Neutrosophic Sets and Systems

Volume 35 Article 14

7-14-2020

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NSS
Neutrosophic Sets and Systems, Vol. 35, 2020
University of New Mexico

Exploration of the Factors Causing Autoimmune Diseases using Fuzzy Cognitive Maps with Concentric Neutrosophic Hypergraphic Approach

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Abstract: Neutrosophic sets are comprehensively used in decision making environment. The manifestation of neutrosophic sets in concentric hypergraphs is proposed in this research work. The intention of developing a decision making model using the combination of Fuzzy Cognitive Maps and concentric neutrosophic hypergraph is to rank the core factors of decision making problem and find the inter relational impacts. This proposed model is validated with the exploration of the causative factors of autoimmune diseases. The proposed model is highly compatible as it assists in determining the core factors and their inter association. This model will certainly benefit the decision maker at all managerial levels to design optimal decisions.

Keywords: Autoimmune disease, fuzzy cognitive maps, neutrosophic hypergraphs, optimal decision making

1. Introduction

Westernization the cause of modernization has unlocked the portals of cultural, behavioural and environmental changes of the people which greatly influence the biological system of human and this also lays the core reason for the outbreak of novel diseases. Presently the people of the world are characterized by multicultural and multi technological adoption. The integration and the association between people of varied culture have brought diverse implications on the external and internal environment of the human. Not just the social interactions contribute to such modifications; also the technological advancement and the work space of an individual cause a varied range of changes in the mankind. The tendency of manhood repelling from indigenous practices is the gateway for several health woes. The health system of the human is getting affected by several factors and especially the vulnerable target group is the women. In recent days, the people are chained by diseases of various kinds, even the economy of the nation face huge falls due to the effect of epidemic diseases, amidst such miserable situations, the immunity of the human is the only armed force against these viruses, but if the immune system fails to be defensive in nature and if it joins hand with the external invaders the entire human health system collapses and it ends in fatality. This is the characterization of auto immune diseases and the women are greatly affected by these diseases. It is highly a dreadful circumstance to tackle the consequences of these self-destructing diseases. The autoimmune diseases predominantly affecting the women are Rheumatoid Arthritis, Multiple Sclerosis, Systemic lupus Erythematosus, Grave's disease, Hashimoto's thyroiditis and Myasthenia gravis. Presently the rate of occurrences of such diseases is at its pinnacle and the medical experts are investigating the ways and means of its mitigation. [1]

Generally the women are highly susceptible to these autoimmune diseases as the immune system gets weakened during pre and post pregnancy stages. This scenario has gained the medical concerns and medical researchers are on their study, to render support to it, this paper aims to underlie the core factors contributing to autoimmune diseases in women and to find the inter association between the core factors. Optimal decisions can be made by applying scientific methods in the process of decision making process. The entire scenario of decision making must be modeled based on decisive factors of the study. One of the realistic tools of decision making is fuzzy cognitive maps (FCM), introduced by Kosko [2], later several academicians extended this FCM tool based on the requirements. FCM is a directed graph representing the casual relationship between factors considered for study. The nodes and the edges of the graph represent the study factors and their association. The weights [-1,1] represent the nature of the association. The integration of FCM with other graphic structures was initiated by Nivetha and Pradeepa [3]. The hypergraphic and fuzzy hypergraphic approaches with FCM unlocked the construction of concentric fuzzy hypergraphs and its integration with FCM [4,5]. This field of integrated FCM with fuzzy hypergraphs has made the researchers explore by introducing various types of concentric fuzzy hypergraphs.

