



Neutrosophic Linguistic Scale for Self-Assessment of Knowledge about Non-Communicable Diseases in Medical Students

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Abstract. Every day there is an increase in the number of non-communicable diseases in different population sectors of Latin America, aspects that lead to dissimilar deaths per year, which has made these an important line of research in the scientific community. That is why during the training of professionals in the medical sciences these are an important unit of knowledge. However, it is still required to use neutrosophic tools to identify the level of knowledge of university students about them. That is why the objective of this research is oriented towards applying a Neutrosophic Linguistic Scale for the self-assessment of knowledge about non-communicable diseases in medical students. During the study, theoretical, empirical, and mathematical-statistical methods were used. The results obtained make evident the need to change the teaching approach of these in the investigated field.

Keywords: neutrosophic scale, medical students, neutrosophic method, knowledge.

1 Introduction

Noncommunicable diseases (NCDs) represent a global problem, especially for developing countries, where they have become a major public health burden in recent years. The statistics published by the World Health Organization (WHO) are alarming and worrying. Morbidity and mortality from NCDs increase practically for years, not only with population aging as life expectancy increases but also increases in very active ages of life [1].

These diseases affect all age groups and represent a heterogeneous group of conditions such as diabetes and high blood pressure, among others, constituting a public health problem for being a cause of morbidity, in the framework of the aging process of the Latin American population and due to the unhealthy way of life [2], [3].

The time series of mortality from the highest impact cardiovascular diseases (heart and cerebrovascular diseases) showed a decrease in the adjusted rate per 100 000 population of 1.3% per year, on average, between 1970 and 2017. Reason that makes it an important area of research since, within the NCD, this is the one with the highest mortality.

According to studies of the 2020s, the WHO warns of an even greater increase in the current decade [1], [4]. They are so for several reasons: the large number of affected cases with their increasing incidence rates, their gradual contribution to overall mortality because they are the most frequent cause of disability, and the high cost of hospitalization, medical treatment, and subsequent rehabilitation [4], [23].

That is why during the training of medical professionals from most universities in Latin America, they include it as an important subject to be passed by their graduates. Well, the incidents show that it is one of the ones that interact the most during the exercise of their profession.

Because of the above-mentioned, a bibliographic search was carried out where authors such as [3], [4], [5], [6] stand out, and their main results are oriented to the linking of this subject with related disciplines. However, the study of neutrosophic tools in the assessment of university medical students on the NCD unit has not been systematized.

Based on the arguments raised above, this research aims to apply a Neutrosophic Linguistic Scale for the self-assessment of knowledge about non-communicable diseases among medical students of the Autonomous Regional University of the Andes, in the Republic of Ecuador.

2 Methodology

2.1 Study subjects

For the selection of the sample, the procedures described by [7], [8], [9], [22], [26] for neutrosophic research were considered. These same authors state that a neutrosophic sample is a chosen subset of a population, a subset that contains some indeterminacy: either with respect to several of its individuals (which may not belong to the population under study or may only partially belong to it) or with respect to the subset as a whole.

For the case of this investigation, the following neutrosophic logic was followed, where:

- 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
- Z = desired confidence level
- d = 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 = size of the sample that will be studied

When working with a confidence level between 95 and 99%, $z = [1.645, 1.96]$, $\alpha = [0.05, 0.1]$ and $p = [0.4, 0.44]$, $N=40$. Where $n = [10.1, 30.6]$ indicates that the sample must be in values between 10 and 31 university students.

In correspondence with the previous formula, a random sample of 30 university medical students of the Autonomous Regional University of the Andes, in the Republic of Ecuador, was selected. 18 of them are female and 12 are males. All with the third year completed and approved. [27], [28]

2.2 Classical methods and techniques used

During the investigative process, classical methods of scientific research were used, such as synthetic analytical and inductive-deductive. Which were used for the work with the different bibliographic sources.

