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Mathematical study to demonstrate the utilization of TOPSIS to find the maximum possibility of HCV causes

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Abstract.: Hepatitis C virus (HCV) is a single strained RNA virus. It is one of the leading cause of liver-related mortality worldwide. Globally, 115 million people are infected with HCV. This study aims to find the maximum possibility of occurrence of HCV causes, genotypes and variables gender wise using TOPSIS (Technique for Order Preference by Similarity to Ideal Solution). Our findings shows that, if a nation controls on intravenous drug users then they would be able to save the male community and in case of blood transfusion and other causes women would be saved by implementing hygienic policies in clinics. Whereas, in case of genotype 1 women are on the top and in all other genotypes men are on top. In case of HAI, by applying TOPSIS we figure out that, the severity of the disease is present in women as relative closeness coefficient was higher for women in case of HAI (greater than equal to 7) as compared to men. Fibrosis score (1-2) are reported in case of infected women and (3-4) are reported in case of infected men. We proposed that, in order to decrease rate of HCV infections, results of different mathematical model like TOPSIS should be utilized to suggest precautions to an infected individual.

AMS (MOS) Subject Classification Codes: 90B50; 62P10; 90C31
Key Words: TOPSIS, HCV, Genotypes, HAI, Fibrosis.

1. INTRODUCTION

Hepatitis C virus (HCV) is a blood borne protracted pathogen accepting conclusive single standard RNA. Firstly it was found out in 1989, this virus is native to a pathogen family Flaviviridae also known as Ribonucleic acid (RNA) virus with an estimated diameter of $40-50$ nm [8,19]. Six dominant HCV genotypes and a couple of subtypes were identified from all over the world. Following the acquisition of the virus, acute HCV infection can lead towards chronic infection, which is associated with several morbidities, such as liver cirrhosis and cancer [6,15]. HCV genome is roughly 9.6 kb in length including single open reading frame and encodes a polypeptide, consisting of 3000 amino acids [$2,9,12$]. HCV is often a prime cause of liver diseases with liver fibrosis, liver cirrhosis and hepatocellular lump. Identification of HCV genotype/subtype is useful clinically before prescribing therapy, because genotypes 1 and 4 exhibit better resistance in comparison to genotypes 2 and 3 to PEG-IFN plus ribavarin treatment. That is why, various kinds of HCV genotypes take the different period and dose of anti-viral therapy. Treatment durations in favor of genotypes 1 and 4 are 48 pace while for 2 and 3 is 24 pace including PEG-IFN surplus ribavarin remedial treatment [14]. The world health organization estimates that roughly, 3% of the world population have already been infected with HCV till now. Roughly a quarter of one million deaths every year take place as a result of chronic liver virus inherent in HCV.

At early stage, it was believed that blood transfusion and contaminated syringes were the main routes of transmission of HCV. Moreover recent studies shows the other reasons of transfer of HCV virus includes contaminated injections, vertical transmission, sexual relations, armpit trimming, shaving at barber shop, tattooing as well as improper sterilization of surgical or dental instruments. In spite of, the utilization of latest laboratory equipment for the purpose of blood screening, blood transfusion is the main cause of transmission of HCV [7,11]. The data for growing hepatitis A and hepatitis B is well established in universal epidemiology. Whereas, for HCV the data is still limited. Remarkably, in the history of infected cases, HCV continues to be unfamiliar because of its asymptomatic structure.

In recent years, application of correlation on different diseases got a high consideration of researchers. Roberto et al. [3] illustrates the assessment of HCV viremia with the help of correlation and they find out that the HCV-Ag assay as an alternative to quantification of HCV RNA. Even if the HCV-Ag evaluation was slighter precise than the PCR evaluation, the correlation within the two assays became outstanding. Mozhgan et al. [17] worked on the correlation between different risk factors of HCV and different genotypes. They examined the predominance of these risk factors for various genotypes of HCV and indicate the possible relations between each risk factor and transmission of every genotype. Ahmed et al. [4] elaborated the relationship of the serum level of IL28B in HCV-infected patients with infection genotype/sub genotype and disease advancement. They concludes that IL28B variations may assume a critical part in HCV infection, but not be considered as risk factors in the development of HCV infection to advances stages, for example, liver cirrhosis and HCC. Shahid et al. [22] investigated the relation among serum biochemical markers, HCV RNA titers in patients with chronic HCV and their study suggests that AST, ALP and ALT may be correlated with liver damage. Muhammad et al. [21] presented an evaluation of HCV knowledge and correlations with health belief model constructed among African American “baby boomers” and assess the status, and survey the status, predictors, and correlations of HCV learning among African-American children of post war America (AABBs) in Washington, DC. They concluded that the lower level of training and old age were huge indicators of lacking HCV knowledge.

