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Ethics in Medical Research and Experimentation

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Abstract. Medical advancements have arisen as a result of technological development, scientific progress, and the numerous investigations conducted in various medical fields. It is essential to establish the relationship between ethical principles and medical research and experimentation, where the protection of the subject should take precedence in any experimental trial. Medical ethics has been a historical topic since the inception of medicine, and its principles are of immeasurable value in the development of scientific research and experimentation. The study presented here conducts an evaluation based on neutrosophic to assess the levels of ethical application in medical research and experimentation involving human subjects. The major challenges present in its components are identified, and the necessary actions for their resolution are carried out through the analysis of neutrosophic criteria and the application of the TOPSIS method and Fuzzy Cognitive Maps.

Keywords: ethics, research, experimentation, medical, protection

1. Introduction

In the field of medicine, historical contributions have been made by figures such as Hippocrates, Aristotle, Maimonides, and Percival, among others. These individuals indirectly addressed ethical issues related to medical practice in all its aspects. They did not perceive clinical practice as an isolated act devoid of human goodness. On the contrary, it was seen as a commitment and dedication to others, as affirmed by Paco Maglio [1], concerning ethics: "recognizing in others a moral agent, demanding beneficence, non-maleficence, justice, and autonomy."

Percival's most recognized work and contribution to both medicine and ethics was his book "Code of Medical Ethics," published in 1803. Leake describes it as "procedures of etiquette among professionals, which directly impact the physician-patient relationship." This became the first institutional code of medical ethics, laying the foundation for the American Medical Association, which published its own code of ethics in 1847. Furthermore, the concept of ethics ceased to be individual and became collective, governed by norms, codes, and sanctions in the morality of medical acts and their relationship with patients [2].

Scientific research constitutes a cultural process of human development based on both inquiry and argumentation, mediated by innovation and the creation of scientific knowledge [3]. Advanced scientific research is a process involving the consideration of science and research, based on the interpretation and transformation of social reality. It implies qualitative changes in researchers, particularly in society, and in progressive and cyclical social relationships [4].

Clinical research refers to the activity aimed at determining whether an intervention or product has diagnostic or therapeutic properties in humans. This practice has existed since the early days of medicine. As humanity began experimenting with products and treatments to improve human health, ethical dilemmas arose in clinical research. Ultimately, scientific research, in general, and biomedical research, in particular, aim to increase our understanding of the real world for the benefit of humanity [5]. Science and research have a dual purpose: to uncover the truth immediately and, in the long term, to serve humanity. Both aspects are essential and fundamental in scientific activity.

Regarding the ethics of scientific research, two aspects should be emphasized: the ethical framework of research and the ethics of the researcher [4]. Following the arguments presented, the goal of a biomedical study or a clinical trial is to acquire novel and applicable knowledge in a specific area, whether in diagnosis, prevention, or treatment. However, methods that go against the intrinsic dignity of a human being as an end in itself should not

be employed. Ethically acceptable applications of science are those that honor and contribute to the integral growth of the individual and their environment.

The classic experiment involving human subjects has always been characterized by three conditions: the marginalization of those affected, lack of consent, and the absence of objective criteria for risk and benefit assessment. Faced with these conditions, a new approach or attitude towards research with human subjects has been developed: the ethics of clinical research, whose basic principle is the protection of research subjects [4].

It is considered that humans have been conducting research since ancient times, initially based on subjective observations and later on objective observations. The rapid scientific development that has occurred in various fields is even more accelerated in the field of medicine, as evidenced by technological advances in increasingly specialized diagnostics, innovative treatments that extend human life, the development of biological products through cell cultures and recombinant DNA technology and genetic engineering, with various methodological designs. These include the evaluation of different epidemiological aspects of various diseases to the conduct of clinical trials to determine the effectiveness and safety of new products developed [6].

The primary goal of clinical research is to generate generalizable knowledge that serves to improve health, and well-being, and/or increase the understanding of human biology. The subjects who participate are merely a means to ensure such knowledge. Consequently, in all clinical research, there is the potential for exploitation by placing these subjects at risk of harm for the benefit of others [7]. The ethical requirements for clinical research are aimed at minimizing the possibility of exploitation to ensure that they are not only used but treated with respect while contributing to the social good [8,9,16].

