1

MEASURES OF POSITION

One Quantitative Variable

Unit 1: Exploratory Data Analysis

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Although not formally a part of the features of a distribution (shape, center, spread, and outliers), measures of position are commonly required.

We will review a few of these we have already discussed and will introduce one additional measure of position important in statistics, that of the standardized score (or z-score).

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Percentiles

- Consider an individual in the WHAS dataset with
  - SYSBP = 200
  - DIASBP = 100
  - BMI = 25.018
- How does this individual compare to other individuals?

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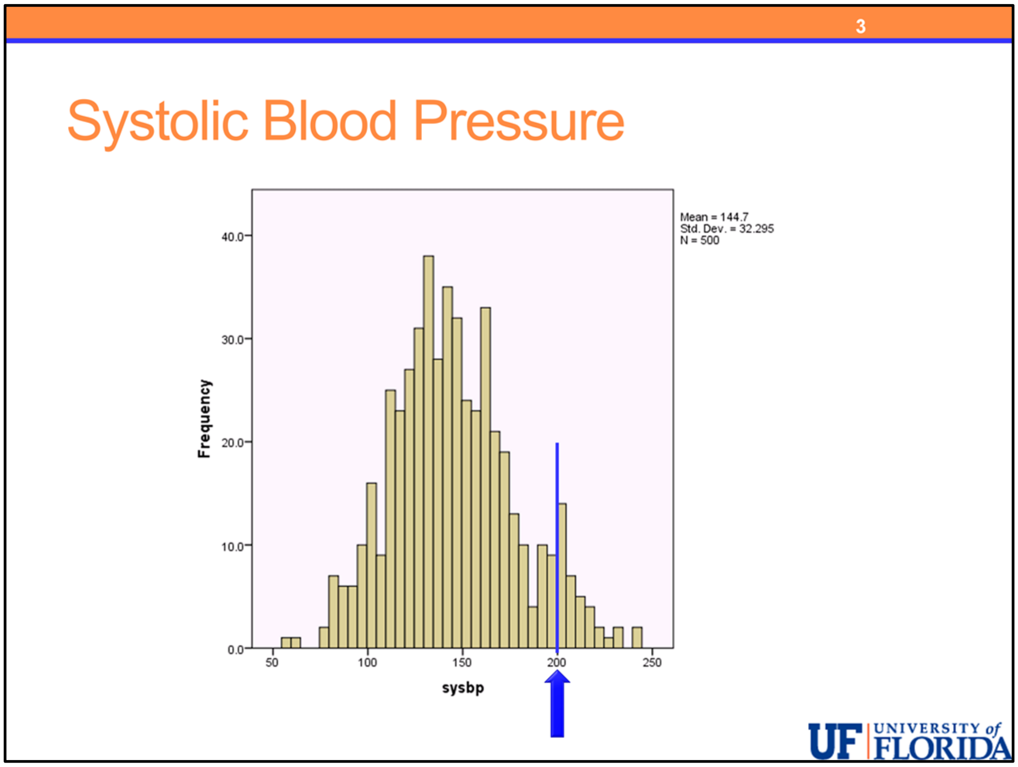
In the WHAS dataset, there is an individual with these measurements.