It is seen that in recent years, many researcher reveal the necessity of correlation in diseases, their symptoms, variables and their effects on human body etc. The main motive of our work is to use a technique which shows the possibility of occurrence of HCV causes, genotypes and variables gender wise. The technique named as TOPSIS was first proposed by Hwang and Young in 1981 [13]. HCV is a chronic viral disease which has numerous causes, genotypes and variables on the basis of which we work out on this disease. In this paper we make three cases based on the causes of HCV which includes intravenous drug use, transfusion and other causes. Then we apply TOPSIS [13] on each cause to check whether the ratio of this cause is greater in men, women or in both genders. After evaluating the results of different cases of HCV causes, we move towards the genotypes and two variables of HCV i.e. Hepatic Activity Index (HAI) and fibrosis score. We again apply TOPSIS on each variable and genotypes to find out maximum concentration of these in both genders separately or collectively. In the last section we discuss the results of our work in a comprehensive manner.

2. TOPSIS

Hwang and Youn firstly gave idea of TOPSIS. It is the most applicable and helpful method in decision making. We employ TOPSIS to choose and to scale the possible choices in any data with the help of distance measure formulas. The primary notion of TOPSIS is that the selected choices are closest to the best alternative and farthest from the worst alternative. The steps for the evaluation of TOPSIS are given below. [13].

Step 1: Make a matrix J which is based on t criteria and s alternatives.

$$J = [x_{ij}]_{s\times t} \tag{2. 1}$$

in eq (1) x_{ij} is the criteria for each alternative.

Step 2 : Normalize the evaluation matrix to the matrix $[n_{ij}]_{s\times t}$ and n_{ij} can be obtained from Eq. (2)

$$n_{ij} = \frac{x_{ij}}{\sqrt{\sum\limits_{i=1}^{s} x_{ij}^2}} : i = 1, 2, \cdots, s \text{ and } j = 1, 2, \cdots, t. \tag{2. 2}$$

Step 3 : Eqs. (3) and (4) are used to find out the most competitive and most unfavorable selection of solution.

$$B^+ = \{< \max(n_{ij}|i = 1, 2, \cdots, s)|j \in \text{Favorable criteria} >, \tag{2. 3}$$

$$< \min(n_{ij}|i = 1, 2, \cdots, s)|j \in \text{Unfavorable criteria} >\}$$

$$B^+ = \{x_1^+, x_2^+, \cdots, x_t^+\}$$

$$B^- = \{< \min(n_{ij}|i = 1, 2, \cdots, s)|j \in \text{Favorable criteria} >, \tag{2. 4}$$

$$< \max(n_{ij}|i = 1, 2, \cdots, s)|j \in \text{Unfavorable criteria} >\}$$

$$B^- = \{x_1^-, x_2^-, \cdots, x_t^-\}$$

Step 4 : Separation matrices $D^+$and D^- can be calculated from Eqs. $(5 - 6)$.

$$D^+ = [d_i^+]_{s\times 1} \tag{2. 5}$$

$$D^- = [d_i^-]_{s\times 1} \tag{2. 6}$$

whereas,

$$d_i^+ = \sqrt{\sum_{j=1}^{t}(n_{ij} - x_j^+)^2}$$

and

$$d_i^- = \sqrt{\sum_{j=1}^{t}(n_{ij} - x_j^-)^2}$$

Step 5 : Relative closeness coefficient (RCC) for every possible choice from the B^+ as well as B^- through the use of Eq. (7).

$$RCC_i = \frac{d_i^-}{d_i^+ + d_i^-} \qquad \text{for } i = 1, 2, \cdots, s \tag{2. 7}$$

Step 6 : Grade the possible choices according to relative closeness coefficient (RCC) largest the value, better will be the choice and vice versa.