Reality is quite pragmatic and not linked to any supernatural force. Medicine, like many other scientific disciplines, is based on experimentation. However, trials are complex as they involve testing on human subjects. Typically, the discovery of new drugs is carried out through a selective process. For instance, when identifying a molecule from a plant or chemical synthesis that is highly effective against a pathogenic bacterium, its potential as an antibiotic is considered. Laboratory tests are initially conducted. Subsequently, animal tests are carried out to determine its toxicity and effective dose. Once these experiments indicate that the drug is safe, trials with patients commence.

To determine the efficacy of a drug or treatment, experiments commonly known as "double-blind" trials are conducted. In these trials, two substances are used: the test drug itself and a substance presented to the patient as a drug but is not actually one. Neither the patient nor the physician knows the identity of each, to prevent subjectivity or a desire to heal from influencing the results. If a drug or treatment proves its efficacy in such trials, it is considered valid because it has experimental support. On the other hand, if it does not outperform the controls in experiments or if it shows toxicity or side effects that make it unsafe, its use is discarded. In general terms, this is the basic operation of an experiment in the field of medicine. Anything beyond these types of tests is considered a valid medical treatment and is incorporated into treatment protocols.

All of the above shows how medical research, since ancient times, has been a necessary process in the discovery and testing of different drugs, the cure of diseases, and the analysis of the behavior of these products in humans. In these processes, compliance with medical ethics and established guidelines for human research and experimentation studies is very important and must be respected and strictly followed in every medical investigation. In this regard, the aim is to evaluate the ethics of medical research and clinical trials through investigative methods.

2. Materials and methods

Definition 1: Let X be a space of points (objects) with generic elements in X denoted by x. A Single Valued Neutrosophic Set (SVNS) A in X is characterized by the truth-membership function $T_A(x)$, the indeterminacy-membership function $I_A(x)$, and the falsity-membership function $F_A(x)$. Thus, an SVNS A can be denoted as A = (x, $T_A(x)$, $I_A(x)$, $F_A(x)$, x ∈ X), where $T_A(x)$, $I_A(x)$, $F_A(x)$ ∈ [0,1] for each point x in X. Therefore, the sum of $T_A(x)$, $I_A(x)$, and $F_A(x)$ satisfies the condition $0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$. For convenience, an SVN number is denoted as A = (a, b, c), where a, b, c ∈ [0,1], and a + b + c ≤ 3.

Definition 2: Let A_1= (a_1,b_1,c_1) and A_2= (a_2,b_2,c_2) be two SVN numbers, then the sum of A_1 and A_2 is defined as follows:

$$A_1 + A_2 = (a_1 + a_2 - a_1a_2, b_1b_2, c_1c_2) \quad (1)$$

Definition 3: Let A_1= (a_1,b_1,c_1) and A_2= (a_2,b_2,c_2) be two SVN numbers, then the multiplication between A_1 and A_2 is defined as follows:

$$A_1 * A_2 = (a_1a_2, b_1 + b_2 - b_1b_2, c_1 + c_2 - c_1c_2) \quad (2)$$

Definition 4: Let A = (a, b, c) be an SVN number and an arbitrary positive real number, then: $\lambda \in \mathbb{R}$

$$\lambda A = \left(1 - (1 - a)^{\lambda}, b^{\lambda}, c^{\lambda}\right), \lambda > 0 \quad (3)$$

Definition 5: Let A={A1,A2, …, An } be a set of n SVN numbers, where Aj= (aj, bj, cj) (j= 1, 2, …, n). The single-valued neutrosophic weighted average operator on them is defined by:

$$\sum_{j=1}^{n} \lambda_j A_j = \left(1 - \prod_{j=1}^{n} (1 - a_j)^{\lambda_j}, \prod_{j=1}^{n} b_j^{\lambda_j}, \prod_{j=1}^{n} c_j^{\lambda_j} \right) \quad (4)$$

