THE *Abdus Salam* INTERNATIONAL CENTRE FOR THEORETICAL PHYSICS
MASTER OF ADVANCED STUDIES IN MEDICAL PHYSICS

Homework #3

Student name: *María Isabel Subía*

Course: *2022 M.M.P. Statistics for Medicine (P5.2)* – Professor: *Massimo Borelli*
Due date: *Saturday 5th March, 2020*

Question

1. Reconsider the data (the `breastioert.csv` dataset) considered during Homework #1 about the paper by Mara Severgnini, Mario de Denaro et al., entitled *In vivo dosimetry and shielding disk alignment verification by EBT3 ...* (PMID 25679150).

2. According to the t-test, is the *Area outside shielding* different, in a statistical sense, with respect of the two levels of *Energy*?

3. Imagine that your analysis belongs to a research project and you are required to publish it. How would you report your finding in the 'Result' section of a paper?

4. Would you report any important issue concerning the analysis in the 'Limitation' section of the paper?

5. Go to `https://ictpmmp.weebly.com/assignements.html` in order to upload your final .pdf document.

Statistics in Medicine, vol. 10, pp. 11–12, 2022
Received Today / published Tomorrow
https://doi.org/232323-nnnn

Severigni's et. al IVFD on IOERT and information collection: A JASP t-test analysis

Student[1]

1. *Department, University, Trieste, Italy*

Abstract

We used t-tests by the means of JASP to generate conclusions on the statistical relation between the data of Area and Energy, from the paper *In vivo dosimetry and shielding disk alignment verification by EBT3 GAFCHROMIC film in breast IOERT treatment*.

Introduction

In the mentioned study, in vivo film dosimetry was performed on IOERT, to improve information on the dose delivered to the tumor target and on the alignment of the shielding disk with respect to the electron beam. Two GAFCHROMIC films were positioned in order to obtain the dose maps at the target and beyond the disk, and calibrated in solid water-equivalent phantom for energies 6 and 9 MeV. The results for 37 patients show the percentage difference between measured and prescribed dose and the area of the field that escapes from the shielding. We want to find statistical relations between the Energy and Area outside shielding.

Materials and methods

JASP

Results

The variables corresponding to the area outside shielding and the energy were analysed through a t-test, by means of the software JASP. First, type of t-test was chosen. Independent samples t-test compares the means for two groups (compare scores on the same variable for two different groups of cases.), so it was used. We proceeded with a classical (not Bayesian) analysis of different tests.

- **Student's t-test.** Used to determine if there is a statistical difference between the means of two independent groups. Results are shown below:

Table 1: Independent Samples T-Test

	t	df	p
Area	−0.827	29	0.415

For this first test, considering the conventional significance level of 5% with a p-value 0.415 and the critical value (±2.756), we can say that the samples are statistically similar.

Regarding assumptions of the parametric independent t-test, the dependent variable (Area) should be approximately normally distributed with no significant outliers. This can be checked using the Shapiro-Wilk test:

Table 2: Test of Normality (Shapiro-Wilk)

		W	p
Area	6	0.848	0.152
	9	0.860	0.003

For 6 MeV, since p is greater than our significance level, the null hypothesis (means are equal) cannot be rejected, and there is evidence that the data tested is normally distributed. For 9 MeV, however, the null hypothesis is rejected.

- **Mann-Whitney U test.** Since normality is violated and group sizes are very different (7 and 30 for 6,9 MeV), we use the Mann-Whitney U test which is a non-parametric equivalent that does not require the assumption of normality. The variances of the

dependent variable should be equal in each group. This can be tested using Levene's Test of Equality of Variances:

Table 3: Test of Equality of Variances (Levene's)

	F	df	p
Area	0.350	1	0.559

Since the value is not statistically significant, the group variances are said to be equal (Welch method is not recommended now).

Table 4: Independent Samples T-Test

	W	df	p	H-L Estimate	95% CI for H-L Estimate Lower	Upper
Area	59.500	–	0.451	−1.400	−4.900	2.500

Note. Mann-Whitney U test.

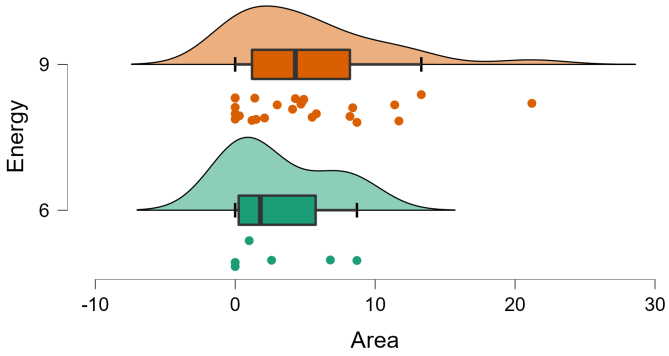

Figure 1: Raincloud plot for Energy and Area.

Therefore, Student and Mann-Whitney t-statistics show that it is not possible to say that there is a significant statistical difference between the two groups. From the descriptive data (See Figure 1), it can be seen that the mean area for the higher energy, 9 MeV, is only slightly higher than the one for 6 MeV, and 9MeV area values are much more disperse (must note the data quantity varies greatly between samples).

- **Bayesian independent sample t-test (Mann-Whitney).** A credible interval of 95% was settled.

  The BF_{10} value and pizza plot (bigger portion is white in Figure 2) suggests anecdotal evidence in favor of the null hypothesis, with this being a weak/inconclusive result. Equivalently, this means that the data is 2.4 times more likely to have occurred under the null than under the alternative hypothesis.

Limitations

In the first six patients, the dimensions of film were smaller than the disk's and it was not possible to estimate the area of the radiation field that escapes outside the shield [1]. Therefore, the size of the sample for each energy differs greatly, limiting the use of some statistical tests. Also, the limited size of the sample decreases the validity of box plots, since the closeness between mean values does not consider the different dispersion of the data.

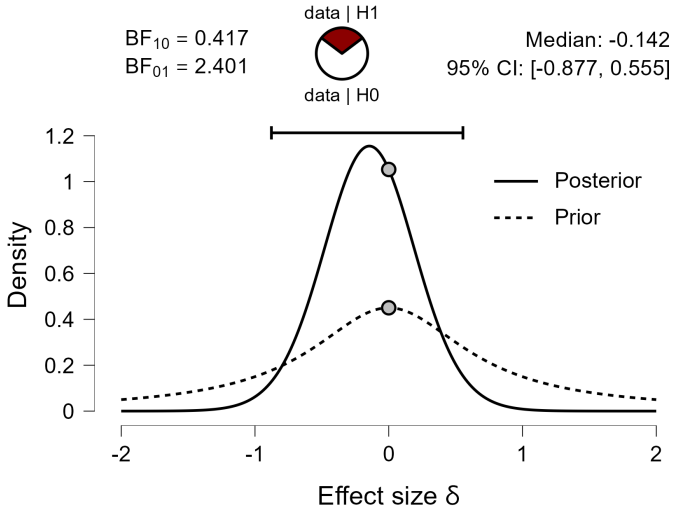

Figure 2: Prior and posterior plot.

References

1 Severgnini, Mara et al. "In vivo dosimetry and shielding disk alignment verification by EBT3 GAFCHROMIC film in breast IOERT treatment." Journal of applied clinical medical physics vol. 16,1 5065. 8 Jan. 2014, doi:10.1120/jacmp.v16i1.5065

2 Goss-Sampson, M. A. (2020). Statistical Analysis in JASP 0.14: A Guide for Students. November 2020.