لجان الدُفعات

STATISTICS

MORPHINE ACADEMY

Pharmaceutical Statistics

Lecture 5

Descriptive statistics

Measures of Dispersion

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ترتيب الأفكار فيد لأيام الامتحانات

Measures of Dispersion → اسمي طبيعي

مقاييس تشتت

Values
- نفس القيم → لا يوجد تشتت
- ليس نفس القيم → يوجد تشتت
  - تشتت كبير (يتم تباعده جدا)
  - تشتت قليل (يتم تقريبه بعض)

Range المدى
- Unit له حسب الـ DATA اللي بدرسها.
- Poor measure → منخفض → بيعطيني معلومات عن أكبر وأقل قيمه فقط.
- Simple → سهل الحساب

Range
- intervals (فترات)
- raw DATA

total Range = (أكبر قيمه − أقل قيمه) + 1

Range = أكبر قيمه − أقل قيمه

Variance التباين
- Unit له حسب الـ DATA اللي بدرسها.
- وتكون وحدات مربعة.

Variance
- Population: $\sigma^2 = \frac{\sum(x-\mu)^2}{N}$ (Population Variance، مجتمع، N عدد القيم)
- Sample: $S^2 = \frac{\sum(x-\bar{x})^2}{n-1}$ (Sample Variance، عينة)

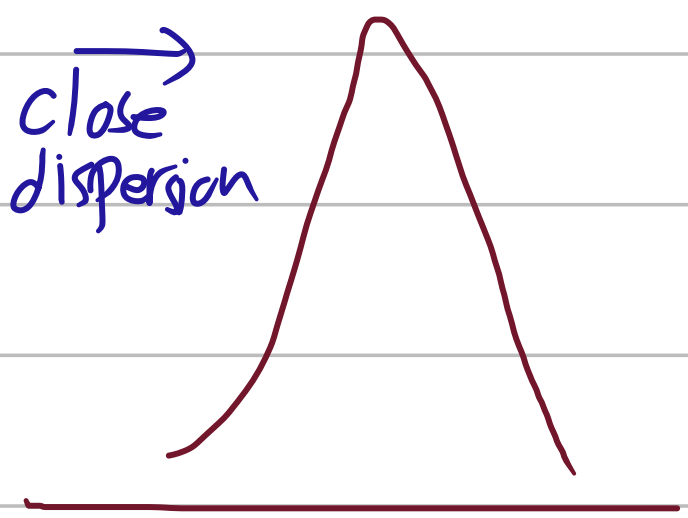
Standard deviation الانحراف المعياري
- Unit له حسب الـ DATA اللي بدرسها.

$S.D = \sqrt{Variance}$

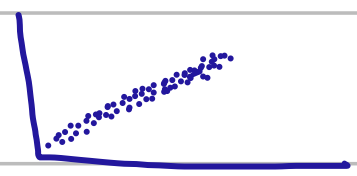
Coefficient of Variation معامل التباين
- Unitless لأنه عبارة عن Ratio
- بيتضم لمقارنة بين شغلات الها وحدات مختلفه.

$C.V = \frac{S}{\bar{X}}$ (S: sample standard deviation، $\bar{X}$: sample mean)

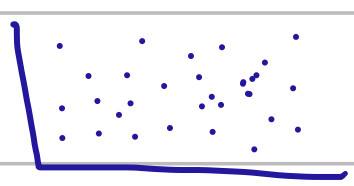
(الرسمات)



- أضيق فترة.
- أقل تشتت/Dispersion/spread
- أقل SD.



- أوسع فترة.
- أكثر تشتت/dispersion/spread.
- أكثر S.D (انحراف معياري).



Measures of Dispersion

- Measures of dispersion characterise how spread out the distribution is, i.e., how variable the data are. It conveys information about the amount of variability present in a set of data.

- **Note: If all the values are the same, there is no dispersion; if they are not all the same, dispersion is present in the data.** If the values **close** to each other the amount of Dispersion **small.** If the values are **widely scattered**, the Dispersion is **greater**.