Where j is the weight of A_j (j= 1, 2, …, n), $\lambda_j \in [0,1]$ and $\sum_{j=1}^{n} \lambda_j = 1$

Definition 6: Let $A^* = \{A_1^*, A_2^*, \dots, A_n^*\}$ be a vector of n SVN numbers, such that Aj* = (a*,b*,c) (j= 1,2,…,n), and $B_i = \{B_{i1}, B_{i2}, \dots, B_{im}\}$ (i= 1,2,…,m), (j= 1,2,…, n). Then, the separation measure between Bi and A* based on the Euclidean distance is defined as follows:

Next, a scoring function to rank SVNNs is proposed:

$$s_i = \left(\frac{1}{3} \sum_{j=1}^{n} \left(|a_{ij} - a_j^*| \right)^2 + \left(|b_{ij} - b_j^*| \right)^2 + \left(|c_{ij} - c_j^*| \right)^2 \right)^{\frac{1}{2}} \quad (i = 1,2, \dots, m) \quad (5)$$

Definition 7: Let A = (a, b, c) be a single-valued neutrosophic number, a scoring function S of a single-valued neutrosophic number, based on the degree of truth membership, the degree of indeterminacy membership, and the degree Falsehood membership is defined by:

$$S(A) = \frac{1+a-2b-c}{2} \quad (6)$$

Where: $S(A) \in [-1,1]$

The scoring function S reduces to the scoring function proposed by [10] if b = 0 and a + b ≤ 1.

A linguistic variable is a variable described using words or expressions in a natural or artificial language, as opposed to numerical values. The values of this variable are represented using specific terms within a set. The concept of linguistic variables is highly useful for addressing problem-solving and decision-making involving complex aspects. For instance, one can express the performance ratings of alternatives in qualitative attributes using linguistic variables such as very important, important, medium, slightly important, very slightly important, etc. These linguistic values can be represented using single-valued neutrosophic numbers [11-15]. In the case of the research, the linguistic variables to be used are presented below:

Table 1: Neutrosophic values of linguistic terms. Adapted from: Kilic and Yalsin [1].

Linguistic term	SVNSs
Very no influential / (VNI)	(0.9;0.1;0.1)
No influential /(NI)	(0.75;0.25;0.20)
Medium influence /(MI)	(0.50;0.5;0.50)
Influential /(I)	(0.35;0.75;0.80)
Very high influential /(VHI)	(0.10;0.90;0.90)

As one of the Multiple Criteria Decision-Making (MCDM) methods that consider both the distance of each alternative from the positive ideal solution and the distance of each alternative from the negative ideal solution, meaning the best alternative should have the shortest distance from the Positive Ideal Solution (PIS) and the longest distance from the Negative Ideal Solution. In the research, it will be used to assess the level of influence that the alternatives have in the process by specialists [12]. In this study, there are 5 criteria and 13 components classified using the TOPSIS method and Fuzzy Cognitive Maps.

In the procedure, there are *k* decision-makers, *m* options, and *n* criteria. These K decision-makers, assess the importance of the m options through the n criteria and rate the performance of these criteria using linguistic statements that are converted into single-valued neutrosophic numbers [13]. In this context, decision-makers typically use a set of weights represented by W = (very important, important, medium, slightly important, and very slightly important), where the importance values are based on single-valued neutrosophic values for the linguistic terms, as detailed in Table 1. Additionally, the Fuzzy Cognitive Maps method is used to complement the TOPSIS for the weight vector. For the working procedure, please refer to [14].

