# Assessment of the Relevance of a Breast Cancer Rehabilitation Program based on a Neutrosophic Linguistic Scale

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**Abstract.** This investigation aims to assess the degree of efficacy of a breast cancer rehabilitation program in Ecuador. To this purpose, a group of experts evaluated the efficacy of the program using the Delphi method. Once experts were rigorously selected, they used a linguistic scale for assessing the program in different aspects. Every element of the linguistic scale was associated with a neutrosophic number, and finally statistically processed. The advantage to use neutrosophy is the possibility to deal with the imprecision in the assessment and to count on a linguistic scale, which undoubtedly usually is more appropriate to express opinions than a numerical one.

**Keywords:** rehabilitation, breast cancer, neutrosophic linguistic scale.

## 1 Introduction

Cancer is a group of diseases defined by the existence of an exaggerated multiplication of malignant cells that can invade tissues, organs and spread at a distance, [1]. That is why there have been several authors who have systematized and defined this disease as a "process of uncontrolled growth and dissemination of cells that can appear practically anywhere in the body." [2,3]. It is also considered to be formed from cells in the breast that have grown abnormally and multiplied to form a lump or tumor.

In various studies by international organizations, they state that since the 18th century, that has been one of the main causes of death in the world, representing the second cause of death in most developed countries and some developing countries, [4].

The World Health Organization (WHO) considers that breast cancer is a major problem in developed countries and increasingly in developing countries, as this disease represents the leading cause of cancer death in the world. It is estimated that 1out of 9 to 12 women with risk factors will develop the disease in her lifetime, [5].

While on the other hand, the Pan American Health Organization (PAHO) states that in the American continent and the Caribbean the trend is similar. Thus, breast cancer represents 29% of all cancer cases and is the second cause of death from malignant tumors, where lung cancer is the first one; but for the year 2030, PAHO estimates more than 596,000 new cases and more than 142,100 deaths in the region, [6,7]. This is a matter that makes this issue a serious health problem both for this area and for the world.

Metastatic breast cancer is considered to present a picture of disease evolution in stages I, II, III, which develops metastasis of cancer in sites and/or organs considered outside the limits of the mammary area. That is one of the reasons this disease is considered dangerous, so it is better to carry out preventive actions when the patient is in the so-called stage 0.

Based on these arguments, Piñeros ([8]) asserts that breast cancer is one of the most important and vulnerable. Because the breast has a sexual meaning, motherhood, beauty, and femininity, the experience of removal or loss of one or both breasts, brings with it an impoverishment of the body image with the perception of feeling mutilated.

There is a variable age for the diagnosis of this disease, but it is without any doubt 50 years old women where there is a greater number of cases, since it reaches levels up to 75% of breast cancers after menopause, [6]. This question makes this population group at risk, so they should systematically practice palpation, self-examination

and then continue with others that are carried out in different health institutions.

Malignant disease of the breast begins as a simple, painless nodule of variable size, more frequently in the superior-external quadrant of the breast, which may or may not show signs of superficial fixation or muscle planes, and is accompanied by axillary lymphadenopathy, [1].

It is, therefore, necessary to carry out a systematic self-examination and before the presence of the symptoms that are reflected below, the patient should see a doctor as soon as possible:

- Shooting pain in some part of the breast that persists after menstruation,
- Changes in the color or appearance of the skin of the breast,
- Dimples or sagging of the skin or palpation of lumps that were not previously palpable,
- Fluid discharge from the nipple, noting the appearance (clear, milky, or bloody), [7].

The surgical technique for the treatment of breast cancer varies depending on the type of lesion and its extension. The choice of this will be determined by a previous procedure, called *sentinel lymph node biopsy* (SLNB), in which the sentinel lymph node is identified and made the decision whether to remove and examine it, that is, that lymph node at cancer cells are likely to spread. In this way, unnecessary dissection of unaffected lymph nodes is avoided, thus reducing the risk of lymphedema from 20% to 3.5-11%, [9-12].

The disease can develop due to genetic and hormonal factors (not modifiable) and lifestyle (modifiable), but among those with a greater contributory burden are hormonal and genetic factors, [6]. That is why post-operative rehabilitation is a viable alternative and that in most cases it manages to improve the quality of health of these patients.

That is why physical exercise and massage programs can prevent the presence of lymphedema. Aspects that have been systematized by various authors and have already been approved by the oncological college of several countries as part of the ongoing care of patients operated on for this pathology, [13-15].

Another rehabilitation alternative for breast cancer-operated patients is occupational therapy, [9,16]. This is aimed at enabling them to carry out activities of daily life. Therefore, it is necessary to imbricate both trends of rehabilitation in an inclusive program.