3. CAUSES OF HCV

Hepatitis C is transmitted by means of association with another individual who is infected with HCV. HCV exists initially in the blood and to a slighter level in other body fluids of an infected individual. Nowadays, it is transferred most ordinarily by means of sharing of contaminated needles via injecting drug users. Blood transfusion is also considered as a major cause of transmission of HCV especially in hospitals. Due to improper sterilization of surgical instrumentation (in dental clinics), the number of HCV infected prople increases more rapidly in devaloping countries as compared to the devaloped ones [7]. In this section application of TOPSIS on three major causes of transmission of HCV on both genders as well as the case of all patients in which men and women both are included is discussed. The data used in table 1 is taken from [23].

Table 1. Data of 112 patients on causes of HCV

	Intravenous drug use	Transfusion	Other
All patients (n = 112)	16	20	76
Men (n = 62)	12	9	41
Women (n = 50)	4	11	35

Step 1.

The matrix J is formed by using eq (1).

$$J = \begin{pmatrix} 16 & 20 & 76 \\ 12 & 9 & 41 \\ 4 & 11 & 35 \end{pmatrix}$$

Step 2.

The normalized matrix is presented below.

$$\begin{pmatrix} 0.7844 & 0.8151 & 0.8156 \\ 0.5883 & 0.3668 & 0.4400 \\ 0.1961 & 0.4483 & 0.3756 \end{pmatrix}$$

Step 3. By using Eqs. $(3-4)$, find the most favorable and unfavorable solution. As the data in table 1 shows the transmission of HCV, there are 3 causes discussed over there so we cannot evaluate them collectively. In such type of situations different cases are made.

Case 1.

Initially consider transfusion as a benefit criteria and other two causes as cost criteria, so the positive optimal solution and negative optimal solution are listed below:

$B^{+} = \begin{pmatrix} 0.1961 & 0.8151 & 0.3756 \end{pmatrix}$ and $B^{-} = \begin{pmatrix} 0.7844 & 0.3668 & 0.8156 \end{pmatrix}$

Case 2.

In this case consider intravenous drug use as positive optimal solution and other two as negative optimal solution.

$B^{+} = \begin{pmatrix} 0.7844 & 0.3668 & 0.3756 \end{pmatrix}$ and $B^{-} = \begin{pmatrix} 0.1961 & 0.8151 & 0.8156 \end{pmatrix}$

Case 3.

Now other causes as positive optimal solution and other two as negative optimal solution.

$B^{+} = \begin{pmatrix} 0.1961 & 0.3668 & 0.8156 \end{pmatrix}$ and $B^{-} = \begin{pmatrix} 0.7844 & 0.8151 & 0.3756 \end{pmatrix}$

Step 4.

Now by using Eq. $(5-6)$ we obtain D^{+} and D^{-} for all three cases and the positive and negative decision matrices for each case is cited below after the usage of concerned values of respective parameters.

For case 1 :

$D^{+} = \begin{pmatrix} 0.7346 \\ 0.5991 \\ 0.3668 \end{pmatrix}$ and $D^{-} = \begin{pmatrix} 0.4483 \\ 0.4237 \\ 0.7391 \end{pmatrix}$

For case 2 :

$D^{+} = \begin{pmatrix} 0.6281 \\ 0.2066 \\ 0.5939 \end{pmatrix}$ and $D^{-} = \begin{pmatrix} 0.5883 \\ 0.7041 \\ 0.5728 \end{pmatrix}$

For case 3 :

$D^{+} = \begin{pmatrix} 0.7396 \\ 0.5430 \\ 0.4474 \end{pmatrix}$ and $D^{-} = \begin{pmatrix} 0.444 \\ 0.4935 \\ 0.6932 \end{pmatrix}$

Step 5 : Finally, relative closeness coefficient is evaluated with the aid of the use of $Eq.(7)$ and values of involved parameters.

Relative closeness coefficient for case 1:

$RCC_1 = 0.3789$, $RCC_2 = 0.4142$, $RCC_3 = 0.6683$.

It shows that when we consider transfusion as our benefit criteria chances of occurrence of HCV would be higher in women.

