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Prediction and analysis of health risk by using fuzzy control system

Gunjan Kalra
Department of the Mathematics, School of Basic and Applied Science, K. R. Mangalam University, Sohna Road Gurugram, Haryana, India-122103
Email: gunjankapoor089@gmail.com

Rahul Boadh
Department of the Mathematics, School of Basic and Applied Science, K. R. Mangalam University, Sohna Road Gurugram, Haryana, India-122103
Corresponding author email: rboadh.iitkgp@gmail.com

Yogendra Kumar Rajoria
Department of the Mathematics, School of Basic and Applied Science, K. R. Mangalam University, Sohna Road Gurugram, Haryana, India-122103
Email: yogendrarajo@gmail.com

Rajendra. P
Department of Mathematics, CMR Institute of Technology, Bengaluru, Karnataka, India
Email: rajendra.padidhapu@gmail.com

***Abstract*---**The Fuzzy Control System (FCS) has various properties that make it reasonable for formalizing the unsure inflections whereupon clinical findings and treatment are typically based. A smart dynamic system for inexact thinking that can around handle the vulnerability of basic risk for human health utilizing a FCS carried out in an apparatus for discovering an investigation. An attempted has been made for the diagnosis of the human health risk has been identified with Blood Pressure, Blood sugar, Kidney functions in different age group. MATLAB2014b has been used for prediction the health risk using FCS tool. Aftercare fully examination, this study get the resendable well results as compared the previous study. It has also found that FCS utilized in this examination has support to take trustworthy choice at the ultimate venture for proposing treatment to the patients instantly and advocate additionally risk to change the lifestyle, food affinities, have checked from the treatment in future. The present FCS may be similarly subsequently used to anticipate different kinds of health risk including intellectual and actual infection conditions.

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Keywords---fuzzy control system, blood pressure, blood sugar, kidney function.

Introduction

Healthcare maintenance play significant role to improve physical health of people by the diagnosis, cure, recovery of disease, sickness, wound, and additional physical deficiency and service facility provided by health specialists. Financing in insurance is planned to fix and calculate the specific humanity risk of different applicants to pay for medicinal crises, and therapy which may probably happen in the future.

Fuzzy logic is an additional substitute for crisp logic, which was recline either zero or one, true or false to be set as the standard for years by researcher [1]. Fuzzy logic only permits in between value and fuzzy value can recline between zero and one. e.g. If any results can be correct up to any certain degree in %.but their crisp value has output either 100% for true, 0% for true. Crisp logic played significant role in development of in machineries and various types of systems with increasing effect of evolution of techno skill in Europe and America. The first who was applied Fuzzy logic in insurance [2]. The Author searched to enumerate the fuzziness in financing and has been worked in arena of insurance by using Fuzzy logic technology and their application which showed important significance in arena of insurance.

Fuzzy logic applied in wide-ranging sense and classified into four major aspects on the basis of narrow sense, set-theoretic, logical inference, relational and epistemic [3]. Fuzzy if-then rule is based on knowledge-based system which expresses the information to be handled for the period of imprecise cognitive. Mostly researcher has applied the fuzzy logic control system in R & D department and mathematicians, software developers, medical researchers, and public policy specialists. Fosters is a strategy for looking at fuzzy net incomes to rank fuzzy venture options from best to most noticeably terrible [4]. Fuzzy logic is based on technology of an Artificial intelligence which has impersonated human mind in form of inexact cognitive. An endeavour has been made to execute the issue of putting cash in the protection area, so as accomplish an exceptional yield with the assistance of fuzzy classification and it is give a superior comprehension of fuzzy classification [5]. The value of Fuzzy Set associated to partial membership in addition to the crisp values which are applicable to build situations. Elements in fuzzy set can overlie, therefore, crisp value related to multiform fuzzy sets which associated to distinct membership degrees for individual set. The Study of fuzzy logic, set and their classification in insurance sector [6].

There are two types of inference system one is given by [7] and other developed by [8] find output. Fuzzy inference rule developed to express a mapping which based on decisions from input to an output by employing fuzzy logic [9]. It has investigated by the special effect from membership function on inference system developed by Mamdani in his thesis [10]. Real life problem by interval type-2 fuzzy system as Defuzzification methods has to check uncertainty avoidance [11]. The

developed and applied fuzzy inference rule has to check effectiveness of the system and give a measurable security index to the cloud service providers [12].

