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Decision making method for accessing the risk factors of blood pressure and cholesterol using Crisp Topsis method

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Abstract

Nowadays, the medical diagnosis is one of the most important factor to identify diseases caused in human kind. The various diseases are emanated from various dangerous disease factors such as environment, pollution, food, water, etc., which are essential in mankind. Specifically, heart diseases is one of the dangerous disease affected in the body. In this paper, we have discussed the control of blood pressure and cholesterol with the range of risk factor, which are the important factors for maintaining the effective heart. A selection of person affected from blood pressure and cholesterol for causing heart attack and this can be done by taking the values in the range by using the crisp TOPSIS Method by securing the crisp value with their probabilities. This method is used for aligning values in the order to identify the particular person to be most affected to less affected.

Keywords

Crisp TOPSIS, Normal TOPSIS, Cholesterol, Blood Pressures.

AMS Subject Classification

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Contents

1. Introduction

Heart diseases cause from various factors that affects the heart in several ways. The heart diseases cause due to blood vessel diseases, such as coronary artery disease, heart rhythm problems heart defects and among others. The term "heart disease" is replaced by the other name as "cardiovascular disease". Cardiovascular disease generally refers that blocked blood vessels that can lead to a heart attack, chest pain or stroke. Other ways, such as affect the heart's muscle, valves or rhythm, also are considered forms of heart disease. Heart disease is one of the biggest causes of morbidity and mortality among the population of the world. Prediction of cardiovascular disease is regarded as one of the most important subjects in the section of clinical data analysis or diagnosis. This makes heart disease a major concern to be dealt with. But it is difficult to identify heart disease because of several contributory risk factors such as diabetes, high blood pressure, high cholesterol, abnormal pulse rate, and many other have risk factors. Due to such constraints, scientists have turned towards modern approaches like Fuzzy TOPSIS Method.

Nowadays, the medical diagnosis is one of the most important factor to identify diseases caused in human kind. The various diseases are emanated from various dangerous disease factors such as environment, pollution, food, water, etc., which are essential in mankind. Specifically, heart diseases is one of the dangerous disease affected in the body. In this paper, we have discussed the control of blood pressure and cholesterol with the range of risk factor, which are the important factors for maintaining the effective heart. A selection of person affected from blood pressure and cholesterol for causing heart attack and this can be done by taking the values in the range by using the crisp TOPSIS Method by securing the crisp value with their probabilities. This method is used for aligning values in the order to identify the particular person to be most affected to less affected.

A Clinical Decision Support Systems (CDSS) is computer software designed to contribute to clinical treatments and diagnoses (Berner, 2007). The computerised patient records to predict the heart diseases proposed system has integrated the clinical decision support that could reduce medical errors, decrease unwanted practice variation, enhance patient safety and enhance patient outcome (Subbalakshmi et al., 2011). Hence, experts require an accurate decision that considering the risk factors thereby designed an expert system using some prediction algorithms to diagnose the heart disease [2].

In the classic formulation of the TOPSIS method, personal judgments are represented with crisp values. However, crisp data are inadequate to model real-life decision problems under many conditions. That is why the fuzzy TOPSIS method was proposed, whereby the weights of criteria and ratings of alternatives are evaluated by linguistic variables represented by fuzzy numbers to deal with the deficiency in the classic TOPSIS. The fuzzy TOPSIS method has been widely applied in many fields; for example, energy [3], environment [1], industrial processes [4], and climate change [7].

TOPSIS algorithm is used to evaluate the preference ranking order the results ofproduction processes related to soil environment. It is a Fuzzy data so that the output is a quantitative data. TOPSIS method is suitable to solve the problem decision making by introducing quantity multiplication operation of triangular Fuzzy number. A case study indicates that the method can be applied effectively with less information and the quantitative result is objective and reasonable. Rank of accessing Organic waste and In-organic fertilizers in the order of using Normal Fuzzy TOPSIS in Agricultural sector [10].