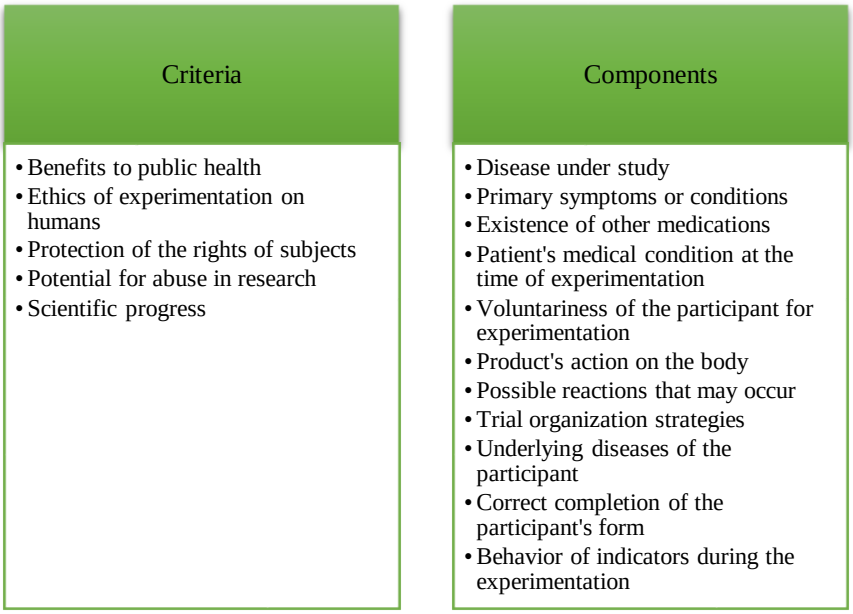
3. Results and discussion

Medical ethics is a discipline that accompanies the physician throughout his professional life. Applied medical ethics allows the analysis of ethical problems to make decisions based on personal values and the moral conscience acquired previously. Medical inquiries and studies have the responsibility to respond to their ethical value. This

research must be meticulously planned to provide useful results capable of reducing the risks involved in the investigations. The efforts made must be justified through the observation of the benefits obtained [2-17-18-19].

In any study related to the field of health, it is essential to conduct a preliminary evaluation for approval to ensure that the process adheres to established ethical principles. When embarking on research, the goal is to meet a need by seeking the truth through knowledge, but each step must be supported by an ethical framework to ensure that what is done contributes to the benefit of humans, society, and the ecological environment. To evaluate the key components in this process, 39 experts with relevant experience and specific knowledge in the field were selected. The criteria and components considered in the development of the research are shown in Figure 1.

Figure 1: Elements relevant to the investigation. Source: own elaboration.



To establish the relationship between the mentioned components and criteria, it was necessary, beforehand, to determine the weights of the components through the NCM method, as described in section 2.2, with the support of the 39 experts. Below is the adjacency matrix (see Figure 2) where the different relationships between them were determined through the values of the relationships, which correspond to the arithmetic mean, serving as the basis to calculate the values of $od(v_i)$ and $id(v_i)$ (see Table 2).

Figure 2: Adjacency matrix. Source: own elaboration.

	C1	**C2**	**C3**	**C4**	**C5**	$\sum_{i=1}^{n} c_{ij}$
C1	0	0.8	0.6	0.8	1	3.2
C2	0.8	0.7	0	0.7	1	3.2
C3	0.4	0	0.3	0.6	0.7	2.0
C4	0.2	0.8	0	0.3	0	1.3
C5	0.7	0.8	0.3	0	0.6	2.4
$\sum_{i=1}^{n} c_{ji}$	2.1	3.1	1.2	2.4	3.3	

Table 2: Determination of the values corresponding to $od(v_i)$ and $id(v_i)$. Source: own elaboration.

	C1	C2	C3	C4	C5	$\boldsymbol{od(v_i)}$
C1	0	0.421053	0.31579	0.421053	0.526316	1.68421053
C2	0.4210052632	0.368421	0	0.368421	0.526316	1.68421053
C3	0.210526316	0	0.15789	0.315789	0.368421	1.05263158

C4	0.105263158	0.421053	0	0.157895	0	0.68421053
C5	0.368421063	0.421053	0.15789	0	0.315789	1.26315789
$\boldsymbol{id(v_i)}$	1.10526316	1.63157895	0.63156895	1.26315789	1.73684211	

Once the values were determined, the centrality value $td(v_i)$ was calculated (see Table 3), which needed to be normalized for further use. The variables were classified as ordinary since $od(v_j) \neq 0$ and $id(v_j) \neq 0$. It was notably observed that the protection of the rights of the subjects is the most important element to ensure the proper development of medical research under the compliance of medical ethics principles, as it facilitates the implementation of necessary actions with the participation of individuals and the least amount of external influences on the research conducted.