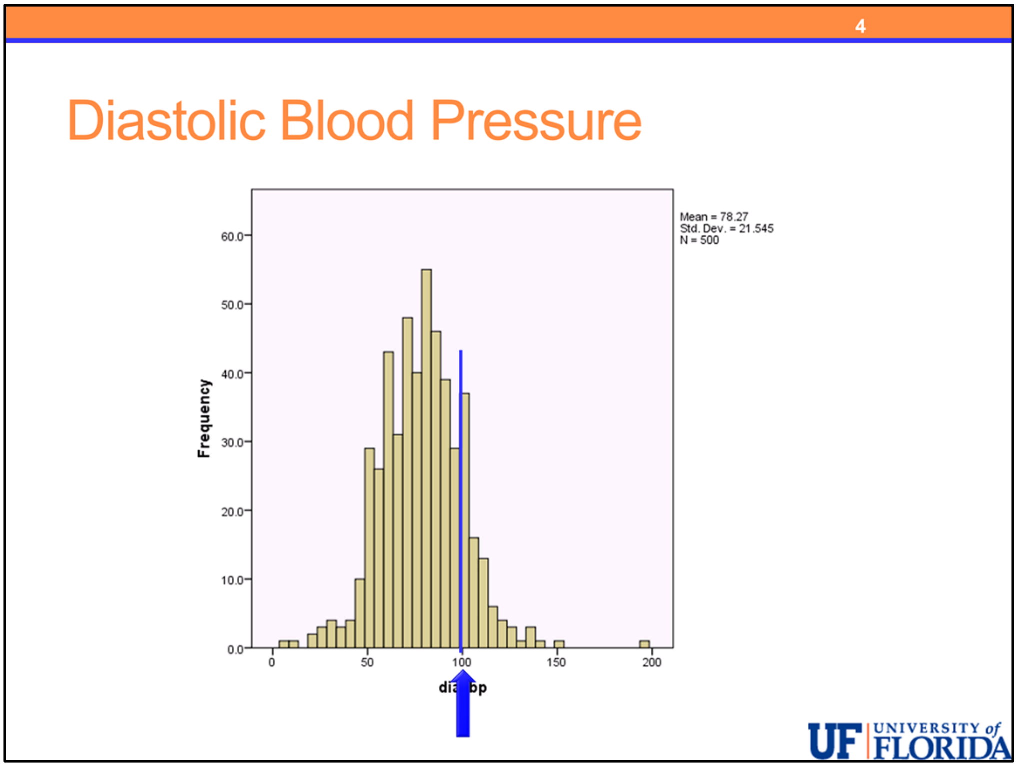
A systolic blood pressure of 200, a diastolic blood pressure of 100, and a BMI of 25.018.

We can view the histograms to get an idea of where this person falls in the respective distributions but to quantify this, we need measures of position.

Percentiles are one method.



For systolic blood pressure, a score of 200 is approximately the 93rd percentile. Approximately 93% of individuals had a systolic blood pressure lower than this individual and approximately 7% had a systolic blood pressure which was higher than 200.

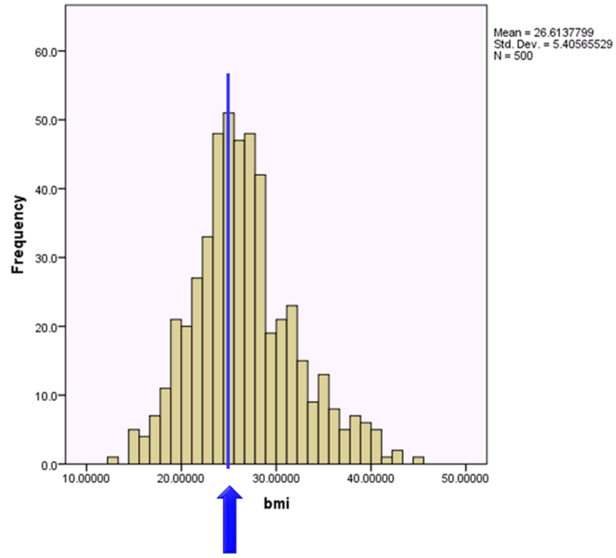


For diastolic blood pressure, the individual's measurement of 100 is closer to the center of the distribution.

The percentile for a diastolic blood pressure of 100 is approximately the 85th percentile.

5

Body Mass Index



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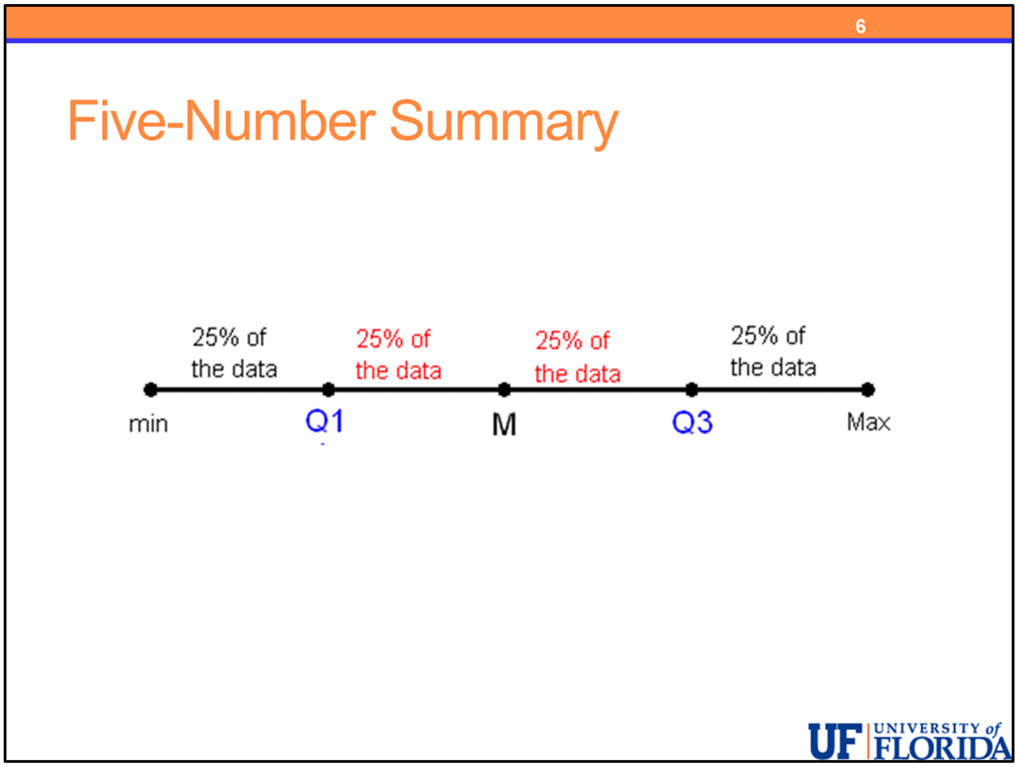
A body mass index of 25.018 corresponds to the 40th percentile.

