Does causation always imply correlation?

Authored by

stats writer

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The concept of causation and correlation often leads to confusion and assumptions about the relationship between two variables. While causation implies a cause-and-effect relationship, correlation means that two variables are related in some way. It is important to note that correlation does not always imply causation. This means that just because two variables are correlated, it does not necessarily mean that one causes the other.

To better understand this, let us consider three examples. In the first example, a study shows that children who eat breakfast have higher academic performance. While this may lead us to believe that eating breakfast causes better grades, there could be other factors at play. Factors such as socioeconomic status or access to resources may also contribute to a child's academic success.

Similarly, in the second example, a person who smokes has a higher risk of developing lung cancer. While there is a strong correlation between smoking and lung cancer, it does not necessarily mean that smoking causes lung cancer. Other factors such as genetics and environmental exposure may also play a role in the development of lung cancer.

Lastly, a company implements a new training program and sees an increase in employee productivity. While one may assume that the training program caused the increase in productivity, there could be other factors at play such as changes in management or company culture.

In conclusion, while causation and correlation are often related, it is important to consider other factors and possible explanations before assuming a cause-and-effect relationship. It is crucial to conduct thorough research and analysis to determine the true cause of a correlation before making any conclusions.

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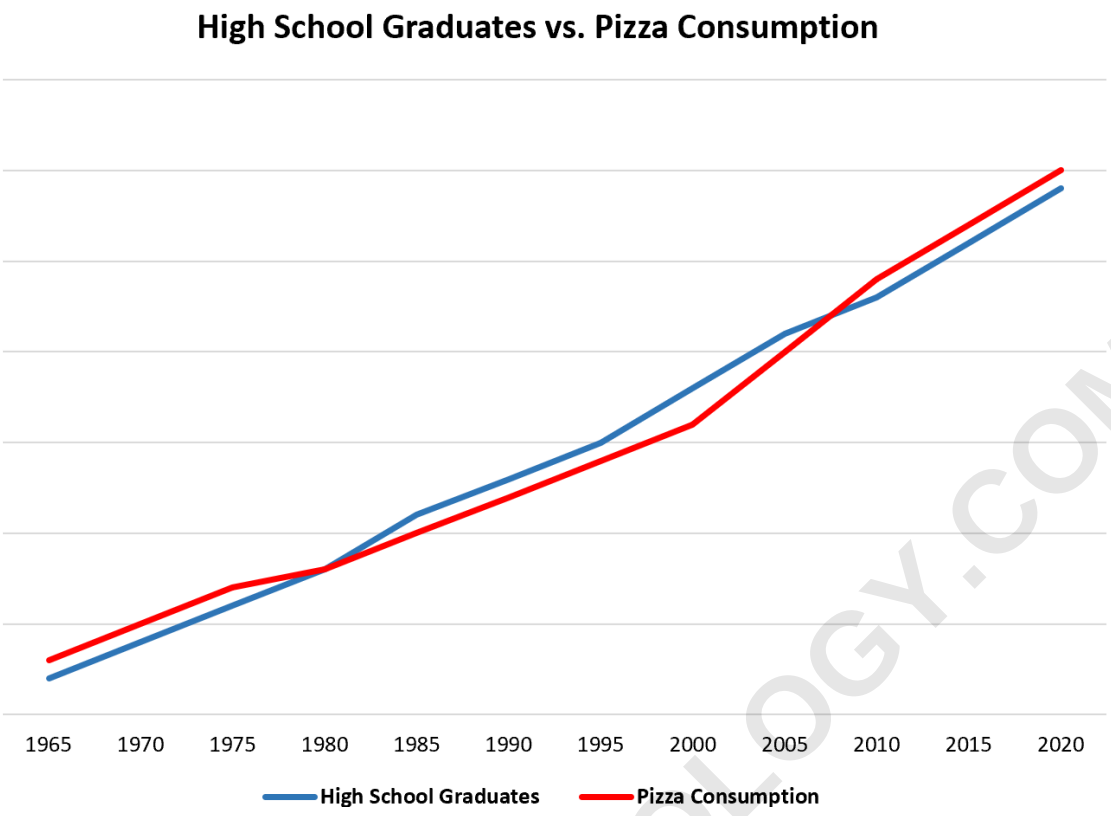
Does Causation Imply Correlation? (3 Examples)

It's well-known that .