In this research work, a fuzzy cognitive map with concentric neutrosophic hypergraphic approach is introduced. The notion of neutrosophic fuzzy sets and neutrosophic logic was first coined by Smarandache [6] and presently many researchers are highly interested to carry out their research in this field, the concepts of neutrosophic is applied in almost all types of decision making tools. Neutrosophic sets, play significant role in making decisions in uncertain environment as it provides space for the pragmatic representation of the expert's opinion. Abdel Basset et al [7]developed a decision making model for evaluating the framework for smart disaster response system in an uncertain environment, neutrosophic sets are used for uncertainty assessments of linear time-cost tradeoffs [8]; resource levelling problem[9] in construction project was modeled under neutrosophic environment. The concept of neutrosophic sets was extended to bipolar neutrosophic representation [10] and it is used in multi criteria decision making framework for professional selection. Das et al [11] developed neutrosophic fuzzy matrices and algebraic operation that had some utility in decision making. Plithogenic sets, the extension of neutrosophic sets are used in solving supply chain problem with the development of a novel plithogenic model [12]. Such massive applications of neutrosophic sets in decision making and its robust nature triggered the idea of integrating neutrosophic sets to concentric hypergraphs. To the best of our knowledge, the integration of neutrosophic concentric fuzzy hypergraphs with FCM has not been instituted and so this is a new arena of research towards optimal decision making.

Fuzzy Cognitive Maps are more useful in determining the association between study factors, if the number of study factors is less, FCM's are highly compatible, but if the number of factors is more, then comparative analysis between the factors is difficult and tedious, to resolve such crisis, the core factors of the problem are to be decided and then the inter association between the core factors can be determined easily. To find the core factors, the intervention of various experts is mandatory, based on which the factors can be ranked and the core factors are decided based on the rank positions of the factors. This eases the process of making decisions as it helps in filtering the non- core factors. Generally in medicinal environment, the medical experts analyze the factors contributing to diseases, initially the causative factors taken for study will be more in number, but the factors have to drop at each stage of their research to find the prime causative factors. In the process of factor filtration, the expert's opinions play a vital role. The role of each causative factor of a disease cannot be certainly express but representation using neutrosophic sets makes it possible and more meaningful. Thus the integration of FCM with concentric neutrosophic hypergraph will help to tackle the difficulties in handling large number of study factors.

The paper is structured as follows: section 2consists of the methodology in which the algorithm of finding optimal decision is presented; section 3 comprises of the adaptation of the proposed model to the decision making problem; section 4 discusses the results and the last section summarizes the research work.

2. Methodology and its application

The steps in making optimal decisions is presented as an algorithm as follows,

Step 1: The expert's opinion of the study factors are represented by concentric fuzzy hypergraphs with neutrosophic fuzzy sets representations of the envelope.

Step 2: The score values of the neutrosophic fuzzy sets are determined.

Step 3: The factors are ranked based on the score values.

Step 4: The core factors are determined based on the ranking positions.

Step5: The inter association between the core factors is obtained based on the conventional FCM procedure.

The case histories of patients belonging to women gender suffering from autoimmune diseases are taken as the source of data collection and the factors contributing to the occurrence of auto immune disease in women [13] are presented below based on the medical expert's opinion and data obtained from questionnaire.

F1. Excess presence of VGLL3 (Vestigial Like Family Member 3) in skin cells
F2. Changes in the gene system
F3. Exposure to ultraviolet radiation from sunlight
F4. Acquaintance with organic mercury
F5. Alteration in food habits
F6. Gene-Environment interface
F7. Fluctuations in sex hormones
F8. Modifications in Nutritional diet
F9. Post pregnancy impacts
F10. Genetic vulnerability
F11. Genetic differences in immunity

