

**AGAINST ALL ODDS**  
**EPISODE 8 – “NORMAL CALCULATIONS”**  
**TRANSCRIPT**

## FUNDER CREDITS

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## INTRO

### **Pardis Sabeti**

Hello, I'm Pardis Sabeti and this is *Against All Odds*, where we make statistics count.

"Normal" can be kind of a tricky term. Remember its special statistical meaning has nothing to do with whether you're an ordinary Joe or a freaky oddball. In statistics, a normal curve is symmetric, single-peaked and bell-shaped, and it's completely described by its mean and standard deviation.

Normal curves have a unique feature that can be summed up by what's called the Empirical Rule. It's also known as the 68-95-99.7 Rule and here's why: about 68% of the observations will fall within one standard deviation of the mean. 95% will fall within two standard deviations of the mean. And 99.7% of observations will be within three standard deviations of the mean. The standard deviation is a natural yardstick for any measurements that follow a normal distribution.

Take a look at the range of heights for all American women. Symmetric – check. Single-peaked – check. Bell-shaped – check. The mean,  $\mu$ , is here at 63.8 inches and the standard deviation,  $\sigma$ , is 4.2. That means the average woman's height is 5 foot, 3.8 inches.

We can measure out with our yardstick. One standard deviation from the mean, in both directions, takes us to 68 inches on one side and 59.6 on the other. So 68% of American women are between 4 foot 11.6 and 5 foot 8. Let's measure out another standard deviation with our yardstick. Now we're 2 sigma out from the mean in both directions – bringing us to 72.2 inches and 55.4 inches. That means 95% of American women are between 4 foot 7.4 and just over 6 feet. We can take it one more standard deviation out, to 3 sigma. Now we wind up at 51.2 and 76.4. 99.7% of American women – the vast majority – are between 4 foot 3.2 and 6 foot 4.4. Only a third of a percent of women – just three in a thousand – are out here at the extremes, shorter than this or taller than this.

Life out at the extremities of a normal distribution can sometimes feel a bit lonely... hence the existence of the Boston Beanstalks! We dropped in on a recent get-together of this club for tall people.

### **Craig Sherman**

If a person wants to join the club, we invite them to one of our social functions, and if we know they're coming, we have a tape measure ready, we put 'em against the wall, and we put a little mark on the wall and measure it....

### **Pardis Sabeti**

The tape measure must read 5' 10" for women and 6' 2" for men to gain admittance to the Boston Beanstalks. These requirements make sure only the loftiest segments of the general population make it into the club. A member's first exposure to a tall club meeting can be quite a departure from the world these tall folks encounter everyday.

**Susan Huffman**

At the end of the night my neck really hurt, and I couldn't understand why. And finally I realized it's 'cause I wasn't looking down. I was either looking even, or up. I was the shortest person there, because it was mostly guys, and they were all like 6' 7," 6' 8".

**Jonathan Bewick**

Instead of the conversation be about a foot below me, where I couldn't hear it because of the music from the dance, I was able to talk to people.

**Susan Flynn**

In my whole life, I was always the tallest one so I could see the entire room and everything around me // And for the first time I had that feeling of the intimacy of a dance floor when you have people that are all the same height around you or are taller around you. It was an amazing perspective change, // and for the very first time in my life I felt like I belonged in a group. Like, this is where I am supposed to be.

**Pardis Sabeti**

At the national average height of about 5' 4", our producer was looking pretty shrimpy compared to the Beanstalks in attendance at this dinner dance.

**Singer**

*R-E-S-P-E-C-T*

*Find out what it means to me!*

**Pardis Sabeti**

The club offers a convivial atmosphere where members can enjoy temporarily being in a place where they are of typical height... and meet others in the same shoes.

**Salome Tomar**

Being in the grocery store and having someone ask you to get something on the top shelf, or you know, it's always about reaching for something...

**Susan Flynn**

We actually have had members thrown off of planes because they couldn't fit behind the seats.

**Jonathan Bewick**

One of the members of the Tall Club has built his own house and he has all of the counters about four inches higher than normal // he says that he used to have back pain all the time but as soon as he put in the raised counters he stopped having the back pain.

**Pardis Sabeti**

But overall these Beanstalks are proud to be tall... and love hanging out with their compatriots in the club.

**Susan Flynn**

It brings such a variety of people together, it's such a large group, it's such an amazing group of people that I can't recommend anything higher than trying to get into a group where you can be a part of this, and for us, it's the Tall Clubs.

**Pardis Sabeti**

The minimum Boston Beanstalks height requirements are 5' 10" for women and 6' 2" for men. These standards seem at a first glance to be reasonable for a tall club, where members are aiming to socialize with the literal upper tiers of society. But just how far above the mean must one be to gain access to the Boston Beanstalks?

