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Risk Factors Prioritization for Chronic Obstructive Pulmonary Disease

Lester Wong Vázquez[1], María Fernanda Cueva Moncayo[2] and Laura Paola Advendaño Castro[3]

[1] Universidad Regional Autónoma de los Andes (UNIANDES), Km 5 ½ Vía a Baños, Ambato, CP. 180166. Ecuador; Email: lwongvazquez@gmail.com
[2] Universidad Regional Autónoma de los Andes (UNIANDES), Km 5 ½ Vía a Baños, Ambato, CP. 180166. Ecuador; Email: mafercm2@yahoo.es
[3] Universidad Regional Autónoma de los Andes (UNIANDES), Km 5 ½ Vía a Baños, Ambato, CP. 180166. Ecuador; Email: pao.avendanoc@gmail.com

Abstract: Lung diseases represent one of the main causes of death in the world. Making an opportune diagnosis would improve the quality of life of patients. A set of factors intervene in the diagnostic process that significantly impact the evolution of the disease. However, there is uncertainty to determine which factors promote the development of lung disease. The present research aims to propose a method for prioritizing risk factors for chronic obstructive pulmonary disease. The method uses a multi-criteria approach where uncertainty is modeled using neutrosophic numbers. The proposed method is implemented in a case study at Alfredo Noboa Montenegro Hospital. The result is the prioritization of the factors whose mitigation would favor the reduction of lung disease.

Keywords: Pulmonary diseases; diagnosis; neutrosophic numbers.

1. Introduction

Chronic obstructive pulmonary disease is an inflammatory pathology that constitutes a major public health problem and one of the main causes of mortality [1, 2] in Ecuador and in the world. In recent years, this phenomenon has shown a constant growth. It has become the fourth cause of death worldwide [3].

Chronic obstructive pulmonary disease is a preventable and treatable condition that creates persistent airflow limitation that is generally progressive and associated with an enhanced chronic inflammatory response to noxious particles or gases in the airways and lung [4, 5]. This disease is one of the leading causes of morbidity and mortality worldwide and generates an economic and social burden that is both substantial and growing [6, 7].

Inhalation of harmful particles, such as tobacco smoke and biomass fuels, cause inflammation that may become a chronic condition and induce the destruction of parenchymal tissue and alter the normal repair and defense mechanisms. These pathological changes cause structural modifications and narrowing of the small airways [8, 9]. Destruction of the lung parenchyma by inflammatory processes leads to the loss of the alveolar attachments to the small airways and decreases the elastic recoil of the lung; so, these changes decrease the ability of the airways to remain open during expiration [10, 11].

The alarming prevalence figures for obstructive pulmonary disease [12-14], have motivated this investigation. The main objective is to develop a method for the prioritization of risk factors for chronic obstructive pulmonary disease. The method uses a multi-criteria approach where the uncertainty is modeled using neutrosophic numbers.

The investigation is structured in several sections, so that each one contributes to reach the previously defined objective. The Preliminaries section describes the main characteristics of chronic obstructive pulmonary disease and identifies the risk factors associated with this condition. The Materials section proposes the method for prioritizing risk factors for chronic obstructive pulmonary disease and describe each of the activities in which it is structured. In the Results section, the proposed method is implemented in a case study at Alfredo Noboa Montenegro Hospital, where the important results obtained demonstrate the need for an early diagnosis of the disease and the applicability of the method.

To carry out the research, we decided to make a cross-sectional study. With this research design we determined the total of cases reported with a diagnosis of chronic obstructive pulmonary disease in the sample obtained from patients of the internal medicine unit at Alfredo Noboa Montenegro hospital, and the prevalence of this pathology under study. The review of the medical records made it possible to identify the clinical factors that influenced the development of this pathology and to analyze the role of the risk factors that most affect chronic obstructive pulmonary disease and whose prioritization is the object of study in this research.

2. Preliminaries

This section provides a description of the main elements associated with the problem. A study of lung diseases is carried out as the basis of this investigation. Subsequently, the main risk factors that affect chronic obstructive pulmonary disease are identified for prioritizing risk factors.