Among the empirical ones, the student survey was used, which was the main technique for collecting information. While measurement was also used to attribute value to each of the terms of the Neutrosophic linguistic scale applied in scientific research.

Also, classical statistical methods, such as descriptive statistics, were used within this frequency distribution analysis. In addition, the Pearson correlation test was employed to identify whether there were coincidences in the answers of the patients to the questions of the survey, the latter was carried out with the help of the statistical program SPSS in its version 20.0.

2.3 Neutrosophic method

The neutrosophic method of investigation is used to consider the contradiction and uncertainty in linguistic labels, and the use of neutrosophic statistics to handle indeterminacy in the sample.

Moment 1. Informative

The Autonomous Regional University of the Andes "UNIANDES" of the Faculty of Medical Sciences researches students' knowledge of non-communicable diseases. For this reason, you are asked to answer this survey as honestly as possible. It is anonymous, so you are guaranteed total confidentiality of the information provided. Thank you in advance for your cooperation.

Moment 2. Determination of the objective

The objective of the same is to assess the knowledge of students about chronic non-communicable diseases

Moment 3. Preparation of the questionnaire

Question 1. How do you rate your knowledge regarding the classification of non-communicable diseases?

Question 2. How do you rate your knowledge about the treatment of non-communicable diseases?

Question 3. How do you rate your knowledge about ways to prevent non-communicable diseases?

A neutrosophic Likert scale was used to determine the relevance, where the values under consideration are composed of PA (x), IA (x), NA (x), where PA (x) denotes a positive belonging, IA (x) is indeterminate, and NA(x) is negative. The patient can evaluate the belonging of his self-assessment criteria to the three sets.

This scale used single-value neutrosophic numbers (SVNS) [10]. Let X be a universe of discourse, an SVNS A over X has the following form [11], [16], [19], [24], [25].

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

Where

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

With

$$0 \leq u_a(x), r_a(x), v_a(x) \leq 3, \quad \forall x \in X$$

The interval $u_a(x), r_a(x)$ and $v_a(x)$ represents the true, undetermined, and false memberships of x in A , respectively. For convenience, an SVN number will be expressed as A , where $a, b, c \in [0,1]$, and $a+b+c \leq 3$

Linguistic term	SVN numbers
Very High (VH)	(1,0,1)
High (H)	(0.70,0.30,0.25)
Medium (M)	(0.50,0.50,0.50)
Low (L)	(0.30,0.70,0.75)
Very Low (VL)	(0,1,1)

Table 1. Linguistic terms of the scale.

Let $A = (T, I, F)$ be a single-valued neutrosophic number, a score function S related to a single-valued neutrosophic value, based on the degree of truth membership, the degree of indeterminacy membership and the degree of belonging to falsehood is defined by:

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

According to the criteria expressed by [12], [13], [14], [15], [21] that in order to obtain more reliable results, conglomerate or cluster analysis can be used, which is a multivariate technique that seeks to group elements or variables trying to achieve the maximum homogeneity in each group and the greatest difference between them, through a hierarchical structure to be able to decide which hierarchical level is the most appropriate to establish the classification.

Its execution algorithm exploits the notion of distance measurements between any two entities and based on this, the clusters are formed. The most commonly used distance formula for these values is the Euclidean one, [7], [17], [29]:

$$d(A - B) = \sqrt{\frac{1}{3} \sum_{i=1}^n [P_A(x_i) - P_B(x_i)]^2 + [I_A(x_i) - I_B(x_i)]^2 + [N_A(x_i) - N_B(x_i)]^2}$$

Based on the formulas and procedures described above, an analysis is carried out following the characteristics of classical statistics. Which is described in the next section.