Relative closeness coefficient for case 2:

$RCC_1 = 0.4836$, $RCC_2 = 0.7731$, $RCC_3 = 0.4909$

Closeness coefficient of case 2 shows that occurrence of HCV would be higher in men.

Relative closeness coefficient for case 3:

$RCC_1 = 0.3730$, $RCC_2 = 0.4761$, $RCC_3 = 0.6077$.

In this case occurrence of HCV would be higher in women.

4. HCV Genotypes and Variables

There are various variables of HCV, on the basis of these variables one can predict the level of activation of virus, liver damage situation and the kind of treatment which should be given to the infected patient. In this section genotypes and two of these variables are discussed.

4.1. **HCV Genotypes.** An essential variable for all patients infected with HCV is the "genotype" of HCV. Basically there are 6 genotypes and each genotype is further divided into sub types. Genotype 1 is noted in maximum number of reported cases of HCV [18].The HCV genotype is not simply related to the extent of liver damage, but it can also help to predict the outcome of anti-HCV treatment with interferon-based treatment regimens. Genotype also helps to determine that, which kind of treatment a patient required. In this paper only two cases of genotype are discussed genotype 1 and non-1 whereas, genotype non-1 means the rest of the genotypes ranging from 2 to 6. The data listed in table 2 is also taken from [23].

Table 2. HCV Genotypes

	Genotype 1	Genotypes $2-6$
All patients $(\mathrm{n}=112)$	63	49
Men $(\mathrm{n}=62)$	33	29
Women $(\mathrm{n}=50)$	30	20

Step 1. The evaluation matrix.

$$K = \begin{pmatrix} 63 & 49 \\ 33 & 29 \\ 30 & 20 \end{pmatrix}$$

Step 2. The normalized matrix is presented below.

$$\begin{pmatrix} 0.8162 & 0.8119 \\ 0.4275 & 0.4805 \\ 0.3887 & 0.3314 \end{pmatrix}$$

Step 3. The same strategy is used in above procedure.

Case 1.

At first consider Genotype 1 as the benefit criteria and genotype $2-1$ as cost criteria.

So the positive optimal solution and negative idea solutions are listed below:

$B^+ = \begin{pmatrix} 0.8162 & 0.3314 \end{pmatrix}$ and $B^- = \begin{pmatrix} 0.3887 & 0.8119 \end{pmatrix}$.

Case 2.

In this case consider Genotypes $2-1$ as our benefit criteria and genotype 1 as cost criteria.

$B^{+}=\begin{pmatrix}0.3887 & 0.8119\end{pmatrix}$ and $B^{-}=\begin{pmatrix}0.8162 & 0.3314\end{pmatrix}$.

Step 4.

Similarly, the positive and negative decision matrices for both cases is cited below after the usage of concerned values of respective parameters.

For case 1 :

$$D^{+}=\begin{pmatrix}0.4805\\0.4163\\0.4275\end{pmatrix} \text{ and } D^{-}=\begin{pmatrix}0.4275\\0.3336\\0.4805\end{pmatrix}$$

For case 2 :

$$D^{+}=\begin{pmatrix}0.4275\\0.3336\\0.4805\end{pmatrix} \text{ and } D^{-}=\begin{pmatrix}0.4805\\0.4163\\0.4275\end{pmatrix}$$

Step 5. Relative closeness coefficients are given below.

Relative closeness coefficient for case 1 :

$RCC_1=0.4708$, $RCC_2=0.44448$, $RCC_3=0.5291$

It shows that when genotype 1 is considered as best alternative chances of occurrence of HCV would be higher in women.

Relative closeness coefficient for case 2 :

$RCC_1=0.5291$, $RCC_2=0.5551$, $RCC_3=0.4708$

Closeness coefficient of case 2 shows that occurrence of HCV would be higher in men.

4.2. **HAI (Hepatic activity index).** Hepatitis activity index HAI or grading and fibrosis stage or staging are two important points that determine the mild, moderate or the severity of the disease. TOPSIS is also applied on the data in table 3 is taken from [23].