2.1. Pulmonary diseases

Chronic obstructive pulmonary disease is not a single disease, but a general concept that designates various chronic lung ailments that limit the flow of air in the lungs. Therefore, it is classified as Chronic Bronchitis and Emphysema [15].

Chronic bronchitis is inflammation of the main airways in the lungs that continues for a long time or that comes back repeatedly. The main cause is smoking. Secondhand smoke may also cause chronic bronchitis, which is worsened by environmental pollution, infection, and allergies [16]. It is considered to be chronic when symptoms persist for more than 90 days a year for two consecutive years, as long as it is not due to a localized bronchopulmonary disease. Smoking is the most common cause of chronic bronchitis and there is no precondition for gender, age or ethnicity. Up to 5% of the population can be affected, and it tends to occur more in women and people over 45 years of age [17, 18].

Pulmonary emphysema is a disease that produces the enlargement of the pulmonary alveoli permanently, damaging them in such a way that they become obstructed and decrease respiratory function [19, 20]. The loss of elasticity causes the airways to narrow, as a consequence your body does not receive the oxygen it needs. This pathology usually appears as a sequel to bronchitis and asthma. Smoking is the most common cause for its appearance. Emphysema is mainly a disease of people over 40 years of age and is more frequent in men than in women, although the increase in the incidence of women has been notable in recent years.

The chronic inflammatory process, ischemia, and limitation of physical activity are associated with this disease, along with the adverse effects of the drugs used in its treatment, produce systemic effects such as cachexia or muscle atrophy. Concomitant diseases such as hypertension or diabetes mellitus influences the clinical status of patients with chronic obstructive pulmonary disease and worsens the prognosis, increasing the risk of developing lung cancer [21, 22]. The prevalence and impact of this disease on the population is expected to increase due to aging and the rise of the smoking rates of the population, both in developed and underdeveloped countries. The worldwide prevalence in the general population is estimated at around 1% and in those over 40 years at 10%.

2.2. Risk factors for chronic obstructive pulmonary disease

Identifying the risk factors that significantly affect lung diseases is the basis for improving the quality of life of patients. Pulmonary diseases have a multifactorial origin and develop due to the interaction of different risk factors, such as: genetic factors, bronchial reactivity and environment [23].

Each risk factor has a set of associated measurement indicators that determine the incidence criteria for medical diagnosis. The risk factors for chronic obstructive pulmonary disease identified from the implemented research design are listed below:

1. Smoking: considered the most important risk factor for the development of chronic obstructive pulmonary disease. The risk increases depending on the number of cigarettes smoked, the age of start, and the time they have been smoking, with tobacco smoke being the main cause [24].
2. Genetic factors: the deficiency of alpha-1-antitrypsin stands out, which is a protein that protects the lungs from damage. That is why its deficit is associated with the early and accelerated development of emphysema and decrease in lung function.
   It should be analyzed primarily in young patients with chronic obstructive pulmonary disease; especially if they are not smokers [25].