So this individual was high on the distribution of systolic blood pressure, somewhat high on the distribution of diastolic blood pressure, and a little lower than the center on the distribution of BMI.



We have already discussed the five-number summary but will mention again here that, since Q1, the median, and Q3 are percentiles, these are measures of location or position.

The minimum and maximum are also clearly measures of the position of the most extreme observations.

7

Standardized Scores

- Uses mean and standard deviation as measures of center and spread

$$z_i = \frac{x_i - \bar{x}}{s}$$

- Provides "the number of standard deviations the given value falls above or below the mean"
- If we standardize an entire variable, the new variable will have a mean of zero and a standard deviation of 1
- Can make different variables "comparable" on some level

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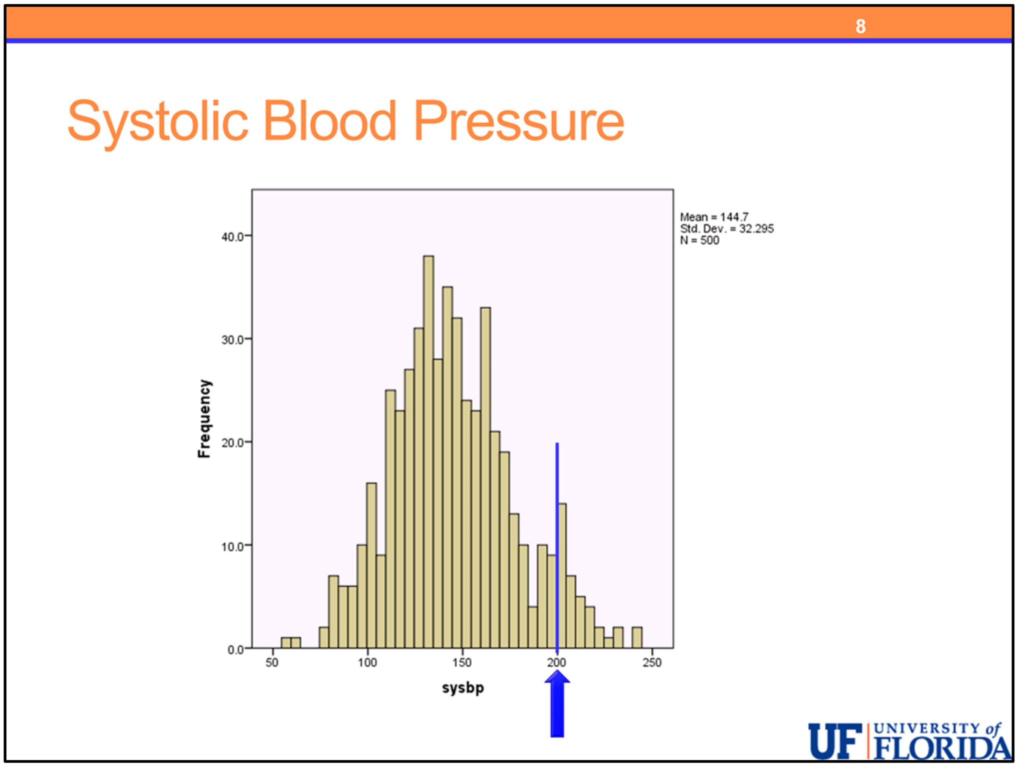
Standardized scores, sometimes called z-scores, use the mean and standard deviation to standardize observations to a distribution which would have a mean of zero and a standard deviation of 1.