Table 3: Calculation of centrality, normalization of centrality, and classification of variables. Source: own elaboration.

$\boldsymbol{td(v_i)}$	$\boldsymbol{W_{td_i}}$	Classification
2.78947368	0.2	Ordinary
2.31578947	0.18181818	Ordinary
2.68421053	0.2107438	Ordinary
2.42105263	0.19008264	Ordinary
2.52631579	0.19834711	Ordinary

In the case of determining the components most influenced by the previously mentioned criteria, the TOPSIS multicriteria method was applied. To begin with, the weight of the decision-maker groups established in Figure 1 was determined. Taking into account the relevance determined within medical ethics in research and the role played by the person guiding the activity, the top five in terms of weight were selected, and the results are shown below (Table 4):

Table 4: Determination of the weight of the main components. Source: own elaboration.

	Group 1			Group 2			Group 3			Group 4			Group 5		
	a	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**	**a**	**b**	**c**
Importance vector $\boldsymbol{\lambda_t}$	(0.10;0.90;0.90)			(0.35;0.75;0.80)			(0.35;0.75;0.80)			(0.10;0.90;0.90)			(0.35;0.75;0.80)		
Numerical importance	0.1646			0.2236			0.2236			0.1646			0.2236		

Subsequently, it was necessary to consider the input from these groups, who were asked to complete a questionnaire to evaluate components against criteria using the neutrosophic linguistic scale determined in section 2.1 (see Table 5). This led to the creation of the matrix of unique values criteria (see Table 6). The mode of the respondents' ratings is the results presented below.

Table 5: Evaluation of components according to criteria. Source: own elaboration.

	Group 1	Group 2	Group 3	Group 4	Group 5
			Benefits to public health		
P1	(0.50;0.5;0.50)	(0.50;0.5;0.50)	(0.50;0.5;0.50)	(0.50;0.5;0.50)	(0.35;0.75;0.80)
P2	(0.75;0.25;0.2)	(0.35;0.75;0.80)	(0.75;0.25;0.2)	(0.75;0.25;0.2)	(0.75;0.25;0.2)
P3	(0.50;0.5;0.50)	(0.50;0.5;0.50)	(0.10;0.90;0.90)	(0.50;0.5;0.50)	(0.50;0.5;0.50)
P4	(0.50;0.5;0.50)	(0.50;0.5;0.50)	(0.10;0.90;0.90)	(0.50;0.5;0.50)	(0.10;0.90;0.90)
P5	(0.50;0.5;0.50)	(0.50;0.5;0.50)	(0.35;0.75;0.80)	(0.50;0.5;0.50)	(0.50;0.5;0.50)
			Ethics of experimentation on humans		
P1	(0.10;0.90;0.90)	(0.10;0.90;0.90)	(0.10;0.90;0.90)	(0.10;0.90;0.90)	(0.35;0.75;0.80)