3. Bronchial reactivity: this factor is associated with the risk of developing chronic obstructive pulmonary disease, since people affected by bronchial reactivity usually present bronchial obstruction [26].
4. Lung growth: people with incomplete lung development have reduced lung function, and consequently a higher risk of developing chronic obstructive pulmonary disease. Lung growth disturbances are often associated with events during pregnancy [18, 19].
5. Passive smoking: passive and continuous exposure to tobacco smoke may cause respiratory symptoms, increase in acute respiratory diseases and worsening lung function, which in the future may trigger the development of chronic obstructive pulmonary disease [12, 13, 27, 28].
6. Respiratory infections: severe respiratory infections have been associated with decreased lung function. These infections generally occur in childhood and may cause damage to the airways; and in adult life cause the appearance of chronic obstructive pulmonary disease.
7. Nutrition: malnutrition is an unfavorable factor in the evolution of this disease. Lack of vitamin C and E and magnesium decrease protection against the development of chronic obstructive pulmonary disease**.**
8. Atmospheric pollution: it contributes to the load of inhaled particles, which produces a greater number of exacerbations, causing an irritating effect in the airways, which conditions greater bronchoconstriction and pulmonary hypersecretion.
9. Exposure to toxins: it manifests itself mainly during the combustion of garbage, exposure to chemicals, combustion at home (wood stove).
10. Demographic factors: the review of medical records showed that demographic elements (Urban, Rural) influence the development of chronic obstructive pulmonary disease; because patients in rural areas have a higher exposure to biomass and work mostly in agriculture, which exposes them to inhalation of chemicals and insecticides.
11. Socioeconomic level: The risk of developing chronic obstructive pulmonary disease is inversely related to socioeconomic position, in such a way that it is more frequent in depressed social classes, due to the fact that they present a greater number of risk factors that are associated with the development of the illness such as: alcohol, smoking, more frequent childhood infections, overcrowding, poor nutrition.
12. Pathological background: various studies have confirmed that the development of chronic obstructive pulmonary disease may be associated with pathological elements such as arterial hypertension, diabetes mellitus, hypothyroidism, hyperthyroidism, among others.
13. Others (age, family history of chronic obstructive pulmonary disease): aging produces an increase in respiratory symptoms and therefore a decrease in lung function, which leads to a future development of the pathology. In the family history are genetic factors and most likely passive smoking that is suffered by the children of the patient with chronic obstructive pulmonary disease, the same ones who may have a predisposition to smoke in the future.

The identification of risk factors for chronic obstructive pulmonary disease shows that there is no single cause that provoke this pathology, it is rather the consequence of various risk factors. The problem lies in the fact that the clinical manifestations of this pathology such as dyspnea, chronic cough, production of profuse and sometimes purulent expectoration, are of a progressive nature, becoming persistent or evident with effort. Chronic obstructive pulmonary disease is a slowly progressive disease that, with proper treatment and compliance with it, the patient can lead a life without complications.

2.3. Neutrosophic multicriteria decision analysis.

Multi-criteria decision-making problems allow uncertainty to be modeled through fuzzy logic, initially introduced by Zadeh [29]. It allows you to model knowledge in a more natural way. The basic idea is the notion of the membership relation that takes truth values in the interval [0,1].

The introduction of the *Intuitionistic Fuzzy Set* (IFS) as a universe with a generalization of fuzzy sets have been defined by K. Atanassov in [30]. In IFS, in addition to the degree of membership $(\mu_A(x) \in [0,1])$ of each element $x \in X$ to a set A, a degree of non-membership $v_A(x) \in [0,1]$, as considered, such as shown in equation 1:

$$\forall x \in X \mu_A(x) + v_A(x) \leq 1 \quad (1)$$

The *Neutrosophic Set* (NS) introduced the degree of indeterminacy (i) as an independent component [31]. The truth value in the neutrosophic set is the following [32, 33]:

Let N be a set defined as: $N = \{(T, I, F): T, I, F \subseteq [0,1]\}$ a neutrosophic evaluation n is a mapping of the set of propositional formulas to N, that is, for each p we have:

$$v(p) = (T, I, F) \quad (2)$$

The *Single Valued Neutrosophic Set* (SVNS) [34, 35] was developed to facilitate real world applications of the set theoretic and neutrosophic set operators. An SVNS is a special case of a neutrosophic set proposed as a generalization of intuitionistic fuzzy sets to treat incomplete information [36-38].

The single value neutrosophic numbers (SVN number) are denoted by $A = (a, \mathrm{b}, c)$, where, [0,1] and $a, b, c \in [0,1]$ and $a + b + c \leq 3$ [39]. In real world problems, we can sometimes use linguistic terms like "good", "bad" to get preferences about an alternative, and we cannot use some numbers to express qualitative information. Some classic multicriteria decision models have been adapted to Neutrosophy, for example, AHP, TOPSIS and DEMATEL [40-42].

3. Materials and Methods

This section describes the structure and operation of the method to assess risk factors for chronic obstructive pulmonary disease. The method consists of eight activities: reference framework, collection of parameters, selection of preferences, calculation of the degree of consensus, control, generation, evaluation of alternatives and classification of risk factors. It is based in previous works on consensus in neutrosophic environments [43-45] . Figure 1 shows the structure of the method.

