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Statistical power calculation workshop with *G*Power* in Medicine Degree: a teaching experience.

Taller de cálculo de la potencia estadística con G*Power en Grado en Medicina: una experiencia docente.

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Abstract: *Objective:* To determine the perception that students in the first year of the Bachelor of Medicine have towards the use of free statistical *software G*Power* for the calculation of statistical power, as well as their level of satisfaction with the delivery of said workshop. *Methodology: Observational, cross-sectional and descriptive* study , in which two surveys were administered to those attending a workshop on the use of *G*Power. Results:* The attendees positively valued the use of *G*Power* , since it allowed them to save time while at the same time they feel more confident in the results that it offers. Additionally, residents are motivated in the present and future use of *G*Power* . Additionally, the attendees highlighted the positive attitude of the teaching staff and the friendliness of the course, considering their recommendation. *Conclusions:* Medicine degree students are favorable to *G*Power* in their future research performance for the calculation of statistical power. Satisfaction with the performance of the statistical power calculation workshop for the attendees was good .

Keywords: workshop; free software; teaching; degree in medicine.

Resumen: Objetivo: Determinar la percepción que los estudiantes de primer curso de Grado en Medicina tienen hacia el uso de software estadístico libre G*Power para el cálculo de la potencia estadística, así como su nivel de satisfacción con la impartición de dicho taller. Metodología: Estudio observacional, de corte transversal y descriptivo, en el que se administraron dos encuestas a los asistentes a un taller de uso de G*Power. Resultados: Los asistentes valoraron positivamente la utilización de G*Power, ya que les permitía ahorrar tiempo a la vez que se sienten más confiados en los resultados que éste ofrece. Adicionalmente, los residentes se encuentran motivados en el uso presente y futuro de G*Power. Adicionalmente, los asistentes destacaron la actitud positiva del profesorado y la amenidad del curso, considerando su recomendación. Conclusiones: Los alumnos de Grado en Medicina se muestran favorables a G*Power en su futuro desempeño investigador para el cálculo de la potencia estadística. La satisfacción con la realización del taller de cálculo de la potencia estadística para los asistentes fue buena.

Palabras clave: taller; software gratuito; docencia; grado en medicina.

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1. Introduction

Biostatistics (or Medical Statistics) occupies a preferential place in evidence-based medicine (EBM) since it enables the medical professional to critically evaluate published medical evidence and improves complex decision-making in daily clinical practice (1). Therefore, it is important that young doctors acquire the necessary skills in Biostatistics from their undergraduate degree. However, Biostatistics is considered by Medical Degree students as a complex subject (2), requiring considerable effort on the part of the students.

As a consequence, recently graduated doctors do not have the necessary knowledge in this discipline, making an inappropriate use of statistical techniques and/or erroneous interpretations of research results (3). Therefore, Biostatistics teachers in Medicine Degree must face this challenge. One way to do this is by conducting computer-specific workshops that reinforce difficult concepts, such as "statistical power," using an *ad hoc statistical package* (4). The scenario of calculating statistical power appears frequently when we find differences of relevant magnitude, although they do not reach statistical significance, then asking ourselves if the hypothesis contrast has sufficient statistical "capacity" (or power) to detect said differences with the sample size. that we have (5-6).

Unfortunately, the statistical package *IBM SPSS* , the most widely used statistical software in medical schools in our country, does not offer the calculation of statistical power. Then the need arises to look for free and/or free software alternatives such as *G*Power* (7). This program, created by researchers at the Heinrich Heine University of Düsseldorf (Germany), hosted at: https://www.psychologie.hhu.de/arbeitsgruppen/allgemeine-psychologie-und-arbeitspsychologie/gpower , is free software (which allows us to calculate power for the most used statistical tests: Student's t for one and two samples, linear correlation, etc. In addition, it is multiplatform (*Windows* and *MacOS*), and has a very friendly graphical user interface (IDE). (see figure 1) and an excellent user manual and tutorial (8).Finally, *G*Power* has been widely accepted among Undergraduate and Postgraduate students in Health Sciences at an international level (9-10).

