

EXCEL SURVIVAL NOTES FOR MAT 120—NORMAL DISTRIBUTIONS
For Excel 2007 Users

How do I convert a raw score (data item) into a z-score?
<p>What function do I use? Z-scores are also known as <i>standard scores</i>. The EXCEL function that converts raw scores into z-scores is STANDARDIZE.</p>
<p>What information do I need?</p> <ul style="list-style-type: none"> • x, the <i>raw score</i> (also known as a data item) • μ, the population <i>mean</i> for a normal distribution • σ, the population <i>standard deviation</i> for the distribution
<p>In what order do I enter the information? STANDARDIZE(raw score, mean, standard deviation) You may access STANDARDIZE from the function menu or by typing its name. The information must be entered in this specific order—raw score, mean, standard deviation.</p>

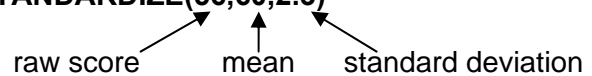
Important note!!!

When accessing a mathematical function by typing its name, don't forget to type the = symbol just before the name of the function. If you omit the = symbol, you won't get the correct answer.

EXAMPLE For a normal distribution with a mean of 60 and a standard deviation of 2.3, convert a raw score of 56 into a z-score.

In the cell where you want the answer to appear, type **=STANDARDIZE(56,60,2.3)**

The answer is **-1.73913**.



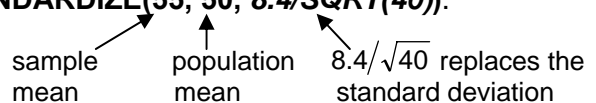
For a Central Limit problem, how do I convert a sample mean into a z-score?
<p>What function do I use? The Central Limit Theorem deals with the <i>distribution of sample means</i>. The standard deviation for this distribution is $\sigma_{\bar{x}} = \frac{\sigma}{\sqrt{n}}$, where σ is the population standard deviation, and n is the size of the sample group.</p> <p>To convert a sample mean into a z-score, you may use STANDARDIZE if you replace the standard deviation with the value of σ/\sqrt{n}. To get the square root of the sample size, use SQRT, the square root function.</p>
<p>What information do I need?</p> <ul style="list-style-type: none"> • \bar{x}, the <i>sample mean</i> (also known as a sample average) • μ, the population <i>mean</i> for the distribution • σ, the population <i>standard deviation</i> • n, <i>sample size</i>
<p>In what order do I enter the information? STANDARDIZE(raw score, mean, standard deviation/SQRT(n))</p> <p>The square root function requires parentheses around the number whose square root you are taking.</p>

EXAMPLE For a distribution with a population mean of 50 and a standard deviation of 8.4, suppose you have a sample group of 40 items. Find the z-score for a sample mean of 55.

For this problem $\sigma/\sqrt{n} = 8.4/\sqrt{40}$, so replace the standard deviation with $8.4/\sqrt{40}$.

In the cell where you want the answer to appear, type **=STANDARDIZE(55, 50, 8.4/SQRT(40))**.

Answer is 3.764616.



How do I find probabilities based on a *standard* normal distribution?

What function do I use?

A *standard* normal distribution is one in which the mean is zero and the standard deviation is one. To find probabilities based on a standard normal distribution, use **NORMSDIST**. “S” indicates a *standard* normal distribution.

What does the function do?

Under the normal curve, NORMSDIST finds the **area to the left** of a specified z-score. Areas under the normal curve are also probabilities. NORMSDIST can be used to find:

- the probability that a z-score is *less than* a specified number (the area to the left of the specified number)
- the probability that a z-score is *greater than* a specified number (the area to the right of the number)
- the probability that a z-score is *between* two specified numbers (the area between the two numbers)

How do I enter the information to find the probability that the z-score is less than a specified number?

NORMSDIST(z-score)

This is the area to the left of the specified z-score. NORMSDIST calculates *the area to the left*.

How do I enter the information to find the probability that the z-score is greater than a specified number?

1 – NORMSDIST(z-score)

This is the **area to the right** of the specified z-score. The entire area under the curve equals 1. To get the *area to the right of the given z-score*, you must subtract the value given by NORMSDIST from 1.