Membership functions got from a portion of the notable pdfs and an application in addressing commotion defiled direct arrangement of conditions are introduced [13]. A sensible way to deal with fuzzy sets technique started by Giles is created for proposed fuzzy strategy concurs with the strategy for most extreme probability whenever utilized in issues of old-style numerical measurements [14]. The initial time clients of the fuzzy logic framework, this paper expects to give an itemized investigation of the current strategies used by analysts and modern experts to plan an ideal fuzzy logic framework [15].

An Algorithm based on genetic advancement calculation for the fuzzy rationale framework. The proposed calculation utilizes fuzzy entropy work as advancement bound(s) boundary. Fuzzy Set is boosted emotional to requirement enhancement and consequently streamlined worth of help is gotten. The proposed calculation enhances the help of Fuzzy Sets and thus can be joined with some other improvement apparatus for getting good outcomes [16]. GA and double molecule swarm improvement (BPSO) are utilized for executing the proposed technique also and they are analysed. It has been shown that utilizing clonal determination calculation is favourable for observing ideal upsides of membership functions of fuzzy [17]. The various levelled structure and the enrolment scaling of the framework are straightforwardly connected to the central association's profile and their procurement targets [18]. A different plan is proposed to create fuzzy enrolment capacities with unaided getting the hang of utilizing self-putting together component map [19]. A basic and effective compelled interjection plot is produced for fitting an enrolment capacity to a limited number of realized participation esteems [20]. In view of the enrolment capacities and the fuzzy standards determined, a comparing fuzzy expert system to deal with inputs is likewise developed [21].

The enhanced fuzzy rationale MPPT regulator (OFLC) is then recreated and assessed, which has shown better exhibitions [22]. In current serious situation the fuzzy rationale framework are being taken on by the car makers for the improvement of value and decrease of advancement time and the expense as well. Fuzzy rationale was imagined as a superior technique for arranging and taking care of information however has shown to be a magnificent decision for some control framework applications [23]. It very well may be smoothed to move along the ideal uprooting and speed signals and it is confirmed that the planned regulator has solid strong flexibility [24]. A widespread capacity estimate hypothesis dependent on a fuzzy powerful model and it has described the consequences of general fuzzy regulators for a huge class of nonlinear frameworks [25].

To extend the extent of utilization of the activity force control model, the help situated change is done to empower it to give wellness content blends important to wellness professionals and educators [26]. By utilizing the Lyapunov combination strategy, the worldwide dependability and the assembly of the shut circle framework under the condition that all factors are consistently limited are broken down, and the versatile laws of the framework boundaries are given too.

At long last, the viability and prevalence of the proposed technique are confirmed by recreation [27]. A fluid level control framework and a constantly mixed tank reactor are considered for reproduction to show the devotion of the proposed strategy for obscure nonlinear frameworks in presence of loud and upset conditions [28]. The gabbing peculiarity that influences sliding mode control and guarantees that the following blunder settles at nothing [29].

The MARCOS method has developed to set rank of insurance companies and used sensitivity analysis to check stability of proposed method [30]. The investigated then it has applied fuzzy on China's maternal health based on method of multi-criteria decision-making (MCDA) [31]. Fuzzy controller has been used for distillation process [32] and used in the many different field [33-35] . The Fuzzy Inference System (FIS) have used for identifying the risk for the Cardiovascular Disease [36] and diagnosis prostate cancer [37]. An attempt is develop the fuzzy logic control system to design fuzzy rule for analysis of risk factor of patients by taking these four factors Blood Pressure, Sugar, Age and Kidney function in consideration as shown in Fig. 1. In this paper introduced fuzzy control system to design fuzzy rule base to analyses the risk factor.

