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Abstract. Currently, humanity has made significant progress in the development of telecommunications and the economic, social, and health sectors; probably, in the same way, a series of pathogenic organisms have evolved considerably, causing harm to humanity. That is why Health Sciences has resorted to the technological advances offered by the industrial and telecommunications era. Among the tools of great help to combat infectious agents are statistical tools, which contribute a decisive step in advancing scientific studies aimed at communities and society. The application of Statistics in Health Sciences is essential to apply its knowledge in preventive activities, health promotion, and clinical studies. This knowledge allows students to face more complex courses and content and formulate better scientific criteria for analyzing and developing healthcare and research activities. Although a level of evidence has been achieved in the recommendations for tracking the health problems faced by the communities and the possible treatments to be applied in patients, there are still certain levels of indeterminacy in the analyzed data that generate arbitrary or discretionary opinions outside the scope of the classical statistics which can be better covered if processed by neutrosophic statistics.

Keywords: community medicine, neutrosophic statistics

1 Introduction

The great social changes of the last decades have allowed significant achievements in technological development, research, and the availability of information. The increasing volume and accelerated appearance of data have led to a decrease in their timing and validity and complicate the need for health professionals to be responsibly updated [1]. The doctor needs to have and adopt tools such as bibliographic search techniques and formal rules to evaluate the literature, which allows the selection and prioritization of the generous information that circulates and which helps to face the challenge of professional updating [2, 3].

The need for a statistical approach is now well recognized in research and practice in the disciplines that constitute health [4], subdivided into communities or populations in which the laws of large numbers and random fluctuations apply [5].

The analysis of the health situation is based on an exhaustive review of statistical data with a clinical-epidemiological and social approach to identify the problems of the individual, families, and the community [6], as well as its possible solutions [7] when developing the work of the health team [8]. As a teaching instrument, it is considered that the objective is for the student to get ahold of the procedure, actively, independently, consciously, and creatively, using the clinical-epidemiological and statistic method [9], and the planning of strategies with a cultural-historical and integral approach [10].

Statistical information makes use of personal and family medical records, vaccination cards, and the insertion of data of interest in clinical forms [11-14]. Subsequently, an integral analysis is made; the problems and their origin are identified; priorities and solutions are established to reduce risk and promote a healthy life; and finally, an action plan is drawn up with tasks and different activities that must solve the identified problems [15]. Each activity must have its completion date and the person responsible identified; the activities or tasks will be monitored and evaluated in a participatory way [16] so that responsibility is maintained while comparing the modifications with those of the analysis of the health situation that has preceded it [17]. All of the above must be reflected in a document and presented to the population so that the patient contributes with ideas and solutions to the identified problems [18].

The extent of statistical knowledge and skills that public health professionals need to acquire [17] area very important, because knowledge of statistical principles and methods and competence in their application is needed for the effective exercise of health in the community and society [19] [20], and additionally for the understanding and interpretation of the data [21]. This study is focused on analyzing one of the many variables that interact in the health field to achieve consensus between arbitrary or discretionary opinions, as indeterminate elements regarding the criteria evaluated in a scientific context [22], with the use of neutrosophic statistics [23] [24].

Based on the analysis referred to in the study and the level of indeterminacy in the neutrosophic statistical data, this study focuses on:

- Problem situation: differences in criteria when making a clinical decision in tracking the health problems faced by communities
- Main objective: determine the levels of evidence in the recommendations for tracking health problems in community medicine
- Specific objectives:
    - Determine the factors and degrees of recommendations for preventive practices by specialists in the clinical pictures presented.
    - Carry out the measurement and modeling of the neutrosophic variable
    - Present potential alternatives when evaluating the existing indeterminacies of the analyzed variable

Regarding the structuring of the study, the following is exposed:

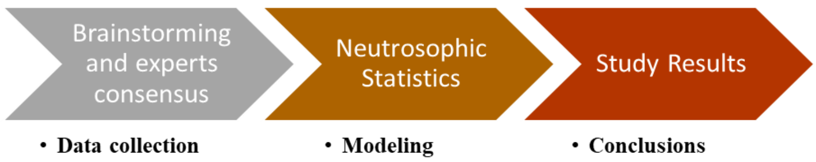

Figure 1: Structure of the study.

