (X)



Monthly Average of Daily Attendance (X)



Daily Average of 36 Days (X)



Type II Error of Omission
10%

Type I Error of Commission
5%

Determination of Sample Size

Simple Random Sample

Purpose of analysis	Sources of Error	Type of Error	General formula for n	Special case
Estimate universe mean	I	I	$\left[\frac{Z S}{D} \right]^2$	$\frac{4 S^2}{D^2}$
Decide whether Universe Mean Conforms to Defined Standard	I	2	$\left[\frac{(Z_1 + Z_2) S}{D} \right]^2$	$\frac{10.9 S^2}{D^2}$
Estimate Differences between Two Universe Means	2	I	$2 \left[\frac{Z S}{D} \right]^2$	$\frac{8 S^2}{D^2}$
Decide Whether Real (non-zero) Differences Exists between Two Universe Means	2	2	$2 \left[\frac{(Z_1 + Z_2) S}{D} \right]^2$	$\frac{21.8 S^2}{D^2}$

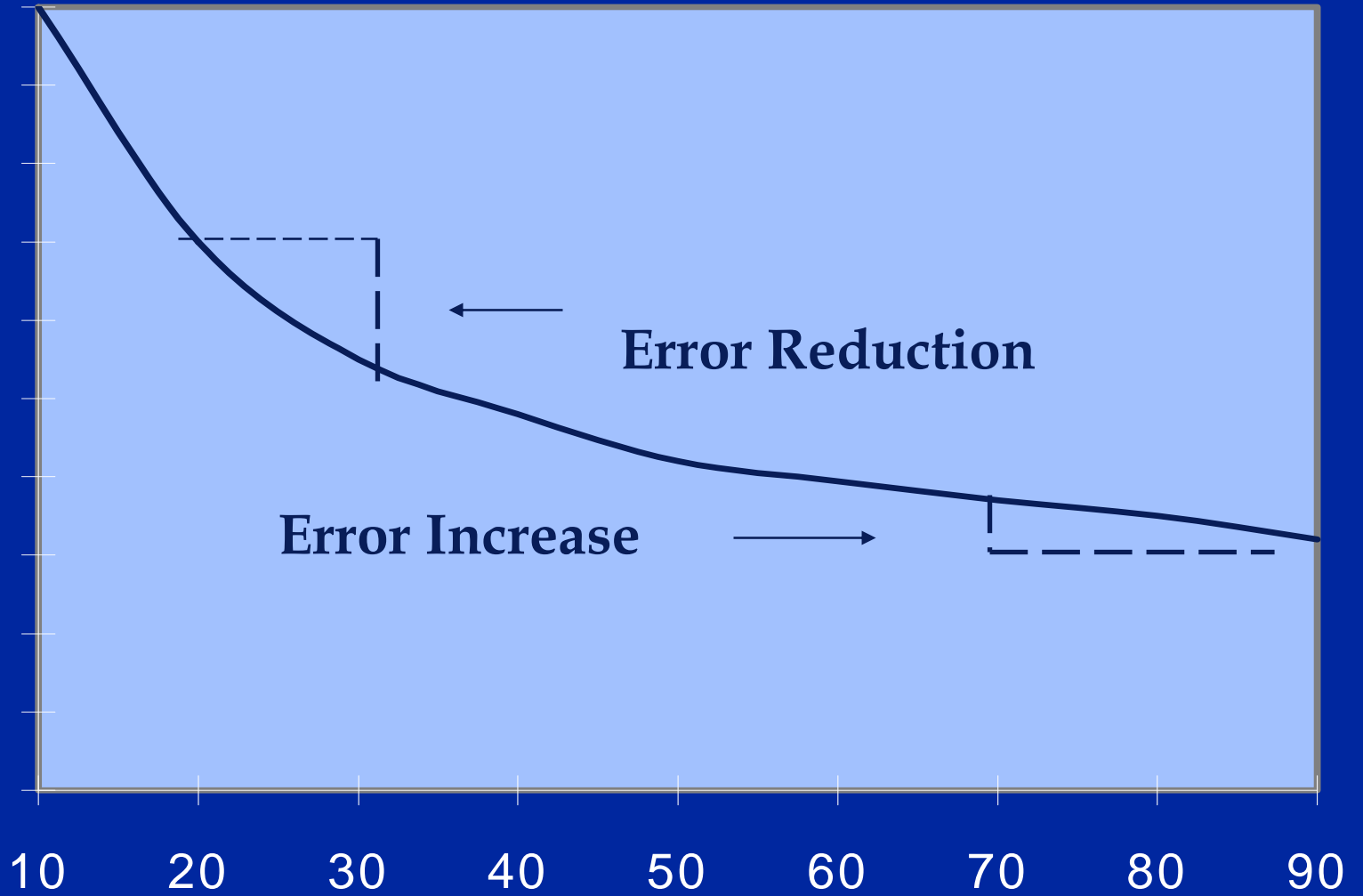
Assumptions:

Z = 2.0 (95% confidence)

Z₁ = 2.0 (5% Risk Type I Error)

Z₂ = 1.3 (10% Risk Type II Error)

**Sampling
Error**



Error Increase

Error Reduction

Sample Size

Rules of Stratification

for *Separate Analysis* of Population Subgroups

- **Select Subgroups as *Homogenous* as Possible**
- **Equalize Subgroup Sample Sizes as Much as Possible**

Population Situation

<u>Subgroup</u> <u>Village</u>	<u>Members per Subgroup</u> <u>(Households)</u>
A	400
B	800
C	200
D	500
E	100
	<hr/> 2,000

Sampling Requirement

- **Sample of 20 Households from Each of 3 Villages**
- **At Start Each of Household Has 60 Chances in 2,000 ($p=.03$) to Be Selected**

Sampling Requirement

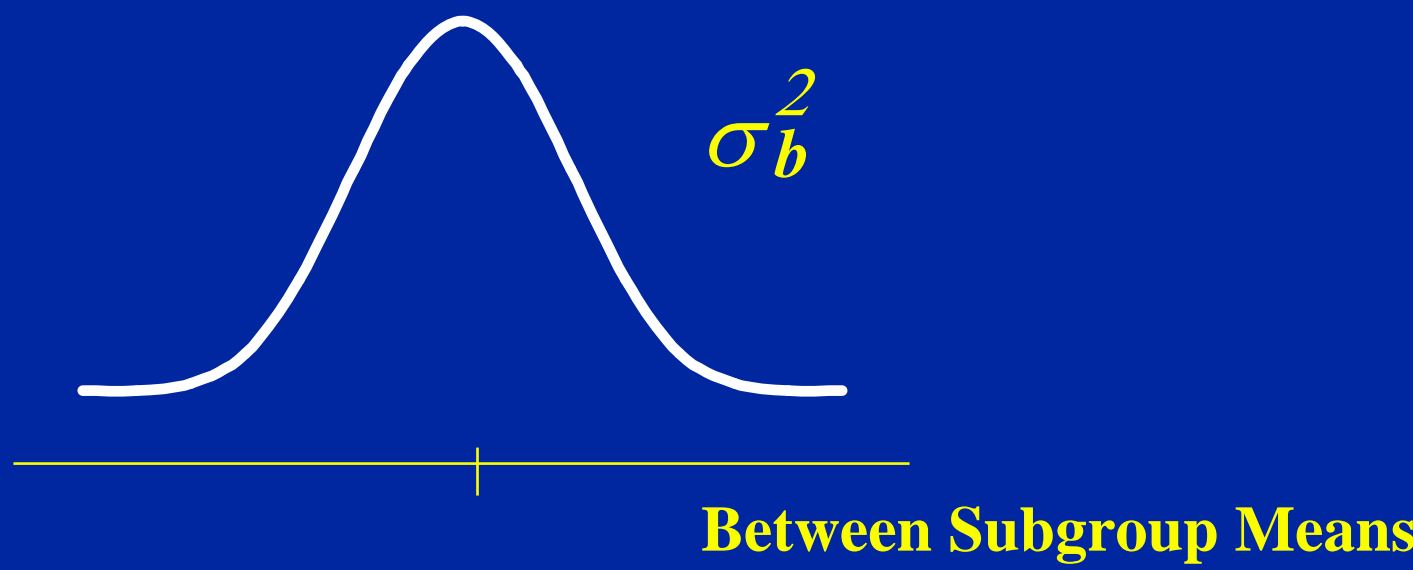