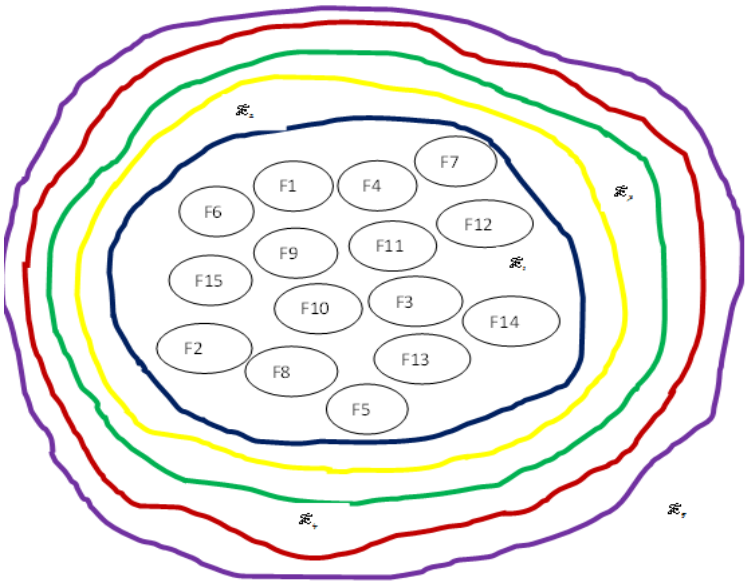

Fig.3.1.Concentric Neutrosophic Fuzzy Hypergraphic representation

The concentric neutrosophic fuzzy hyper envelopes with neutrosophic representations of the expert's opinion are presented below in Table 3.1.

Table 3.1 Representations of Expert's opinion

Experts	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**	**F10**	**F11**
E1	(0.3,0.2, 0.8)	(0.5,0.2, 0.3)	(0.4,0.1, 0.5)	(0.3,0.4, 0.6)	(0.8,0.1, 0.2)	(0.7,0.2, 0.3)	(0.7,0.3, 0.4)	(0.7,0.2, 0.3)	(0.3,0.2, 0.8)	(0.5,0.2, 0.3)	(0.5,0.2, 0.3)
E2	(0.2,0.2, 0.9)	(0.4,0.3, 0.5)	(0.5,0.2, 0.3)	(0.2,0.2, 0.9)	(0.7,0.2, 0.3)	(0.6,0.2, 0.3)	(0.7,0.5, 0.4)	(0.6,0.2, 0.3)	(0.4,0.3, 0.5)	(0.6,0.2, 0.3)	(0.8,0.3, 0.2)
E3	(0.3,0.4, 0.6)	(0.3,0.5, 0.6)	(0.4,0.3, 0.5)	(0.3,0.2, 0.8)	(0.8,0.3, 0.2)	(0.9,0.2, 0.3)	(0.9,0.1, 0.3)	(0.6,0.2, 0.3)	(0.3,0.5, 0.6)	(0.7,0.3, 0.4)	(0.6,0.2, 0.3)
E4	(0.5,0.2, 0.3)	(0.2,0.2, 0.9)	(0.5,0.2, 0.3)	(0.4,0.4, 0.6)	(0.7,0.1, 0.2)	(0.7,0.3, 0.4)	(0.6,0.2, 0.3)	(0.7,0.1, 0.2)	(0.2,0.2, 0.9)	(0.6,0.2, 0.3)	(0.4,0.3, 0.5)
E5	(0.2,0.5 ,0.6)	(0.3,0.2, 0.8)	(0.6,0.2, 0.3)	(0.5,0.2, 0.3)	(0.6,0.2, 0.3)	(0.8,0.1, 0.2)	(0.6,0.2, 0.3)	(0.9,0.2, 0.3)	(0.4,0.4, 0.6)	(0.5,0.2, 0.3)	(0.7,0.3, 0.4)

The score values of the factors are presented in Table 3.2 and it is represented graphically in Fig.3.2

Table 3.2 Score values of the Factors

F1	F2	F3	F4	F5	F6	F7	F8	F9	F10	F11
0.571	0.571	0.546	0.538	0.667	0.783	0.756	0.573	0.445	0.636	0.667
7	7	8	9	5	1	2	6	10	3	4