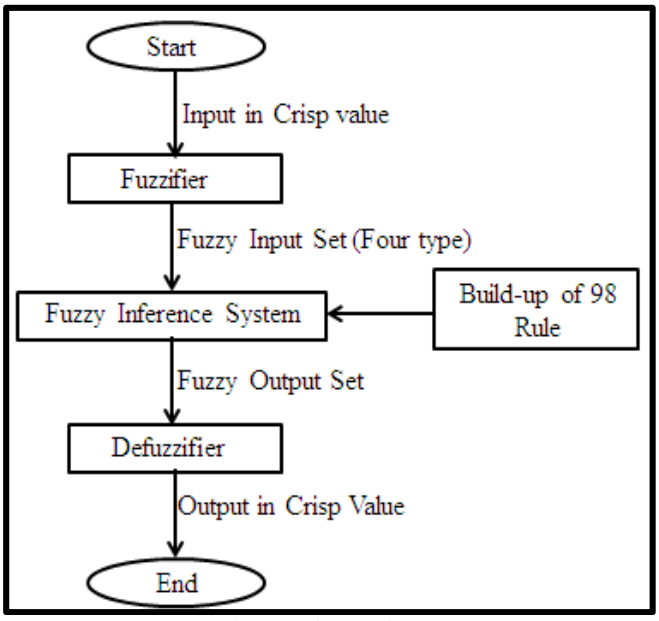

Fig.1: Flow Chart

Materials and Methods

Fuzzy standard based frameworks incorporate numerous parts of fuzzy qualities, like the guidelines predecessors and result. The principles structure is typically of the structure IF . . . THEN, at that point. In its fundamental structure this sort of control is identical phonetically to a PI controller, and relying upon the yield, regardless of whether it is gradual or supreme, the controller is known as PI or PD individually. An illustration of such a standard is IF "Blood sugar is high", THEN "risk factor is high". A more refined design can be a PID controller, where the

information, its subordinate, and basic are considered as three data sources. The standards are created either from the master or made by hand contingent upon the experience of the developer. This incorporates tuning the enrollment capacities as far as the shape, width and position. The examination of different kind of controller is broadly utilized and is the most appropriate control type in disease [38].

FCS used for prediction and alaysis health risk by using MATLAB-2014b tool [38]. Fuzzy Logic Control addresses the estimation for measure control as a fuzzy association between information on the condition of the cycle to be controlled and the control action. The encapsulation of fuzzy control estimations is an unexpected statement between a fuzzy input parameter X and a fuzzy output parameter Y. This is conveyed by a phonetic ramifications explanation, for example

X implies Y (X condition denotes condition B)

This can be written such as

IF X THEN Y

There is an equivalency between this verbalization and the association gained through Cartesian expansion, for example, R=XxY ≡ IF X THEN Y. A fuzzy variable is communicated through a fuzzy set, which thus is characterized by a membership function μ. The fuzzy variable might be discrete or continuous.

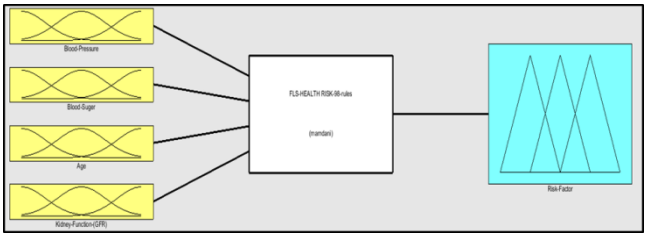

Fig. 2: Methodology for analysis of risk factor

For measuring the health risk analysis based on the given input parameters such as Blood Pressure (BP), Blood Sugar (BS), Age of the patient and Kidney function in the form of Glomerular Filtration Rate (GFR) shown in the Fig. 2. In the end the risk factor analysed by using all four input parameters.

The risk factor has been inspected by utilizing a Fuzzy Logic (FL) control framework dependent on a Fuzzy Inference System. The method Fuzzification was a handle for the initial step a legitimate decision of interaction state factors and control factors is crucial for the description of the action of a FL control framework [39]. In vibrant basis, IF…THEN rule base shadow for approximating the contribution approvals contracted. At last, the Defuzzification remains equipped for associating the fuzzy output of the relative multitude of rules to give single crisp output.

Results and Discussions

In present section the result and discussion has been discussed based on four major parameters such as blood pressure, blood sugar, kidney function and age have been used as input for finding the risk factor for human health.

Input Parameters

The membership grade functions of fuzzy sets of all four input parameters have shown in the Fig. 3. The range of the Blood Pressure (BP) with membership grade function has shown in Fig. 3 (a), blood pressure characterized in low, medium and high. The very high blood pressure when the systolic is 240, diastolic is 140 and pulse is 100 [39]. In this study similar kind of the BP has been used. In this study, the blood sugar has been considered after two hours of the eating food. The normal range of blood sugar considered 120-140, Pre Diabetic (PD) has considered between 140-160 and if the sugar level is more than 200 then patent will be considered as Diabetic (D) (Fig. 3b).