As a simple example, if we collect data for the total number of high school graduates and total pizza consumption in the U.S. each year, we would find that the two variables are highly correlated:



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This doesn't mean that an increased number of high school graduates is *causing* more pizza consumption.

The more likely explanation is that U.S. population has been increasing over time, which means that the number of people receiving a high school degree and the total pizza being consumed are both increasing as population increases.

But what about the reverse statement: Does causation imply correlation?

If one variable causes another variable, does it

necessarily mean that the two variables will be correlated?

The short answer: No.

The following examples show why.

Example 1: Quadratic Relationship

Suppose some variable, X, causes variable Y to take on a value equal to X2.

For example:

If X = -10 then Y = -102 = 100
If X = 0 then Y = 02 = 0
If X = 10 then Y = 102 = 100

And so on.

If we plotted the relationship between X and Y, it would look like this:

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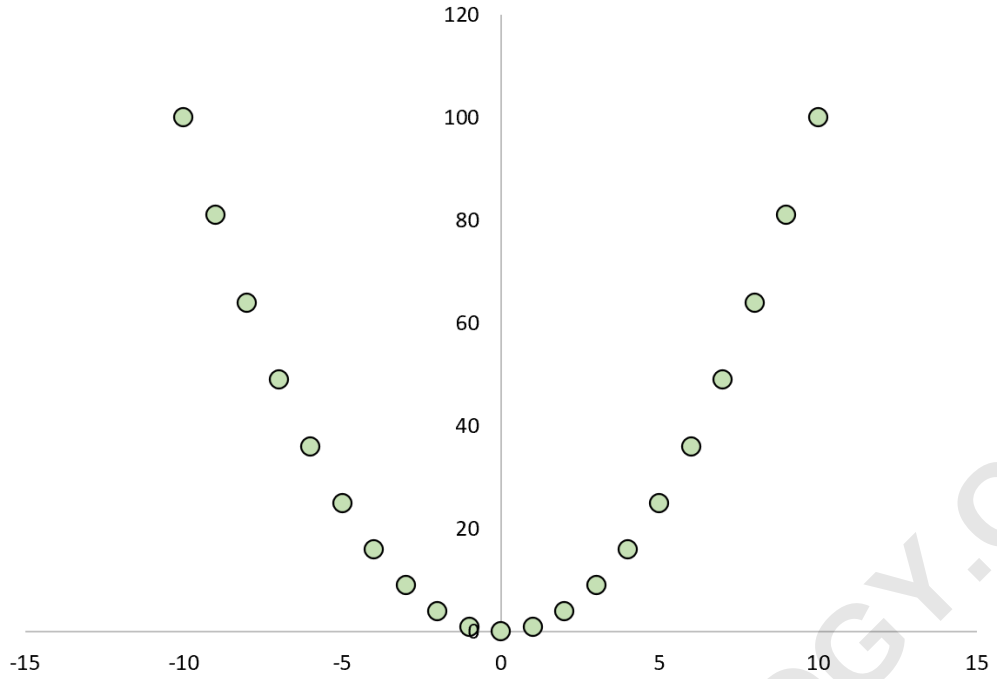

If we calculated the between the two variables, we would find that the correlation is zero.

Example 2: Quartic Relationship

Suppose some variable, X, causes variable Y to take on a value equal to X4.

For example:

If X = -10 then Y = -104 = 10,000
If X = 0 then Y = 04 = 0
If X = 10 then Y = 104 = 10,000

And so on.