2. Normal Crisp TOPSIS Method

In general the TOPSIS method procedure follows these steps: **Step 1:** The normalized fuzzy decision matrix. In TOPISIS, the performance of each alternative needs to be graded with equation (2.1)

$$\mathrm{r_{ij}} = \frac{s_{ij}}{\sum_{j=1}^{m} s_{ij}}, \text{ with x = decision matrix ;}$$
$$\mathrm{i} = 1,2,3,\ldots,\mathrm{m}; \text{ and } \mathrm{j} = 1,2,3,\ldots,\mathrm{n}(1). \tag{2.1}$$

Step 2: obtain the weight Wi from the given initial table.

$$\sum_{j=1}^{n} W_j \text{ with } j = 1,2,3,\ldots,\mathrm{m}$$

Step 3: The weighted normalized fuzzy decision matrix. Positive ideal solution P+ and negative ideal solution P- can be determined based on the weighted normalized (yij) as:

$$y_{ij} = w_j(r)_{ij}; \text{ with } i = 1,2,3,\ldots,m; \text{ and } j = 1,2,3,\ldots,n. \tag{2.2}$$

Step4: Determining positive and negative ideal solution positive ideal solution matrix calculated with equation (2.3), whereas the negative ideal solution matrix based on equation (2.4)

$$\mathrm{P}^{+} = \left(\mathrm{z}_1^{+}, \mathrm{z}_2^{+}, \ldots\ldots, \mathrm{z}_\mathrm{n}^{+}\right) \tag{2.3}$$
$$\mathrm{P}^{-} = \left(\mathrm{z}_1^{-}, \mathrm{Z}_2^{-}, \ldots\ldots, \mathrm{Z}_\mathrm{n}^{-}\right). \tag{2.4}$$

Step 5: The distance of each candidate from positive from positive and negative ideal solution The distance alternative P with positive ideal solution can be formulated with equation (2.5)

$$D_i^{+} = \sum_{j=1}^{n} \left|y_{ij} - z_i^{+}\right|; i = 1,2,3\ldots m. \tag{2.5}$$

The distance between alternative P with negative ideal solution can be formulated with equation (2.6)

$$D_i^{-} = \sum_{j=1}^{n} \left|y_{ij} - z_i^{-}\right|; i = 1,2,3\ldots m. \tag{2.6}$$

Step 6: Determining the value of preference for each alternative the preference value for each alternative $(\mathrm{C_i})$ is given as:

$$C_i = \frac{D_i^{-}}{D_i^{+} + D_i^{-}}$$

Method of selection of patient's affecting heart diseases by using the range in TOPSIS Methods:

Table 1. Range of risk factors in Blood Pressure

Input variable crisp sets	Blood	Urine	Pulse
Person 1	[0.3-0.5]	[0.4-0.6]	[0.2-0.3]
Person 2	[0.2-0.3]	[0.3-0.4]	[0.2-0.3]
Person 3	[0.1-0.2]	[0.1-0.2]	[0.0-0.1]
Person 4	[0.0-0.1]	[0.0-0.1]	[0.0-0.1]

where $\mathrm{C_1} = \text{Person 1}, \mathrm{C_2} = \text{Person 2}, \mathrm{C_3} = \text{Person 3}, \mathrm{C4} =$ Person 4and $\mathrm{A_1} = \text{Blood}$, $\mathrm{A_2} = \text{Urine}$ $\mathrm{A_3} = \text{Pulse}$.

Table 2. Probability for the range of A_1, A_2 and A_3

Criteria \ Alternative	A_1	A_2	A_3	TOTAL
C_1	0.45	0.40	0.50	2.50
C_2	0.25	0.30	0.40	1.50
C_3	0.15	0.20	0.20	0.80
C_4	0.05	0.10	0.10	0.70
TOTAL	1.0	1.0	1.2	4.5

Weight $\sum W_j = 1$; $\mathrm{W_1} = 0.2222$, $\mathrm{W_2} = 0.2222$, $\mathrm{W_3} = 0.2667$.

Table 3. Normalized Fuzzy Numbers

Criteria \ Alternative	A_1	A_2	A_3
C_1	0.45	0.40	0.4167
C_2	0.25	0.30	0.3333
C_3	0.15	0.20	0.1667
C_4	0.05	0.10	0.0833

$\mathrm{y_{ij}} = \left(\mathrm{r_{ij}}\right)\mathrm{W_j}$.