Table 3. HAI of Patients

	$1-6$	≥ 7
All patients $(\text{n}=112)$	58	54
Men $(\text{n}=62)$	33	29
Women $(\text{n}=50)$	25	25

Step 1. The evaluation matrix.

$$L=\begin{pmatrix}58 & 54\\33 & 29\\25 & 25\end{pmatrix}$$

Step 2. The normalized matrix is presented below.

$$\begin{pmatrix}0.8139 & 0.8157\\0.4631 & 0.4380\\0.3508 & 0.3776\end{pmatrix}$$

Step 3. Here same strategy is utilized.

Case 1.

Consider HAI $(1-6)$ as the benefit criteria and HAI (≥ 7) as cost criteria.

so the positive optimal solution and negative ideal solutions are listed below:

$B^{+}=\begin{pmatrix}0.8139 & 0.3776\end{pmatrix}$ and $B^{-}=\begin{pmatrix}0.3508 & 0.8157\end{pmatrix}$

Case 2.

In this case consider ≥ 7 as positive optimal solution and $(1-6)$ as negative optimal solution.

$B^{+} = \begin{pmatrix} 0.3508 & 0.8157 \end{pmatrix}$ and $B^{-} = \begin{pmatrix} 0.8139 & 0.3776 \end{pmatrix}$

Step 4.

Similarly, the positive and negative decision matrices for both cases is defined below.

For case 1 :

$D^{+} = \begin{pmatrix} 0.4381 \\ 0.3559 \\ 0.4631 \end{pmatrix}$ and $D^{-} = \begin{pmatrix} 0.4631 \\ 0.3940 \\ 0.4381 \end{pmatrix}$

For case 2 :

$D^{+} = \begin{pmatrix} 0.4631 \\ 0.3940 \\ 0.4381 \end{pmatrix}$ and $D^{-} = \begin{pmatrix} 0.4381 \\ 0.3559 \\ 0.4631 \end{pmatrix}$

Step 5.

Relative closeness coefficient are given below.

Relative closeness coefficient for case 1 :

$RCC_1 = 0.5138$, $RCC_2 = 0.5254$, $RCC_3 = 0.4861$

It shows that when HAI $(1-6)$ is considered as best alternative chances of occurrence of HCV would be higher in men.

Relative closeness coefficient for case 2 :

$RCC_1 = 0.46300$, $RCC_2 = 0.4745$, $RCC_3 = 0.51387$

Closeness coefficient of case 2 shows that occurrence of HCV would be higher in women.

4.3. **Fibrosis score.** Chronic HCV is a main cause of liver-related morbidity and mortality worldwide, which leads to liver fibrosis and other liver complications [10]. Liver fibrosis is a bulk of extracellular matrix proteins including collagen and it is considered as a wound healing response to chronic liver damage. Fibrosis ratings varies from 0 to 4, zero shows no symptoms of fibrosis and four shows the presence of cirrhosis. Middle ratings, which includes 3 shows that fibrosis has grown and is related to different regions in the liver, that incorporate fibrosis [16]. Fibrosis score also determine the extent of treatment, that should be given to infected patient. High fibrosis score indicates chances of cirrhosis, liver disease, or both. The data listed in table 4 is taken from [23].

Table 4. Fibrosis score of Patients

	$0-2$	$3-4$
All patients (n = 112)	78	34
Men (n = 62)	43	19
Women (n = 50)	35	15

Step 1.

The evaluation matrix.