3 Results

Question 1	Very High (6)	High (4)	Medium (3)	Low (2)	Very low (1)
How do you rate your knowledge regarding the classification of non-communicable diseases?	4 (13.3%)	6 (20%)	10 (33.4%)	6 (20%)	4(13.3%)

Table 2. Results of question 1 of the student survey

Table 2 refers to the results of question 1 of the survey applied to students. Whose results are displayed as follows: 4 students, for 13.3%, self-assessed their knowledge as Very High, meanwhile 6, for 20%, assigned themselves the High category. While 10, for 33.4%, indicated having a Regular category, 6 for 20% of the total number of students surveyed selected the Low option, while the rest of the members of sample 4 for 13.3%, chose the Very low category.

Question 2	Very High (6)	High (4)	Medium (3)	Low (2)	very low(1)
How do you rate your knowledge about treatments for non-communicable diseases?	3 (10%)	6(20%)	12 (40%)	6(20%)	3(10%)

Table 3. Results of question 2 of the student survey

Table 3 shows the results, where only 3 students, for 10% of the studied sample, chose Very High, while 6 students, for 20%, selected the High category. On the other hand, the linguistic term Medium was valued by 12 students for 40% of the sample. The Low was selected by 6 students for 20% and the rest of the sample, 3 for 10%, self-assessed as Very Low.

Question 3	Very High (6)	High (4)	Medium (3)	Low (2)	Very low(1)
How do you rate your knowledge about ways to prevent non-communicable diseases?	5 (16.6%)	4 (13.3%)	15 (50%)	5 (16.6%)	1(3.5%)

Table 4. Results of question 3 of the student survey

Table 4 shows the results of question 3 of the applied survey, where 5, for 16.6%, rated themselves as Very high in the investigated subject, while 4 of them, for 13.3%, rated themselves as High. While the intermediate category of the neurosophic Likert scale was the most indicated by the students as 15 for 50% self-assessed their knowledge as Medium. On the other hand, the category of Low was indicated by 5 students for 16.6% and the remaining 1 for 3.5% as Very low.

The results shown revealed that there is still a growing need to continue delving into this subject in the training stage of the medical sciences professional since they still feel that they can acquire more knowledge on this subject.

Study Validation

To deepen the validity of the results, a study of correlations was carried out, since this marks the relationships between 2 or more variables, that is, the degree of possibility that they have to coincide. Table 5 presents the correlation matrix between the variables corresponding to the content of the three questions of the survey applied to university students. Correlation coefficients have been calculated for all possible pairs of study variables.

This statistical analysis has been carried out from the Pearson Correlation, where significant results were considered in r , ($p < 0.005$). In this sense, the answers to the content of the survey questions correlate with each other. All the above makes evident the level of significance of the results obtained in this research. [18], [20]

Correlations		Classification	Treatments	Prevention
Classification	Pearson correlation	1	.945**	.919**
	Next (2-sided)	-	,000	,000
	N	30	30	30
Treatments	Pearson correlation	.945**	1	.901**
	Next (2-sided)	,000	-	,000
	N	30	30	30
Prevention	Pearson correlation	.919**	.901**	1

Correlations		Classification	Treatments	Prevention
	Next (2-sided)	,000	,000	-
	N	30	30	30
**. The correlation is significant at the 0.01 level (bilateral).				

Table 5. Results of the application of the Pearson Correlation. Source: Processing with SPSS version 20

Conclusion

The theoretical elements consulted in the present investigation allowed the creation of a theoretical base to support the results obtained, in addition to the interweaving of contents of the medical sciences with Neutrosophy.

After applying the instruments of this research, it can be stated that it is still necessary to go deeper into the knowledge of non-communicable diseases among students of medical sciences at the Autonomous Regional University of the Andes.

The application of the neutrosophic linguistic scale made it possible to give greater robustness to the results obtained since it created a range of possible answers for the university students who were part of the sample.