2 Materials and methods

<u>Neutrosophic statistics</u>

[25-46] Neutrosophic probabilities and statistics are a generalization of classical and imprecise probabilities and statistics. The Neutrosophic Probability of an event E is the probability that event E will occur [47], the probability that event E does not occur, and the probability of indeterminacy (not knowing whether event E occurs or not). In classical probability nsup≤1, while in neutrosophic probability nsup≤3 +. The function that models the neutrosophic probability of a random variable x is called the neutrosophic distribution:

$NP(x) = (T(x), I(x), F(x)),$

Where T(x) represents the probability that the value x occurs, F(x) represents the probability that the value x does not occur, and I(x) represents the indeterminate or unknown probability of the value x.

Neutrosophic Statistics is the analysis of neutrosophic events and deals with neutrosophic numbers, the neutrosophic probability distribution [48], neutrosophic estimation, neutrosophic regression, etc. It refers to a set of data formed totally or partially by data with some degree of indeterminacy and the methods to analyze them.

Neutrosophic statistical methods allow the interpretation and organization of neutrosophic data (data that can be ambiguous, vague, imprecise, incomplete, or even unknown) to reveal the underlying patterns [49].

In short, the Neutrosophic Logic [50, 51], Neutrosophic Sets, and Neutrosophic Probabilities and Statistics have a wide application in various research fields and constitute a new reference of study in full development.

The Neutrosophic Descriptive Statistics includes all of the techniques to summarize and describe the characteristics of the neutrosophic numerical data [52].

Neutrosophic Numbers are numbers of the form $N = a + bI$ where a and b are real or complex numbers [53], while "I" is the indeterminacy part of the neutrosophic number N.

The study of neutrosophic statistics refers to a neutrosophic random variable where X_l and $X_u I_N$ represents the corresponding lower and upper level that the studied variable can reach, in an indeterminate interval $[I_l, I_u]$. Following the neutrosophic mean of the variable when formulating ($\bar{x}_N$):

$$X_N = X_l + X_u I_N;\ I_N \in [I_l, I_u] \quad (1)$$

Where, $\bar{x}_a = \frac{1}{n_N} \sum_{i=1}^{n_N} X_{il}, \bar{x}_b = \frac{1}{n_N} \sum_{i=1}^{n_N} X_{iu}, n_N \in [n_l, n_u]$ (2)

is a neutrosophic random sample. However, for the calculation of neutral frames (NNS), it can be calculated as follows.

$$\sum_{i=1}^{n_N}(X_i-\bar{X}_{iN})^2=\sum_{i=1}^{n_N}\begin{bmatrix}\min\begin{pmatrix}(a_i+b_iI_L)(\bar{a}+\bar{b}I_L),(a_i+b_iI_L)(\bar{a}+\bar{b}I_U)\\(a_i+b_iI_U)(\bar{a}+\bar{b}I_L),(a_i+b_iI_U)(\bar{a}+\bar{b}I_U)\end{pmatrix}\\\max\begin{pmatrix}(a_i+b_iI_L)(\bar{a}+\bar{b}I_L),(a_i+b_iI_L)(\bar{a}+\bar{b}I_U)\\(a_i+b_iI_U)(\bar{a}+\bar{b}I_L),(a_i+b_iI_U)(\bar{a}+\bar{b}I_U)\end{pmatrix}\end{bmatrix},I\epsilon[I_L,I_U] \quad (3)$$

Where $a_i = X_l b_i = X_u$. The variance of the neutrosophic sample can be calculated by

$$S_N^2=\frac{\sum_{i=1}^{n_N}(X_i-\bar{X}_{iN})^2}{n_N};\ S_N^2\epsilon[S_L^2,S_U^2] \quad (4)$$

The neutrosophic coefficient (NCV) measures the consistency of the variable. The lower the NCV value, the more consistent the factor's performance is than the other factors. For example, NCV can be calculated as follows[54].

$$CV_N=\frac{\sqrt{S_N^2}}{\bar{X}_N}\times 100;\ CV_N\epsilon[CV_L,CV_U] \quad (5)$$

3 Results

Data collection

Statistics make it possible to analyze situations in which the sample includes random components that contribute significantly to the variability of the data obtained. In community health, the random components are due, among other aspects, to the knowledge or the impossibility of measuring some determinants of the health and disease statuses and the variability in the responses given by the patients who are subjected to the same treatment.

For the development of the neutrosophic statistical study, it is recommended by the experts to analyze the levels of evidence in the recommendations for tracking health problems from the statistical study bases in community medicine (Table 1).