- Other terms used synonymously with dispersion include variation, spread, and scatter.

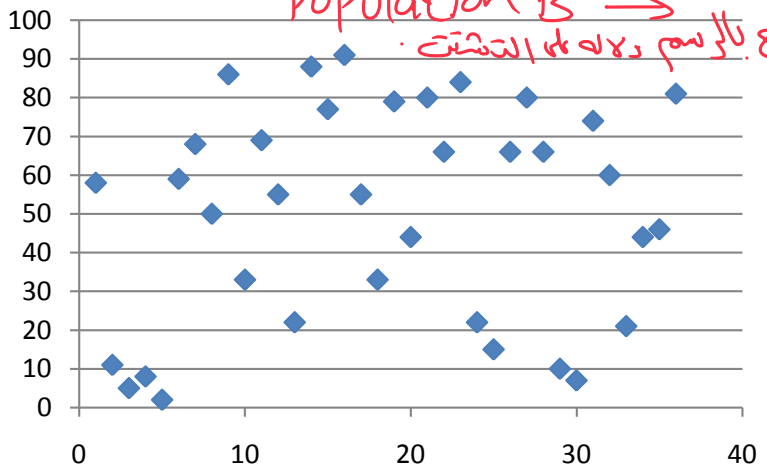
تغايرًا

More variability

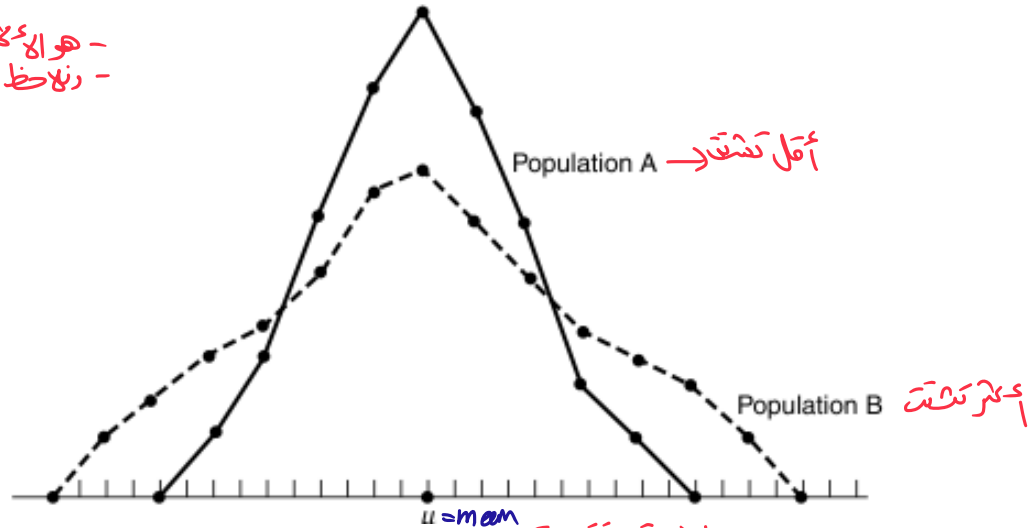
more dispersion / spread / scatter

Population B →

- هو الأكثر تشتتاً
- نلاحظ انه واسع بالرسم دلالة على التشتت.



Population B, which is more variable than population A.