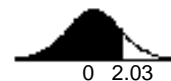
How do I enter the information to find the probability that the z-score is between two specified numbers?

NORMSDIST(larger z-score) – NORMSDIST(smaller z-score)

This is the **area between** two specified z-scores. This involves using NORMSDIST twice—once for the larger z-score and once for the smaller z-score. The difference between the two NORMSDIST answers is the area between the two z-scores.

EXAMPLE For a standard normal distribution, find $P(z < 2.03)$.

On paper, you may find it helpful to draw, label, and shade the standard normal curve. The “less than” symbol means shade the **area to the left** of 2.03.

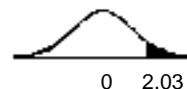


In the cell where you want the answer to appear, type **=NORMSDIST(2.03)**.

Answer is 0.978822.

EXAMPLE For a standard normal distribution, find $P(z > 2.03)$

The “greater than” symbol means shade the **area to the right** of 2.03.

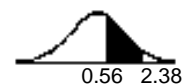


In the cell where you want the answer to go, type **= 1 – NORMSDIST(2.03)**.

Answer is 0.021178.

EXAMPLE For a standard normal distribution, find $P(0.56 < z < 2.38)$.

The fact that z is located **between** two numbers means that you should shade the area between the two z-scores.



In the cell where you want the answer to appear, type **= NORMSDIST(2.38) – NORMSDIST(0.56)**.
Answer is 0.279083.

How do I find probabilities based on a normal distribution with a given mean and standard deviation?

What function do I use?

To find probabilities based on a normal distribution with a given mean and standard deviation, use **NORMDIST**. (Hint—Use NORMDIST without the letter “S” in the middle because this normal distribution is not standard.)

What does the function do?

Under the normal curve, NORMDIST finds the **area to the left** of a specified raw score (data item). Areas under the normal curve are also probabilities. NORMDIST can be used to find:

- the probability that a raw score is *less than* a specified number (the area to the left of the specified number)
- the probability that a raw score is *greater than* a specified number (the area to the right of the specified number)
- the probability that a raw score is *between* two specified numbers (the area between the two specified numbers)

How do I enter the information to find the probability that the raw score is less than a specified number?

NORMDIST(raw score, mean, standard deviation, 1)

Notice the number **1** is the last entry inside the parenthesis. When Excel sees 1 in this position, it knows that you are looking for the **area to the left** of the specified raw score. NORMDIST delivers *the area to the left of a given raw score*.

For NORMDIST, the numbers must be entered in this specific order —raw score, mean, standard deviation, 1.

How do I enter the information to find the probability that the raw score is greater than a specified number?

1 – NORMDIST(raw score, mean, standard deviation, 1)

This is the **area to the right** of the specified raw score. The entire area under the curve equals 1. To get the *area to the right of the given raw score*, you must subtract the value given by NORMDIST from 1.

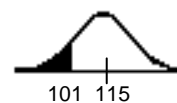
How do I enter the information to find the probability that the raw score is between two specified numbers?

NORMDIST(larger raw score, mean, standard deviation, 1) – NORMDIST(smaller raw score, mean, standard deviation, 1)

This is the **area between** two specified raw scores. This involves using NORMDIST twice—once for the larger raw score and once for the smaller raw score. The difference between the two NORMDIST answers is the area between the two raw scores.

Example For a normal distribution with a mean of 115 and a standard deviation of 12.3, find the probability that a raw score is less than 101, $P(x < 101)$.

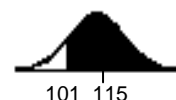
“Less than” means shade the **area to the left** of 101.



In the cell where you want the answer to appear, type **=NORMDIST(101, 115, 12.3, 1)**. **Answer is 0.127516.**

Example For a normal distribution with a mean of 115 and a standard deviation of 12.3, find the probability that a raw score is greater than 101, $P(x > 101)$.

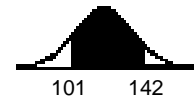
“Greater than” means shade the **area to the right** of 101.



In the cell where you want the answer to appear, type **=1 – NORMDIST(101, 115, 12.3, 1)**. **Answer is 0.872484.**

EXAMPLE For a normal distribution with a mean of 115 and a standard deviation of 12.3, find the probability that a raw score is between 101 and 142, $P(101 < x < 142)$.

