

2.10 Small sample sizes

There is one necessary restriction on the use of PERMDISP, which is that the number of replicate samples per group must exceed $n = 2$. The reason is that, if there are only two replicates, then, by definition, the distance to the centroid for those two samples must be equal to one another. Consider a single variable and a group with two samples having values of 4 and 6. The centroid (average) in Euclidean space for this group is therefore 5. The distance from sample 1 to the centroid is 1 and the distance from sample 2 to the centroid is also 1. These two values of z are necessarily equal to one another. This will also be the case for other groups having only 2 replicate samples, so the within-group variance of the z 's when $n = 2$ for all groups will be equal to zero. If the within-group variance is equal to zero, then the F statistic will be infinite, so the test loses all meaning. Clearly, the test is also meaningless for a group with $n = 1$, which will have only a single z value of zero. Thus, if the sample size for any of the groups is $n \leq 2$, then the PERMDISP routine will issue a warning accordingly. Although test results are meaningless in such cases, the individual deviations (the z 's) can nevertheless still be examined and compared in their value across the different groups, if desired. More generally, the issue here is the degree of correlation among values of z , which increases the smaller the sample size. [Levene \(1960\)](#) showed the degree of correlation is of order $n-2$ which, he suggested, will probably not have a serious effect on the distribution of the F statistic. We suggest that formal tests using PERMDISP having within-group sample sizes less than $n = 10$ should be viewed with some caution and those having sample sizes less than $n = 5$ should probably be avoided, though (as elsewhere) further simulation studies for realistic multivariate cases would be helpful in refining such rules-of-thumb.

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