# FAILURE TIMES OF BEARINGS

## 3.    Displaying the Failure Times

Graphical displays of the data can be very helpful for understanding the information contained in the data. We will obtain the side-by-side boxplots of failure times for the five compounds on the original, logarithmic, and reciprocal scales.

**3.1    Side-by-Side Boxplots of Failure Times on the Original Scale**
**3.2    Side-by-Side Boxplots of Failure Times on a Logarithmic Scale**
**3.3    Side-by-Side Boxplots of Failure Times After a Square Root Transformation**
**3.4    Side-by-Side Boxplots of Failure Times After a Reciprocal Transformation**
**3.5    Conclusion**

**3.1**    SPSS produces the following side-by-side boxplots of lifetimes for the five experimental groups on the original scale of measurement:
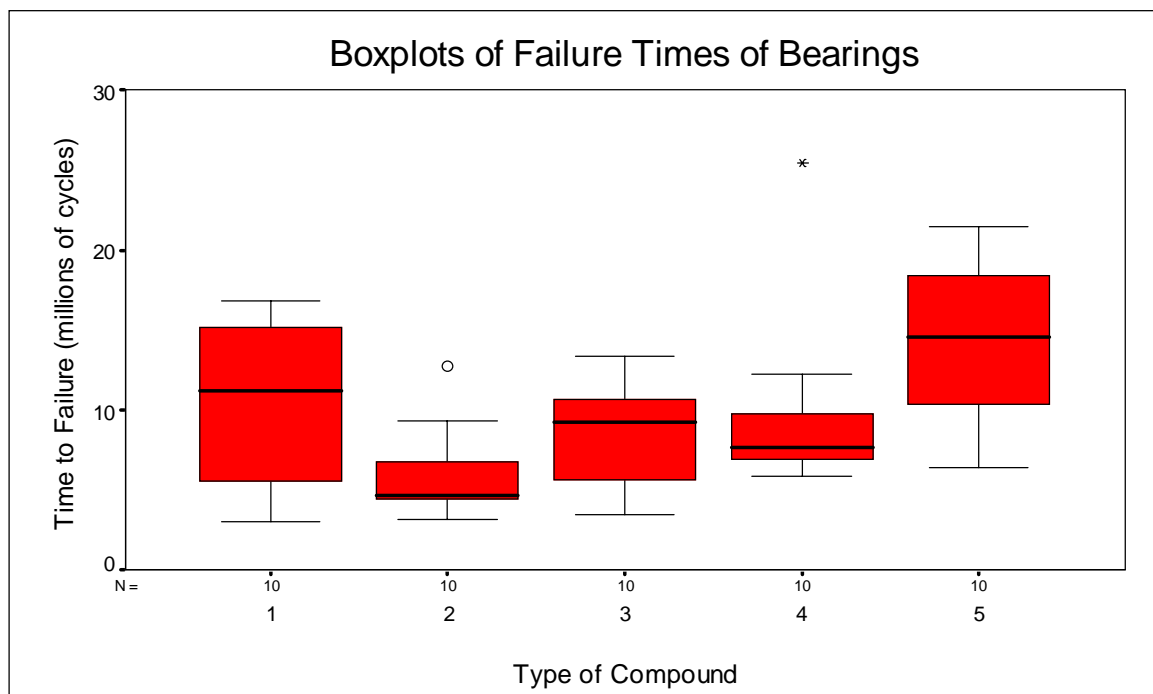


The positions of medians indicate that the median failure time was shortest for the group 2 and longest for the group 5. The same conclusions can be reached about the maximum failure time by examining the positions of the upper whiskers in the above boxplots.

Notice some large differences in the variation of the failure times for the five groups. The variability is very small for the groups 2 and 4, the groups with relatively low median failure times, but it is much larger for the remaining three groups. In general, we observe here increasing spread with increasing median.

The side-by-side boxplots show that the distribution of failure times are fairly symmetric for the groups 1 and 5, but skewed for the remaining three groups. The distribution of failure time is extremely skewed to the right for the group 2.

Notice the presence of an outlier for the group 2 and an extreme observation for the group 4.

It is very important to observe that the above boxplots are obtained for a relatively small number of observations, ten for each of the five groups. Under the circumstances, the above-described patterns do not have to hold in some general populations and our conclusions are weak.