References

- [1] Organización Mundial de la Salud. Noticias ONU. Retos de salud urgentes para la próxima década según la OMS [Internet]. Ginebra: OMS; 2010
- [2] RS, Cooper Kennelly JK, Orduñez García P. Health in Cuba. *Int J Epidemiol*; 35(4): 817–24, 2006
- [3] MA Serra, Serra M, Viera M. Las enfermedades crónicas no transmisibles: magnitud actual y tendencias futuras. *Finlay [revista en Internet]*. 8(2), 2018
- [4] P Varona-Pérez, Bonet-Gorbea M, Chang-De la Rosa M, Suárez-Medina R. Implementation of chronic disease risk factor surveillance in 12 Cuban municipalities. *MEDICC Rev*; 16(1), 2014
- [5] JI Fernández-Montequín, Betancourt BY, Leyva-González G, Mola EL, GalánNaranjo K, Ramírez-Navas M, et al. Intraleisional administration of epidermal growth factor-based formulation (Heberprot-P) in chronic diabetic foot ulcer: treatment up to complete wound closure. *Int Wound J*;6(1):67–72. 2009
- [6] P Patel, Orduñez P, Di Pette D, Escobar MC, Hasell T, Wyss F, et al. Improved blood pressure control to reduce cardiovascular disease morbidity and mortality: The Standardized Hypertension Treatment and Prevention Project. *J Clin Hypertens (Greenwich)*;18(12):1284–94, 2016
- [7] M. Leyva & F. Smarandache. "Neutrosofía: Nuevos avances en el tratamiento de la incertidumbre". Ed. Infinite Study.187, 2018
- [8] G E, Sara; Z R Nazate Chugá; R I Tavera; M C Villareal Gel; D M Ramírez Guerra. Neutrosophic Statistical Analysis of Arthrofibrosis of the Knee Rehabilitation." *Neutrosophic Sets and Systems* 44, (1). 2021
- [9] A. Palacios, Jesús Estupiñán Ricardo, Iyo Alexis Cruz Piza, y Marcia Esther España Herrería. «Phenomenological Hermeneutical Method and Neutrosophic Cognitive Maps in the Causal Analysis of Transgressions against the Homeless». *Neutrosophic Sets and Systems* 44: 147-56. 2021
- [10] F Smarandache. Of Neutrosophic Numbers. *Critical Review*, Vol. 13, 2016, 2016. 13: p. 103.
- [11] F Smarandache. On Multi-Criteria Decision Making problem via Bipolar Single-Valued Neutrosophic Settings. *Neutrosophic Sets & Systems*, 2019. 25.
- [12] R. G. Ortega, M. Rodríguez, M. Leyva Vázquez, and J. E. Ricardo, "Pestel analysis based on neutrosophic cognitive maps and neutrosophic numbers for the sinos river basin management," *Neutrosophic Sets and Systems*, vol. 26, no. 1, pp. 16, 2019.
- [13] R. M Carballido, Paronyan, H., Matos, M. A., & Santillán Molina, A. L. Neutrosophic statistics applied to demonstrate the importance of humanistic and higher education components in students of legal careers. *Neutrosophic Sets and Systems*, 26(1), 26. 2019.
- [14] D. M. Ramírez Guerra, Y. M. Gordo Gómez, L. J. Cevallos Torres, F. G. Palacios Ortiz. Social sports Competition Scoring System Design Using Single Value Neutrosophic Environment. *International Journal of Neutrosophic Science (IJNS)*, Vol. 19, No. 01, PP. 389-402, 2022
- [15] J. Estupiñán, Diego Fernando Coka Flores, Jorge Alfredo Eras Díaz, y Karina Pérez Teruel. «An Exploration of Wisdom of Crowds using Neutrosophic Cognitive Maps». *Neutrosophic Sets and Systems* 37 (1): 2, 2020.
- [16] R. Martínez Martínez, C. D. Castañeda Guillot, & I. Pimienta Concepción. "Microbiota intestinal y diabetes". *Universidad y Sociedad*, vol. 14 no. 2, pp 158-163, 2022.
- [17] C M. Méndez Cabrita, M. G. Gordón Martínez, M. R. Dávila Castillo, & J. R. Cadena Morillo. "El derecho natural convergente y la justificación ética del derecho". *Universidad y Sociedad*, vol. 14 no. 2, pp 120-123, 2022.
- [18] L. A. Llerena Ocaña, F. A. Viscaino Naranjo, & W. V. Culque Toapanta. "Desarrollo de software con Net Core". *Universidad y Sociedad*, vol. 14 no. 2, pp 85-89, 2022.
- [19] Romero Fernández, A. J., Álvarez Gómez, G. A., & Estupiñán Ricardo, J. "La investigación científica en la educación superior como contribución al modelo educativo". *Universidad Y Sociedad*, vol. 13 no. S3, pp 408-415, 2021