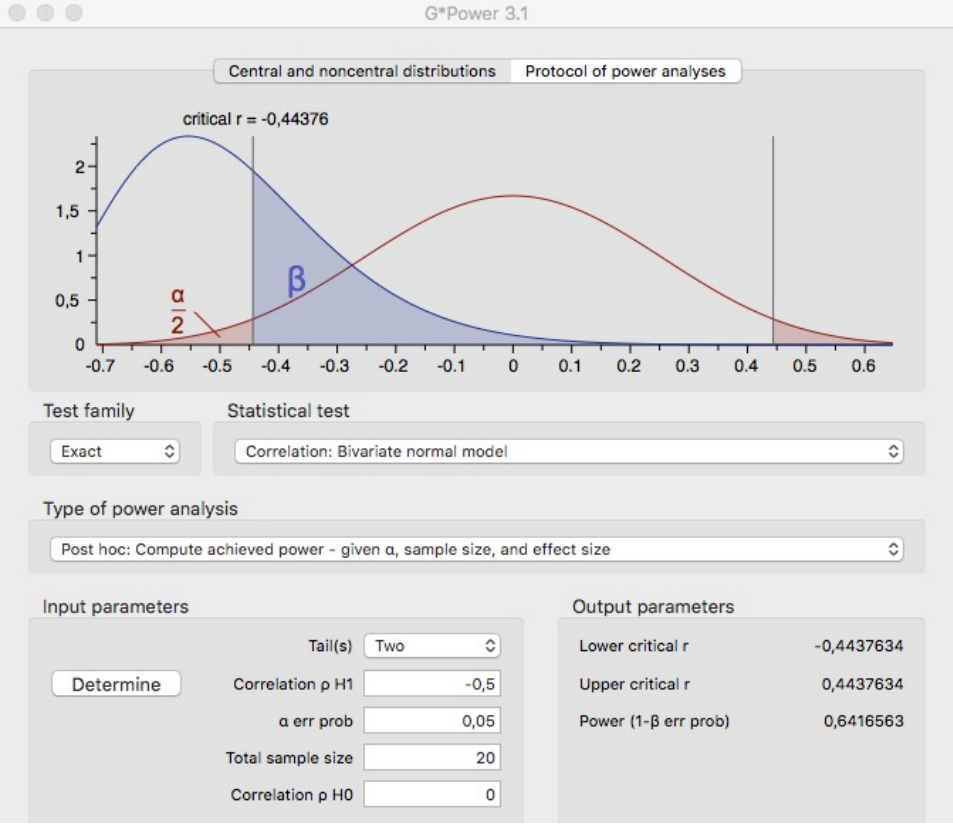

Figure 1. G*Power graphical user interface .

This work aims to verify that *G*Power* is a pertinent program for the calculation of statistical power in the teaching of Biostatistics in Medical Degrees, helping to strengthen

this concept among students. To this end, a workshop on calculating statistical power with *G*Power is proposed* in a Spanish Faculty of Medicine and subsequent assessment by students of its ease of use and learning.

2. Methods

Design

Observational, cross-sectional and analytical study.

Study population and sample selection

The participants in the study were students of the Degree in Medicine at the Faculty of Health and Sports Sciences of Huesca who were in the first year. Recruitment was carried out using a non-probabilistic convenience sampling. The data was collected in May 2021.

Process

A study of the ease of use and learning time of *G*Power* (new software) was proposed. For this, the last week of the month of May 2021, once the knowledge of Biostatistics has been explained and the student is already familiar with the management of statistical *software* , the students of the first year of the Medicine Degree were invited. The students downloaded *G*Power* from their website "in situ" and received a workshop on the application of the calculation of statistical power in the main research scenarios with *G*Power*: a test of Student's t hypothesis for the population mean, and Student's t hypothesis tests for the comparison of two population means (independent) and linear correlation study; all of them on real and current research that analyzed data on COVID-19.

Instrument

Through a questionnaire carried out *ad hoc* for this study, the sociodemographic characteristics (age and sex) were collected, as well as a survey on the ease of use, intuitiveness and speed of *G*Power* through a questionnaire of Likert-type questions (figure 2) and a satisfaction survey of the attendees who participated in the workshop course composed of Likert-type items (figure 3).

Statistic analysis

The mean and standard deviation were reported for a better understanding of the reader, although the non-parametric Wilcoxon signed-ranks test was used for a sample with the aim of contrasting whether the median score of each questionnaire item differs from 3 (score neutral on a scale of 5). As well as the non-parametric Mann-Whitney U test for two independent samples with the objective of contrasting whether the median score of each item of the questionnaire differs according to sex. A result was considered statistically significant when p-value < 0.05. All p-values were adjusted for multiple comparisons according to the Bonferroni method. Data analysis was carried out with the statistical package jamovi for macOS (11).