**3.2**    SPSS produces the following side-by-side boxplots of lifetimes for the five experimental groups on a logarithmic scale:
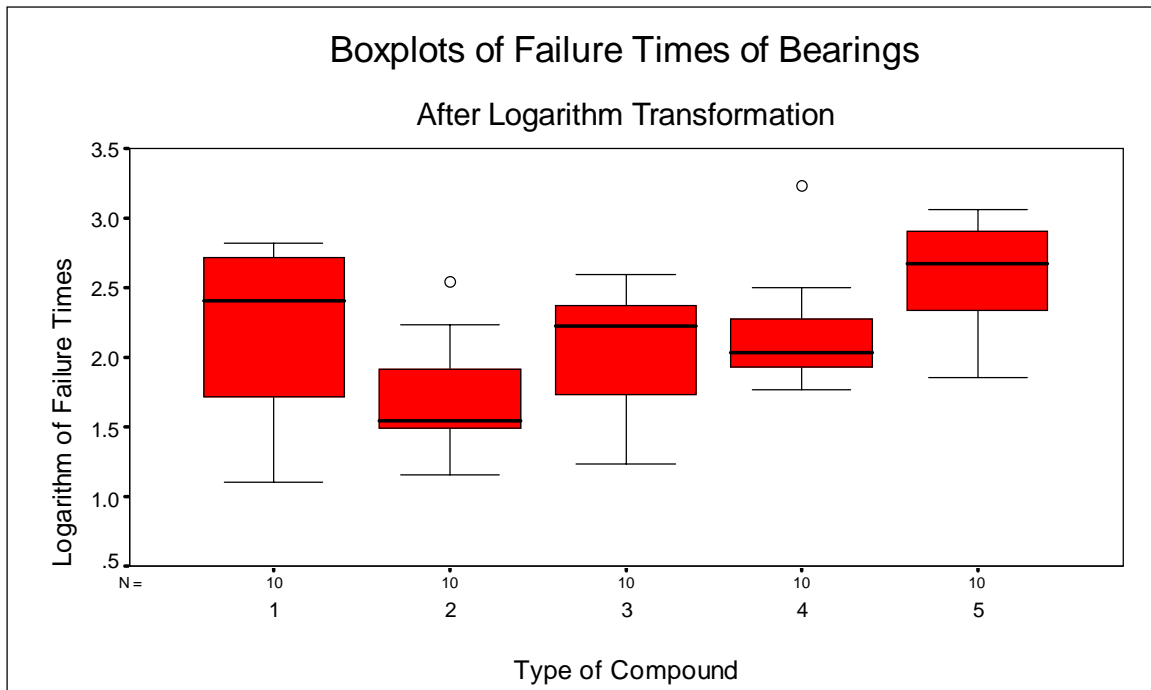


As you can see, the logarithm transformation was not effective to remove the skewness in our data. The data for the group 2 is still highly skewed to the right. Moreover, there are still some outliers in the data.

**3.3**    SPSS produces the following side-by-side boxplots of lifetimes for the five experimental groups after a square root transformation:

**Boxplots of Failure Times**

After Square Root Transformation
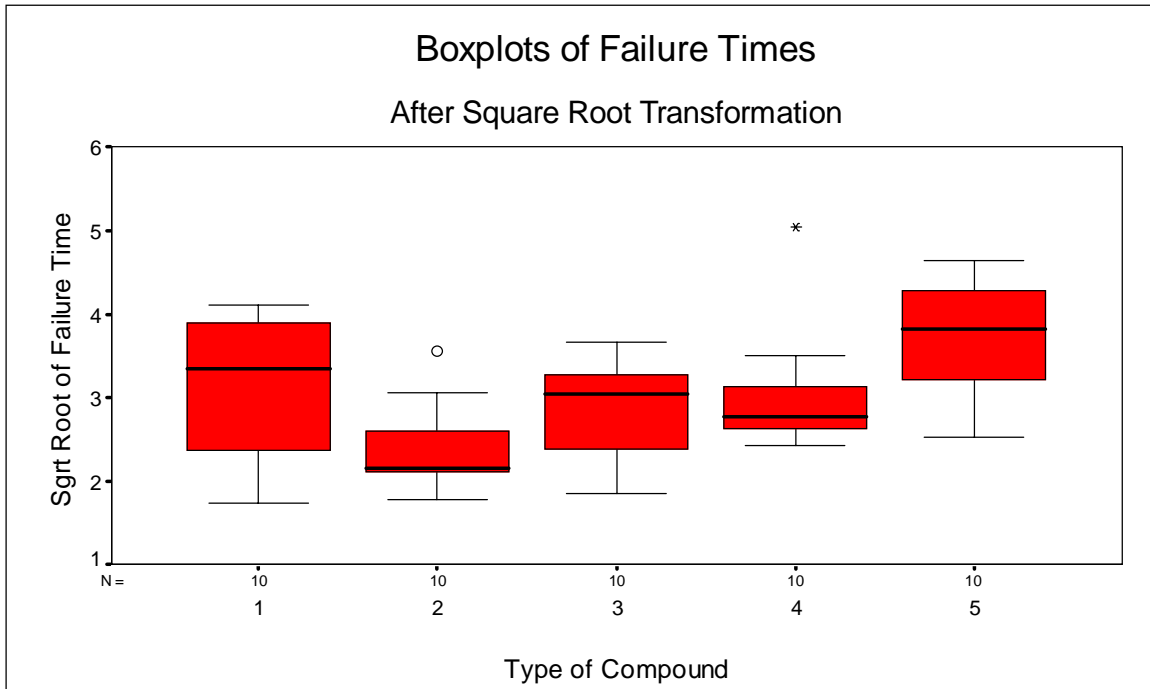


The square root transformation was not able to remove skewness in our data either. There are also an outlier and an extreme observation. This is what we might expect because the square root transformation is less effective in compressing data over the range than the natural logarithm transformation.

**3.4**    SPSS produces the following side-by-side boxplots of lifetimes for the five experimental groups after a reciprocal transformation:

**Boxplots of Failure Time**

After Reciprocal Transformation
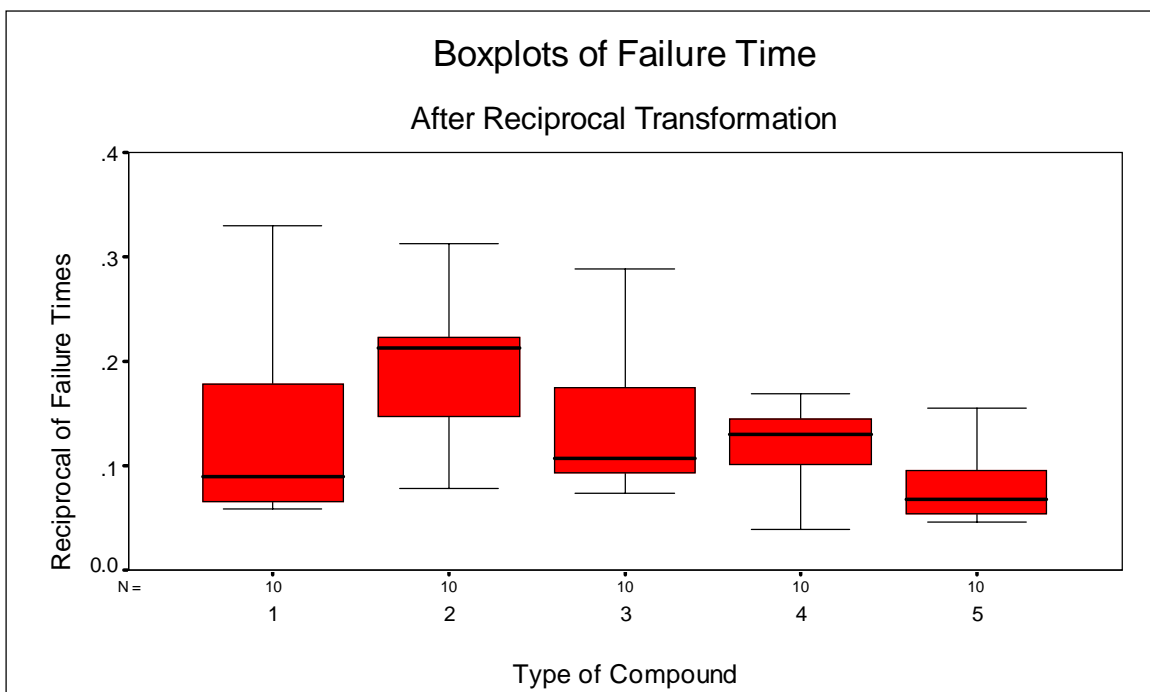
**3.5**    In order to make inferences from the data with ANOVA, we have to make sure that the failure times of the five compounds follow approximately a normal distribution with approximately the same spread. The data displayed on the original scale of measurement exhibits skewness, outliers, and different spreads. By comparing the boxplots obtained above on the original scale, logarithmic scale, after a square root and reciprocal transformation, we conclude that none of these scales is ideal, but no transformation appears preferable to analysis on the original scale.