

Comparing Two Data Sets with Variability

Grade 7 math · Lesson · Standards: 7.SP.B.3, 7.SP.B.4

Quick answer: To compare two populations, compare their centers and their spreads. Use the mean with the mean absolute deviation (MAD), or the median with the interquartile range (IQR). When the spreads are similar, divide the difference between the centers by the MAD to say how many MADs apart the groups are.

Standards: 7.SP.B.3, 7.SP.B.4 · **Level:** Grade 7

How do you compare the centers of two populations?

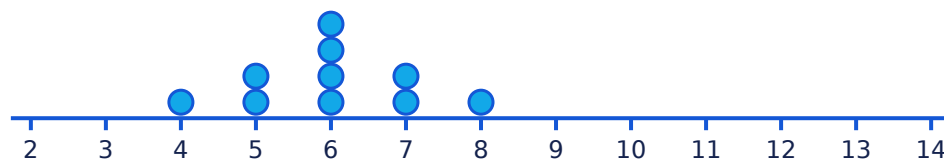
To compare two groups, first compare their centers. Use the mean or the median of each data set. Then compare how spread out each group is, because a gap between centers matters more when the data are tightly packed.

Measures to know

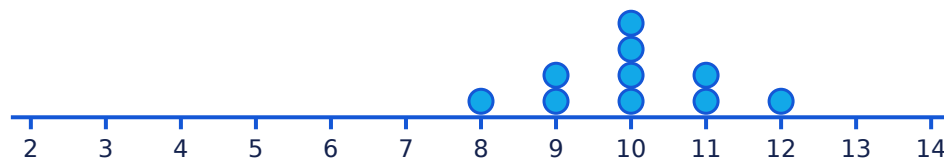
- **Center:** mean (the balance point) or median (the middle value).
- **Mean absolute deviation (MAD):** the average distance of the data from the mean.
- **Interquartile range (IQR):** $Q3 - Q1$, the width of the box in a box plot.
- **Range:** greatest value – least value.

Pair the mean with the MAD, and pair the median with the IQR.

Route A



Route B



Wait time (minutes)

Both dot plots have the same shape; Route B sits 4 minutes to the right.

How do you find the mean absolute deviation?

1. Find the mean.
2. Find how far each value is from the mean, ignoring signs.
3. Add those distances.
4. Divide by the number of values.

Worked example: Route A

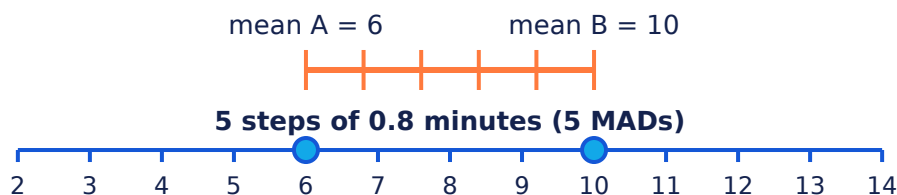
The mean wait is $60 \div 10 = 6$ minutes.

Value	Count	Distance from 6	Count $\times$ distance
4	1	2	2
5	2	1	2
6	4	0	0
7	2	1	2
8	1	2	2

Total distance 8, so $\text{MAD} = 8 \div 10 = 0.8$ minute. Route B has the same shape, so its MAD is also 0.8 minute.

How do you measure the gap between two groups?

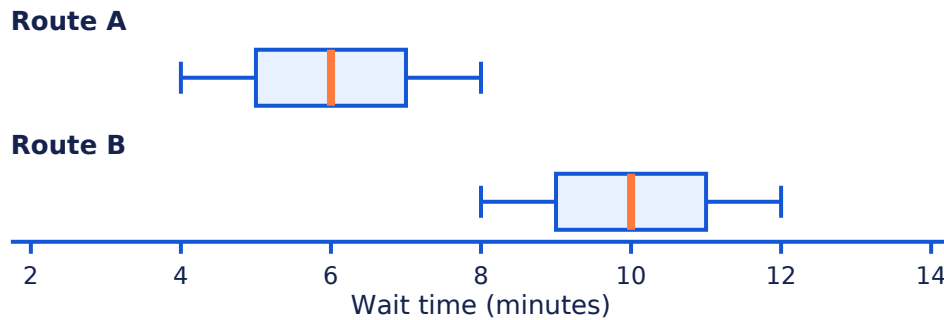
When the spreads are similar, divide the difference of the centers by the spread. Route B has a mean of 10 and Route A has a mean of 6. The difference is 4 minutes. Divide by the MAD: $4 \div 0.8 = 5$. The centers are 5 MADs apart, a large gap, so the two plots barely overlap.



The difference of the means is 4 minutes, which is 5 times the MAD of 0.8.

What do box plots show?

A box plot marks the least value, Q1, the median, Q3 and the greatest value. The two box plots below match the dot plots: the medians are 6 and 10, and both boxes are 2 minutes wide.



Box plots: both have IQR 2 minutes.

Common mistake

Comparing only the centers. Two groups with the same mean can look very different if one is much more spread out.

Mathbot's tip

A gap of about 1 MAD between centers is small and the plots overlap a lot. A gap of 3 or more MADs is clear.

Key points to remember

- Mean pairs with MAD; median pairs with IQR.
- MAD = the average distance from the mean.
- IQR = $Q3 - Q1$, the width of the box.
- Gap in MADs = difference of centers $\div$ MAD.
- A gap of 3 or more MADs is a large difference.

Comparing Two Data Sets with Variability: frequently asked questions

What does the mean absolute deviation tell you?

It tells you the typical distance of the data values from the mean. A small MAD means the values are packed tightly. A large MAD means they are spread out.

When should I use the median and IQR instead of the mean and MAD?

Use the median and IQR when a data set has extreme values or a skewed shape, because they are not pulled by outliers. Use the mean and MAD when the data are fairly symmetric.

How do you read the IQR from a box plot?

Subtract the value at the left edge of the box ($Q1$) from the value at the right edge ($Q3$). The width of the box is the IQR, and it covers the middle half of the data.

What does it mean if the centers are 5 MADs apart?

It means the groups are far apart compared with their spread, so their dot plots hardly overlap. A difference this large is unlikely to be an accident of which values were picked.

Can two data sets have the same mean but different spreads?

Yes. For example, 4, 6 and 8 have a mean of 6 and a MAD of about 1.33. The values 1, 6 and 11 also have a mean of 6 but a MAD of about 3.33, so the second set is more spread out.