Based on the previous arguments, this research proposes an integrative rehabilitation program for breast cancer patients, which, before being applied in the different hospitals of the Republic of Ecuador, must be evaluated by a group of experts to know and improve it to obtain satisfactory results in its implementation.

Therefore, the objective of the present work is to identify the relevance of the rehabilitation program for patients operated on for breast cancer, using the criterion method of experts and with emphasis on the neutrosophic linguistic scale. Each expert was evaluated for selecting the most qualified, latter Delphi method was applied to evaluation. Delphi method consists of the independent evaluation of experts during many rounds until the final evaluation converges. For evaluation, we provided a linguistic scale associated with neutrosophic numbers. So, this combination of linguistic terms and neutrosophic numbers allows us to deal with imprecision and also with accuracy when experts asses with linguistic terms.

## 2 Materials and Methods

This section describes the main characteristics and procedures of the Delphi method and the fundamental bases that support the use of the neutrosophic linguistic scale.

### 2.1 Preliminaries in the Delphi method

Delphi method belongs to the so-called subjective forecasting methods and is based on the use of the intuitive judgment of a group of experts who issue criteria on a certain problem, [17,18]. That is why it is very effective to know the degree of relevance of some scientific projection.

This method offers multiple advantages due to its confidentiality, since it allows the freedom of opinions of the experts, encourages creativity, improves and redesigns the proposals that are subject to evaluation. Decision alternatives are offered without encouraging conflict between the experts.

An important aspect to take into account in this method is to theoretically understand who are considered experts. That is why they are considered a group of people or organizations capable of offering, with a maximum of competence, conclusive assessments on a certain problem, make real forecasts on the effect, applicability, feasibility, and relevance that the proposed solution may have in practice and provide recommendations on what to do for its improvement, [17].

This method is developed in the following stages:

1. Target identification,
2. Selection of experts,
3. Choice and application of the methodology,
4. Information processing.

The five values scale with positive Likert statements was used as an evaluative criterion.

- Very suitable (VS) five points,
- Fairly suitable (FS) four points,
- Suitable (S) three points,
- Poorly suitable (PS) two points,
- Not suitable (NS) one point.

## 2.2 Neutrosophic evaluative scale

**Definition 1**:

([19,20]) The *Neutrosophic set* N is characterized by three membership functions, which are the truth-membership function $T_A$, indeterminacy-membership function $I_A$, and falsity-membership function $F_A$, where U is the Universe of Discourse and $\forall x \in U$ , $T_A(x), I_A(x), F_A(x) \subseteq ]^-0, 1^+[$ , and $^-0 \leq \inf T_A(x) + \inf I_A(x) + \inf F_A(x) \leq \sup T_A(x) + \sup I_A(x) + \sup F_A(x) \leq 3^+$ .

See that according to Definition 1, $T_A(x), I_A(x), F_A(x)$ are real standard or non-standard subsets of $]^-0, 1^+[$ and hence, $T_A(x), I_A(x), F_A(x)$ can be subintervals of $[0, 1]$.

**Definition 2**:

([20-23]) The *Single-Valued Neutrosophic Set* (SVNS) N over U is $A = \{< x; T_A(x), I_A(x), F_A(x) > : x \in U\}$, where $T_A: U \to [0, 1], I_A: U \to [0, 1]$, and $F_A: U \to [0, 1], 0 \leq T_A(x) + I_A(x) + F_A(x) \leq 3$.

The *Single-Valued Neutrosophic number* (SVNN) is symbolized by $N = (t, i, f)$, such that $0 \leq t, i, f \leq 1$ and $0 \leq t + i + f \leq 3$.

| Linguistic term | SVN numbers |
|---|---|
| Very suitable (VS) | (1,0,0) |
| Fairly adequate (FS) | (0.70,0.25,0.30) |
| Suitable (S) | (0.50,0.50,0.50) |
| Poorly suitable (I) | (0.30,0.75,0.70) |
| Not suitable (NS) | (0,1,1) |

**Table 1:** Linguistic terms of the scale

Let A = (T, I, F) be a single-valued neutrosophic number, a *scoring function* $s: [0, 1]^3 \to [0, 1]$ related to a single-valued neutrosophic value, based on the degree of belonging to the truth, the degree of belonging to the indeterminacy, and the degree of belonging to falsehood is defined by ([24]):

$$s(A) = \frac{2 + T - F - I}{3} \qquad (1)$$

The definition of the *precision index* is given in Equation 2.

$$a(a) = T - F \qquad (2)$$

Where $a: [0, 1]^3 \to [-1, 1]$.