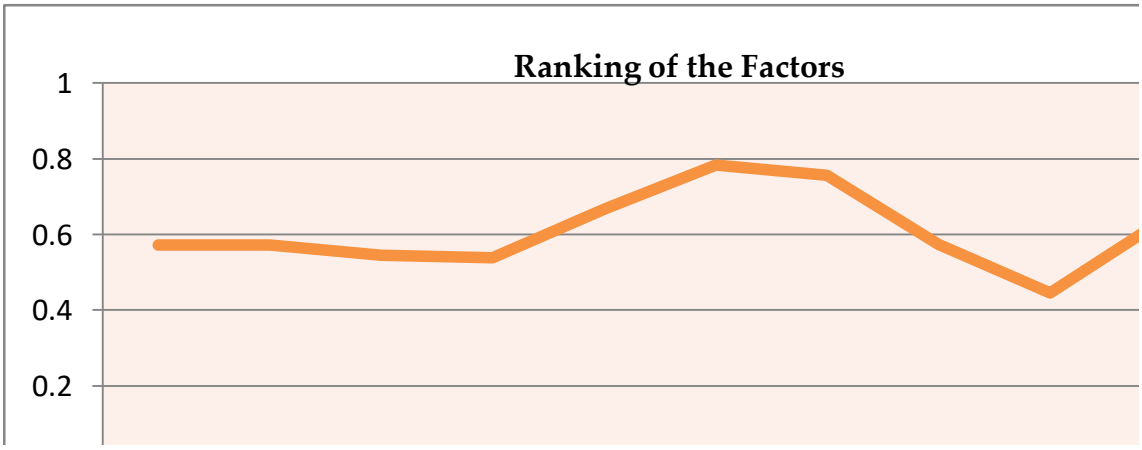

Fig.3.2

Based on the scores, the following factors are considered as the core factors and their inter association is expressed as linguistic variables, which then later quantified by heptagonal fuzzy numbers.

HP1. Alteration in food habits

HP2. Gene-Environment interface

HP3. Fluctuations in sex hormones
HP4. Genetic vulnerability
HP5. Genetic differences in immunity
The connection matric between the factors, based on the expert's opinion

	HP1	HP2	HP3	HP4	HP5
HP1	0	M	H	L	L
HP2	L	0	M	H	H
HP3	L	M	0	M	L
HP4	L	M	H	0	M
HP5	L	M	M	H	0

The modified matrix based on the values of quantification in Table 3.3

Linguistic Variable	**Heptagonal Weight**	**Membership value**
Low	(0,0.1,0.2,0.3,0.35,0.4,0.45)	**0.26**
Medium	(0.4,0.45,0.5,0.55,0.6,0.65,0.7)	**0.55**
High	(0.65,0.7,0.8,0.9,1,1,1)	**0.86**

	HP1	HP2	HP3	HP4	HP5
HP1	0	0.55	0.86	0.26	0.26
HP2	0.26	0	0.55	0.86	0.86
HP3	0.26	0.55	0	0.55	0.26
HP4	0.26	0.55	0.86	0	0.55
HP5	0.26	0.55	0.55	0.86	0

The interrelationship between the factors is determined by the similar application of FCM methodology [9-10] and it is presented graphically in Fig 3.2