$L = \begin{pmatrix} 78 & 34 \\ 43 & 19 \\ 35 & 15 \end{pmatrix}$

Step 2.
The normalized matrix is presented below.
$$\begin{pmatrix} 0.8150 & 0.8146 \\ 0.4493 & 0.4552 \\ 0.3657 & 0.3593 \end{pmatrix}$$
Step 3.
Case 1.
Consider fibrosis score $(0-2)$ as the benefit criteria and $(3-4)$ as cost criteria.
so the positive optimal solution and negative idea solutions are listed below:
$B^{+} = \begin{pmatrix} 0.8150 & 0.3593 \end{pmatrix}$ and $B^{-} = \begin{pmatrix} 0.3657 & 0.8146 \end{pmatrix}$
and reversing the criteria gives
$B^{+} = \begin{pmatrix} 0.3657 & 0.8146 \end{pmatrix}$ and $B^{-} = \begin{pmatrix} 0.8150 & 0.3593 \end{pmatrix}$
Step 4.
Similarly, the positive and negative decision matrices for both cases are written below.
For case 1 :
$$D^{+} = \begin{pmatrix} 0.4553 \\ 0.3780 \\ 0.4493 \end{pmatrix} \text{ and } D^{-} = \begin{pmatrix} 0.4493 \\ 0.3689 \\ 0.4553 \end{pmatrix}$$
For case 2 :
$$D^{+} = \begin{pmatrix} 0.4493 \\ 0.3689 \\ 0.4553 \end{pmatrix} \text{ and } D^{-} = \begin{pmatrix} 0.4553 \\ 0.3780 \\ 0.4493 \end{pmatrix}$$
Step 5.
Relative closeness coefficient are given below.
Relative closeness coefficient for case 1 :
$RCC_1 = 0.4966$, $RCC_2 = 0.4939$, $RCC_3 = 0.50331$
This case shows occurrence of HCV would be higher in women.
Relative closeness coefficient for case 2 :
$RCC_1 = 0.50331$, $RCC_2 = 0.50609$, $RCC_3 = 0.4966$
In this case occurrence of HCV would be higher in men.

5. Discussion and Conclusion

In recent years, many developed countries have controlled the spreading of HCV through unsafe blood transfusions. Chances of possessing transfusion transmitted HCV is below 1 case per million blood units in many countries. Whereas, scenario is quite different in case of poor areas of the world, where many people infected with HCV each year due to unhygienic blood transfusions, reuse of infected medical tools and intravenous drug use etc. Intravenous drug use is not only considered as a cause of HCV but it is also responsible for social and environmental disaster [1]. The most important measure to be taken in this regard is the rehabilitation and recovery of drug addicts. A number of epidemiological studies have introduced associations between HCV seropositivity and the use of unhygienic health-care devices like syringes [11]. By the time, when health-care products and services form a high number of alternatives, it is vital that other blood transmission specialists study their own policies and priorities. As well as, discuss them with specialists in other medical

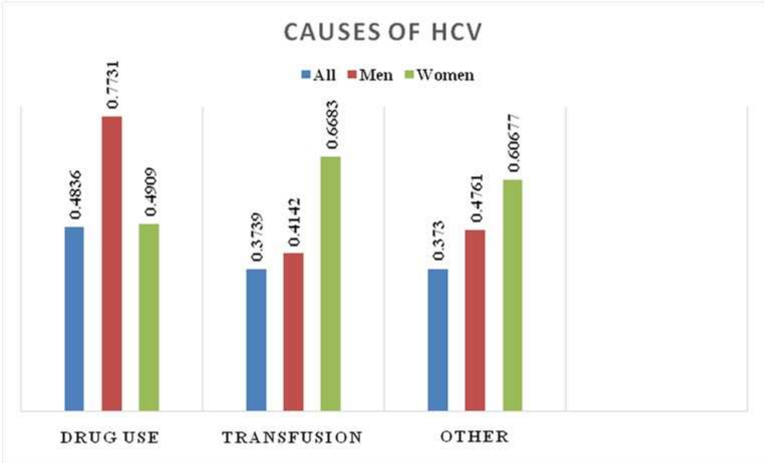

FIGURE 1. RCC values for Causes of HCV

disciplines, which ensures that the strategy of future decisions would be vital for an educated community. Need of the time is to work on this virus and compile a global method to decrease the number of infected people. The health care surroundings are free of risk to some extent. Even though in countries who have preferred strong hygienic practices, patients still get HCV infection from other patients or infected health-care workers.

The above mentioned discussion is all about the causes of transmission of HCV. But in case of genotypes and variables like fibrosis score and HAI, they only predict that on which stage our patient lies, how much the liver is being damaged, to what extent the virus is activated and which kind of treatment should be provided.

The motive of this paper is to reveal the necessity of multi criteria decision making TOPSIS. With the utilization of this technique we investigate the maximum possibility of each variable and HCV causes in both genders separately and collectively. Our results shows that:

(1) In case of intravenous drug use men are at the top of the list whereas in the other two causes of HCV women are at highest rank.
(2) In case of HCV genotypes when genotype 1 is our benefit criteria women are on the top and in genotypes $2-6$ men are at the top.
(3) In case of HAI when HAI value lies in the interval $1-6$, men are on the top and in case of ≥ 7, women are at the top.
(4) In case of fibrosis score when score is $0-2$ then women are on the highest rank and in case of $3-4$ men are at the top.