Less variability

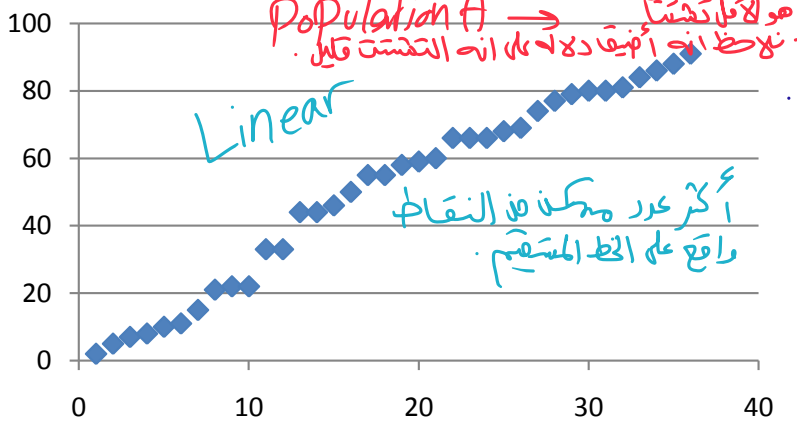
less dispersion / spread / scatter

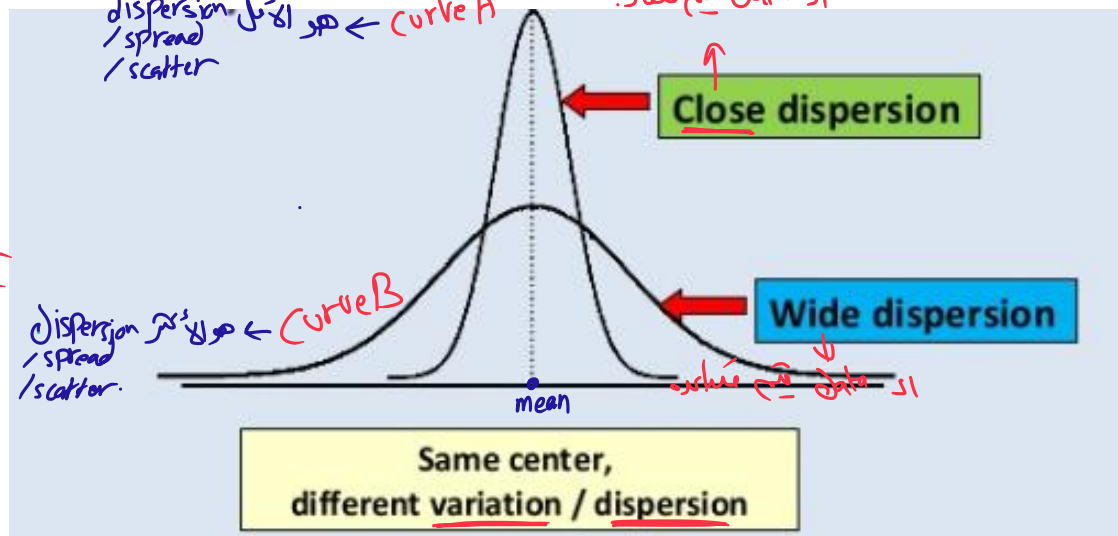
Population A →

- هو الأقل تشتتاً
- نلاحظ انه أضيق دلالة على انه التشتت قليل.

Linear

أكثر عدد ممكن من النقاط واقع على الخط المستقيم.





نفس المتوسط الحسابي

Two frequency distributions with equal means but different amounts of dispersion.

ولكن مختلفين بـ تشتت الـ data

Indicators of dispersion

- Variation in experiments or in any assay is due to several reasons as

- The instrument used for analysis.
- The analyst performing the assay.
- The particular sample chosen.
- Unidentified error commonly known as noise.

Variation is an inherent characteristic of experimental observations.