Please circle/mark the degree of agreement with each of the following statements, with 1 = "Strongly disagree" and 5 = "Strongly agree".

Gratuity	Although G*Power is free, it offers me all the advantages of a licensed software for calculating statistical power.	**1**	**2**	**3**	**4**	**5**
Resolution	G*Power solves the problem of calculating statistical power in a simple and intuitive way.	**1**	**2**	**3**	**4**	**5**
Time	Solving problems with G*Power saves me time compared to other statistical packages in calculating statistical power.	**1**	**2**	**3**	**4**	**5**
Motivation	I feel more motivated to use G*Power for statistical power calculation than other statistical programs.	**1**	**2**	**3**	**4**	**5**
Confidence	G*Power gives me confidence in the results obtained.	**1**	**2**	**3**	**4**	**5**
Utility	In the future, I will use G*Power for statistical power calculation.	**1**	**2**	**3**	**4**	**5**

Figure 2. Survey about the use of G*Power to calculate statistical power.

In general, as a summary, rate the following aspects related to the activity. Please circle/mark the degree of agreement with each of the following statements, with 1 = "Strongly disagree" and 5 = "Strongly agree".

Amenity	The sessions has been very pleasant	**1**	**2**	**3**	**4**	**5**
Utility	The teachings received have broadened my training	**1**	**2**	**3**	**4**	**5**
Faculty	I am satisfied with the teachers	**1**	**2**	**3**	**4**	**5**
Activity	I am satisfied with the activity carried out	**1**	**2**	**3**	**4**	**5**
Recommendation	I would recommend this activity	**1**	**2**	**3**	**4**	**5**
Participation	I would participate in a similar activity again	**1**	**2**	**3**	**4**	**5**

Figure 3. Survey about workshop satisfaction

Ethical aspects

This work is part of the teaching innovation project of the University of Zaragoza entitled: "Improving the statistical power of undergraduate and postgraduate Medicine students with free and open-source software" (reference: PIIDUZ_19_039). The participants signed an informed consent. The questionnaires were filled out anonymously.

3. Results

The 30 students enrolled in the Biostatistics course attended the workshop on statistical power (100%). Of these, 20 were women (67%). The mean age of the attendees was 19.1 years (SD = 1.9). The survey was completed by the 30 attendees to the workshop (100%).

Table 1 shows the scores of the survey on the use of G*Power for the calculation of statistical power. Most students consider that G*Power, despite being free, offers all the advantages of licensed software (such as IBM SPSS, Stata or SAS, for example), as reflected in the average score for the 'free' item, which was 4.90 (SD = 0.30), being significantly higher than neutral (mean score of 3 on a 5-point scale) ($p<0.001$). In addition, in relation to the calculation of the statistical power with G*Power (items "resolution", "time" and "confidence"), they perceived that it allows them to save time (Mean = 4.87; $p<0.001$) at the same time who feel confident in the results it offers (Mean = 4.67; $p <0.001$), highlighting

that this package solves said calculation in a simple and intuitive way (Mean = 4.80; p <0.001). Finally, the high scores in the items 'motivation' (Mean=4.57; p<0.001) and "utility" (Mean=4.70; p<0.001) indicated that the students are favorable in the future use of G *Power for calculating statistical power. No differences were found in the questionnaire regarding gender.

Table 1. Results of the questionnaire on the use of *G*Power* for the calculation of statistical power.

Item		Mean (SD)	p
Gratuity	Although *G*Power* is free, it offers me all the advantages of a licensed *software* for calculating statistical power.	4.90 (0.30)	<0.001
Resolution	*G*Power* solves the problem of calculating statistical power in a simple and intuitive way.	4.80 (0.51)	<0.001
Weather	Solving problems with *G*Power* saves me time compared to other statistical packages in calculating statistical power.	4.87 (0.36)	<0.001
Motivation	I feel more motivated to use *G*Power* for statistical power calculation than other statistical programs.	4.57 (0.57)	<0.001
Confidence	*G*Power* gives me confidence in the results obtained.	4.67 (0.55)	<0.001
Utility	In the future, I will use *G*Power* for statistical power calculation.	4.70 (0.53)	<0.001

SD: Standard deviation. p: p-value of the Wilcoxon contrast for a sample.