Characterizations of age have been shown in Fig. 3c, if the age under 25 than patent will consider as young, the middle age has consider between 35 to 45 and old has been consider if the age is 60 or more than 60. The distribution of the membership grade function of the kidney function in term of Glomerular Filtration Rate (GFR) has been shown in Fig. 3d. If the GFR less than 15 then we consider that kidney fail, if GFR in between 15 to 29 then kidney damage, below moderate has been consider when range of the GFR in between 30 to 40, moderate when range 49 to 59, below normal when range in between 80 to 89 and kidney will be normal if GFR is grater then 90.

Health Risk Factor

After every individual rule is handled and based on whether the prerequisites for the rules are met or then again not, we will acquire a scope of levels of membership to every one of the yield participation capacities. Two rules might give an alternate level of membership to a similar yield work. To bargain with this inconsistency in rules, fuzzy logic permits us to pick whether we need to utilize the min, worst case scenario, item, or an assortment of different strategies to number the last degree membership of every one of the yield capacities. In our structure, we utilize the maximum capacity, which keeps the paramount level of membership related with every one of the participation capacities.

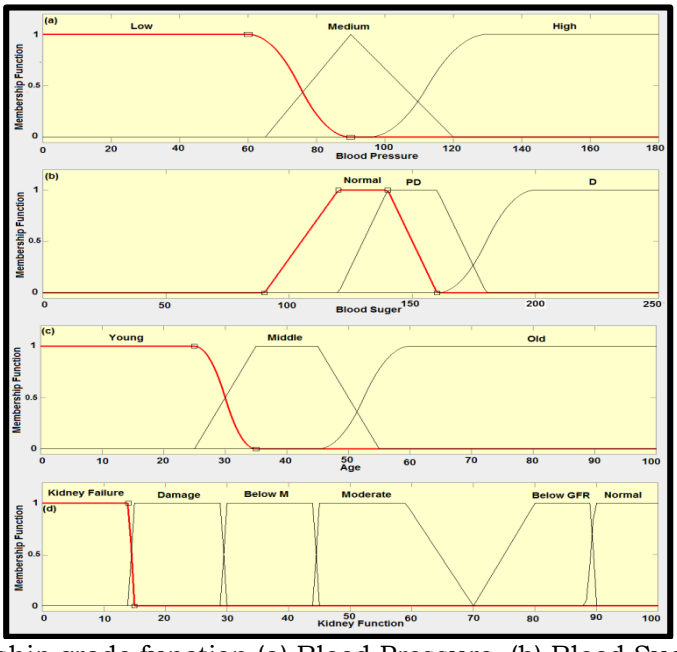

Fig. 3: Membership grade function (a) Blood Pressure, (b) Blood Sugar, (c) Age and (d) Kidney Function

Since we have a degree for every participation work in the output of the risk factor, it is required to include one more condition to assess the final output, or what is known as the output of the crisp value in the Defuzzification pace.

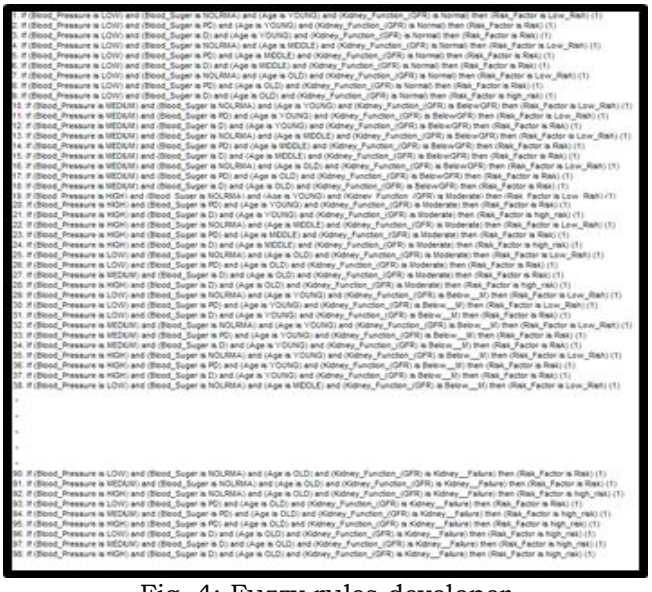

Fig. 4: Fuzzy rules developer

For the same purpose, the FCS has been selected. The total ninety eight rules (Fig. 4) have been created for risk assessment. For developing the fuzzy rule, the

membership functions have been allocated for the particular variable. The Defuzzification process has been completed with the help of FIS. The particular variables assigned the membership function shown in Fig. 4. The total 98 rules have been developed in this study. It has been observed that if the knowledge base rules are more than accuracy is more for decision making [39].