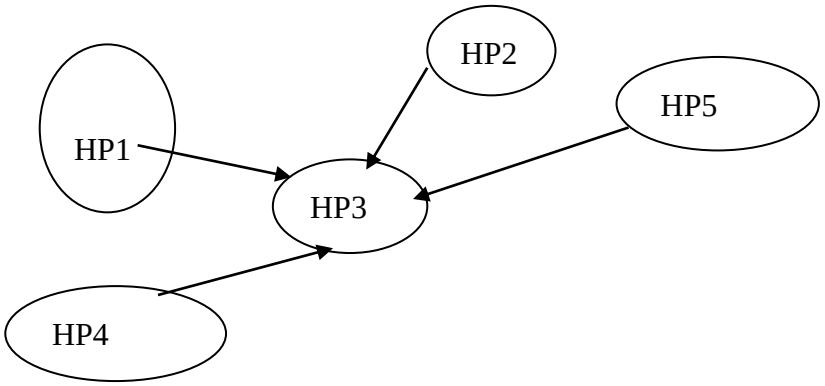

Fig.3.2 FCM representation of the inter association of the core factors

4. Results and Discussion

Fig. 3.2 clearly states the factor, fluctuations in sex hormone is the core causative factor of auto immune diseases. The findings of this research will certainly assist the medical experts to ascertain the causes of the auto immune disease in women and give treatment in accordance to it. Hormonal imbalance is quite common in the life of the women as they undergo various stages of puberty, maternity, menopause, but still proper medications has to be given to avoid the risks of such fatal diseases. The representation of the imprecise data in the form neutrosophic sets is the pragmatic reflection of the expert's opinion, as the factors contributing to the diseases are quite uncertain. The degree of truth values, indeterminacy and false values are indeed very essential in making optimal decisions.

5. Conclusion

The proposed decision making tool with the integration of FCM and concentric neutrosophic fuzzy hypergraphs is a highly feasible tool to obtain optimal decisions. The difficulty in handling several factors in FCM is reduced and this integrated approach facilitate the determination of inter association between the factors. This method of decision making can be extended to other kinds of concentric fuzzy hypergraphs with various representations. Plithogenic sets representation is the future extension of this proposed research work.

References

1. Shashi Pratab Singh., Pranay Wal1., Ankita Wal1., Vikas Srivastava., , Ratnakar Tiwari., , Radha Dutt Sharma., Understanding autoimmune disease: an update review, IJPTB. 2016,3,51-65.
2. Kosko B.Fuzzy Cognitive Maps, International Journal of Man-Machine Studies,1986, 24 65-75.
3. Nivetha Martin, Pradeepa.I., Pandiammal.P., Evolution of Concentric Fuzzy Hypergraph for Inclusive Decision Making, International Journal of Engineering and Advanced Technology,2019, 8, 358-362.
4. Nivetha Martin., Pradeepa.I.,Pandiammal.P., Student's Low Academic Performance Appraisal Model with Hypergraphic Approach in Fuzzy Cognitive Maps , Journal of Information and Computational Science,2019, 9,661-671.
5. Pradeepa.I., Nivetha Martin, Pandiammal.P., Prioritizing the obstacles in building swipe and touch classroom environment using blended method, Journal of Interdisciplinary Cycle Research, 2019, 9, 383-392.
6. Smarandache,F.,Neutrosophic set, a generalization of the Intuitionistic Fuzzy Sets, International Journal of Pure and Applied Mathematics, 2005,24, 287-297.
7. Abdel-Basset, M., Mohamed, R., Elhoseny, M., & Chang, V.,Evaluation framework for smart disaster response systems in uncertainty environment. Mechanical Systems and Signal Processing, 2020, 145, 106941.
8. Abdel-Basset, M., Ali, M., & Atef, A., Uncertainty assessments of linear time-cost tradeoffs using neutrosophic set. Computers & Industrial Engineering,2020, 141, 106286.
9. Abdel-Basset, M., Ali, M., & Atef, A., Resource levelling problem in construction projects under neutrosophic environment. The Journal of Supercomputing, 2020,76(2), 964-988.
10. Abdel-Basset, M., Gamal, A., Son, L. H., & Smarandache, F.,A Bipolar Neutrosophic Multi Criteria Decision Making Framework for Professional Selection. Applied Sciences,2020, 10(4), 1202.

11. R. Das, F. Smarandache and B.C. Tripathy, Neutrosophic fuzzy matrices and some algebraic operation, Neutrosophic Sets and Systems, 2020,32,401-409.
12. Abdel-Basset, M., Mohamed, R., Zaied, A. E. N. H., Gamal, A., & Smarandache, F.,Solving the supply chain problem using the best-worst method based on a novel Plithogenic model. In Optimization Theory Based on Neutrosophic and Plithogenic Sets,2020, (pp. 1-19). Academic Press.
13. Autoimmune Disease. Available at http://www.nlm.nih.gov/medlineplus/ autoimmunediseases.html (April 2016).

Received: Apr 24, 2020. Accepted: July 14, 2020