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Neutrosophic Statistical Analysis of Behavioral Medicine Knowledge in University Students

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Abstract. In the present investigation, a neutrosophic statistical analysis was carried out to determine the level of knowledge of medical students about behavioral medicine. It is based on the recognition that Neutrosophic Descriptive Statistics includes all the techniques to summarize and describe the characteristics of the neutrosophic numerical data. That is why the objective of this investigation is to carry out a neutrosophic statistical analysis in behavioral medicine that allows identifying the level of knowledge of university students about behavioral medicine. Techniques from both classical and neutrosophic statistics were used, within the latter, the neutrosophic frequency distribution and the results obtained present an adequate level of validity and leave new edges of the investigated theme open for future investigations.

Keywords: statistics, neutrosophy, behavioral medicine, neutrosophic frequency distribution.

1 Introduction

Since the beginning of mankind with the development of the hominid ancestors of *homo sapiens*, in the prehistoric period, illness was considered a natural characteristic and was sufficient reason to abandon or isolate oneself from the sick person. A tendency that was stripped of all ethics and values that society should possess.

The field of behavioral medicine emerged basically from the initiative of psychologists working in the health field, but medical professionals were immediately attuned to the new approach given its scientific nature and its application in various scenarios. This is an area of health sciences that has been systematized from various approaches and perspectives.

The term "behavioral medicine" was proposed by Lee Birk in 1973 when he published his book "Biofeedback: Behavioral medicine" indicating the usefulness of biofeedback in various diseases. According to the aspects stated by Blanchard [1], who is considered one of the scientists who made important contributions to this subject.

On these arguments, the psychiatrist Engel, [2], proposed an alternative to the biomedical model, establishing the biopsychosocial model, emphasizing the emotional, behavioral, and contextual aspects of the human being. Important postulates for the development of behavioral medicine worldwide. These assessments contributed to the international scientific community to resume research in this area of knowledge.

On the other hand, this development was aimed at the fact that Behavioral Medicine offers a space for interdisciplinary discussion to exchange ideas and theoretical approaches in this regard. This is taken into account by several medical specialties in the treatment of complex diseases that require a look from this approach.

The conceptual basis of the topic addressed in this research has as important support the clinical models that have shown greater effectiveness in addressing health problems are those derived from the Cognitive Behavioral Theory. For this reason, it is essential to address topics related to the study and systematization of Behavioral Medicine during the medical courses or degrees where new physicians are trained.

An approach that should be considered in Behavioral Medicine is the use of behavioral modification techniques, which could change people's lifestyles and, therefore, improve their health, prevent various organic diseases and reduce their symptoms.

On the other hand, the researcher Agras [3], has pointed out that the development of behavioral medicine implies a different scientific approach to the field of Health-Disease, which leads to interdisciplinary research activities.

There is a consensus of several authors such as Baños [4]; Watson [5], who consider that behavioral medicine suggests a complex scenario of interaction of multiple variables (environmental, psychological, physiological,

sociological, and nutritional) at different levels, resulting in variations in physiological responses, in such a way that a change in a certain variable could determine an organic dysfunction.

It is important to point out that some other disciplines and sciences can enrich the work of Behavioral Medicine. Such is the case of neutrosophy, which according to researchers such as Smarandache [6], [7] is: a new branch of philosophy, which opened a new field of research in metaphilosophy, and which studies the origin, nature, and scope of neutralities, as well as their interactions with different ideational spectra.

Etymologically neutrosophy (from French neutre and Latin neuter meaning neutral and Greek sophia, knowledge) is the knowledge of neutral thoughts. It forms the basis for neutrosophic logic, neutrosophic sets, neutrosophic probability, and neutrosophic statistics [8].

The benefits offered by Behavioral Medicine are diverse, which is why it is required to know if during the training of doctors, and professionals of the health sciences in general, they have or receive knowledge of Behavioral Medicine. Based on the aforementioned criteria, the level of knowledge of undergraduate medical students of the Autonomous Regional University of the Andes (UNIANDES) in Ecuador is evaluated.

The objective of this research is to perform a neutrosophic statistical analysis in behavioral medicine that allows the identification of the level of knowledge of university students about behavioral medicine.

2 Materials and Methods

2.1 Subjects under study

At the time of conducting this research, the calculation of the population was done using neutrosophic statistical tools, since it is necessary to identify the total number of university students to be investigated. In accordance with the fact that the total population under study is known, the calculation shown in the following expression is used:

p = approximate proportion of the reference population to be studied in the present investigation, q = proportion of the reference population that does not present the subject under study (1 -p). The desired confidence level (Z). Indicates the degree of confidence that the true value of the parameter in the population will be found in the calculated sample. The absolute precision (d). It is the desired width of the confidence interval on both sides of the true value of the difference between the two proportions (in percentage points). N means the size of the investigated population.