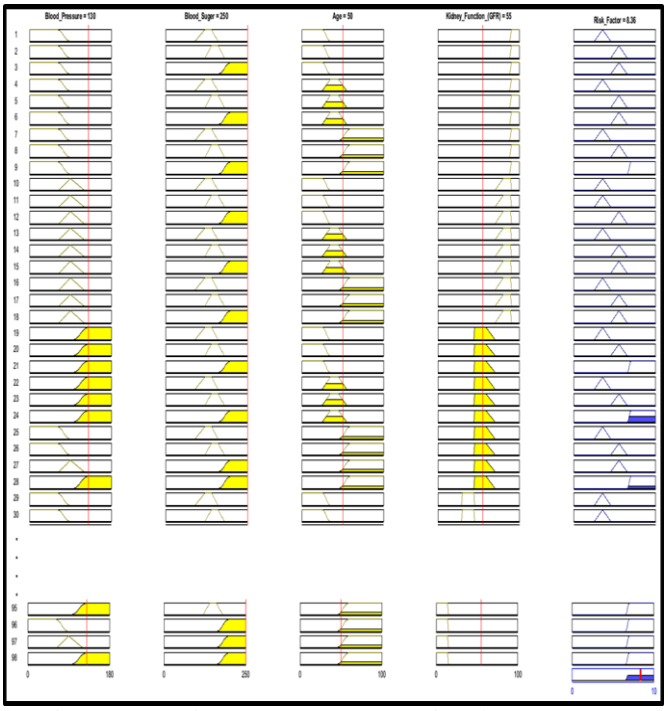

Fig. 5: Fuzzy Inference System Rule Viewer at Age 50

After developing the fuzzy rules, the risk factor has been calculated for the different cases. If we have considered the age of the patent is 50 with blood pressure is 130 and blood sugar is 250 and kidney function GFR is 55 than risk factor has 8.36 (Fig. 5). If age is 40 and blood pressure is 110 and blood sugar is 120 and kidney function is 100 then risk factor is 5 (Fig. 6). On the other case shown in Fig. 7, if age is 25 and blood pressure is 90 and blood sugar is 200 and kidney function is 80 than risk factor is 5.5. In that case risk factor is less may be patient is young and blood sugar maybe controlled by doing exercises on daily morning basis.

Only blood pressure used as input parameter for finding the health risk factor in their study [39]. But in this study four parameters such as age, blood pressure, blood sugar and kidney function used those are very important for integrating the health risk factor (Figs. 5, 6 and 7). Fuzzy structure is utilized to get the seriousness level which is the solitary yield variable of the structure. The risk decides the degree of seriousness of risk given the contribution of blood pressure, blood sugar, age and kidney function values. The fuzzy system gives a target interaction to acquiring the decline risk level.

In this study, many cases in different conditions of blood pressure, blood sugar, age and kidney function have been analysis for the risk factor, few cases from them shown in table 1. For analysis the risk factor the different age group people have considered with extreme or light conditions of the blood pressure, blood sugar and kidney function (GFR). It has been analysis that if the age is 20 and GFR is 25 and blood pressure is normal and blood sugar is more than 200 then the risk factor is 8.3 that is very high.