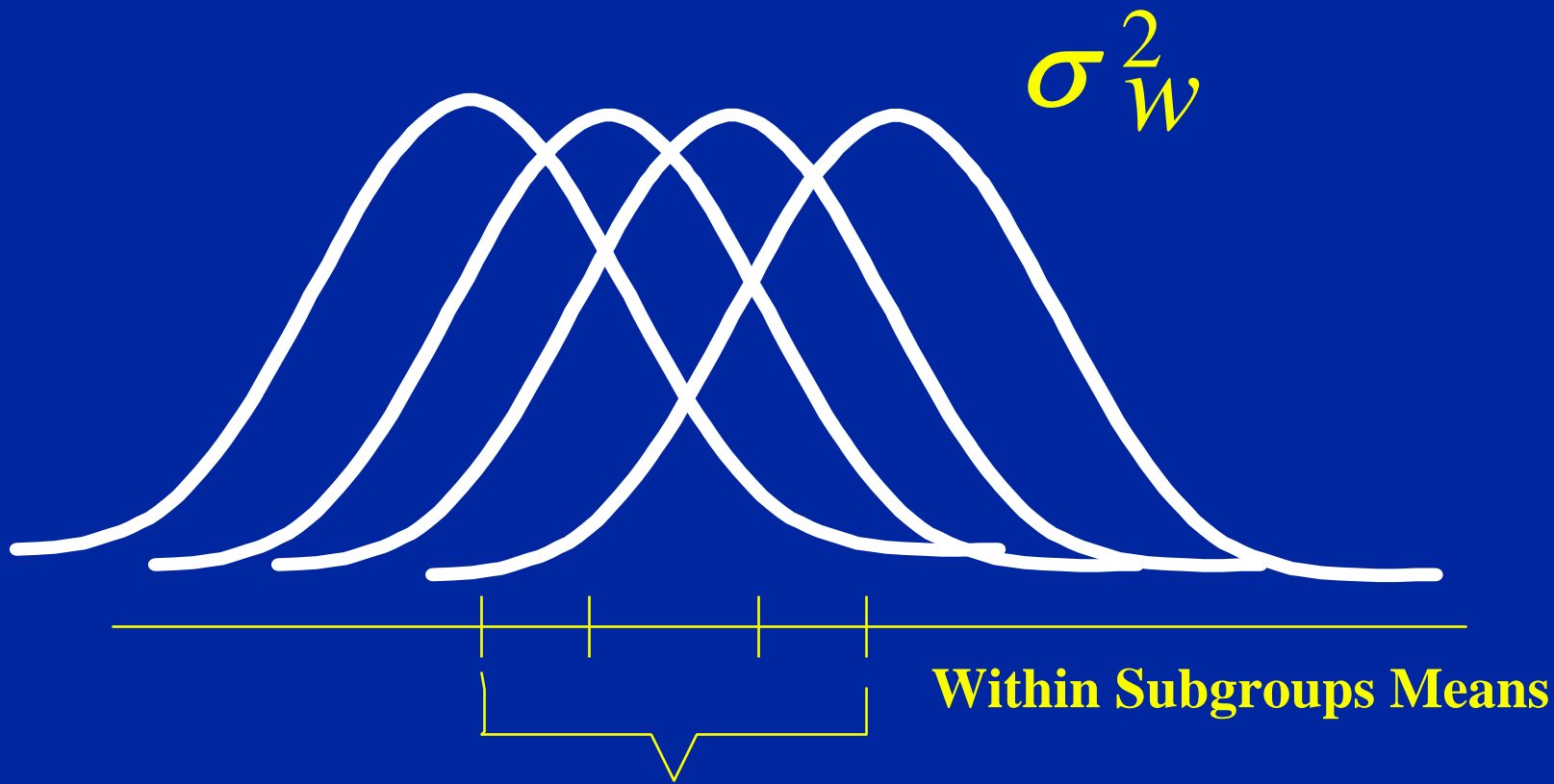
- Sample of 20 Households from Each of 3 Villages
- At Start Each of Household Has 60 Chances in 2,000 ($p=.03$) to Be Selected

Example

Probability that a Specific Household in Village D is Selected:

$$3 \times \frac{500}{2,000} \times \frac{20}{500} = \frac{60}{2,000}$$

Village Chosen	Probability Proportional to Size(PPS)	Probability in Selected Village
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Rules of Multistage Sampling for Combining Subgroup Information to Obtain Aggregate Estimates

- **Select Subgroups as *Heterogeneous* as Possible**
- **Select Subgroups with Probability Proportional to Size (PPS)**
- **Obtain Equal Number of Observations per Subgroups**