The interpretation of a given standardized score is as the number of standard deviations above or below the mean (or average).

Positive z-scores indicate the value was above average and negative indicates the value was below average.

Like percentiles, these values allow us to compare across individuals or across distributions.

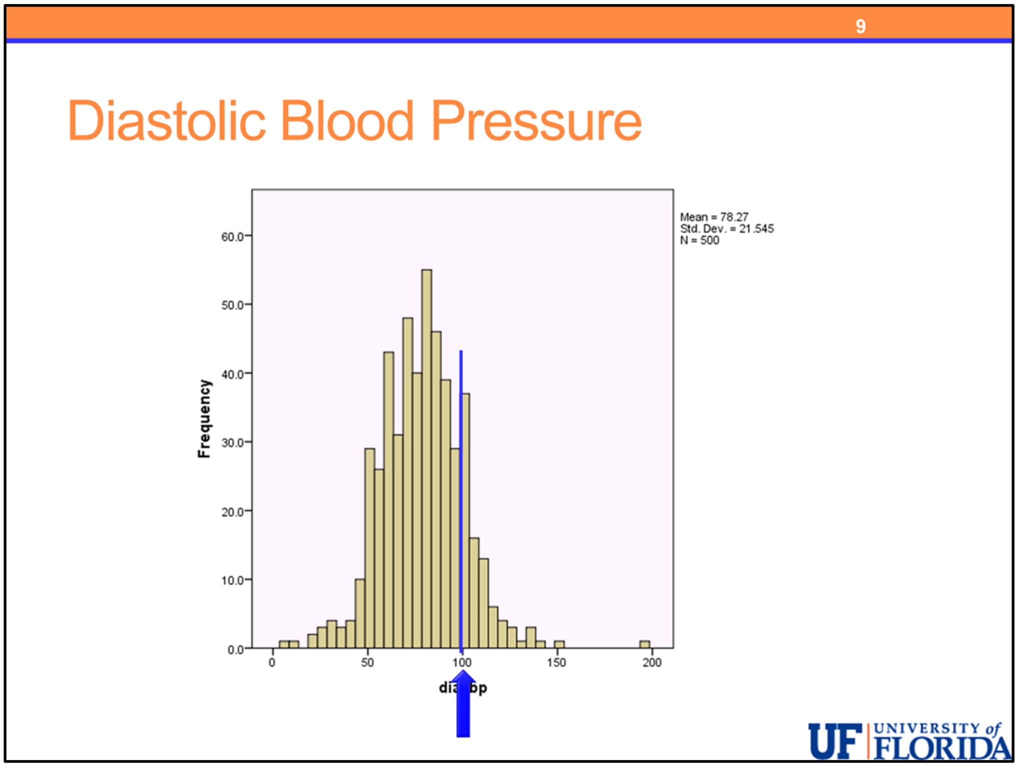
We will return to the individual from the WHAS dataset to illustrate the idea of standardized scores.



Recall that a systolic blood pressure of 200 is approximately the 93rd percentile. This is clearly above average.

The z-score for this observation is (200 – 144.7)/32.295 = 1.71

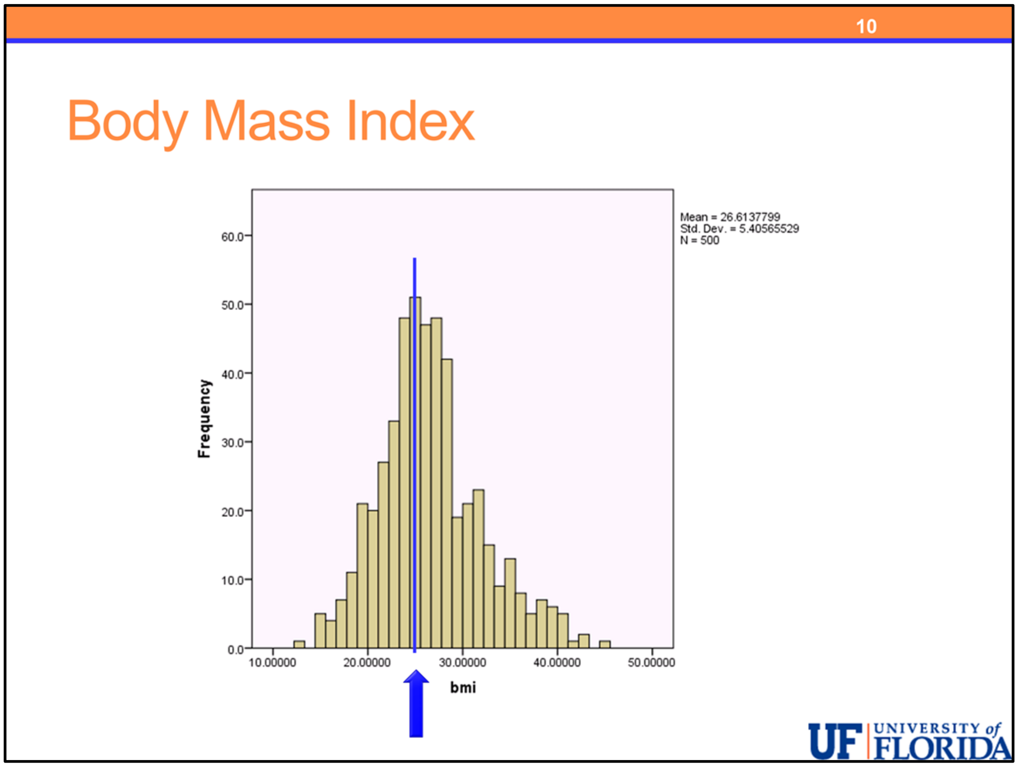
A systolic BP of 200 is 1.71 standard deviations above the mean systolic BP.