Development of the method

For the neutrosophic statistical modeling of the clinical decision of the health specialist, five factors are selected equivalent to five clinical decisions that exist in the health field, based on typical conditions in the community and society (Table 2).

Variable	Coding	Sample by factor	Scale
Levels of evidence in the recommendations for tracking health problems in community medicine	ERPS	100	$[0;\ 1], \forall\ F_n$ ERPS = 0 (false) ERPS = 1 (True) $ERPS\ \neq 0.5$ (Existing indeterminacy in ERPS)

Table 1. Characteristics of the variable. Own elaboration

It should be taken into account that the recommendations are subject to constant updates motivated by advances in clinical research and the contributions of statistical information at the international level.

Factor	**Clinical diagnosis of the patient**	**Grade**	**Recommendations of preventive practices by specialists**	**Scale**	**Range of acceptance of the clinical decision regarding treatment**
F1	Hypertension screening in people over 18 years of age.	A	Intervention is recommended. Good evidence was found that the measure	[0; 1]	$[0;\ 1], \forall\ F_1$ ERPS = 0 (false) $0 \leq ERPS \geq 1$;
F2	Breast cancer screening with mammography every	B	Intervention is recommended. Moderate evidence was found that the measure improves	[0; 1]	

	1-2 years in women aged 40 and over.		health outcomes. The benefits outweigh the risks		ERPS = 1 (True)
F3	Routine screening for osteoporosis in postmenopausal women under 60 years of age.	C	There is no recommendation for or against the intervention. At least moderate evidence was found that the measure improves health outcomes. The benefits are very similar to the risks.	[0; 1]	$ERPS \neq 0.5$ (Level of acceptance of the recommendation among specialists)
F4	Screening for pancreatic cancer in asymptomatic adults using abdominal palpation, ultrasound, or serological markers.	D	It is recommended against performing the intervention. We found moderate evidence that the measure is ineffective. The risks outweigh the benefits.	[0; 1]	ERPS = 0.5 (Indeterminacy of ERPS level, other clinical studies are required to make a consensual and accepted decision)
F5	Routine screening for dementia in the elderly	I	The evidence is insufficient to recommend for or against the intervention.	[0; 1]	

Table 2. Process of basing clinical decisions based on the definitive diagnosis of the patient. Own elaboration

For the development of the statistical study, the neutrosophic frequencies of the factors are analyzed to relate the consensus of clinical decisions based on the definitive diagnosis of the patient. For each factor, a clinical decision agreed by health specialists is analyzed before a definitive diagnosis of the patient in days that make up the set of clinical decisions regarding treatment in a group of patients (Table 3).

Days	**Neutrosophic frequencies**				
	A	**B**	**C**	**D**	**I**
1	[0.3; 1]	[0.2; 1]	[0.2; 1]	[0.3; 1]	[0.4; 1]
2	[1 ; 1]	[0.2; 1]	[0.2; 1]	[0.1; 1]	[0.9; 1]
3	[0.5; 1]	[0.9; 1]	[0.3; 1]	[0.7; 1]	[0.5; 1]
4	[0.8; 1]	[0; 1]	[0.5; 1]	[0.5; 1]	[1 ; 1]
5	[1 ; 1]	[0.1; 1]	[0.7; 1]	[0.8; 1]	[0; 1]
6	[0.6; 1]	[0; 1]	[0.4; 1]	[0.1; 1]	[0.8; 1]
7	[1 ; 1]	[0; 1]	[0.1; 1]	[0.2; 1]	[0.9; 1]
8	[0.8; 1]	[0.7; 1]	[0.3; 1]	[1 ; 1]	[0.6; 1]
9	[0.6; 1]	[1 ; 1]	[0.8; 1]	[0.1; 1]	[0.9; 1]
10	[0; 1]	[0.6; 1]	[0.5; 1]	[0; 1]	[0.5; 1]
11	[0.3; 1]	[0.8; 1]	[0.3; 1]	[0.4; 1]	[0.3; 1]
12	[0.1; 1]	[0.4; 1]	[0.8; 1]	[0.2; 1]	[0.5; 1]
13	[0.5; 1]	[0.8; 1]	[0.8; 1]	[0.5; 1]	[1 ; 1]
14	[0.1; 1]	[0.9; 1]	[0.4; 1]	[0.5; 1]	[0.2; 1]
15	[0.9; 1]	[0.9; 1]	[0; 1]	[0.9; 1]	[0.3; 1]
16	[0.5; 1]	[1 ; 1]	[0.8; 1]	[0.2; 1]	[0.5; 1]
17	[0.7; 1]	[0.3; 1]	[0.9; 1]	[0.6; 1]	[0.6; 1]
18	[1 ; 1]	[0.6; 1]	[0.1; 1]	[0.2; 1]	[0.1; 1]
19	[0; 1]	[1 ; 1]	[0.5; 1]	[0.4; 1]	[0.3; 1]
20	[0.4; 1]	[0.2; 1]	[0.5; 1]	[0.4; 1]	[0; 1]
0-100	[51.1; 100]	[49.9; 100]	[48.9; 100]	[50.4; 100]	[53.9; 100]

