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Protocol 02- Estimation

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Data Analysis in Biosciences — Level: L3 biology
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We aim to estimate an unknown parameter related to a random phenomenon, usually the mean μ, the variance σ^2, or the standard deviation σ of the distribution.

To do this, we consider independent observations $X_1, \ldots, X_n$ (identically distributed). This forms a sample. From this sample, we define a new variable X whose value is close to the unknown parameter.

The objective is to list the steps in SPSS to construct a confidence interval (CI) for the mean. Consider the following example:

Example 1. *A sugar test in a solution was conducted on 8 samples from the same population. The results in g/L are:*

19.5	*19.7*	*19.8*	*20.1*	*20.2*	*20.3*	*20.4*	*20.8*

(1) Determine point estimates of the mean and standard deviation.

(2) What is the 95% confidence interval for the mean?

(3) What is the 99% confidence interval for the mean?

Solution with SPSS

- Launch SPSS and open the data editor.
- Switch to "Variable View" to define the variable (name, type, etc.).
- Switch to "Data View" and enter the 8 values above.

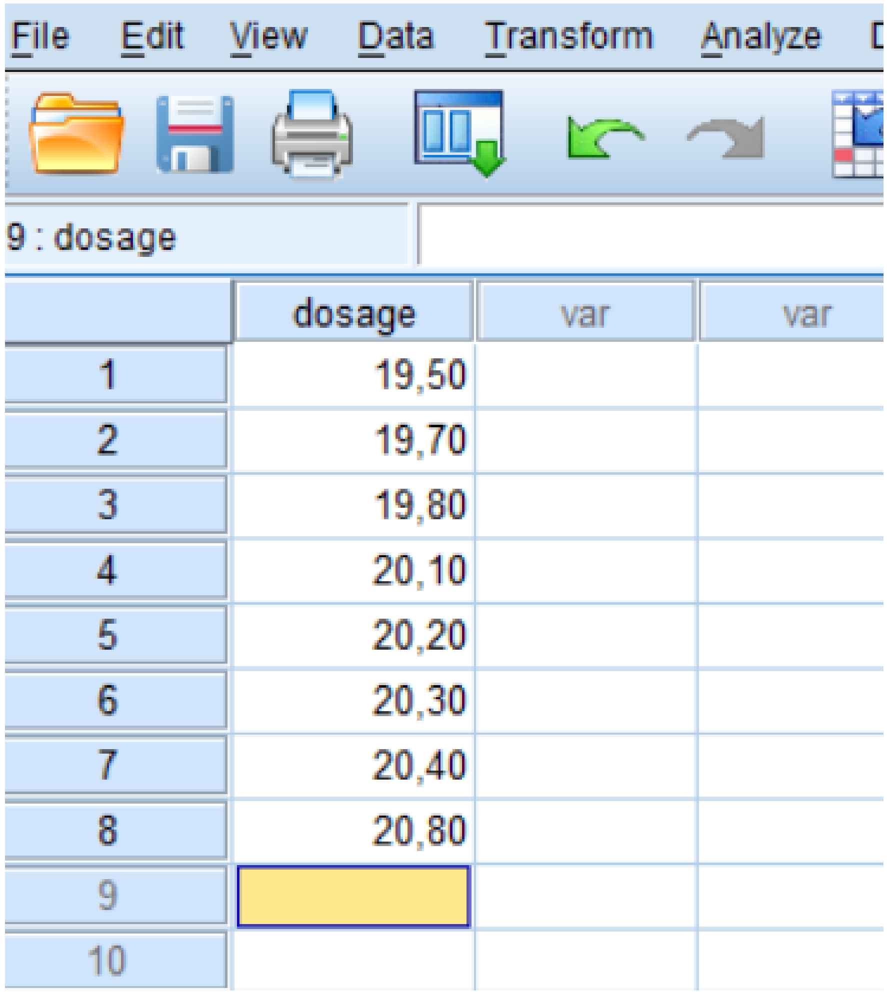

Figure 1: Data Input in SPSS

Steps to calculate confidence interval:

- Go to: **Analyze** → **Compare Means** → **One-Sample T Test**

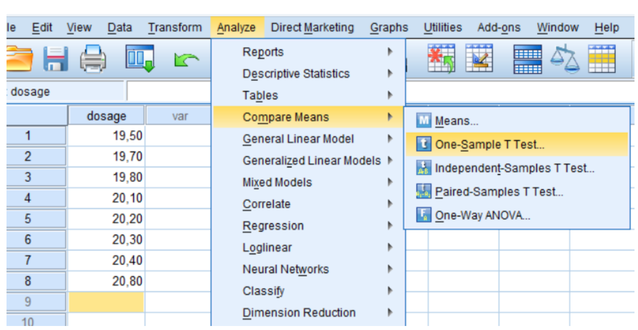

Figure 2: Selection of the Estimation Method Using Confidence Intervals

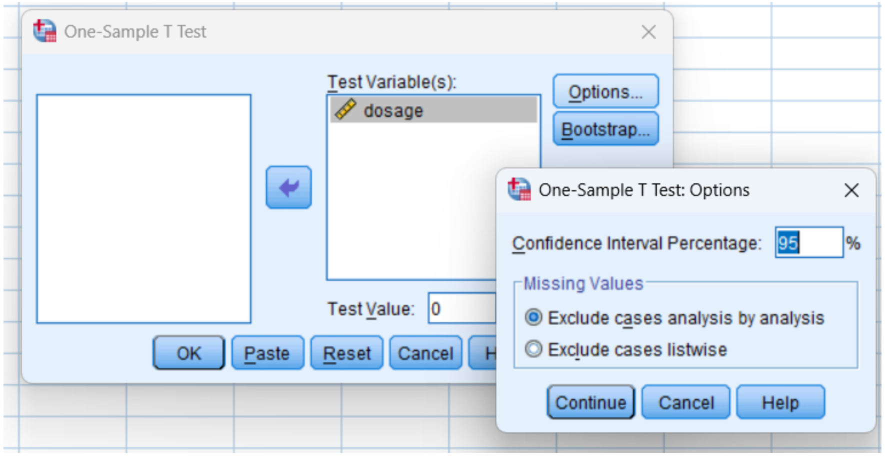

Figure 3: Choosing the Target Variable and Setting the Confidence Level

- Move the variable (e.g., dosage) to the test field.
- Set the test value to 0.
- Click on "Options" and set the confidence level (e.g., 95% or 99%).
- Click OK.

Interpretation of the results:

The first table presents the answer to Question 1, which consists of a point estimate for the mean:

$$\bar{X} = 20.1$$

and a point estimate of the standard deviation which is:

$$S = \sqrt{\frac{1}{n-1}\sum(X_i - \bar{X})^2} = 0.42088$$

Statistiques sur échantillon unique

	N	Moyenne	Ecart-type	Erreur standard moyenne
dosage	8	20,1000	,42088	,14880

Figure 4: SPSS Output Window Showing Estimation Results: Table 1

The key information in the second table, for the purpose of our example, is the column titled *95% Confidence Interval of the Difference*, which represents the 95% confidence interval for the mean (i.e., the lower and upper bounds of this interval). Therefore, at 95%, we have:

$$\mu \in [19.7481\,;\,20.4519]$$

Test sur échantillon unique

	Valeur du test = 0					
					Intervalle de confiance 95% de la différence	
	t	ddl	Sig. (bilatérale)	Différence moyenne	Inférieure	Supérieure
dosage	135,076	7	,000	20,10000	19,7481	20,4519

Figure 5: SPSS Output Window Showing Estimation Results: Table 2

For question 3, it is sufficient to follow the same steps as before, with the only change being at Step 3, where the confidence level is adjusted to 99%. The confidence interval for the mean is now given as follows:

$$\mu \in [19.5793\,;\,20.6207] \quad \text{at 99\% confidence level.}$$

Test sur échantillon unique

	Valeur du test = 0					
					Intervalle de confiance 99% de la différence	
	t	ddl	Sig. (bilatérale)	Différence moyenne	Inférieure	Supérieure
dosage	135,076	7	,000	20,10000	19,5793	20,6207

Figure 6: SPSS output window showing estimation results for $\alpha = 1\%$ (i.e., a 99% confidence level)

Example 2. *Verify that the following results are correct using SPSS: a probability exam is conducted for a very large class. A sample of 4 grades is selected.*

12.5	*10*	*14.5*	*14*

Given $n = 4 < 30$ *and* σ *unknown, we use the Student's t-distribution:*

$$\mu \in \left[\bar{X} - t_{\alpha/2,n-1} \cdot \frac{S}{\sqrt{n}},\ \bar{X} + t_{\alpha/2,n-1} \cdot \frac{S}{\sqrt{n}}\right]$$

With $\alpha = 0.05,\ n-1 = 3,\ t = 3.182$ *from the t-table:*

$$\bar{X} = 12.75, \quad S^2 = 4.08 \Rightarrow \mu \in [9.535;\ 15.964]$$

Example 3. *A biologist wants to estimate the mean infection rate after inoculation. He measured the percentage of infected cells in 15 cultures:*

08	*10*	*09*	*11*	*12*	*07*	*09*	*13*	*08*
10	*14*	*07*	*09*	*11*	*08*			

(1) Compute the point estimates of the mean and standard deviation.

(2) Compute the 99% confidence interval for the mean.