Recall that the percentile for a diastolic blood pressure of 100 is approximately the 85th percentile. Again, this is clearly above average.

The z-score for this observation is (100 – 78.27)/21.545 = 1.01

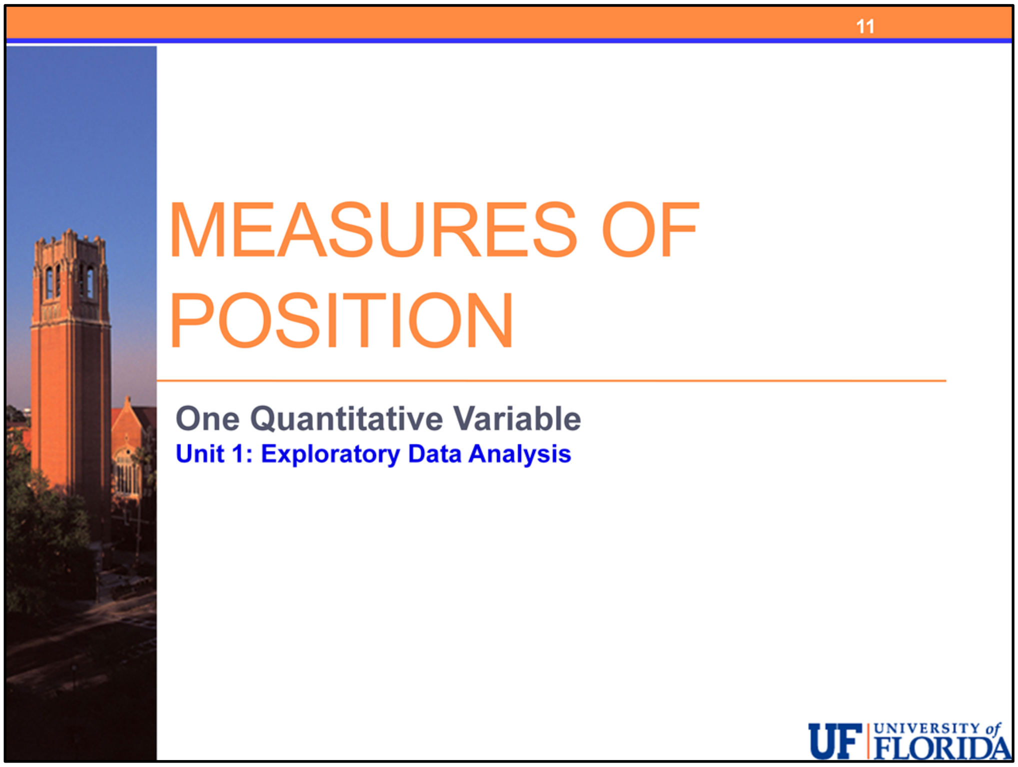
A diastolic BP of 100 is 1.01 standard deviations above the mean diastolic BP.



A body mass index of 25.018 corresponds to the 40th percentile which is slightly below average.

The z-score for this observation is (25.018 – 26.614)/5.406 = -0.30

A BMI of 25.018 is 0.3 standard deviations below the mean BMI.



Hopefully this gives you some indication of why measures of position are relevant to our study of biostatistics.