Table 3. Relative neutrosophic frequency of the ERPS level. Own elaboration

Table 3 analyzes the level of ERPS for a sample of 100 patients from the community for each factor, of which the level of acceptance of health specialists about the clinical decision regarding treatment is measured. From the neutrosophic frequencies, it can be observed with a level of acceptance of the clinical decision regarding the treatment of $[0;\ 1]$ for each clinical picture reviewed with a level of total indeterminacy of $A = 48.9, B = 50.1, C = 51.1, D = 49.6, I = 46.1$, with a level of representativeness of $[46.1\%;\ 51{,}1\%]$, on the days that complex clinical pictures are evaluated. of patients, where the preliminary screening results have a level of contradiction or indeterminacy close to 0.5 per factor analyzed, with a higher incidence of factors *screening for breast cancer with mammography every 1-2 years in women over 40 years of age and screening for pancreatic cancer in asymptomatic adults using abdominal palpation, ultrasound or serological markers.* Given the existing levels of indeterminacy, the use of classical statistics is not appropriate, so it is necessary to use neutrosophic statistics for a better understanding.

Neutrosophic statistical analysis

While modeling the data on the level of acceptance of the clinical decision regarding the treatment of affectations of the evaluated patients, it can be observed that factors 2 and 4 require studies with a level of depth to determine an accurate prognosis (Table 4). To understand which factor implies a representative mean, $\bar{x} = \in [\bar{x}_L; \bar{x}_U]$, the values of the neutrosophic means are calculated, and for the study of the variations of the affectations, the values of the neutrosophic standard deviation $S_N \in [S_L; S_U]$. To determine which factor requires a level of evidence in the recommendations for tracking health problems in community medicine, the values $CV_N \in [CV_L ; CV_U]$ are calculated.

Factors	$\bar{x}_N$	YN	CVN
Hypertension screening in people over 18 years of age.	0.852 + 1.667 I	0.157 + 0.808 I	0.184 + 0.485 I
Breast cancer screening with mammography every 1-2 years in women aged 40 and over.	0.832 + 1.667 I	0.16 + 0.811 I	0.192 + 0.487 I
Routine screening for osteoporosis in postmenopausal women under 60 years of age.	0.815 + 1.667 I	0.129 + 0.728 I	0.158 + 0.437 I
Screening for pancreatic cancer in asymptomatic adults using abdominal palpation, ultrasound, or serological markers.	0.84 + 1.667 I	0.107 + 0.704 I	0.127 + 0.422 I
Routine screening for dementia in the elderly	0.898 + 1.667 I	0.125 + 0.721 I	0.139 + 0.433 I

Table 4. Neutrosophic statistical analysis of the level of ERPS. Own elaboration

Table 4 shows that for the routine screening of dementia in the elderly, health specialists needed a level of clinical studies to achieve consensus in the clinical decision lower than the other factors analyzed. This means that the I degree recommendation for the corresponding type of clinical picture is, on average, the one that most influences when it comes to obtaining the consensus of the specialists without having to resort to the results of studies of great clinical complexity. On the other hand, the CV_{ND} analysis for this factor is lower compared to the rest. This represents that for the screening of pancreatic cancer in asymptomatic adults using abdominal palpation, ultrasound, or serological markers there is a level of contradiction and uncertainty when deciding a treatment if there are no weight elements to apply D degree recommendation with the necessary clinical tests (Figure 2)