	Group 1	Group 2	Group 3	Group 4	Group 5
P2	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.35;0.75;0.80)
P3	(0.10;0.90;0.90)	(0.35;0.75;0.80)	(0.10;0.90;0.90)	(0.10;0.90;0.90)	(0.10;0.90;0.90)
P4	(0.10;0.90;0.90)	(0.10;0.90;0.90)	(0.35;0.75;0.80)	(0.10;0.90;0.90)	(0.10;0.90;0.90)
P5	(0.10;0.90;0.90)	(0.10;0.90;0.90)	(0.35;0.75;0.80)	(0.10;0.90;0.90)	(0.35;0.75;0.80)
	Protection of the rights of subjects				
P1	(0.10;0.90;0.90)	(0.10;0.90;0.90)	(0.35;0.75;0.80)	(0.10;0.90;0.90)	(0.35;0.75;0.80)
P2	(0.10;0.90;0.90)	(0.50;0.5;0.50)	(0.10;0.90;0.90)	(0.10;0.90;0.90)	(0.10;0.90;0.90)
P3	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.10;0.90;0.90)	(0.35;0.75;0.80)	(0.35;0.75;0.80)
P4	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.50;0.5;0.50)
P5	(0.35;0.75;0.80)	(0.50;0.5;0.50)	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.10;0.90;0.90)
	Potential for abuse in research				
P1	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.10;0.90;0.90)
P2	(0.10;0.90;0.90)	(0.50;0.5;0.50)	(0.10;0.90;0.90)	(0.50;0.5;0.50)	(0.10;0.90;0.90)
P3	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.50;0.5;0.50)	(0.35;0.75;0.80)	(0.35;0.75;0.80)
P4	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.10;0.90;0.90)	(0.35;0.75;0.80)	(0.50;0.5;0.50)
P5	(0.10;0.90;0.90)	(0.10;0.90;0.90)	(0.10;0.90;0.90)	(0.35;0.75;0.80)	(0.10;0.90;0.90)
	Scientific progress				
P1	(0.50;0.5;0.50)	(0.35;0.75;0.80	(0.50;0.5;0.50)	(0.50;0.5;0.50)	(0.50;0.5;0.50)
P2	(0.50;0.5;0.50)	(0.35;0.75;0.80)	(0.50;0.5;0.50)	(0.50;0.5;0.50)	(0.35;0.75;0.80)
P3	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.50;0.5;0.50)
P4	(0.35;0.75;0.80)	(0.35;0.75;0.80)	(0.50;0.5;0.50)	(0.50;0.5;0.50)	(0.35;0.75;0.80)
P5	(0.75;0.25;0.20)	(0.50;0.5;0.50)	(0.75;0.25;0.20)	(0.50;0.5;0.50)	(0.75;0.25;0.20)

Table 6: Single value criteria matrix. Source: own elaboration.

	C1	C2	C3	C4	C5
P1	(0.5061;0.5221;0.5161)	(0.5061;0.5221;0.5161)	(0.5061;0.5221;0.5161)	(0.5061;0.5221;0.5161)	(0.5061;0.5221;0.5161)
P2	(0.1632;0.864;0.8766)	(0.1632;0.864;0.8766)	(0.1632;0.864;0.8766)	(0.1632;0.864;0.8766)	(0.1632;0.864;0.8766)
P3	(0.2482;0.8137;0.8433)	(0.2482;0.8137;0.8433)	(0.2482;0.8137;0.8433)	(0.2482;0.8137;0.8433)	(0.2482;0.8137;0.8433)
P4	(0.5718;0.4282;0.4074)	(0.5718;0.4282;0.4074)	(0.5718;0.4282;0.4074)	(0.5718;0.4282;0.4074)	(0.5718;0.4282;0.4074)
P5	(0.2625;0.805;0.8374)	(0.2625;0.805;0.8374)	(0.2625;0.805;0.8374)	(0.2625;0.805;0.8374)	(0.2625;0.805;0.8374)

Next, the weights of the problems defined by the group of experts were determined (see Table 7). In addition, the aggregate weighted decision matrix was calculated (see Table 8).

Table 7: Vector of weights of the criteria. Source: own elaboration.

	Criterion weight
C1	(0.6431;0.36581;0.3699)
C2	(0.56289;0.45317;0.44142)
C3	(0.68262;0.31738;0.30487)
C4	(0.55363;0.45751;0.46262)
C5	(0.38126;0.65378;0.67023)

Table 8: SVNS aggregate decision weighted matrix. Source: own elaboration.