Table 2. Results of the workshop satisfaction questionnaire.

Item		Mean (SD)	P
Amenity	The session has been very pleasant	4.43 (0.73)	<0.001
Utility	The teachings received have broadened my training.	4.87 (0.43)	<0.001
Faculty	I am satisfied with the teachers.	4.70 (0.65)	<0.001
Exercise	I am satisfied with the activity carried out.	4.66 (0.67)	<0.001
Recommendation	I would recommend this activity.	4.53 (0.68)	<0.001
Stake	I would participate in a similar activity again.	4.27 (0.83)	<0.001

SD: Standard deviation. p: p-value of the Wilcoxon contrast for a sample.

Table 2 shows the overall evaluation of the workshop by the students. Given that all the mean scores were significantly higher than the "neutral" (mean of 3 on a 5-point scale), it is assumed that the balance of the workshop has been positive. In particular, the participants highlight the usefulness of the workshop to broaden their training in Biostatistics. Likewise, the attendees showed a high degree of satisfaction both with the activity carried out and with the teaching staff in charge of its delivery; highlighting the amenity of it. In this sense, they are in favor of recommending this workshop and tending to carry out others with similar characteristics during the course. No differences were found in the questionnaire regarding gender.

4. Discussion

This work reports for the first time in the international literature the perception that Medicine Degree students have about the use of free software such as *G*Power* in the calculation of statistical power through the teaching of a specific workshop.

In relation to the first item of the questionnaire ("free"), medical students positively perceive that *G*Power*, despite being a free program, has all the advantages of a proprietary one. This result could be explained in the *G*Power* graphical user interface (IDE), as simple, intuitive and friendly as any commercial package. In this sense, medical students report that working with *G*Power* saves them time according to their response to the third item ("time"). The explanation may lie in the fact that *IBM SPSS* , the statistical package with which you are familiar, works with three windows: one for data, another for results and the last for syntax, while *G*Power* offers data visualization on a single screen. and results, together with the calculation options of each module (see Figure 1), thus avoiding having to continually resort to dialog boxes such as *IBM SPSS* . In this sense, they also considered that the results of *G*Power* are more reliable than IBM SPSS according to the fifth item of the questionnaire ("confidence"), since, during the workshop, we calculated the statistical power manually (by applying formulas) to compare both results. Finally, future medical researchers are motivated to perform the statistical power calculation with *G*Power* , as they responded to the fourth ('motivation') and sixth ('utility') items.

This study highlights the high degree of satisfaction of the attendees with the content, implementation and performance of the workshop faculty and shows that training through the use of active methodologies is highly relevant for the training of medical students (4).

Among the strengths of this workshop, it is worth highlighting: (a) This course follows the recommendations of authors such as Greengham (12), who maintain that the best way to learn MBE is to intersperse practical courses introduced during medical school, such as the one here we present. (b) The markedly practical nature of this workshop through the use of problem-based learning (PBL) tries to avoid the barriers of traditional methodologies that it infers in the matter of research, so that medical students who, although they show good attitudes towards research (13), can become involved in research tasks (14). (c) A high percentage of attendees were medical students, reflecting the interest that this approach arouses in this group. (d) The advancement of information and communication technologies (ICTs) and their approach to the classroom can be a facilitating element for the training of medical students (15); the use of specific computer programs for calculating statistical power, such as *G*Power* , is useful in training for the use of these tools.

However, the use of non-probabilistic convenience sampling in a single center and with a small sample size should be noted as a limitation, which makes it impossible to generalize the findings, as well as the use of an "ad hoc" designed satisfaction scale. for this study, therefore, not validated.

By virtue of the findings obtained, the implementation of a *G*Power workshop is proposed as a future line in Medicine* residents who are pursuing a research postgraduate degree, regular users of *IBM SPSS* , to test its future implementation in Master's Degrees in Sciences of Medicine and Health.

5. Conclusions

- *G*power* software is a methodological aid to medical students and researchers during the data analysis phase when it is concluded that the effect found does not reach statistical significance and an explanation for this finding must be found by calculating the statistical power.

- The satisfaction with the completion of the statistical power calculation workshop for the attendees was good and has given them the knowledge and autonomy to be able to interpret a scientific work and even carry out their own study.

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