Measures of Dispersion

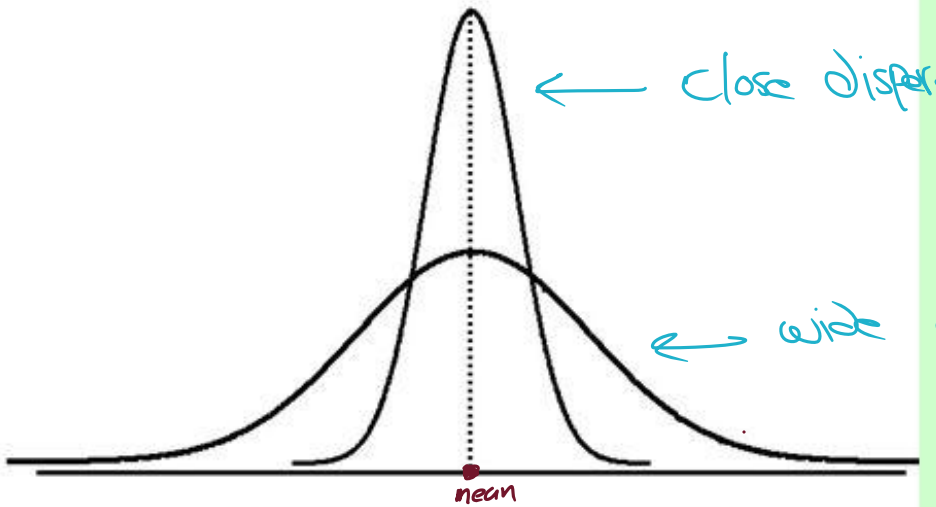
مقاييس التشتت / spread / scatter

Variation

- **Range** — المدى
- **Variance** — التباين
- **Standard Deviation** — الانحراف المعياري
- **Coefficient of Variation** — معامل التباين

- Measures of variation give information on the **spread** or **variability** or **dispersion** of the data values.

(Spread = variability = dispersion)



نفس المعدل

Same centre, different variation / dispersion.

1.The Range (R):

- The **R** is the difference between the largest and smallest value in a set of observations.
- Range = (X)Largest value- Smallest value

- **Properties of the R**
- Simplicity of its computation
- Poor measure of dispersion, as its value is concerned only onto two values, so imparts minimal information about a data set and therefore is of limited use.

- Data:
- 43,66,61,64,65,38,59,57,57,50. (raw DATA)
- Find Range?
- Range=66-38=28

2.The Variance:

- **It measure dispersion relative to the scatter of the values about the mean.**

Statistic ← أي معلومة يوخذها من ال Sample بسميها
Parameter ← أي معلومة يوخذها من ال Population بسميها

Population	Sample
mean → μ	mean → $\bar{x}$
N → Count of values	n → Count of values
Variance → σ	Variance → S^2

a) Sample Variance:

S^2

Sample Variance

$$S^2 = \frac{\sum_{i=1}^{n} (x_i - \bar{x})^2}{n-1}$$

مجموع — كل مشاهدة — المتوسط الحسابي — عدد القيم

$\bar{x}$ = is sample mean

n = count of values for the sample

b) Population Variance (σ)^2:

Population Variance

$$\sigma^2 = \frac{\sum_{i=1}^{N} (x_i - \mu)^2}{N}$$

مجموع — كل مشاهدة — المتوسط الحسابي — N ← Count of values

- **where Mu(μ) is Population mean**

2. The Variance:

EXAMPLE:

$$S^2 = \frac{\sum_{i=1}^{n}(x_i - \bar{x})^2}{n-1}$$

- **Find Sample Variance of ages (5,7,8,12,6,9,11,6).**

Solution:

$\bar{x}$ **= (5+7+8+12+6+9+11+6)/8 = 8**

- $S^2 = [(5-8)^2 + (7-8)^2 + (8-8)^2 + (12-8)^2 + (6-8)^2 + (11-8)^2 + (6-8)^2] / 7$
- $S^2 = 9+1+0+16+4+1+9+4 / 7$
- $= 44/7$
- $= 6.28$

$S^2 = 6.28$

sample Variance

3. The Standard Deviation:

- **The variance represents squared units and, therefore, is not an appropriate measure of dispersion when we wish to express this concept in terms of the original units.**
- **To obtain a measure of dispersion in original units, we merely take: the square root of the variance.**