If we look back at our normal distribution of women's heights, 5' 10", or 70 inches, is pretty far out here on the right. Statisticians can do more than simply eyeball it to say how far out our card-carrying Beanstalks are towards the tallest extreme of the height range. We can figure out what's called the standardized value of any observation. This value, often called a z-score, tells us how many standard deviations our observation falls from the mean, and in which direction. It's a way to convert data from a normal distribution into a standard normal distribution, setting its mean at zero and standard deviation at one. Almost all the data then falls between -3 and 3.

In this case, the observation we're interested in is the 70 inch height requirement. So 70 is our  $x$ . We know from before that the mean,  $\mu$ , is 63.8, so we can add that to our equation. And sigma, we know, is 4.2. Do the math, and we have a z-score of 1.48.

Well that's great, but what the heck does that mean? It means that a woman who just meets the minimum club requirement of 70 inches has a standardized height of 1.48, or 1.48 standard deviations above the mean. z-scores can be negative, too, if they represent an observation that is below the mean.

How do the gentlemen Beanstalks stack up against the general male population? Just plug in their numbers to the z-score equation and we can see that the 74 inch requirement for membership is .98 standard deviations above the mean.

A standard deviation of .98 is pretty darn close to one. Think back to the 68-95-99.7 Rule and we can estimate just how much of the male general population is eligible for Beanstalk membership. 68% of heights are within one standard deviation. That leaves 32% of people further away from the mean... 16% are shorter than one standard deviation away, and 16% are taller. Based on our .98 z-score, we're approximating that 16% of American men are up to snuff in the height department, at least as far as membership in this club is concerned.

But since we actually have a precise z-score, we don't have to estimate, we can calculate the percentile that's the actual cutoff for Beanstalk membership. There are two ways to do this: you can turn to a z-table, which lists how much of the distribution falls below any given z-value. In our case, we look up .98 by locating 0.9 for the tenths place on the vertical axis, and .08 for the hundredths place on the horizontal axis... and that gives us .8365 as the proportion of heights that are lower than 6 foot 2. In other words, 83.65% of American men are too short to join up with the Beanstalks, meaning 16.35% of American men make the cut, so to speak. That's pretty darn close to our estimate using the Empirical Rule! Alternatively, you can use software to calculate these percentages directly without using a z-score at all.

What's helpful about z-scores is they allow you to compare observations from two different Normal distributions by standardizing them with a common scale. For instance we can compare the eligibility requirements for male and female Boston Beanstalks. With the gents at a minimum z-score of .98, and the ladies at a minimum z-score of 1.48, we can see that the height requirements are actually more stringent for female Beanstalks. They're half a standard deviation further from the mean than their male counterparts.

The height cutoffs are kind of a historical accident, left from when all the Tall Clubs around the United States joined together in the 1940's. But maybe it also helps keep the genders equally represented, since some women may be more motivated to hang out with taller men than vice versa.

We can also use z-scores to compute the percent of data that falls in the interval between two observations. Let's say we want to know how much of the American population is taller than I am, but still not tall enough to make it into the Boston Beanstalks.

Basically, we want to know the percentage of area between two points. Calculate the z-score for my height, 64.5 inches. It's 0.16, just above the mean at 0. We already know the z-score for 70 inches, the Beanstalk cutoff. It's out here at 1.48. Looking up the proportions in a z-table I see that .9306 or 93.06% of American women are shorter than the shortest Boston Beanstalk. I'm pretty close to the mean, with .5636 or 56.36% of women shorter than I am. Subtract the two areas

and you can see that this chunk – taller than I, but shorter than the club members – is 36.7% of the population.

Well, I'm pretty sure that I stopped growing a long time ago, so the Boston Beanstalks is one club that won't ever accept me as a full-fledged member!

For *Against All Odds* I'm Pardis Sabeti. See you next time!

## PRODUCTION CREDITS

Host – Dr. Pardis Sabeti

Writer/Producer/Director – Maggie Villiger

Associate Producer – Katharine Duffy

Editors – Brian Truglio

–Jared Morris

–Seth Bender

Director of Photography – Dan Lyons

Sound Mix – Richard Bock

Animation – Jason Tierney

Title Animation – Jeremy Angier

Web + Interactive Developer – Matt Denault / Azility, Inc.

Website Designer – Dana Busch

Production Assistant – Kristopher Cain

Teleprompter – Sue Willard-Kiess

Hair/Makeup – Emily Damron

Additional Stills

- Tall Clubs International Photos Courtesy of the TCI Archives

Music

DeWolfe Music Library

Based on the original Annenberg/CPB series *Against All Odds*,  
Executive Producer Joe Blatt

Annenberg Learner Program Officer – Michele McLeod

Project Manager – Dr. Sol Garfunkel

Chief Content Advisor – Dr. Marsha Davis

Executive Producer – Graham Chedd

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