



Neutrosophic Statistical Analysis of Self-Assessment of Rehabilitation Knowledge in University Students

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Abstract. This study arises because of the growing demand for rehabilitation in different population sectors since after the COVID-19 pandemic that the whole world experienced, this discipline is an important alternative in recovering from the sequelae caused by this disease. In accordance with the aforementioned, the objective of the present research is to carry out a neutrosophic statistical study of the self-assessment of knowledge about rehabilitation in undergraduate medical students. For this, theoretical, empirical, and mathematical-statistical methods and techniques were used. Techniques of neutrosophic statistics were used in the validation. The results obtained denote an important level of validity and allowed identifying the need to develop further studies on this topic.

Keywords: neutrosophy, neutrosophic statistics, neutrosophic model, rehabilitation.

1 Introduction

Several medical specialties are studied and applied in order to keep the different population groups as vital as possible. Within them, rehabilitation plays a leading role, since its objective is to recover patients who, because of their illness, have been affected in carrying out their daily activities.

Rehabilitation is a global and continuous process of limited duration and with defined objectives, aimed at promoting and achieving optimal levels of physical independence and functional abilities of people with disabilities, as well as their psychological, social, vocational, and economic adjustment that allow them to lead their own lives freely and independently. Rehabilitation is a complex process that results from the integrated application of many procedures to restore the individual to his optimal functional status, both at home and in the community to the extent that the appropriate use of all residual capacities allows [1].

In modern rehabilitation, comprehensive therapy is always used, since no therapeutic method, taken separately, can guarantee the recovery of the patient or the total restoration of their ability to work. The means of comprehensive therapy are therapeutic regimen, diet therapy, drug therapy, physiotherapy, balneotherapy, mechanotherapy, psychotherapy, Therapeutic Physical Culture, and others [2].

Special methods of therapy are also used selectively, such as surgical, radiotherapeutic, and diet therapy, guaranteeing the patient rational nutrition according to the particularities of his illness. Drug therapy or pharmacotherapy consists of using drugs to act on the body or, preferably, on certain systems and organs.

Physiotherapy uses both natural factors (sun rays, air, water) and artificial ones (electric currents, radiation therapy, light sources, ultrasound, and heat treatments) to cure diseases. Balneotherapy contributes to the healing and prevention of diseases with mineral waters applied externally (in the form of baths) and internally [2].

Mechanotherapy is a therapeutic method based on the execution of movements, strictly limited, with the help of special devices that are used fundamentally to avoid stiffening of the joints. Psychotherapy consists of the influence of the environment on the patient's psyche, as well as in the regimen of therapeutic institutions, positive emotions, the benevolent attitude of health personnel, and advice and conversations that contribute to the manifestation of trust in the patient reinstatement. Therapeutic Physical Culture is combined with all the elements of comprehensive rehabilitation mentioned [2] [3], [20].

That is why medical professionals must have notions of this medical specialty since they must prescribe them at certain times of their professional work. That is why the present study aims to link elements of neutrosophy and medicine to unravel the knowledge of a group of medical students from the Autonomous Regional University of the Andes in Ecuador.

That is why the objective of this research is to carry out a neutrosophic statistical study of the self-assessment of knowledge about rehabilitation in medical university students.

2 Methodology

2.1 Study subjects

When calculating a neutrosophic sample, the procedure described by authors such as [4], [5], [6], [7], [21] is followed, who agree that the order to perform this is as follows:

p = approximate proportion of the phenomenon under study in the reference population

q = proportion of the reference population that does not present the phenomenon under study ($1 - p$).

The desired confidence level (Z), indicates the degree of confidence that the true value of the parameter in the population is found in the calculated sample.

The absolute precision (d). It is the desired width of the confidence interval on either side of the true value of the difference between the two proportions (in percentage points).

N is population size.

To develop this research, a confidence interval between 95 and 99% was used, $z = [1.645, 1.96]$, $d = [0.05, 0.1]$ and $p = [0.4, 0.42]$, $N = 40$. The result that is called the neutrosophic sample $n = [10.1, 30.6]$ indicates that the sample must have values between 10 and 31 individuals.

Based on the previous calculations, a sample of 28 medical students from the Autonomous Regional University of the Andes (UNIANDES) is selected. For this, a probabilistic sampling was used, where all the students had the same possibility of being chosen. To form the sample, the raffle technique was used. All students signed the informed consent.

2.2 Classical methods and techniques used

The research used methods and techniques such as those of a theoretical nature, among which the synthetic analytical and deductive inductive methods and techniques were applied to work with the bibliographic sources. They were also used for the synthesis of the results obtained.