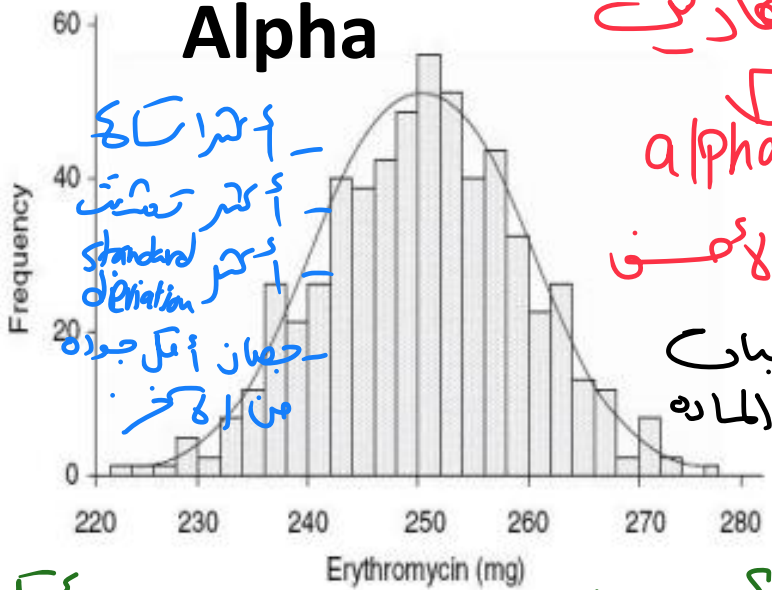
the square root of variance= $\sqrt{Variance}$

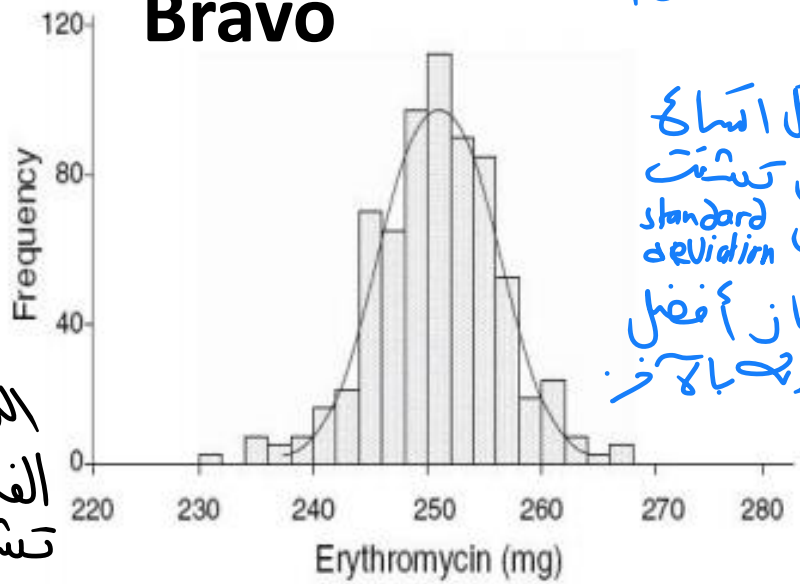
A. Sample Standard Deviation = S = $\sqrt{S^2}$

A. Population Standard Deviation = σ = $\sqrt{\sigma^2}$

3. The Standard Deviation

- Example:We have two tableting machines ('Alpha' and 'Bravo') producing erythromycin tablets with a nominal content of 250 mg.
- Five hundred tablets are randomly selected from each machine and their erythromycin contents assayed.





Histogram of erythromycin of 500 mg tablets from both Alfa and Bravo tableting machines; respectively.

The Standard Deviation

- An 'indicator of dispersion' is required in order to convey this difference in variability, which is **standard deviation**.

Alpha machine			Bravo machine		
Erythro content (mg)	Deviation from mean	Deviation squared	Erythro content (mg)	Deviation from mean	Deviation squared
249	**0.3**	0.09	251	**−0.1**	0.01
242	**−6.7**	44.89	247	**−4.1**	16.81
252	**3.3**	10.89	257	**5.9**	34.81
235	**−13.7**	187.69	250	**−1.1**	1.21
257	**8.3**	68.89	254	**2.9**	8.41
244	**−4.7**	22.09	251	**−0.1**	0.01
264	**15.3**	234.09	252	**0.9**	0.81
249	**0.3**	0.09	255	**3.9**	15.21
255	**6.3**	39.69	244	**−7.1**	50.41
240	**−8.7**	75.69	250	**−1.1**	1.21
Mean 248.7		Total 684.1	Mean 251.1		Total 128.9

mean ± SD
248.7 ± 8.72

Mean ± SD
251.1 ± 3.78

Sum of squared deviations = 684.1
684.1/9 = 76.01
SD = square root 76.01
= **8.72 mg (SD)**