## 2.3 General characteristics of the rehabilitation program

Each rehabilitation session was divided into three stages, namely, initial, main and final. The first one was intended to condition the muscles and joints for subsequent activity, while the main part included the following

groups of exercises:

- Low-impact aerobic exercise,
- Muscle-strengthening exercises,
- Joint mobility exercises,
- Fine motor exercises,
- Pulley exercises.

We worked with an intensity of very light (60% of heartbeats per minute) in the first 10 weeks, to light (70% of heartbeats per minute) in the remaining 13 weeks.

The calculation of the percentage of heartbeats per minute necessary to work was carried out according to the formula: maximum $HR = (220 - age)0.6$ for 60% and maximum $HR = (220 - age)0.7$ for 70%.

## 2.4 Statistical analyzes

The statistical analyzes were performed with SPSS v. 20 (SPSS Inc, Chicago, IL, United States). The data relating to the descriptive statistics are presented through the distribution of frequencies, while Kendall's coefficient of agreement and the $\chi^2$ contrast was used to determine the existence or not of significance in the community of interests of the experts, [25].

## 3 Results

To develop this section, the stages described above for the application of this method are retaken ([17]).
1-Target identification
The objective is identified: to assess the theoretical-methodological coherence and the degree of applicability of a breast cancer rehabilitation program.

2-Selection of experts:
A survey was applied to the possible experts to measure their coefficient of competence (K), through their self-assessment. According to the categories of high (H), medium (M), and low (L), regarding the sources of argument proposed in a standard table established for this purpose and the coefficient of competition was calculated using the formula $K = (Kc + Ka)/2$.

Where,
Kc: It is the coefficient of knowledge or information that the expert has about the problem, which is calculated based on the expert's assessment on a scale from 0 to 10 and multiplied by 0.1, so that:

The value zero (0) indicates a complete ignorance of the problem being evaluated.

The value ten (10) indicates full knowledge of the aforementioned problem. Among these borderline (extreme) evaluations, there are nine (9) intermediate ones.

Ka: It is the coefficient of argumentation or justification of the criteria of the experts, determined as the sum of the points obtained from the standard table to which reference has been made.

K: is the coefficient of competence of the experts and allows them to be classified according to what is agreed in:

- $0.8 \leq K \leq 1 \Rightarrow$ high competition,
- $0.5 \leq K < 0.8 \Rightarrow$ average competition,
- $K < 0.5 \Rightarrow$ low competition.

The survey was sent to 26 possible experts, after calculating the coefficient of competence, 16 were included in the research since they were in the high and medium categories. In other words, all those with a low Ka were excluded. Table 2 shows experts' distribution:

| Academic level | N | % |
|---|---|---|
| Doctors (Ph.D) | 5 | 31.25 |
| Masters (MSc.) | 7 | 43.75 |
| Rehabilitation Specialist (RS) | 4 | 25 |

**Table2:** Expert characterization

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3-Choice and application of the methodology

For the work of the experts in the evaluation of the proposed program described in the present investigation, the Delphi methodology is used. Thus, this allows the application of consultation rounds, to identify if there is a coincidence between the experts' criteria when evaluating a set of indicators, previously established and that are listed below:

- Stages of the rehabilitation session,
- Selected exercises,
- Intensity of rehabilitation,
- Possibility of being applied in practice.

4-Information processing

After tabulating the information offered by the experts, the results are shown in Table 3:

| Indicators to be evaluated by the experts | VS | FS | S | PS | NS |
|---|---|---|---|---|---|
| Stages of the rehab session | 14 (87.5%) | 1 (6.25%) | 1 (6.25%) | | |
| Selected exercises | 15 (93.75%) | 1 (6.25%) | | | |
| Rehabilitation intensity | 14 (87.5%) | 2 (12.5%) | | | |
| Possibility of being applied in practice | 15 (93.75%) | 1 (6.25%) | | | |

**Table 3.** Results of the tabulation of the criteria offered by the experts after evaluating the rehabilitation program.

When performing a descriptive analysis of these results, the following is noticed:

Referring to the indicator "stages of the rehabilitation session", most of the experts (14 or 87.5%) agreed that they were very adequate and that they were in correspondence with the majority of rehabilitation programs for both patients operated on breast cancer, like other diseases of the osteomyoarticular system. For its part, one expert, or 6.25%, assessed this indicator as quite adequate, while that same amount valued it as adequate. It is noteworthy that there were no negative criteria or evaluations.

