

Sample vs Population Standard Deviation

The sample and population standard deviation are not two styles of the same calculation; they answer different questions and use different denominators for a specific mathematical reason.



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What this answers

This page answers "which standard deviation should I use, and why do the two formulas differ?" The choice depends on whether your data represent the entire group you care about or a sample drawn from a larger group you want to describe.

Why the denominators differ

The population standard deviation divides the sum of squared deviations by n , the full count, because every member of the group of interest is already included; there is nothing left to estimate. The sample standard deviation divides by $n - 1$ because using the sample mean, rather than the true population mean, to calculate deviations slightly understates the true spread; dividing by a smaller number corrects that downward bias so the result is a fair estimate of the population's variability.

When each applies

Use the population formula only when your data genuinely represent the entire population of interest, such as the exam scores of every student in a specific class if your question is only about that class. Use the sample formula whenever your data are a subset drawn from, or intended to generalize to, a larger group, which describes the overwhelming majority of applied statistics, surveys, and experiments. When in doubt, the sample formula is the safer default, and the difference between the two shrinks as sample size grows.

Worked example

For the values 2, 4, and 6, the mean is 4 and the squared deviations are 4, 0, and 4, summing to 8. The population standard deviation divides 8 by 3 and takes the square root, giving about 1.63. The sample standard deviation divides 8 by 2 instead, giving about 2.00, a noticeably larger value at this very small sample size. As sample size grows into the hundreds, this gap becomes negligible.

Assumption audit

Calculated from your data: both the sample and population standard deviation, side by side, whenever you use the linked calculator, so you can compare them directly for your own values.

Evidence to review: your sample size, since the difference between the two formulas matters most at small sample sizes and becomes negligible for large ones.

You must verify: whether your data represent an entire population of interest or a sample drawn from a larger one, since no calculation on the values alone can answer that question for you.

Source

This explanation follows the standard treatment of the two standard deviation estimators in the NIST/SEMATECH e-Handbook of Statistical Methods and the shared statistical reasoning contract every StatReason engine is built against.

Limitations

This page covers the standard sample and population formulas used throughout this site; a confidence interval for the standard deviation itself requires at least two observations and is covered separately on that engine's own page.

Next action: use the [Standard Deviation Calculator](#) to compute both versions for your own data, or the [Variance Calculator](#) for the squared form.