ECAT Information

How to interpret the Z-score in relation to the homogeneity of the sample used in a survey

Introduction

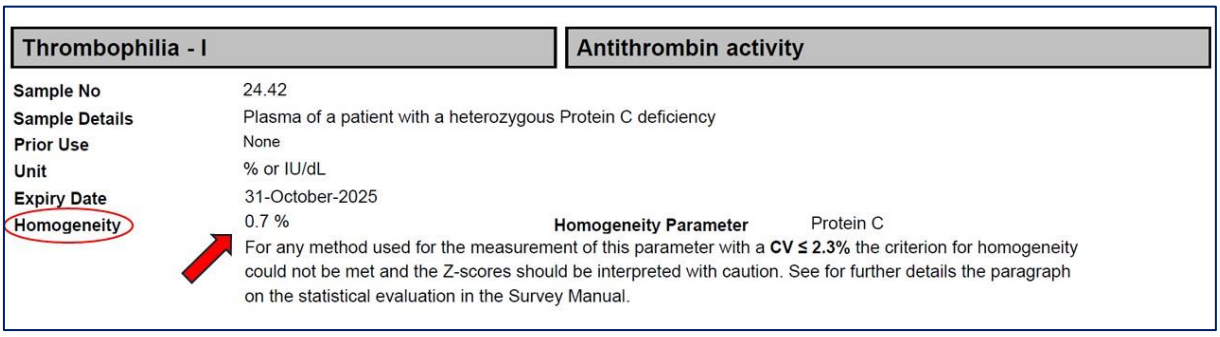
An important aspect for the comparison of the results between participants in an external quality assessment programme is the homogeneity of the samples distributed. The more homogeneous a sample, the less impact it has on the variation in test results between participants. In this short communication we explain the relationship between the homogeneity of a sample and the between-laboratory variation as well as the impact of the homogeneity on the interpretation of the Z-score by a participant.

Homogeneity

Homogeneity is the quality property of a sample used in a survey that reflects the variability in concentration or activity of a certain parameter between different vials. As a result of the preparation process of samples used in a survey (e.g. filling of the samples, lyophilisation process) each batch is subject to some variation. This variation between vials is called the inhomogeneity of the sample. The lower the inhomogeneity of samples the less variability between vials. This implies also a lower impact on the between-laboratory variation between test results observed in a survey (see below).

The international standard for statistics in an external quality assessment programme (ISO13528:2022) contains a general rule that indicates that the inhomogeneity in a sample should be less than or equal to 0.3 times the between-laboratory variation in a survey. If this is the case the effect of the inhomogeneity on the between-laboratory variation is negligible.

The homogeneity of a sample is indicated in the samples details of a survey report (see example below).

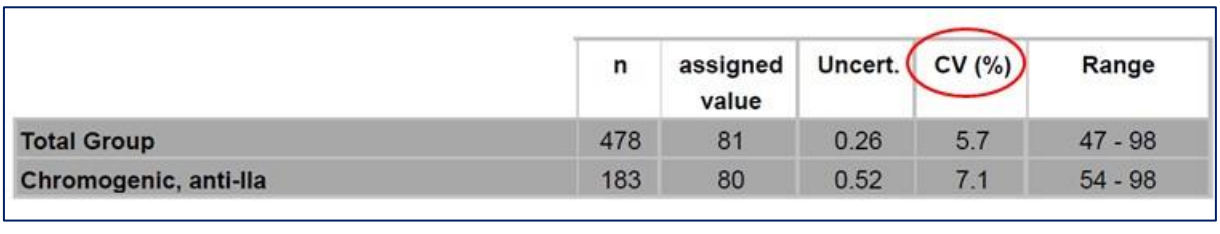


Thrombophilia - I	Antithrombin activity
Sample No	24.42
Sample Details	Plasma of a patient with a heterozygous Protein C deficiency
Prior Use	None
Unit	% or IU/dL
Expiry Date	31-October-2025
Homogeneity	0.7 % **Homogeneity Parameter** Protein C

For any method used for the measurement of this parameter with a **CV ≤ 2.3%** the criterion for homogeneity could not be met and the Z-scores should be interpreted with caution. See for further details the paragraph on the statistical evaluation in the Survey Manual.

Between-laboratory variation

The between-laboratory variation reflects the distribution of the test results reported by the participants for a certain parameter in a particular survey. This variability in test results is expressed in the survey reports by the coefficient of variation (CV) {%}) (see example below).



	n	assigned value	Uncert.	CV (%)	Range
Total Group	478	81	0.26	5.7	47 - 98
Chromogenic, anti-IIa	183	80	0.52	7.1	54 - 98

The between-laboratory variation is calculated on the basis of the robust mean and standard deviation obtained from a set of test results reported by the participants (CV = SD/mean *100%).

However, it should be realised that the CV as reported in the survey reports is in fact a combination of the analytical variation in test results between participants and the inhomogeneity of the samples distributed to the participants. The more homogeneous a sample, the less impact this has on the between-laboratory CV.

Z-score

As an individual performance indicator, ECAT uses the Z-score. The Z-score reflects the deviation between a participant's result and the assigned value (= mean value) corrected by the variation in the distribution of the participant's results. The Z-score is calculated by the following equation:

[(laboratory result) - (assigned value)] / (standard deviation)

As shown in the above-mentioned equation the Z-score depends on the standard deviation. The standard deviation reflects the distribution of the test results of the participants which includes the analytical variation in test results between participants as well as the inhomogeneity of the samples used. This implies a dependence of the Z-score on the homogeneity of a sample.

Evaluation of Z-score in relation to the homogeneity

The homogeneity indicated in the sample details of the report should be less than 0.3 times the between-laboratory CVs given in the survey report . If this is not the case the contribution of the inhomogeneity to the standard deviation is not negligible. This means that the calculation of the Z-score is not predominantly determined by the analytical variability between participants. In such a case the Z-score of a participant not only reflects the deviation from the target value because of analytical variation but also depends on the sample vial received in the survey. Therefore, the participant should evaluate their Z-score with caution.

This is explained by the following example:
Let's assume an inhomogeneity of 1.5%. This means that any CV ≤ 5.0% (1.5/0.3) does not fulfil the homogeneity criterion. The Z-score for a participant's result probably not only reflects the analytical deviation from the assigned value but may also depend on the vial received by the participant. This may also imply that a Z-score < -3 or > 3 may not be caused by any insufficient performance on the part of the participant. Nevertheless we advise the participant still to investigate whether any problem in the test performance may have caused an unacceptable Z-score. It's also wise to compare the Z-score with those obtained in previous surveys.

Remark in survey report

According to ISO standards 17043:2023 and 13528:2022 a comment should be made in the survey report if a plasma is used which, for one or more methods used by the participants, does not meet the criterion for homogeneity (CVs ≤ 0.3 CV). An example of such a comment is given below.

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Expiry Date	31-October-2025
Homogeneity	0.7 % **Homogeneity Parameter** Protein C

For any method used for the measurement of this parameter with a **CV ≤ 2.3%** the criterion for homogeneity could not be met and the Z-scores should be interpreted with caution. See for further details the paragraph on the statistical evaluation in the Survey Manual.

In the example given for all cases with a CV ≤ 2.3% the Z-score should be interpreted with caution.

Such a comment is only made if the homogeneity is > 0%. If a homogeneity of 0% is indicated, all CVs will meet the homogeneity criterion.

ECAT strives to use samples with as low an inhomogeneity as possible. Because we use the greatest number possible of patient samples it is not always possible to use samples that fulfil the homogeneity criterion mentioned earlier.

More information can also be found in the annual Survey Manual.