- [20] Rodríguez, M. D. O., León, C. A. M., Rivera, C. D. N., Cueva, C. M. B. R., & Ricardo, C. J. E. “Herramientas y buenas prácticas de apoyo a la escritura de tesis y artículos científicos”. *Infinite Study*, 2019.
- [21] Leyva Vázquez, M. Y., Estupiñán Ricardo, J., Coles Gaglay, W. S., & Bajaña Bustamante, L. J. “Investigación científica. Pertinencia en la educación superior del siglo XXI”. *Conrado*, vol. 17 no. 82, 2021.
- [22] Ricardo, J. E. (2018). “Estrategia de Gestión en la Educación Superior; pertinencia e impacto en la interrelación de los procesos académicos, de investigación científica y de vinculación con la sociedad en el periodo enero 2016-mayo 2018 en la Facultad de Ciencias Jurídicas, Sociales y de la Educación de la Universidad Técnica de Babahoyo en Ecuador”. *Infinite Study*, 2018.
- [23] Estupiñán Ricardo, J., Leyva Vázquez, M. Y., Marcial Coello, C. R., & Figueroa Colin, S. E. “Importancia de la preparación de los académicos en la implementación de la investigación científica”. *Conrado*, vol. 17 no. 82, pp 337-343, 2021.
- [24] Ramos Sánchez, R. E., Ramos Solorzano, R. X., & Estupiñán Ricardo, J. “La transformación de los objetivos de desarrollo sostenible desde una dinámica prospectiva y operativa de la Carrera de Derecho en Uniandes en época de incertidumbre”. *Conrado*, vol. 17 no. 81, pp 153-162, 2021.
- [25] von Feigenblatt, O. F., Peña-Acuña, B., & Cardoso-Pulido, M. J. “Aprendizaje personalizado y education maker: Nuevos paradigmas didácticos y otras aproximaciones”. *Ediciones Octaedro*, 2022.
- [26] L. O. Albarracín Zambrano, D. V. Ponce Ruiz, & C. M. Marín Vilela. “La inclusión familiar de personas con discapacidad física mediante la automatización aplicada”. *Universidad y Sociedad*, vol. 14 no. S3, pp 291-308, 2022.
- [27] J. L. Maldonado Cando, B. A. Quiñonez Guerrero, J. R. Santillán Andrade & G. F. A. Acurio Hidalgo. “La corresponsabilidad económica de niñas, niños y adolescente”. *Universidad y Sociedad*, vol. 14 no. S3, pp 280-290, 2022.
- [28] J. L. Maldonado Cando, J. R. Cabrera Granda, R. V. Coppiano Ocampo & J. R. Santillán Andrade. “Agravantes genéricas en los delitos con concurso de dos personas”. *Universidad y Sociedad*, vol. 14 no. S3, pp 271-279, 2022.
- [29] G. M. Morales Torres, D. L. Lema Rodriguez, S.I. Marcillo Singaicho & M. de Mela Quintela, “Investigación de la enfermedad periodontal en adolescentes escolarizados”. *Universidad y Sociedad*, vol. 14 no. S3, pp 262-270, 2022.

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