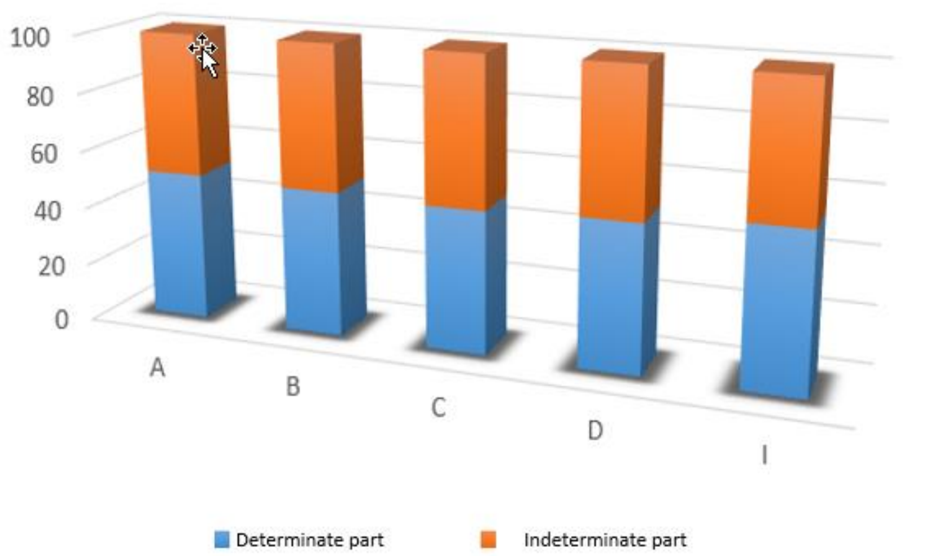

Figure 2. Neutrosophic bar graph of ERPS incidents from clinical specialists. Own elaboration

Comparative analysis

To determine the associated indeterminacy measure $\bar{x} = \in [\bar{x}_L; \bar{x}_U]$, $S_N \in [S_L; S_U]$ and $CV_N \in [CV_L ; CV_U]$ for the form of neutrosophic numbers (Table 5). In the results obtained, it is observed that the values go from 0.127 to 0.192 with the measure of indeterminacy of 69.9 generated by *screening for pancreatic cancer in asymptomatic adults using abdominal palpation, ultrasound, or serological markers*. It is required for these clinical pictures that more in-depth studies be directed for screening tracking of health problems in community medicine and the search for statistical studies on the subject where contradictions and indeterminacies are diversified in various degrees of recommendation to obtain a level of consensus of specialists within the analyzed element of the neutrosophic set of the community.

Factors	$\bar{x}_N$	***YN***	***CVN***
F1	0.852 + 1.667 I; I $\in [0; 0.48]$	0.157 + 0.808; I $\in [0; 0.80]$	0.184 + 0.485 I; I $\in [0; 0.62]$
F2	0.832 + 1.667 I; I $\in [0; 0.50]$	0.16 + 0.811 I; I $\in [0; 0.80]$	0.192 + 0.487 I; I $\in [0; 0.60]$
F3	0.815 + 1.667 I; I $\in [0; 0.51]$	0.129 + 0.728 I; I $\in [0; 0.82]$	0.158 + 0.437 I; I $\in [0; 0.63]$
F4	0.84 + 1.667 I; I $\in [0; 0.49]$	0.107 + 0.704 I; I $\in [0; 0.84]$	0.127 + 0.422 I; I $\in [0; 0.69]$
F5	0.898 + 1.667 I; I $\in [0; 0.46]$	0.125 + 0.721I; I $\in [0; 0.82]$	0.139 + 0.433 I; I $\in [0; 0.67]$

Table 5. Neutrosophic forms with a measure of indeterminacy

The results obtained in the study propose promoting alternatives based on the results of preliminary clinical studies in patients with presented clinical pictures. The variants presented allow actions to be taken based on the level of indeterminacy and acceptance of the levels of evidence in the recommendations for tracking health problems in community medicine (Figure 3).