In the selected "exercises indicator", most of the experts also agreed that this was very adequate. This was reflected in that 15 or 93.75% out of the total of the experts indicated this category. Only one (6.25%) considered the exercises contained in the presented rehabilitation program to be quite adequate, it is also worth noting that this indicator did not receive an evaluative category or unfavorable criteria.

In the "indicator intensity of rehabilitation", it is noteworthy that the majority of the experts in consultations consider that these are very adequate since 14 of them (87.5%) gave this evaluative category. While only two (12.5%) of the total classified it as quite adequate. Therefore, no unfavorable evaluative category was received.

The indicator possibility of "being applied in practice", an important group of experts considered that it has a very adequate evaluative category, results that were endorsed by 15 experts or 93.75% of the total. On the other hand, only one (6.25%) considered that it is quite adequate. These results are very favorable and important because they come from a group of professionals with high and medium knowledge of this subject.

After the consultation was completed, some modifications to the program were relocated under the criteria issued by the experts, among which the following stand out:

- Make a description of the exercises to be used in the initial part of the rehabilitation session,
- Include pulley exercises,
- Describe how to perform the intensity calculation.

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Finally, to determine the validity of the experts' criteria, the Kendall coefficient of concordance was used to determine the existence or not of significance in the experts' community of interests.

To do this, it begins with the formulation of the statistical hypothesis:

Nullity hypothesis ($H_0$): there is no community of preference among the experts.

Alternative hypothesis ($H_1$): there is a community of preferences among the experts.

Prefixing as significance level $\alpha = 0.05$.

| Kendall's agreement | coefficient of | Alpha value | N-1 GL | S2 / CHI (Boards) | S2 / CHI (Calculated) |
|---|---|---|---|---|---|
| | 0.84 | 0.05 | 4 | 14.067 | 88.511 |

**Table 4.** Inferential statistics results

As observed in the table presented above, Kendall's coefficient of agreement reaches a value of 0.84, so it can be considered the existence of a high agreement between the expert evaluations, this is corroborated with the $\chi^2$ contrast in which 14.067 was less than its calculated value (88.511), so the null hypothesis ($H_0$) is rejected and the alternative hypothesis ($H_1$) is accepted.

From the linguistic assessment, a numerical final result is given as follows:

- Every assessment is converted from a linguistic term into its associated neutrosophic number, according to Table 1.
- Secondly, every neutrosophic number is converted into a crisp value using Equation 1 of the scoring function.
- The arithmetic mean of the results is calculated.
- If the moderator of the Delphi method wants to output a linguistic term, the numerical results obtained above are compared with the scoring function of every neutrosophic number in Table 1, and the linguistic term associated with the closest one to the obtained value is assigned.

Then, applying the precedent procedure, we obtained:

- Stages of the rehabilitation session: 0.95104 or "Approximately Very suitable".
- Selected exercises: 0.98229 or "Approximately Very suitable".
- Rehabilitation intensity: 0.96458 or "Approximately Very suitable".
- Possibility of being applied in practice: 0.98229 or "Approximately Very suitable".

So, the collected criteria were favorable, they express that the program proposed in this research is correctly designed; which guarantees the adequate practical application to achieve the rehabilitation of breast cancer operated patients. Issue by which it can be stated that it contributes to the enrichment of the proposal to achieve more effective practical application and thus improve the quality of life of the patients.

## Conclusion

In this paper, we presented the analysis of the theoretical and methodological references on the assessment of the relevance of a breast cancer rehabilitation program. The use of the neutrosophic linguistic scale shows the existence of different bibliographic sources on the subject, however, programs that integrate various types of treatment for these patients are required. The assessment based on linguistic terms and neutrosophic numbers allows containing the accuracy to evaluate with linguistic values and also the imprecision with neutrosophic numbers.

The interpretation of the results derived from the criteria of the experts consulted makes it evident that there are positive criteria, aspects that were ratified with Kendall's coefficient of agreement, which was less than 0.005, therefore that ratified the existence of an agreement between them.

## References

[1]    Yumar-Carralero, A.C., Ramírez-Guerra, D.M. and Pérez-Iribar, G. (2020) Breast cancer: pathophysiological bases and benefits of physical and occupational rehabilitation. Acción, 16, 1-11.

[2]     Moreno, P.M. (2017) Degree thesis: Bibliographic review on the benefits of home interventions in oncology users from Occupational Therapy. Miguel Hernández University, Faculty of Medicine, Ecuador.

[3]     Álvarez, S. (2001) Topics of Comprehensive General Medicine, Medical Sciences Editorial, Havana.

