Chapter 39
Fisher Exact Tests Convenient for Small Samples

1 General Purpose

Fisher-exact test is used as a test for the analysis of cross tabs, and as a contrast test to the chi-square test (Chap. 38), and the z-test (Chap. 36), and, also, as a binary outcome test for small samples, e.g., samples of $n < 100$. It, essentially, makes use of faculties expressed as the sign **"!"**: e.g.,

[5**!**] indicating $5 \times 4 \times 3 \times 2 \times 1$.

In the past, it was rather laborious with large data, but nowadays any pocket calculator calculates largest faculties within seconds. E.g., using the Scientific Calculator from the Chap. 1, you press 6 and then the 2ndF button, and the CE button: In the display is 720, which is equal to

$6! = 6 \times 5 \times 4 \times 3 \times 2 \times 1 = 720.$

This chapter assesses the performance of the faculty-based Fisher exact test as compared to the traditional distribution-based methods.

2 Schematic Overview of Type of Data File

Outcome binary	Predictor binary
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(continued)

T.J. Cleophas, A.H. Zwinderman, *Clinical Data Analysis on a Pocket Calculator*,
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Outcome binary	Predictor binary
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.	.
.	.

3 Primary Scientific Question

Is the Fisher exact test a reliable alternative to the chi-square test and z-test.

4 Data Example

The underneath example shows two groups assessed for narcolepsia during the dag.

	Sleepiness	no sleepiness
Left treatment (left group)	5 (a)	10 (b)
Right treatment (right group)	9 (c)	6 (d)

Unlike the chi-square test a z-test, the Fisher test does not make use of chi-square or normal frequency distributions to approximate the level of statistical significance, but, instead, computes exact p-values like 0.05132 (rather than < 0.05). The underneath computation is given.

$$\text{p-value} = \text{probability} = \frac{(a+b)!\,((c+d)!\,(a+c)!\,(b+d))!}{(a+b+c+d)!\,a!b!c!d!} = 0.200$$

The chi-square value from the above data is in the previous chapter (Chap. 38), and equals 2.143. A approximated p-value as obtained from the t-table is >0.10. A more precise approximation can be obtained from the internet. E.g., the Quick P Value from Chi-Square Score Calculator is helpful. The approximated p-value from the internet = 0.143222. This is much larger than 0.05, but considerably smaller than 0.200. Fisher-exact test may be OK, but it is, obviously, somewhat conservative as compared to the traditional chi-square test. This means that statistical significance tends to be somewhat harder to obtain.

5 Conclusion

Fisher-exact test is used as a test for the analysis of cross-tabs, and also as a contrast test to the chi-square test (Chap. 38) and the z-test (Chap. 36). It is, particularly, convenient for small samples, e.g., samples of $n < 100$.

The approximated p-value from the chi-square test and z-test tend to be smaller than those of the Fisher-exact test. Consequently, statistical significance may be somewhat harder to obtain with the Fisher-exact test.

6 Note

More background, theoretical and mathematical information of the Fisher-exact test is given in Statistics applied to clinical studies 5th edition, Chap. 3, Springer Heidelberg Germany, 2012, from the same authors.