Empirical methods were also employed, such as the student survey, which was used as the main way of obtaining the results. In addition, the measurement was applied since values were attributed to each of the categories of the elaborated Likert scale. [22]

Within the mathematical-statistical methods, descriptive statistics were used, particularly frequency analysis. Spearman's correlation coefficient was also applied. Techniques of neutrosophic statistics such as neutrosophic graphs were also employed.

This was utilized to graph the absolute neutrosophic frequencies, where different types of graphs can be used, which must contain and differentiate the determined and indeterminate part of the analyzed frequencies [7], [8], [14], [15], [16], [19].

2.3 Neutrosophic method

To develop the investigation, the following neutrosophic model is followed, as described below.

Step 1. Identification of the problem

Step 2. Study of the state of the art of the investigated problem

Step 3. Selection of the investigated sample

Step 4. Selection of instruments

Step 5. Preparation of the personnel involved in the study

Step 6. Application of the instruments

Step 7. Tabulation of the results

Step 8. Analysis and interpretation of the results

For the compilation of the information, a Likert scale was applied, and the arguments raised by Smarandache were used, [9] states that generalizing the concept of several sets such as the classic set, the fuzzy set, and the paradoxical set, and $TA(x)$, $IA(x)$, and $FA(x)$ are membership functions that can be real standard or nonstandard subsets.

In this form, it was not possible to apply it to real-world problems in science and engineering. Several authors

have systematized these aspects that have enriched the study of a single value neutrosophic set (SVNS), to overcome this [10], [11], [12], [13], [17], [18].

Let X be a universe of discourse, an SVNS A over X has the following form:

$$A = \{(x, u_a(x), r_a(x), v_a(x)): x \in X\}$$

Where

$$u_a(x): X \rightarrow [0,1], r_a(x): X \rightarrow [0,1] \text{ y } v_a(x): X \rightarrow [0,1]$$

With

$$0 \leq u_a(x), r_a(x), v_a(x) \leq 1, \quad \forall x \in X$$

The intervals $u_a(x)$, $r_a(x)$ and $v_a(x)$ denote the true, indeterminate, and false memberships of x in A, respectively.

For convenience, an SVN number will be expressed as A, where a, b, c [0,1], and $a+b+c \leq 1$.

Linguistic term	SVN numbers
Excellent (E)	(1,0,0)
Good (G)	(0.71,0.35,0.30)
Regular (R)	(0.50,0.50,0.50)
Bad (M)	(0,1,1)

Table 1. Linguistic terms of the scale

This means that $A = (T, I, F)$ is a single-valued neutrosophic number, a scoring function S which in turn is related to a single neutrosophic value, corresponding to the degree of relevance to truth, the degree of membership to indeterminacy and the degree of membership to falsehood is defined by: (4)

The scoring function for single-valued neutrosophic sets is proposed to make the distinction between the numbers.

3 Results

This section presents the results obtained from the application of the neutrosophic survey applied to the medical students of the Autonomous Regional University of the Andes. Which are grouped according to the option marked on the Likert scale used. [23], [24], [25]

Question 1	Excellent (5)	Good (3)	Regular (2)	Bad (1)
How do you rate your knowledge of the main rehabilitation techniques?	3 (10.7%)	5 (17.8%)	11 (39.3%)	9 (32.2%)

Table 2. Results of question 1 of the student survey

Table 2 shows the results of question 1 of the survey applied to the students. Where only a minority of students selected the option with the highest score on the elaborated Likert scale. This was reflected in 3 students for 10.7%. On the other hand, 5 students, for 17.8% selected the category of Good, while most students, 12 for 42.8%, self-assessed as Regular. While 7, for 25.1%, marked the lowest category of the indicated scale.

Question 2	Excellent (5)	Good (3)	Regular (2)	Bad (1)
How do you rate your knowledge of	5 (17.8%)	4(14.3%)	12(42.8%)	7(25.1%)

Question 2	Excellent (5)	Good (3)	Regular (2)	Bad (1)
the cardinal principles of rehabilitation?				

Table 3. Results of question 2 of the student survey

Table 3 represents the results of question 2 of the applied survey, where, like the previous one, a small group of 5 students for 17.8% indicated the category of excellent. On the other hand, 4 for 14.3% marked Good. While most of the students 12 for 42.8% self-assessed as Regular and 7 for 25.1% indicated the category of Bad.