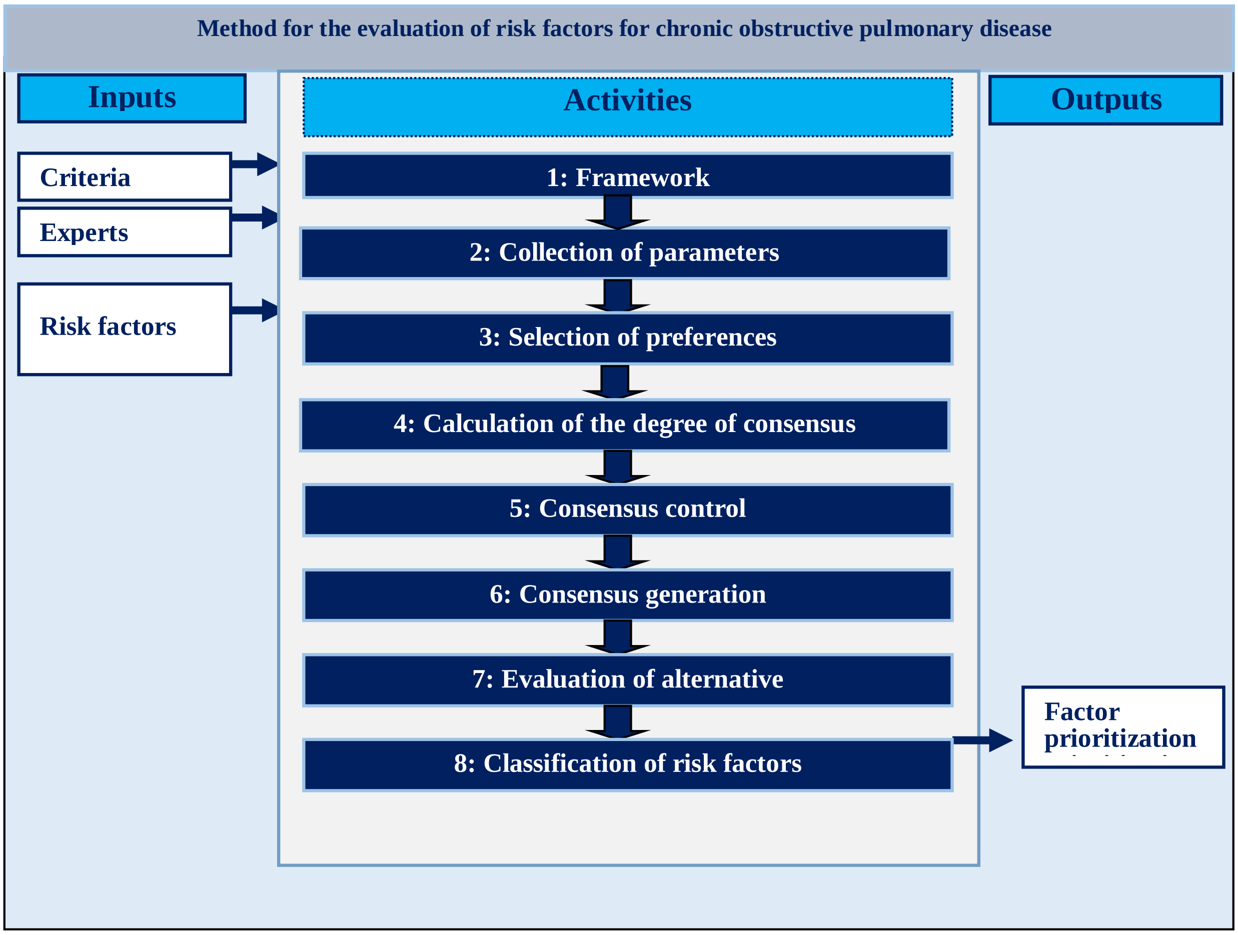

Figure 1. General diagram of how the method works.