“Between” means that you should shade the **area between** 101 and 142.



In the cell where you want the answer to go, type = **NORMDIST(142, 115, 12.3, 1) – NORMDIST(101, 115, 12.3, 1)**.

Answer is 0.858406.

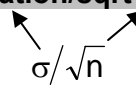
Using the Central Limit Theorem, how do I find probabilities based on a distribution of sample means when I am given a population mean, standard deviation, and sample size?

What function do I use?

If you replace the standard deviation with σ/\sqrt{n} , NORMDIST can be used in the same way that it was for normal distributions with a given mean and standard deviation.

How do I enter the information?

NORMDIST(raw score, mean, standard deviation/sqrt sample size, 1)



- NORMDIST calculates the answer for “less than” problems.
- 1 – NORMDIST calculates the answer for “greater than” problems.
- NORMDIST for the larger sample mean – NORMDIST for the smaller sample mean calculates the answer for “between” problems.

To use any of the above, just replace the standard deviation with the standard deviation divided by the square root of the sample size, σ/\sqrt{n} .

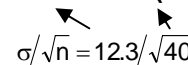
Example For a normal distribution with a population mean of 115 and a standard deviation of 12.3, find the probability that a sample of 40 randomly selected scores will have a sample mean that is less than 112, $P(\bar{x} < 112)$.

“Less than” means shade the **area to the left** of 112.



In the cell where you want the answer to appear, type =**NORMDIST(112, 115, 12.3/SQRT(40), 1)**.

Answer is 0.061467.



Given an area under the standard normal curve, how do I find a z-score?

What function do I use?

NORMSINV calculates z-scores based on areas under the standard normal curve. (Hint—The letter “S” in NORMSINV indicates that this is a *standard* normal distribution.)

What does the function do?

NORMSINV calculates the z-score that corresponds with a cumulative area (area to the left of the desired z-score) under the standard normal curve. To use this function, you must know the area to the left of the desired z-score. If you are given the area to the right of the z-score, subtract it from 1 to find the area to the left.

Areas are often given as percentiles, quartiles, deciles, and percentages.

How do I enter the information?

NORMSINV(area to the left of the desired z-score)

EXAMPLE For a standard normal distribution, find the z-score that corresponds with P_{35} , the 35th percentile.

The 35th percentile is the score that separates the bottom 35% of scores from the remaining 65%. The bottom 35% represents the area to the left of the score. Therefore, the area to the left is .35.

In the cell where you want the answer to appear, type **=NORMSINV(.35)**.

Answer is -0.38532.

EXAMPLE For a standard normal distribution, find the z-score that separates the top 22% of the scores from the bottom 78%.

The bottom 78% represents the area to the left of the z-score.

In the cell where you want the answer to appear, type **=NORMSINV(.78)**.

Answer is 0.772193.

Given an area under a normal curve with a given mean and standard deviation, how do I find a raw score (data item)?
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What function do I use?

NORMINV calculates raw scores based on areas under a normal curve. (Hint—Use NORMINV without the letter “S” in it because this normal distribution is not standard.)

What does the function do?

NORMINV calculates a raw score that corresponds with a cumulative area under a normal curve. To use this function, you must know the area to the left of the desired score. If you are given the area to the right of the score, subtract it from 1 to find the area to the left.
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How do I enter the information?
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NORMINV(area to the left of the desired score, mean, standard deviation)

EXAMPLE For a normally distributed population with a mean of 115 and a standard deviation of 12.3, find the raw score (data item) that corresponds with P_{80} , the 80th percentile.

The 80th percentile is the score that separates the bottom 80% of scores from the remaining 20%. The bottom 80% represents the area to the left of the score. Therefore, the area to the left is .80.

In the cell where you want the answer to appear, type **=NORMINV(.80, 115, 12.3)**.

Answer is 125.3519.

EXAMPLE For a normally distributed population with a mean of 115 and a standard deviation of 12.3, find the raw score that separates the top 75% of the scores from the bottom 25%.

The bottom 25% represents the area to the left of the data item.

In the cell where you want the answer to appear, type **=NORMINV(.25, 115, 12.3)**.

Answer is 106.7038.