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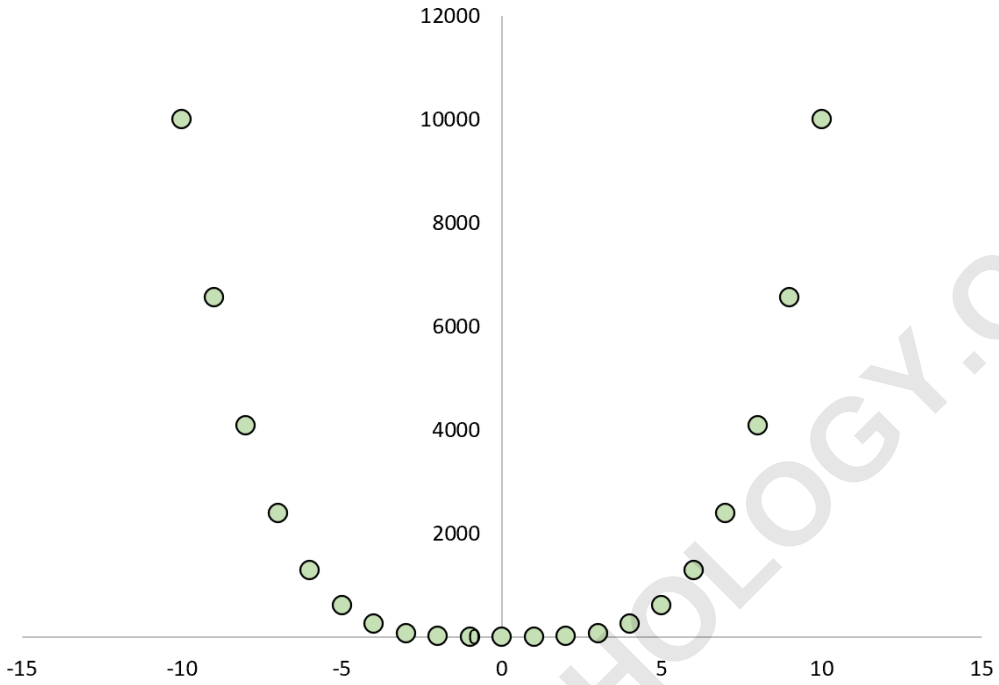
If we plotted the relationship between X and Y, it would look like this:



If we calculated the between the two variables, we would find that the correlation is zero.

We know that X causes Y, but the linear correlation between the two variables is zero.

Example 3: Cosine Relationship

Suppose some variable, X, causes variable Y to take on a value equal to cos(X).

For example:

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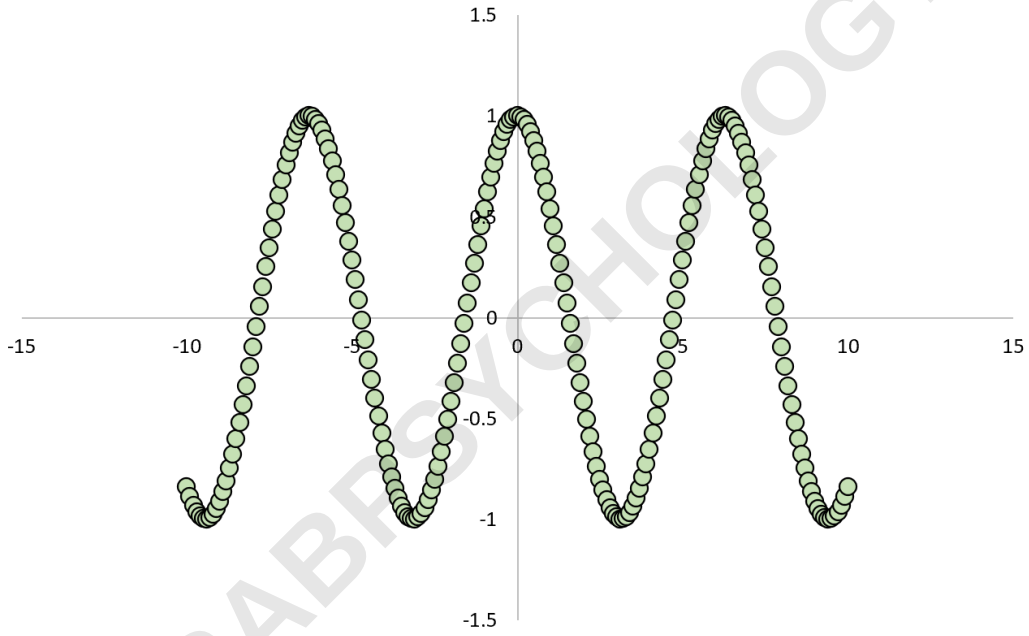
If X = -10 then Y = cos(-10) = -0.83907

If X = 0 then Y = cos(0) = 1

If X = 10 then Y = cos(10) = -0.83907

And so on.

If we plotted the relationship between X and Y, it would look like this:



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If we calculated the between the two variables, we would find that the correlation is zero.

We know that X causes Y, but the linear correlation between the two variables is zero.

Additional Resources

The following tutorials provide additional information about correlation and causation:

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