	Criterion 1	Criterion 2	Criterion 3	Criterion 4	Criterion 5
P1	(0.28017;0.74074;0.73996)	(0.34547;0.67378;0.66363)	(0.28488;0.73867;0.7297)	(0.19296;0.83454;0.84042)	(0.32547;0.69692;0.69509)
P2	(0.13741;0.89893;0.911579)	(0.16943;0.87283;0.89107)	(0.13971;0.89813;0.91247)	(0.09463;0.9355;0.94833)	(0.15962;0.88185;0.90126)
P3	(0.09035;0.92622;0.93369)	(0.1114;0.90716;0.91422)	(0.09186;0.92563;0.93107)	(0.06222;0.95291;0.95931)	(0.10495;0.91375;0.92225)
P4	(0.31657;0.6898;0.68155)	(0.39032;0.60968;0.58807)	(0.32186;0.68732;0.66899)	(0.218;0.80203;0.80458)	(0.36772;0.63767;0.6266)
P5	(0.14533;0.89421;0.91262)	(0.17919;0.86689;0.88697)	(0.14776;0.89337;0.90917)	(0.10008;0.93249;0.94638)	(0.16881;0.87633;0.89755)

Table 9 shows the results corresponding to the proximity coefficient values, which served as the basis for determining the ranking of the effects regarding the difficulties in the development of medical ethics in the research under study (see Table 10).

Table 9: Positive and negative ideal values and distances. Source: own elaboration.

	Ideal + value	Ideal - value
P1	(0.10495;0.91375;0.92225)	(0.10495;0.6374;0.6678)
P2	(0.09186;0.92563;0.93107)	(0.0918;0.6873;0.669)
P3	(0.1114;0.90716;0.91422)	(0.1114;0.6097;0.5881)
P4	(0.09035;0.92622;0.93369)	(0.31657;0.6898;0.6816)
P5	(0.06222;0.95291;0.95931)	(0.06222;0.802;0.8046)

Table 10: Ranking of components according to Proximity Coefficient (CP). Source: own elaboration.

Alternatives	d+	d-	CP	Order
C1	0.35506471	0.381339	0.51784	4
C2	0.15049808	0.565311	0.78975	2
C3	0.15460157	0.602875	0.7959	1
C4	0.45245592	0.367267	0.44804	5
C5	0.15340259	0.559522	0.78483	3

Based on the analysis of the results, it can be determined that the behavior of indicators during experimentation is the main issue within medical research. In this regard, the action of the product and the main symptoms or conditions that may appear or be eradicated constitute the class in research to determine the positive or negative action of a product. Throughout the entire process, medical ethics in research is a fundamental element in working with the participants, ensuring that organizational strategies prioritize the well-being of the individuals involved in the trial and minimize any other potential side effects resulting from the product's action. Ethics in medical research and experimentation should be paramount at all stages involving different individuals participating in ongoing research.

Conclusion

Ethical issues related to scientific research have a long history throughout human civilization. Current debates about the social role of science, its ethical dimension, and the moral responsibility of scientists extend beyond

specific fields of science. It is of great importance to promote ethics as a key element in clinical care, health research, and ethical guidance in biomedical research involving human subjects. Significant advancements in Neutrosophic Science have allowed for the evaluation and understanding of the current situation regarding each essential component and the challenges faced in this area. These aspects were assessed through the NCM technique due to the presence of indeterminacies in some cases when comparing them.

Neutrosophic has provided a more precise insight into the fact that, despite numerous research efforts and ongoing discussions on the topic in recent years, there are still challenges in the correct implementation of its fundamental principles and elements in the context of medical ethics in research. It is essential to take actions aimed at addressing and dealing with this issue, particularly focusing on the current era of scientific advancement and the emergence of diseases impacting the population.

The analysis of the results obtained through the application of Neutrosophic Science revealed that in the context of ethics in medical research and experimentation, the most impacted aspect is behavior during clinical trials. This implies the need for establishing proper priorities and adopting strategies to control the emotions of participants and understand events related to the action of the product in the testing phase. These measures aim to explore new ways to address the disease under study and contribute to human well-being.

References

[1] Maglio P., La dignidad del otro. Buenos Aires: Libros del zorzal; 2011.

[2] Cartes, V., Thomas Percival: Contribuciones, ética Médica y su legado. *Vida y Ética*, *24*(2), 2022,16-16.

[3] Dávila AV., Ética e investigación clínica. ARS MÉDICA. 2008;27(1).