The main activities involved in the proposed method are described below. Each activity describes the main elements that are managed.

Activity 1: Framework. This activity defines the evaluation framework for the decision problem of prioritizing risk factors for chronic obstructive pulmonary disease. The frame is set in such a way that:

$C = \{c_1, c_2, .. c_n\}, n \geq 2$, is the set of criteria that represent risk factors for chronic obstructive pulmonary disease.

$E = \{e_1, e_2, .. e_k\}, k \geq 2$, is the set of experts involved in the process.

$X = \{x_1, x_2, .. x_m\}, m \geq 2$, is the finite set of patients to be diagnosed.

Criteria and experts could be grouped. The group of experts will provide the evaluations of the decision problem. The main criteria that represent risk factors for chronic obstructive pulmonary disease according to [23]. Figure 2 shows the identified factors.

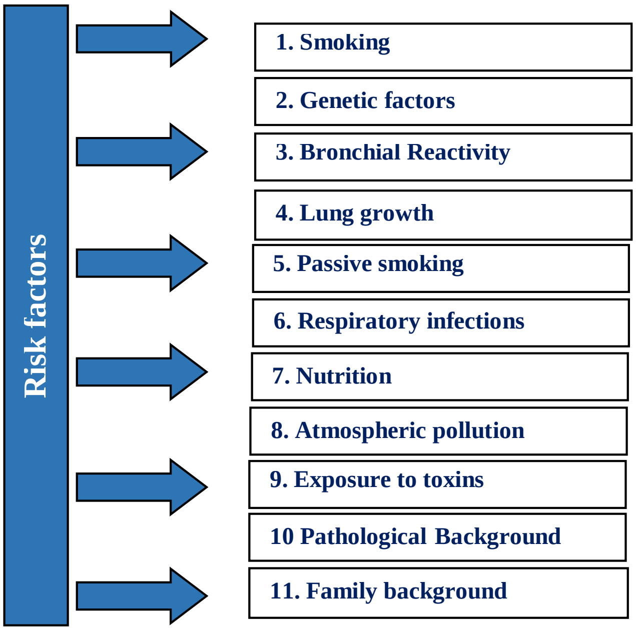

Figure 2. Risk factors for chronic obstructive pulmonary disease.

Activity 2: collection of parameters**.** The granularity of the linguistic term is selected. Parameters are brought together to control the consensus process: consensus threshold μ ∈ [0,1] and MAXROUND ∈ N to limit the maximum number of discussion rounds. The acceptability threshold $\varepsilon \geq 0$, is also collected, to allow a margin of acceptability to avoid generating unnecessary recommendations.

Activity 3: selection of preferences. For each expert, their preference is compiled using the chosen set of linguistic terms.

In this activity, each e_k expert, provides the evaluations using evaluation vectors:

$$U^k = (v_1, i = 1, .. n, j = 1, .. m) \quad (3)$$

The evaluation, v_i^k provided by each expert e_k for each criterion c_i of each alternative X_j, is expressed by SVN numbers.

Activity 4: calculation of the degree of consensus. The degree of standardized collective consensus is calculated in a range of values [0,1].

For each pair of experts, $e_k, e_t (k < t)$ s a similarity vector is determined

$$SM_{kt} = \left(sm_i^{kt}\right), sm_i^{kt} \in [0,1] \quad (4)$$

is calculated:

$$sm_i^{kt} = 1 - \left(\frac{1}{3}\sum_{j=1}^{n}\left\{\left(\left|t_i^k - t_i^t\right|\right)^2 + \left(\left|i_i^k - t_i^t\right|\right)^2 + \left(\left|f_i^k - t_i^t\right|\right)^2\right\}\right)^{\frac{1}{2}} \quad (5)$$

$$(i, 2, .., m)$$

A consensus vector $CM = (cm_i)$ is obtained by adding similarity values:

$$cm_i = OAG_1(SIM_i) \tag{6}$$

Where OAG_1 is an aggregation operator, $SIM_i = \left\{sm_i^{12}, sm_i^{1m}, .., sm_i^{(m-1)m}\right\}$ representing all pairs of experts determines the similarity in their opinion on the preference between (v_i, v_j) and cm_i is the degree of consensus reached by the group in their opinion. Finally, a degree of general consensus is calculated:

$$cg = \frac{\sum_{i=1}^{n} cv_i}{n} \tag{7}$$

Activity 5: consensus control**.** The degree of consensus cg is compared with the consensus threshold (μ). If $cg \geq \mu$, the consensus process ends; otherwise, the process requires additional discussion. The number of rounds is compared to the MAXROUND parameter to limit the maximum number of discussion rounds.