A neutrosophic sample is a chosen subset of a population, a subset that contains some indeterminacy: either with respect to several of its individuals (who may not belong to the population under study or may only partially belong to it) or with respect to the subset as a whole. While classical samples provide precise information, neutrosophic samples provide vague or incomplete information [6], [28].

Following Smarandache's statement, in the present investigation a confidence level between 90 and 95% is desired, z= [1.645, 1.96], d= [0.05, 0.1] and p = [0.4,0.44], N=40. The result, known as the neutrosophic sample n= [10.1, 30.6], indicates that the sample should be in values between 10 and 31 university students [8], [21].

Once the neutrosophic sampling had been applied and the level of determination and indeterminacy of the sample had been identified, a total of 25 university students from the Medical School of the Autonomous Regional University of the Andes, in the Republic of Ecuador, were randomly selected. All of them have passed the third year of study. [29], [30]

2.2 Type of research

An exploratory, descriptive and non-experimental research was carried out. With a cross-sectional design [9, 24]. Therefore, the selected instruments are applied once. This is done to obtain reliable data on this topic to enrich the syllabus of the medical school of UNIANDES.

2.3 Instruments

Methods and techniques used in the research

Analytical-synthetic: it allowed a study on the theoretical and methodological foundations that support the neutrosophic statistical analysis of behavioral medicine in university students. It was used for the systematization, generalization, and concretization of the information processed.

Inductive-deductive: it made it possible to make inferences and generalizations from the neutrosophic statistical analysis on behavioral medicine in university students, as well as the interpretation of the data obtained, from which new logical conclusions are deduced.

Survey: It was carried out to 100% of the members of the sample under study since this was the instrument used to identify the knowledge of university students about behavioral medicine.

Measurement: It was used to attribute values to each of the survey questions and to be able to quantify the results derived from them.

Applied statistical analysis

Statistical analyses were performed with SPSS v. 20 software (SPSS Inc, Chicago, IL, United States). Data relating to descriptive statistics will be presented by frequency distribution and percentage analysis.

The present research takes into account Smarandache's [6], [22], [23], [26] evaluations of neutrosophic descriptive statistics, for whom it comprises all the techniques for summarizing and describing the characteristics of neutrosophic numerical data. Within it, the neutrosophic frequency distribution will be used in particular.

2.3.1 Neutrosophic Method

For the realization of this research, the postulates of several researchers were taken into account, among which the following stand out [10], [11], [12], [13], [14], [15], [18], which make explicit the procedure for the realization of a statistical analysis using the neutrosophic frequency distribution. For this purpose, the knowledge of behavioral medicine in university students is taken into account. Assessed from a deterministic and indeterministic approach. [27]

For the development of the research with a neutrosophic approach, a flow of activities was taken into account, as illustrated in Figure 1.

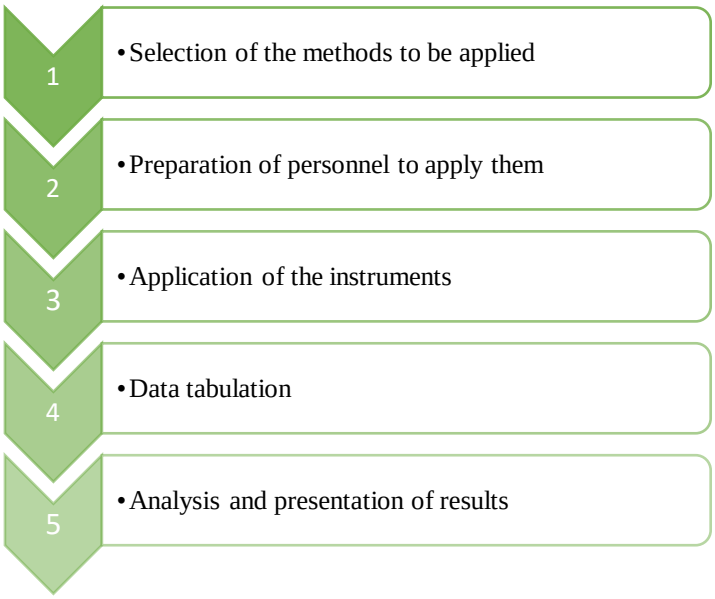

Figure 1: Logic followed for neutrosophic statistical analysis

According to authors who have systematized neutrosophic statistics such as [16], [17], [19], [20], [25] all agree that at the beginning there is imprecise information, which is why it is necessary to calculate the extremes (min and max) of the absolute or estimated frequencies, therefore, it is necessary to work as shown below:

$$min_{fn} = 3 + 2 + 6 + 11 = 22$$

$$max_{fn} = 4 + 3 + 8 + 17 = 32$$

Once the relative neutrosophic frequencies have been calculated, it is necessary to identify the minimum and maximum values for each of the results obtained as the level of knowledge of the university students. For this purpose, the following formula will be applied:

$$min_{fnri} = \frac{min_{fni}}{max_{fn}}$$

And

$$max_{fnri} = \frac{max_{fni}}{min_{fn}}$$

For the case of frequencies that do not present indeterminacy, it is satisfied that:

$$min_{fni} = max_{fni} = fni$$

Therefore:

$$min_{fnr0} = \frac{min_{fn0}}{max_{fn}} = \frac{3}{32} = 0{,}093$$

$$max_{fnr0} = \frac{max_{fn0}}{min_{fn}} = \frac{4}{22} = 0.181$$

$$min_{fnr3} = \frac{min_{fn3}}{max_{fn}} = \frac{2}{32} = 0{,}062$$

$$max_{fnr4} = \frac{max_{fn4}}{min_{fn}} = \frac{3}{22} = 0{,}136$$

$$max_{fnr6} = \frac{max_{fn6}}{min_{fn}} = \frac{6}{32} = 0{,}187$$

$$max_{fnr8} = \frac{max_{fn8}}{min_{fn}} = \frac{8}{22} = 0{,}363$$

$$max_{fnr11} = \frac{max_{fn11}}{min_{fn}} = \frac{11}{32} = 0{,}343$$

$$max_{fnr17} = \frac{max_{fn17}}{min_{fn}} = \frac{17}{22} = 0{,}772$$

The cumulative neutrosophic relative frequency value was obtained by summing the observed neutrosophic relative frequencies.

$$Frna = [0{,}093\ ,0.181] + [0{,}062, 0{,}136] + [0{,}187\ , 0{,}363] + \ [0{,}343\ , 0{,}772] = \ [0{,}685\ , 1{,}452]$$

Table 1 shows the results of the absolute and relative neutrosophic frequencies, which will be evaluated using graphs in the following section, as they will be described in greater depth.

Number of undergraduate students with knowledge of behavioral medicine	Neutrosophic absolute frequency	Neutrosophic relative frequency
2	5	[0,093 ,0.181]
4	10	[0,062, 0,136]
8	[10,20]	[0,187 , 0,363]
10	[11,19]	[0,343 , 0,772]
Total 2-10	[22,32]	[0,685 , 1,452]

Table 1. Results of absolute and relative neutrosophic frequencies. Source: own elaboration

3 Results

Once the results have been tabulated, they are presented. This is the basis of this section of the present research. Where the data of each of the questions of the survey applied to the medical students that were selected for the study are shown.

Question	Yes	No	Does not answer the question
Do you know what behavioral medicine consists of?	5	18	2

Table 2. Results of question 1 of the survey applied to UNIANDES medical students. Source: Results obtained by the researchers.

The results in Table 2 show that most of the university students participating in the research have little knowledge of what behavioral medicine consists of. Only 5 of them gave a positive answer to this question, a majority of 18 students reported not having any knowledge and 2 of them refused to answer the question. These results make it evident that further work is still needed to increase the knowledge of university students about what is behavioral medicine.

Question	Yes	No	Does not answer the question
Are you familiar with the objectives and contents of behavioral medicine?	4	20	1

Table 3. Results of question 2 of the survey applied to UNIANDES medical students. Source: Results obtained by the researchers

Once the results of question 2 of the survey applied to the university students were tabulated. It is observed that they are similar to those of the previous question, which denotes that the investigated university students present gaps in theoretical knowledge on this subject. Only 4 answered that they knew the objectives and contents of behavioral medicine. While the vast majority (20 of them) said they did not know them, nor had they studied them during their study program.

Question	Yes	No	Does not answer the question
Are you familiar with the methodological bases that support behavioral medicine?	2	22	1

Table 4. Results of question 3 of the survey applied to UNIANDES medical students. Source: Results obtained by the researchers

The results in Table 4 are those derived from the university students' answers to question 3 of the survey applied. It shows that there is little knowledge of the methodological bases that support behavioral medicine. Only 2 university students marked this option in the survey. On the other hand, the majority of them (22) selected the option "no". This supports the statement expressed above and only 1 student returned this question of the survey blank.

The results shown allow affirming that this line of research requires deepening the teaching-learning process of university students of medicine. They still have gaps in theoretical and methodological knowledge about Behavioral Medicine, which is why it is necessary to review the possible spaces for the inclusion of this topic in the medical curriculum of UNIANDES.

Conclusion

The analysis of the theoretical and methodological references on the study of Behavioral Medicine in university students evidences the existence of different bibliographic sources on the subject, however, tools are required to accurately assess the current state of this subject.

The methodological logic followed was based on general scientific methods such as measurement and survey, which made it possible to identify the level of knowledge of university students about Behavioral Medicine.

The interpretations of the results offer validity to the research developed because a neutrosophic statistical analysis allowed to open new lines of research that imbricate the neutrosophic sciences with Behavioral Medicine.

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