[4]     American-Society-of-Clinical-Oncology (2019) Breast cancer Netherlands, Cancer.net Editorial Board.

[5]     Durruthy, L.S., Toirac, R.R., Rubio-Hernández, M.C., Fitz, A.T., Camejo, Y.C. and Madruga, T.G. (2017) Risk Factors Associated with Breast Cancer. Journal Archive of the University Hospital "Calixto García", Available in:http://www.revcalixto.sld.cu/index.php/ahcgelectronica. 5, 13-19.

[6]     National-Institute-of-Statistics-and-Geography (2015) Statistics about the world day of the fight against breast cancer, Sec. Press Releases.

[7]     Osorio-Bazar, N., Bello-Hernández, C. and Vega-Bazar, L. (2020) Risk factors associated with breast cancer. Cuban Journal of Comprehensive General Medicine, 36, 11-47.

[8]     Piñeros, M. (2008) Guidelines for Exercise Testing and Prescription, Sixth edition Williams & Wilkins, Baltimore.

[9]     Lillo, S.G. and Imperatore-Blanche, E. (2010) Development of Occupational Therapy in Latin America. Chilean Journal of Occupational Therapy, 2010, 123-135.

[10]    Worthingham, D. (2003) Muscle balance techniques, Editorial Grafos, S.A., Madrid Spain.

[11]    De-Vita, V.T., Hellman, S. and Rosenberg, S. (2001) Cancer: principles and practice of oncology, Lip-pincott, Philadelphia.

[12]    Hagelin, K. (2006) Breast Cancer. Available in: http://www.nature.com.

[13]    Macías, A.R. (2009) Doctoral Thesis: Physical exercise program for the rehabilitation of mastectomized patients. University of Physical Culture and Sports Sciences, Havana.

[14]    Morrison, R., Olivares, D. and Vidal, D. (2011) Human Occupation and the Social Paradigm of Occupation. Some reflections and proposals on current epistemologies in Occupational Therapy. Chilean Journal of Occupational Therapy, 11, 102-119.

[15]    Ramírez, K., Acevedo, F., Herrera, M.E., Ibáñez, C. and Sánchez, C. (2017) Physical activity and breast cancer: a targeted treatment. Medical Journal of Chile, 145, 75-84.

[16]    Lyons, K.D., Svensborn, I.A., Kornblith, A.B. and Hegel, M.T.A. (2015) Content Analysis of Functional Recovery Strategies of Breast Cancer Survivors. OTJR: occupation, participation and health, 35, 73-80.

[17]    Crespo, T. (2007) Answers to 16 questions about the use of the Delphi method in pedagogical research, Editorial San Marcos, Lima, Peru.

[18]    Smarandache, F., Estupiñán-Ricardo, J., González-Caballero, E., Leyva-Vázquez, M.Y. and Batista-Hernández, N. (2020) Delphi method for evaluating scientific research proposals in a neutrosophic environment. Neutrosophic Sets and Systems, 34, 204-213.

[19]    Smarandache, F. (2016) of Neutrosophic Numbers. Critical Review, 13, 103.

[20]    Vázquez, M.L., Estupiñan, J. and Smarandache, F. (2020) Neutrosofía en Latinoamérica, avances y perspectivas. Revista Asociación Latinoamericana de Ciencias Neutrosóficas, 14, 1-8.

[21]    Mohana, K., Christy, V. and Smarandache, F. (2019) On Multi-Criteria Decision Making problem via Bipolar Single-Valued Neutrosophic Settings. Neutrosophic Sets and Systems, 25, 125-135.

[22]    Gómez, G.Á., Moya, J.V. and Ricardo, J.E. (2020) Method to measure the formation of pedagogical skills through neutrosophic numbers of unique value. Revista Asociación Latinoamericana de Ciencias Neutrosóficas, 11, 41-48.

[23]    Ramos, E.L.H., Ayala, L.R.A., Torres, D.F.T. and Gonzalez, R. (2020) Method for Treatment and its Incidence in the Change of Social Rehabilitation Regime using Neutrosophic Compensatory Logic. Neutrosophic Sets and Systems, 37, 381-388.

[24]    Alfredo-Cacpata, W., Gil-Betancourt, A.S., Enríquez-Guanga, N.J. and Castillo-Núñez, K.T. (2019) Validation of the proof reversal on the inexistence of untimely dismissal by using neutrosophic IADOV technique. Neutrosophic Sets and Systems, 26, 45-51.

[25]    Siegel, S. and Castellan, N.J. (1998) Non Parametric Statistics for the Behavioral Scíences, Editorial Trillas, Mexico D.F.

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