Partial solutions

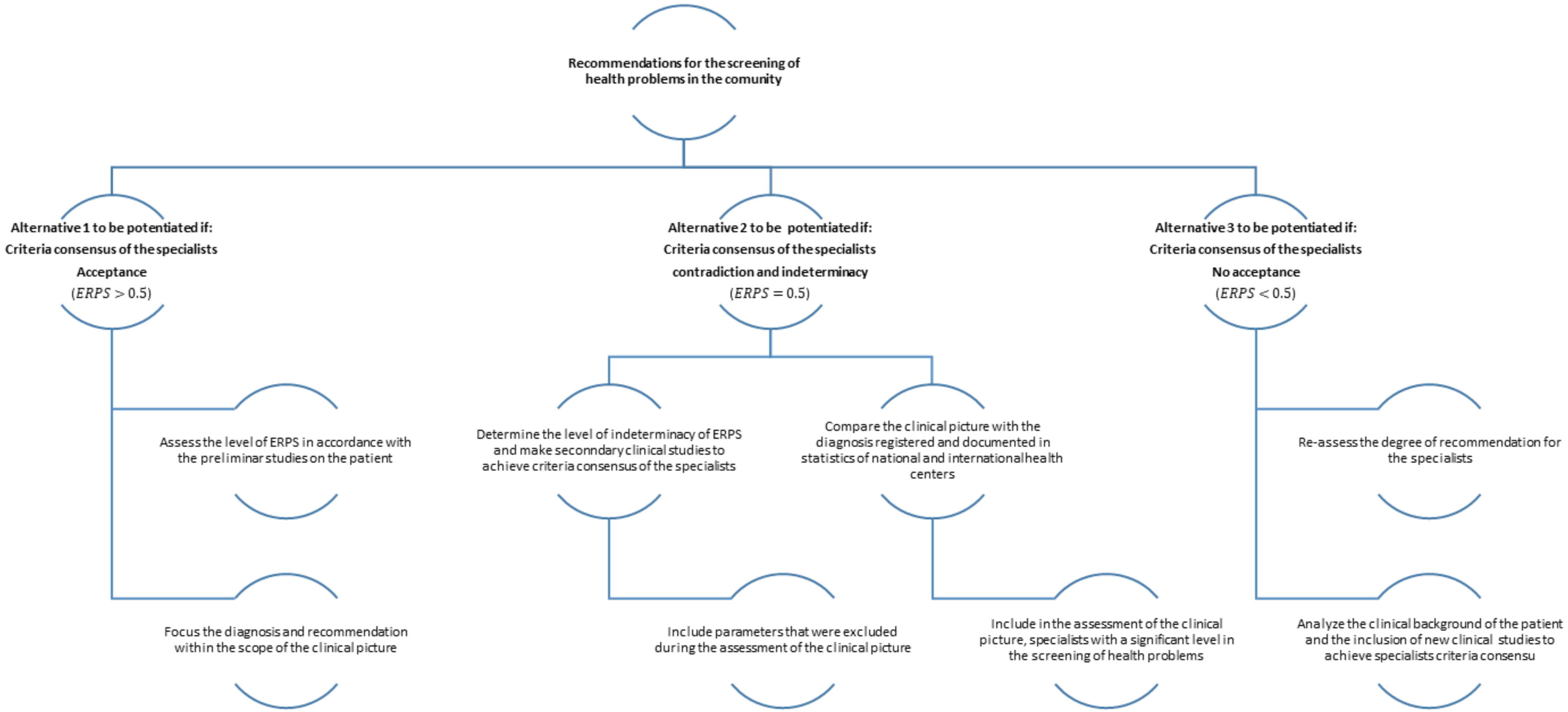

Figure 3. Alternatives based on the neutrosophic states of the ERPS variable [0; 1]. Own elaboration

Conclusions

- Statistical analysis in medicine provides knowledge of the population's health status by considering the different indicators for the population, scientific contributions, and statistical studies of diagnoses of clinical pictures. Although, the scenario measures deviations from the health status and not the health itself, it must be taken into account that the community health situation may vary greatly in short periods and the learning of the elaboration of the analysis of the health situation has a formative character for the learners.
- Neutrosophic statistics reveal a more direct approach in community health, considering among the investigations the indeterminacies of the variables that influence the health field. This study made it possible to evaluate the levels of evidence in the recommendations for the screening of health problems in community medicine, among which the screening factor for *pancreatic cancer in asymptomatic adults using abdominal palpation, ultrasound, or serological markers* as an element with a CV of 69.9% of indeterminacy for the analyzed sample so that it affects the moment of giving a diagnosis and a correct grade of recommendation.
- Neutrosophic statistics are present in each health field dimension, subdivided into neutrosophic components of the analyzed variable. Each alternative responds to each neutrosophic state of the variable in the neutrosophic set. Statistical studies and research are required to determine variables with a level of indeterminacy in the field of study.

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