Table 4. The preference for the alternatives with blood pressures

S.No.	Criteria	$S_i^+ = \left\|y_{ij} - z_i^+\right\|$	$S_i^- = \left\|y_{ij} - z_i^-\right\|$	$C_i = \frac{D_i^-}{D_i^+ + D_i^-}$	Rank
1	C_1	0.0889	0.1123	0.5582	2
2	C_2	0.1345	0.0667	0.3315	4
3	C_3	0.0901	0.1111	0.5522	3
4	C_4	0.0678	0.1334	0.6630	1

Table 5. Weighted and Normalized Fuzzy Numbers

Criteria \ Alternative	A_1	A_2	A_3
C_1	0.0100	0.0889	0.1111
C_2	0.0556	0.0667	0.0889
C_3	0.0333	0.0444	0.0445
C_4	0.0111	0.0222	0.0222

$P^+ = \{0.0100, 0.0889, 0.0222\}, P^- = \{0.0556, 0.0222, 0.1111\}$

$D_i^+ = \left|y_{ij} - z_i^+\right|$

$D_1^+ = 0.0889 D_2^+ = 0.1345 D_3^+ = 0.0901 D_4^+ = 0.0678$

$D_i^- = \left|y_{ij} - z_i^-\right|$

$D_1^- = 0.1123 \quad D_2^- = 0.0667 D_3^- = 0.1111 D_4^- = 0.1334$

$$C_i = \frac{D_i^-}{D_i^+ + D_i^-}$$

Table 6. Range of risk factors in Cholesterol

	Low Density Lipoprotein (LDL)	High Density Lipoprotein (HDL)	Triglycerides
Person 1	[0.0-0.1]	[0.1-0.2]	[0.3-0.4]
Person 2	[0.1-0.2]	[0.3-0.4]	[0.6-0.7]
Person 3	[0.3-0.4]	[0.4-0.5]	[0.6-0.7]
Person 4	[0.4-0.5]	[0.5-0.6]	[0.6-0.8]
Person 5	[0.6-0.7]	[0.4-0.6]	[0.7-0.8]
Person 6	[0.5-0.6]	[0.3-0.4]	[0.4-0.6]
Person 7	[0.7-0.8]	[0.4-0.5]	[0.3-0.4]
Person 8	[0.3-0.5]	[0.6-0.7]	[0.5-0.6]
Person 9	[0.2-0.4]	[0.8-0.9]	[0.7-0.8]
Person 10	[0.8-0.1]	[0.9-0.1]	[0.6-0.7]

Where $C_1 =$ Person 1, $C_2 =$ Person 2, $C_3 =$ Person 3, $C_4 =$ Person 4, $C_5 =$ Person 5, $C_6 =$ Person 6 $C_7 =$ Person 7, $C_8 =$ Person 8, $C_9 =$ Person 9, $C_{10} =$ Person 10 and $A_1 =$ Low Density Lipoprotein (LDL), $A_2 =$ High Density Lipoprotein (HDL), $A_3 =$ Triglycerides.

Table 7. Probability for the range of A_1, A_2 and A_3

Criteria \ Alternative	A_1	A_2	A_3	TOTAL
C_1	0.81	1.56	0.35	2.72
C_2	0.85	0.51	0.65	2.01
C_3	0.32	0.47	0.63	1.42
C_4	0.53	0.56	0.70	1.79
C_5	0.65	0.50	0.78	1.93
C_6	0.54	0.32	0.50	1.36
C_7	0.75	0.45	0.40	1.60
C_8	0.42	0.65	0.54	1.61
C_9	0.35	0.80	0.72	1.87
C_{10}	0.85	0.92	0.68	2.45
TOTAL	6.07	6.74	5.95	18.76

Weight

$W_1 = 0.3236$, $W_2 = 0.3593$, $W_3 = 0.3172$.

Table 8. Normalized Fuzzy Numbers

Criteria \ Alternative	A_1	A_2	A_3
C_1	0.1334	0.2315	0.0588
C_2	0.1400	0.0757	0.1092
C_3	0.0527	0.0697	0.1059
C_4	0.0873	0.0831	0.1176
C_5	0.1071	0.0742	0.1311
C_6	0.0890	0.0475	0.0840
C_7	0.1236	0.0668	0.0672
C_8	0.0692	0.0964	0.0908
C_9	0.0577	0.1187	0.1210
C_{10}	0.1400	0.1365	0.1143

