



Measures of Variability: Range, Variance, and Standard deviation

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Outline



- What is Measures of variability
- Definition of Range, Variance and standard deviation.
- Applications of Range in Medical Research
- Definition of Variance
- Standard Deviation

❑ What is Measures of variability?

- Also called **measures of dispersion** are statistical methods used to describe **how spread out** or **scattered data values** are in a dataset.
- They show the degree to which **observations differ from one another**.
- **Example: Dataset A: 10, 11, 12, 13, 14.**
- The values are close together, so variability is small.
- **Dataset B: 2, 8, 12, 20, 30.** The values are widely spread

❑ Importance of Measures of Variability?



- They help researchers to:
 - i. Understand data distribution
 - ii. Compare datasets
 - iii. Assess consistency of results
 - iv. Detect outliers
 - v. Interpret research findings accurately.

❑ Main Measures of Variability

- The most common measures of variability are:
 1. Range.
 2. Variance.
 3. Standard Deviation

➤ Definition of Range:

- The range is defined as the difference between the **maximum value** and the **minimum value** in a dataset.

➤ **Formula for Range:** $\text{Range} = \text{Maximum value} - \text{Minimum value}$

❖ Steps in Calculating Range

1. Identify the highest value
2. Identify the lowest value
3. Subtract the lowest value from the highest value.

➤ Example 1: Body Temperature:

- Body temperatures of patients: **36.5, 37.0, 38.2, 36.8, 37.5.**
- Maximum = 38.2°C
- Minimum = 36.5°C

$$\text{Range} = 38.2 - 36.5 = 1.7$$

➤ Therefore, the range is 1.7°C .

➤ Interpretation of Range:

- Small range: → data values are close together.
- Large range: → data values are widely spread.

➤ Example:

✓ **Dataset A:** 10, 11, 12, 13, 14 Range = 4

✓ **Dataset B:** 5, 10, 15, 20, 25 Range = 20

- Dataset B has greater variability because the values are more spread out.

❑ Advantages of Range



1. Easy to calculate
2. Simple to understand
3. Useful for quick comparisons
4. Gives a basic idea of data spread

❖ Limitations of Range



1. Uses only two values (highest and lowest)
2. Ignores all other observations
3. Strongly affected by outliers (extreme values)
4. Not reliable for large datasets

❖ Applications of Range in Medical Research



➤ Range is commonly used in:

- Blood pressure measurements
- Body temperature monitoring
- Blood glucose analysis
- Laboratory test results
- Epidemiological studies

❑ Definition of Variance:

- Variance is defined as the **average squared deviation** of data values from the mean.
 - It shows the degree of spread or variability within a dataset.
- Types of Variance: There are two main types:
1. Population variance
 2. Sample variance

❖ Population Variance:



- Definition Population variance: Is a statistical measure that shows how far the values in an **entire population** spread out from the population mean.
- It measures the average squared deviation of each observation from the population mean.

❑ Sample Variance:



- Definition Sample variance is a statistical measure that describes how spread out the values in a **sample** are around the sample mean.
- It measures the average squared deviation of sample observations from the sample mean.

❑ Example: How to Calculate Variance:



- Suppose the following data represent the haemoglobin levels of patients: 2, 4, 6

Step 1: Calculate the Mean

- Use the formula:

$$\bar{x} = \frac{\sum x}{n}$$

- Substitute the values:

$$\bar{x} = \frac{2 + 4 + 6}{3} = 4$$

- Therefore: $\bar{x}=4$

- Step 2: Subtract the Mean from Each Observation

Observation (x)	Mean ($\bar{x}$)	$x - \bar{x}$
2	4	-2
4	4	0
6	4	2

- Step 3: Square Each Deviation

$x - \bar{x}$	$(x - \bar{x})^2$
-2	4
0	0
2	4

❑ Step 4: Add the Squared Deviations.

$$4+0+4=8$$

➤ Step 5: Divide by $n-1$

➤ Formula for sample variance:

$$s^2 = \frac{\sum (x - \bar{x})^2}{n-1}$$

➤ Substitute the values:

$$s^2 = \frac{8}{3-1} = \frac{8}{2} = 4$$

➤ Final Answer: Variance= 4.

❖ Example 2: Data: 5, 7, 9, 11, 13

- Step 1: Mean $\bar{x} = \frac{5+7+9+11+13}{5} = 9$

➤ Step 2: Deviations:

x	$x - 9$	$(x - 9)^2$
5	-4	16
7	-2	4
9	0	0
11	2	4
13	4	16

Sum:

$$16 + 4 + 0 + 4 + 16 = 40$$

Step 3: Variance

$$s^2 = \frac{40}{5-1} = \frac{40}{4} = 10$$

❑ **Standard Deviation:**

- **Definition:** Standard deviation is a statistical measure that describes how far data values spread from the mean (average).
- It is the positive square root of the variance.

➤ **Importance of Standard Deviation:**

- Measures consistency of data
- Uses all observations
- Helps compare datasets
- Supports medical and scientific research

❑ Steps in Calculating Standard Deviation:



- i. Calculate the mean.
- ii. Subtract the mean from each observation.
- iii. Square each deviation.
- iv. Add the squared deviations.
- v. Divide by $n-1$ to obtain variance.
- vi. Find the square root of the variance.

❑ **Example:** Suppose the data are: 2, 4, 6

- Step 1: Calculate the Mean. $\bar{x} = \frac{2+4+6}{3} = 4$

$$\text{Mean} = 4$$

- Step 2: Calculate Deviations and Squared Deviations.

x	$x - 4$	$(x - 4)^2$
2	-2	4
4	0	0
6	2	4

Sum of squared deviations:

$$4 + 0 + 4 = 8$$

- Step 3: Calculate Variance: $s^2 = \frac{8}{3-1} = 4$

$$\text{Variance} = 4$$

- Step 4: Calculate Standard Deviation

$$s = \sqrt{4} = 2$$

Therefore:

$$\text{Standard Deviation} = 2$$

❑ Applications in Medical Research:

- Standard deviation is commonly used in:
 - i. Blood pressure studies.
 - ii. Haemoglobin analysis.
 - iii. Blood glucose measurements.
 - iv. Clinical laboratory investigations.
 - v. Drug trials.

References



1. National Commission for the Protection of Human Subjects of Biomedical and Behavioral Research. (1979). The Belmont Report.
2. World Medical Association. (2013). Declaration of Helsinki.
3. Council for International Organizations of Medical Sciences (CIOMS). (2016). International Ethical Guidelines for Health-related Research Involving Humans.



Thanks