Activity 6: consensus generation. When$cg < \mu$, the experts must modify the preference relationships to make their preferences close to each other and increase the degree of consensus in the next round. The consensus generation begins to compute the collective preferences w^c. This collective preference model is calculated by adding the reference vector of each expert:

$$w^c = OAG_2(v^1, .. v^m) \tag{8}$$

Where: OAG_2 is an aggregation operator and $v \in U$. After that, a proximity vector (PP^k) is obtained between each of the expert e_k and w^c. The proximity values, $pp_{ij}^k \in [0,1]$ are calculated as:

$$pp_{ij}^k = \left(\frac{1}{3}\sum_{j=1}^{n}\left\{\left(\left|t_i^k - t_i^c\right|\right)^2 + \left(\left|i_i^k - t_i^c\right|\right)^2 + \left(\left|f_i^k - t_i^c\right|\right)^2\right\}\right)^{\frac{1}{2}} \tag{9}$$

Subsequently, preference relationships to change (CC) are identified. The preference relationship between the criteria c_i and c_j with a degree of consensus, below the defined (μ) is identified:

$$CC = \{w_i^c | cm_i| < \mu\} \tag{10}$$

Then, depending on the CC, those experts who should change their preference are identified. To calculate an average proximity pp_i^A, the proximity measures are added.

$$pp^A = OAG_2(pp^1, .., pp_i^m) \tag{11}$$

Where OAG_2 is an SVN aggregation operator.

e_k experts whose $pp_i^k < pp_i^A$ are advised to modify their preference ratio W_i^k.

Finally, the direction rules are checked to suggest the direction of the proposed changes. A threshold $\varepsilon \geq 0$ has been established to avoid generating an excessive number of unnecessary tips.

DR 1: If $v_i^k - w_i^c < -\varepsilon$ then e_k should increase its value of the preference relation v_i.

DR 2: If $v_i^k - w_i^c < -\varepsilon$ then e_k should decrease its value of the preference relation v_i.

DR 3: If $-\varepsilon \leq v_i^k - w_i^c \leq -\varepsilon$ then e_k must not modify the value of the preference relation v_i.

Steps 3 through 6 are repeated until the consensus reaches the maximum number of rounds.

Activity 7: evaluation of alternatives. The objective of this activity is to obtain a global evaluation for each alternative. Taking into account the previous phase, an evaluation is calculated for each alternative, using the selected resolution process that allows managing the information expressed in the decision frame.

In this case, the alternatives are classified according to the single value neutrosophic weighted average aggregation operator (SVNWA):

$$F_w(A_1, A_2, .., A_n,) = \langle 1 - \prod_{j=1}^{n}\left(1 - T_{Aj}\right)^j, \prod_{j=1}^{n}\left(I_{Aj}(x)\right)^{wj}, \prod_{j=1}^{n}\left(F_{Aj}(x)\right)^{wj}\rangle \tag{12}$$

Where $W = (w_1, w_2, , .. w_n)$ is the weight vector of $A_j (j = 1,2, , .., n)$, $w_n \in [0,1]$ and $\sum_j^n w_j$.

Activity 8: classification of risk factors. In this activity, the alternatives are ranked and the best scoring function is chosen [29]. According to the scoring and precision functions of the SVN sets, a sort order of the set of alternatives can be generated [46]. Selecting the options with the highest score.