As it is clear from Fig 1 that the relative closeness of men drug users is higher in case of causes of transmission of HCV. Additionally in the $21st$ century, nationwide surveys shows that males offend drugs at higher contribution than females. In 2013 national survey on drug use and health proposed that near to 12 percent of American men age 12 and older were presently using narcotic drug, compared with only over 7.3 percent of females within the equivalent age group. Multi-drug practice was more usual in males than in females.

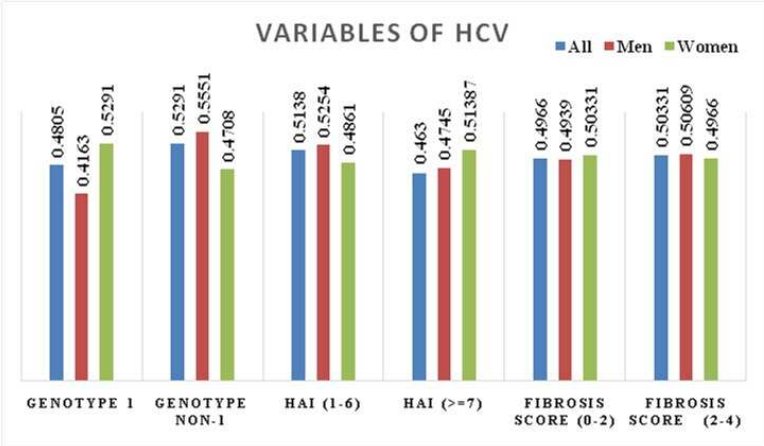

FIGURE 2. RCC values for Genotype and Variables of HCV

In addition the reasons that why men are more addicted to drugs are:

(1) Males get started the use of drugs at an earlier age.
(2) Males offend drugs more often and in more amounts.
(3) Males usually tend to use alcohol and tobacco.

According to analysis of the national institute on drug abuse (NIDA) since 2012, there have been more deaths due to HCV as compared to other 60 well known viral disease. NIDA recommends that more males practice drugs at their teen age not for the reason that they are more attracted to drug abuse, but they have got many chances. Pre-adult males are more likely to exhibit drugs in consequence of their age group than pre-adult girls, who are usually made known to drugs by boys. People infected from HCV and intravenous drug use in men generally be afflicted by many other health conditions simultaneously, such as mental sickness and HIV/aids, thus demanding protection from many health care workers. Unsafe sexual relations also cause higher risk of HCV [24].

Eventually, anybody infected with HCV and drug users, must be given appropriate information about getting treatment of the disease. Literature have been found on various strategies that should be taken to reduce the rate of HCV infection worldwide [20].There is no proof to strengthen the explanation that intravenous drug users must be forbidden from getting HCV treatment individually on the base of their history or current drug use position. It is time to treat intravenous drug users because drug users are the maximum portion of population infected with HCV.

Fig 2 shows that, relative closeness of genotype non-1 is maximum in case of men when we compare HCV genotypes, Fibrosis score and HAI. HCV is a disease which affects males more than females. After primary HCV infection, females usually tend to eliminate the infection automatically. Females also have slower rates of liver disease development than males if they turn into chronically infected. That is why fibrosis score is higher in case of men. Whereas, by the time the variation of disease development occurs in case of females. Old age females have high rates of fibrosis compared to young females, because protective effects of estrogen have lost in old age. Estradiol and estrogen receptors in the liver protects hepatocytes from oxidative stress, incitive wound and cell death, that all lead fibrosis. As a consequence of the total slower liver disease development and elevated viral clearance in females, the rate of HCV infection is mostly high in male [5].

Our study concludes that, mathematical models like TOPSIS should be utilized in future by the biologists to decrease the ratio of HCV in males and females, because the models predict the occurrence of maximum or minimum possibility of a disease in a person. As a result of these predictions a person can take precautions to save his/herself from the risk of disease.

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