$$y_{ij} = (r_{ij})\, W_j$$

Table 9. Weighted and Normalized Fuzzy Numbers

Criteria \ Alternative	A_1	A_2	A_3
C_1	0.0432	0.0832	0.0187
C_2	0.0453	0.0272	0.0346
C_3	0.0171	0.0250	0.0336
C_4	0.0283	0.0299	0.0373
C_5	0.0347	0.0267	0.0416
C_6	0.0289	0.0171	0.0266
C_7	0.0400	0.0240	0.0213
C_8	0.0224	0.0346	0.0288
C_9	0.0187	0.0426	0.0384
C_{10}	0.0453	0.0490	0.0363

$$P^{+} = \{0.0171, 0.0832, 0.0187\} \text{ and}$$
$$P^{-} = \{0.0453, 0.0171, 0.0416\}$$
$$D_i^{+} = \left|y_{ij} - z_i^{+}\right|$$
$$D_1^{+} = 0.0261, D_2^{+} = 0.1001, D_3^{+} = 0.0731, D_4^{+} = 0.0831,$$
$$D_5^{+} = 0.097, D_6^{+} = 0.0858, D_7^{+} = 0.0847, D_8^{+} = 0.064,$$
$$D_9^{+} = 0.0619, D_{10}^{+} = 0.08$$
$$D_i^{-} = \left|y_{ij} - z_i^{-}\right|$$
$$D_1^{-} = 0.0911, D_2^{-} = 0.0171, D_3^{-} = 0.0441, D_4^{-} = 0.0341,$$
$$D_5^{-} = 0.0202, D_6^{-} = 0.0314$$
$$D_7^{-} = 0.0325, D_8^{-} = 0.0532,$$
$$D_9^{-} = 0.0553, D_{10}^{-} = 0.0372$$
$$C_i = \frac{D_i^{-}}{D_i^{+} + D_i^{-}}$$

Table 10. The preference for the alternative with cholesterol

S.NO	CRITERIA	$D_i^{+} = \left\|y_{ij} - z_i^{+}\right\|$	$D_i^{-} = \left\|y_{ij} - z_i^{-}\right\|$	$C_i = \frac{D_i^{-}}{D_i^{+} + D_i^{-}}$	Rank
1	C_1	0.0261	0.0911	0.7773	1
2	C_2	0.1001	0.0171	0.1459	10
3	C_3	0.0731	0.0441	0.3763	4
4	C_4	0.0831	0.0341	0.2910	6
5	C_5	0.097	0.0202	0.1724	9
6	C_6	0.0858	0.0314	0.2679	8
7	C_7	0.0847	0.0325	0.2773	7
8	C_8	0.064	0.0532	0.4539	3
9	C_9	0.0619	0.0553	0.4718	2
10	C_{10}	0.08	0.0372	0.3174	5

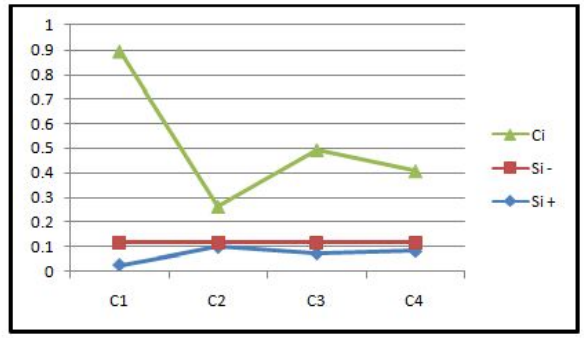

Figure 1. The preference for the alternatives with blood pressures

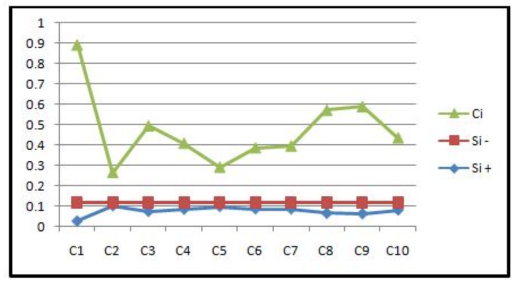

Figure 2. The preference for the alternative with cholesterol

3. Conclusion

From the Table 5 above with Blood pressure, we have observed that the 4th person should be treated first having the high risk probability ,1st person should be treated second having the second high risk probability, third person should be treated 3 rd having the 3rd high risk probability and the 2nd person should be treated finally having the low risk probability.

Similarly from the Table 10 above with cholesterol, we observed that 1th person should be treated first having the high risk probability. In succession, we proceed for the treatment for all the person with given ranks and finally the second person should be treated last having the low risk probability.

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