To order alternatives a scoring function is used [35]:

$$s(V_j) = 2 + T_i + F_j - I_j \tag{13}$$

Additionally, a precision function is defined:

$$a(V_j) = T_i - F_j \tag{14}$$

So

1. Si
   a. $a(V_j) = a(V_i)$, then V_j are equal, denoted by $V_j = V_i$.
   b. $a(V_j) < a(V_i)$, then V_j is less than V_i, denoted by $V_j < V_i$.

3. Si $s(V_j) < s(V_i)$, then V_j is less than V_i, denoted by $Vj < Vi$.
   a. Si $a\ (Vj)\ < a\ (Vi)$, then V_j is less than V_i, denoted by $V_j < V_i$.
   b. Si a $(Vj)\ =\ a\ (Vi)$, then V_j and V_i are equal, denoted by $Vj\ =\ Vi$.

Another option is to use the scoring function proposed in [47]:

$$s(V_j) = (1 + T_j - 2F_j - I_j)/2 \qquad (15)$$

where $s(V_j)\ \in\ [-1,1]$.

According to the classification method of the SVN scoring function[48, 49], the classification order of the set of risk factors for chronic obstructive pulmonary disease can be generated and the alternatives can be prioritized.

4. Results

To demonstrate the applicability of the proposed method, we decided to conduct a case study, taking as a reference a patient admitted to the intensive care unit at Alfredo Noboa Montenegro Hospital in Ecuador. In this study, we had the collaboration of three experts $E = \{e_1, e_2, e_3\}, n = 3$ from which their preferences are determined. To increase the way in which the input data is interpreted, a set of linguistic terms with cardinality nine is used (Table 1).

Linguistic terms	**SVNSs**
Extremely good (EG)	(1,0,0)
Very very good (VVG)	(0.9, 0.1, 0.1)
Very good (VG)	(0.8,0,15,0.20)
Good (G)	(0.70,0.25,0.30)
Medium good (MG)	(0.60,0.35,0.40)
Medium (M)	(0.50,0.50,0.50)
Medium bad (MB)	(0.40,0.65,0.60)
Bad (B)	(0.30,0.75,0.70)
Very bad (VB)	(0.20,0.85,0.80)
Very very bad (VVB)	(0.10,0.90,0.90)
Extremely bad (EB)	(0,1,1)

Table 1. Linguistic terms used to provide the assessments [47].

The scope of the consensus process is defined by eleven criteria $C = \{c_1, c_2, .., c_{11}\}$ shown in Table 2.

Node	**Description**
c_1	Smoking
c_2	Genetic factors
c_3	Bronchial reactivity
c_4	Lung growth
c_5	Passive smoking
c_6	Respiratory infections
c_7	Nutrition

c_8	Atmospheric pollution
c_9	Exposure to toxins
c_{10}	Pathological background
c_{11}	Family background

Table 2. Criteria for prioritizing risk factors for chronic obstructive pulmonary disease.

The parameters used in this case study are shown in Table 3.

Consensus threshold	$\mu = 0{,}9$
Maximum number of discussion rounds	MAXROND =10
Acceptability threshold	$\varepsilon = 0.1$

Table 3. Defined parameters.

Initially, experts provide the following preferences:

	c_1	c_2	c_3	c_4	c_5	c_6	c_7	c_8	c_9	c_{10}	c_{11}
E1	B	M	B	VG	G	G	G	B	G	M	B
E2	VG	G	G	G	G	G	G	VG	G	G	VG
E3	VB	VG	M	G	VG	VG	G	VB	VG	VG	VG

Table 4. Preference Round 1

First round

Similarity vectors are obtained.

s^{12}=[0,9226; 0,9221; 0,95; 0,5807; 0,9702; 0,9707; 0,9707; 0,6807; 0,9204; 0,9606; 0,9606]

s^{13}=[0,9402; 0,9414; 0,7424; 0,62; 0,9802; 0,9707; 0,7825; 0,8752; 0,9608; 0,9604; 0,9204]

s^{23}= [0,9204; 0,9704; 0,9414; 0,7234; 0,9428; 0,9406; 0,9207; 0,896; 0,9554; 0,9402; 0,9606]

The consensus vector obtained is CV = [0,9277; 0,9446; 0,8779; 0,6413; 0,9644; 0,9606; 0,8913 0,8173; 0,9455; 0,9537; 0,9472]. Finally, a degree of general consensus is calculated: cg = 0.8974

Since cg 0.6848 <μ 0.9, the generation of tips is activated.