Question 1	Excellent (5)	Good (3)	Regular (2)	Bad (1)
How do you rate your knowledge of the different forms of rehabilitation assessment?	3 (10.7%)	8(28.5%)	8(28.5%)	9 (32.2%)

Table 4. Results of question 3 of the student survey

Table 4 shows information referred to question 3 of the survey, where only a minority of 3 for 10.7% of the total number of students surveyed. On the other hand, the category of Good was marked by 8 students for 28.5%. The Regular category was the option indicated by 8 for 28.5%. While most students 9 for 32.2% self-assessed themselves as Bad.

As the results show, most of the students self-assess themselves in the categories with the lowest score on the elaborated scale. This denotes that they present a low level of knowledge about rehabilitation, its main techniques, and ways of evaluating, which makes evident the need to continue delving into this type of research topic.

Neutrosophic graph of indeterminacy of the reason for the answers

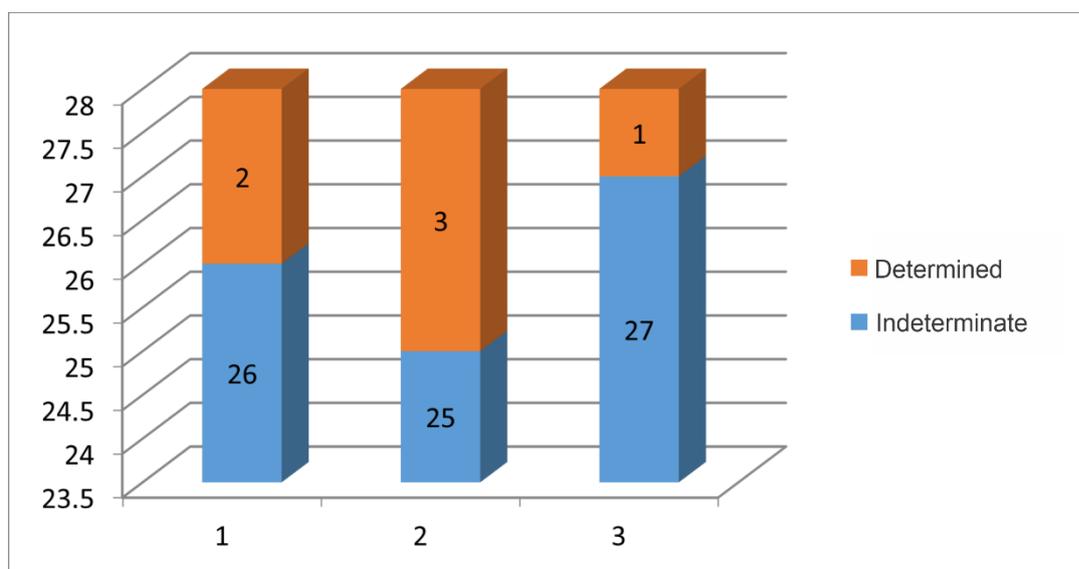


Figure 1. Neutrosophic Graph: Relation of determination indeterminacy for each of the questions of the survey

Figure 1 represents in a general way the number of students who determined the reason for their response to the question and the number who did not tell why they selected that option in said instrument. In question 1, 2

students showed indeterminacy of why their answers. While in question 2, there were 3 students who had indeterminacy. In question 3, only one student showed indetermination.

Validation of the study

Correlations					
Question content			Techniques	Principles	Evaluation
Spearman's Rho	Techniques	Correlation coefficient	1,000	.926**	.953**
		Next (2-sided)	.	,000	,000
		N	28	28	28
	Principles	Correlation coefficient	.926**	1,000	.903**
		Next (2-sided)	,000	.	,000
		N	28	28	28
	Evaluation	Correlation coefficient	.953**	.903**	1,000
		Next (2-sided)	,000	,000	.
		N	28	28	28
**. The correlation is significant at the 0.01 level (bilateral).					

Table 5. Results of Spearman's correlation coefficient. Source: processed by SPSS for Windows v 20.

Table 5 shows the correlation between the questions of the applied survey, where after processing the data with the statistical program SPSS, version 20, it is evident that among the contents of the questions of the survey there is a high level of significance because in the three cases $p < 0.00$.

Conclusion

The study of the sources consulted in this research made it possible to justify the need to carry out a neutrosophic statistical study of the self-assessment of knowledge about rehabilitation in medical university students.

The results obtained through the application of elements of neutrosophic statistics allowed identifying that there is a low level of knowledge about rehabilitation among university medical students of the Autonomous Regional University of the Andes.

The study of the neutrosophic granted a higher level of validity to the results obtained, since it allowed an analysis of the indeterminacy of the students about the reason for their responses to the applied survey.

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