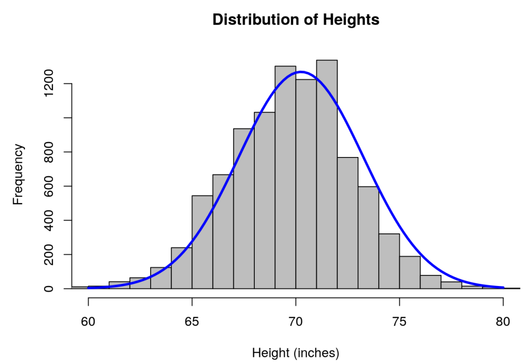
**Evan Scharnhorst**
**Capstone Project - Advanced Algebra**
**My Topic**: Normal Distribution and Z-scores
**My Driving Question**: What are your chances of being over 6 feet as a male in the US? How does it compare to other countries? Does it follow a normal distribution?

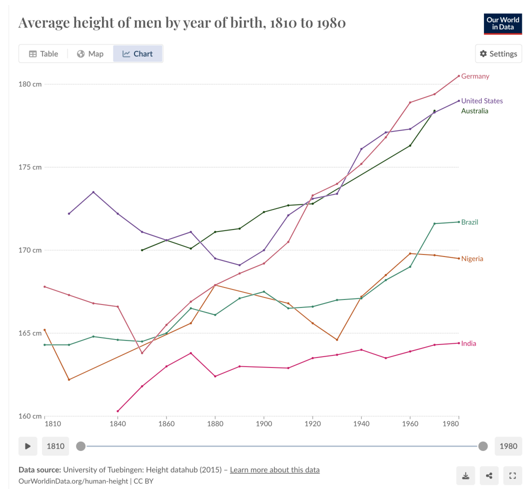
Pieces of evidence:

1. There have been several studies on heights of men in the USA. One I found from a CDC study randomly sampled 9569 males living in the USA. They found that the mean was 70.25 inches. In other words, 5' 10.25". That same sample had a minimum of 49 inches and a maximum of 93 inches. It also had a standard deviation of 3.009. This sample followed a normal curve, however it was not perfectly distributed. Theoretically, if you took an infinite sample size, it would be normally distributed (meaning it follows the bell-curve pattern shown in the picture).




2. Based on this information, what is your chance of being over 6 feet? We can use z-scores to solve this, but how? First, you have to calculate the z-score, or number of standard deviations the value is away from the mean. To do this use the formula $\frac{x-\mu}{\sigma}$. In other words, observed value minus the mean, divided by the standard deviation. Our observed value is 6ft, or 72 inches, our mean is 70.25, and our standard deviation is 3.009. We can plug these all in to get the equation $\frac{72-70.25}{3.009}$ = 0.581588568. This is our z-score. Now, to figure out what % chance you have for that z-score, we can use our calculator's normal-cdf function. This sounds more complicated than it actually is. We basically will just give it a lower bound and upper bound, both given in z-scores. Then, it will tell us the probability of a value from the normal distribution falling within that range. This only works for normally distributed data sets. Our data set is not perfectly normally distributed, but is very close so we can still use it, so long as we do not trust our answer with complete and utter confidence. It will give us a good estimate.
3. Okay, it is time to plug in our values to normal-cdf. On my calculator (TI-26X Pro) I press 2nd, stat-reg/distr, DISTR, normalcdf. Just set the mean to 0 and sigma (standard deviation) to 1. Scroll down, and now you can enter the lower and upper bounds. If you do not have a calculator with this function, you can use this website. Let's think about this, what should be the lower bound, well it would be the z-score we found earlier. And, what would be the upper bound? Well, we would in reality want to set it to infinity, but most calculators can't do that, so we will just set it to 100 which will be plenty for our purposes. When we enter that it gives us 0.2804… This is the probability of a US male to be 6ft or over (based on this data set)! You can easily convert this to a percentage by moving the decimal to the right by two places. You get 28.04%.

4. Let’s double check this, does this make sense? Well, when we look at the data distribution (picture on evidence no. 1) It does seem to make sense. We know that our probability cannot be more than 50% because our range is all on one side of the peak. And if you find 72 on the graph, the frequency is a good deal lower than the mean. In conclusion, your chances of being 6ft or over as a US male are roughly 28.04%
5. Now, **does this follow a normal distribution?** No, but it is approximately normally distributed and it is very close and follows the overall curve of the bell curve, so we can use normalcdf and assume our answer to be a good approximation.
6. How does the US compare to other countries in terms of height? It is actually pretty tall. I found this graph from [this site]() and I found it pretty interesting. It is the average height of different countries throughout history. If you look, in 1885 or so the average height of a US male was about 5’ 6”! I thought that was pretty interesting. Anyways, your chance of being six foot relates a lot to the average height of men in a certain country so we can say with decent confidence that if a country has a taller average height, they have a greater chance of being 6ft or over. So, based on that, which is not completely accurate, the US has a pretty good chance of being 6ft compared to other countries like India, Brazil, and Nigeria. Germany is slightly taller than the USA in terms of average height of men.




I think it is also interesting that about 60-80% of height is genetic, but the rest is up to good nutrition and other factors (like don’t lift heavy weights when you are too young).

I hope that you learned something about z-scores and some cool height statistics. My challenge for you is to calculate what chance someone has of being your height or above based on [this chart](). Let me know your results! Hope you enjoyed!
-Evan

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Sources:
Hampden-Sydney College: “Distribution of Heights of Men in USA.” Hampden-Sydney College, 1 College Road Hampden-Sydney, VA 23943.
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Our World In Data: “Average height of men by year of birth, 1810 to 1980.” Our World In Data, Wellington Square, Oxford OX1 2JD, UK.
https://ourworldindata.org/grapher/average-height-of-men-for-selected-countries

Tools:
ListenData: “Quick Normal CDF Calculator.” ListenData 2024.
https://www.listendata.com/p/normal-cdf-calculator.html