The collective preferences are calculated using the SVNWA operator, in this case giving the same importance to each expert W^c =[(0,80; 0,15; 0,20)(0,65; 0,50; 0,50)(0,5; 0,50;0,50)(0,70; 0,25; 0,30) (0,70; 0,25; 0,30)(0,70; 0,25; 0,30)(0,70; 0,25; 0,30)(0,60;0,40;0,40)(0,70; 0,25; 0,30)(0,6; 0,40;0,40) (0,60;0,40;0,40)]

The proximity vectors are calculated k

pp_1=[0,92; 0,92; 0,95; 0,58; 0,97; 0,97; 0,97; 0,68; 0,92; 0,96; 0,96]

pp_2=[0,94; 0,94; 0,94; 0,62; 0,98; 0,97; 0,78; 0,87; 0,96; 0,96; 0,92]

pp_3=[0,92; 0,97; 0,94; 0,72; 0,94; 0,94; 0,92; 0,89; 0,95; 0,94; 0,96]

Then the exchange preferences (CC) are identified.

$CC = \{w_i^c | cm_i| < 0.9\}= w_4, w_8$

The average proximity for this value is calculated as follows:

$pp_4^A = 0.6413, pp_8^A = 0.8173$

The proximity values for each preference expert w_4, w_8 as follows:

$pp_4^1 = 0.611, pp_8^1 = 0.979$
$pp_4^2 = 0.9605,\ \ pp_8^2 = 0.8462$
$pp_4^3 = 0.9682\ \ pp_8^3 = 0.8566$

The preference sets to change are: $\{v_4, v_8\}$
According to the DR1 rule, experts are required to increase the following ratios: v_4^1
According to the DR2 rule, experts are required to decrease the following relationships: v_8^2,
and according to rule DR3, these relationships should not be changed: v_8^3

Second round

In accordance with the previous advice, the experts implemented changes and the new preferences obtained are shown in table 5.

	c_1	c_2	c_3	c_4	c_5	c_6	c_7	c_8	c_9	c_{10}	c_{11}
E1	B	M	B	G	G	G	G	B	G	M	B
E2	VG	G	G	G	G	G	G	B	G	G	VG
E3	VB	VG	M	G	VG	VG	G	B	VG	VG	VG

Table 5. Round 2 Preferences.

Similarity vectors are again obtained:
s^{12}=[0,9226; 0,9221; 0,95; 0,9207; 0,9702; 0,9707; 0,9707; 0,9207; 0,9204; 0,9606; 0,9606]
s^{13}=[0,9402; 0,9414; 0,7424; 0,962; 0,9802; 0,9707; 0,7825; 0,9652; 0,9608; 0,9604; 0,9204]
s^{23}= [0,9204; 0,9704; 0,9414; 0,9472; 0,9428; 0,9406; 0,9207; 0,9406; 0,9554; 0,9402; 0,9606]
The consensus vector CV = [0,9277; 0,9446; 0,8779; 0,94; 0,9644; 0,9606; 0,8913; 0,94 0,9455; 0,9537; 0,9472; 0,9357]
Finally, a degree of general consensus is calculated: cg=0.9357
Since cg = 0.93>μ = 0.9, the desired level of consensus is reached.
From the result obtained, we concluded that the prioritized risk factors were $C = c_1, c_{10}, c_8, c_9$ respectively, which correspond to smoking, family history, air pollution and genetic factors.

Conclusions

The proposed method consists of eight activities, includes automatic search mechanisms for areas of conflict and recommendations to experts to bring their preferences closer. A study was carried out from which it was possible to show that the prevalence of chronic obstructive pulmonary disease in the population selected for the study was high and the prevalent risk factors are smoking, family history, primary education, air pollution and genetic factors. The implementation of the proposed method allowed the prioritization of risk factors.

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