Sum of squared deviations = 128.9
128.9/9 = 14.32
SD = square root 14.32
= **3.78 mg (SD)**

↑SD
↑dispersion /spread/scatter
↓ جودہ جھاز

3. The Standard Deviation

- The Alpha machine produces rather variable tablets and so several of the tablets deviate considerably (e.g. -13.7 or +15.3 mg) from the overall mean. So producing a **high** final SD (8.72 mg).

- In contrast, the Bravo machine is more consistent and individual tablets never have a drug content much above or below the overall average.

- The small figures in the column of individual deviations, leading to a **lower** SD (3.78 mg).

Reporting Standard deviation

Reporting the SD:

- The ± symbol is used in reporting the SD
- The symbol ± reasonably interpreted as meaning 'more or less'.
- ± is used to indicate variability.
- With the tablets from our two machines, we would report their drug contents as:

- **Alpha machine: 248.7±8.72 mg (SD)**
- **Bravo machine: 251.1±3.78 mg (SD)**

Units of SD:

- The SD is not a unitless number. It has the same units as the individual pieces of data.
- Since our data consisted of erythromycin contents measured in milligrams, the SD is also in milligrams.

4. Coefficient of Variation (C.V)

- The standard deviation is useful as a measure of variation within a given set of data.

- When one desires to compare the dispersion in two sets of data, however, comparing the two standard deviations may lead to fallacious results.

- In this case is a measure of relative variation rather than absolute variation is required. Such a measure is found in the **coefficient of variation**, which expresses the standard deviation as a percentage of the mean.

Coefficient of variation expresses variation relative to the magnitude of data

4.The Coefficient of Variation (C.V):

- Is a measure use to compare the dispersion in two sets of data which is independent of the unit of the measurement .

$$C.V = \frac{S}{\overline{X}} * (100)$$

- S: Sample standard deviation.
- $\overline{X}$: Sample mean.

- Suppose two samples of human males yield the following data:

	Sampe1		Sample2
Age	25-year-olds		11year-olds
Mean weight	145 pound	>	80 pound
Standard deviation	10 pound		10 pound

Question: examine the sample that has more variability?

A comparison of the standard deviations might lead one to conclude that the two samples possess equal variability.

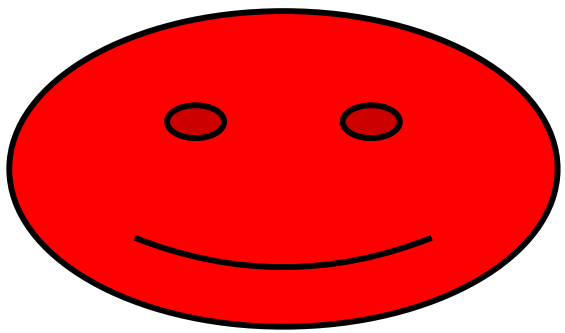
Solution:

- C.V (Sample1)= (10/145)*100= 6.9
- C.V (Sample2)= (10/80)*100= 12.5

Then, it is clear that **Sample2** (age of 11-years old) has more variation than **Sample1** (25-year-olds).

In other words, variation is much higher in the sample2 than sample1.

Now you got quite a different impression.



Coefficient of Variation

- Since the coefficient of variation is independent of the scale of measurement so:
  - It is a useful statistic for comparing the variability of two or more variables (results) measured on different scales. for example, use the coefficient of variation to compare the variability in weights of one sample of subjects whose weights are expressed in pounds with the variability in weights of another sample of subjects whose weights are expressed in kilograms
- It is useful in comparing the results obtained by different persons who are conducting investigations involving the same variable.
- Because the coefficient of variation is a ratio, it is unitless (unlike the SD).