[4] Riquelme Abreu I, Álvarez Guerra S, Ramos Rodríguez V, Saborido Martín L, González Hernández Z., Breves consideraciones sobre la bioética en la investigación clínica. Rev Cubana Farm. 2016

[5] Peacok Aldana, S., Cala Calviño, L., Labadié Fernández, S., & Álvarez Escalante, L., Ética en la investigación biomédica: contextualización y necesidad. *Medisan*, *23*(5), 2019, 921-941.

[6] Ontano, M., Mejía-Velastegui, A. I., & Avilés-Arroyo, M. E., Principios bioéticos y su aplicación en las investigaciones médico-científicas: Artículo de revisión. *Ciencia Ecuador*, *3*(3), 2021, 9-16.

[7] Begoña AM., Investigación social cualitativa y dilemas éticos: de la ética vacía a la ética situada. EMPIRIA. Revista de Metodología de las Ciencias Sociales. [citado 22/09/2018]; 34, 2016, 101-19.

[8] Irigoyen Coria A, Morales López H., Aspectos conceptuales de la ética de la investigación en medicina. Arch Med Fam.,15(2), 2013, 31-5.

[9] Ávila Morales JC, Robayo Téllez AV., La bioética y su inseparable relación con la investigación. REDIIS. Revista de Investigación e Innovación en Salud. 2017;1.

[10] Salgado, MS, Torres, YV y Remache, JB. Factores limitantes de circunstancias atenuantes mediante el uso de 2-tupla neutrosófica. Revista Internacional de Ciencias Neutrosóficas (IJNS), 18 (4), 2022, pp. 135-142.

[11] H. S. Kilic and A. S. Yalcin, "Comparison of municipalities considering environmental sustainability via neutrosophic DEMATEL based TOPSIS," Socio-Economic Planning Sciences, 75(1), 2021. p. 100827.

[12] Polgar, S., & Thomas, S. A., *Introducción a la investigación en ciencias de la salud*. Elsevier Health Sciences. 2021, p. 224

[13] P. Gulum, E. Ayyildiz, and A. T. Gumus, "A two level interval valued neutrosophic AHP integrated TOPSIS methodology for post-earthquake fire risk assessment: An application for Istanbul," International Journal of Disaster Risk Reduction, 61(1), 2021, p. 102330.

[14] O. E. Ochoa Escobar, S. F. Fiallos Bonilla, and R. C. Jiménez Martínez, "Analysis of the violation of the right to work in the lgtbiq+ community in Ecuador through neutrosophic cognitive maps and topsis. ," *Revista Universidad y Sociedad*, vol. 14, pp. 447-458, 2022.

[15] Álvarez Gómez, G. A., Viteri Moya, J. R., Viteri Intriago, D. A., & Estupiñán Ricardo, J. ¨Integración de los procesos sustantivos para la mejora de la calidad del aprendizaje¨. Conrado, vol 17 núm 80, pp 21-27, 2021

[16] Ricardo, J. E., & Vázquez, I. R. S.¨La educación sexual para padres de niños con retraso mental, una vía para su consolidación¨. Magazine de las Ciencias: Revista de Investigación e Innovación, vol 4 núm 3, pp 137-144, 2019

[17] Florentin Smarandache. ¨New Types of Soft Sets" HyperSoft Set, IndetermSoft Set, IndetermHyperSoft Set, and TreeSoft Set": An Improved Version¨. Neutrosophic Systems With Applications, vol 8, pp 35–41, 2023. https://doi.org/10.61356/j.nswa.2023.41

[18] R.Janani, & A.Francina Shalini. ¨An Introduction to Bipolar Pythagorean Refined Sets¨. Neutrosophic Systems With Applications, vol 8, pp 13–25, 2023. https://doi.org/10.61356/j.nswa.2023.16

[19] Afzal, U., & Aslam, M. ¨New Statistical Methodology for Capacitor Data Analysis via LCR Meter¨. Neutrosophic Systems With Applications, 8, 26–34, 2023. https://doi.org/10.61356/j.nswa.2023.19

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