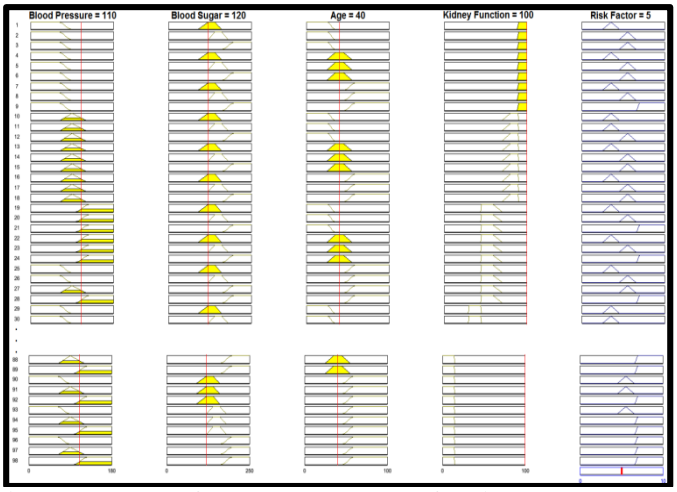

Fig. 6: Fuzzy Inference System Rule Viewer at Age 40

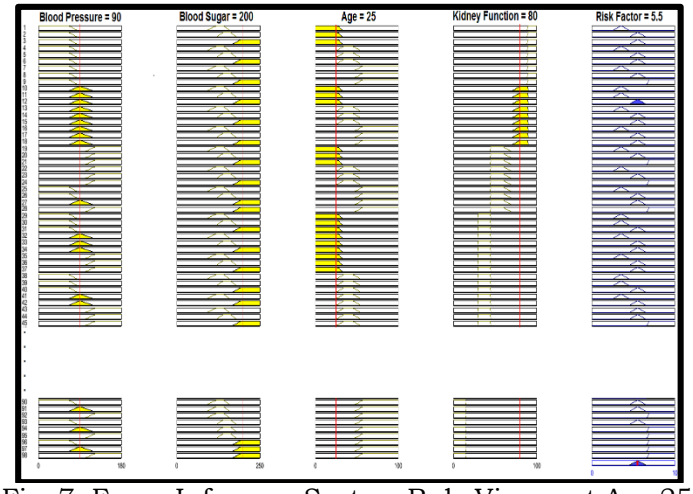

Fig. 7: Fuzzy Inference System Rule Viewer at Age 25

After carefully of examinations it has been observed that if the input of the linguistic parameter from blood pressure, blood sugar and kidney function will high then risk factor also will high. It is feasible to make a FL approach to an issue utilizing MATLAB's Fuzzy Inference System. The framework permits us to obviously see the connection among info and yield and to change the kinds of estimations done by the guidelines and yield degree planning.

The 3D diagrams of the membership function of the all parameters have been shown in the Fig. 8. The risk factor of blood pressure and blood sugar has shown in Fig. 8a. It is clearly seen that when blood sugar is more than 140 and blood pressure is more than 120 then risk factor is more than 7. When is more than 60 and pressure 120 then maximum risk factor is up to 5 can show in Fig. 8b. It can be observed that if only blood pressure not much harmful for the human health.

If other variable means blood sugar or kidney function is effective with blood pressure than it may more harmful for human health and risk factor is more.

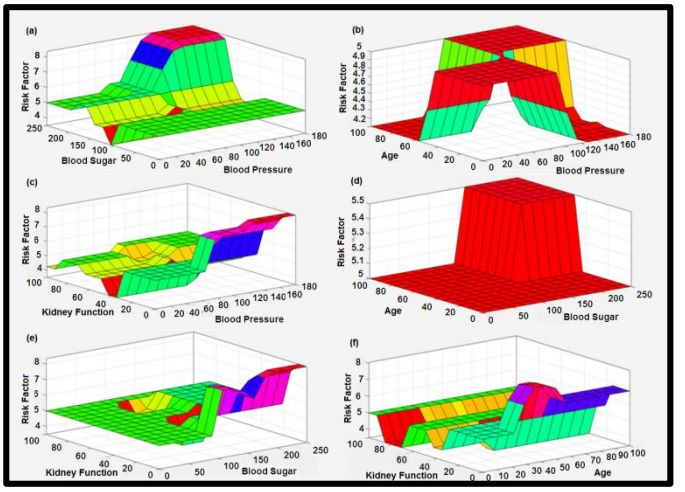

Fig. 8: Analysis of the risk factor: (a) Blood Sugar vs Blood Pressure, (b) Age vs Blood Pressure, (c) Kidney Function vs Blood Pressure, (d) Age vs Blood Sugar, (e) Kidney function vs Blood sugar, and (f) Kidney Function vs Age

It is also observed that if the kidney function is affected and blood pressure is more than 120 that time risk factor of human health varies 7 to 8 (Fig. 8c). The risk factor of health always high if the blood sugar is high in any age (Fig. 8d). If kidney function is affected and blood sugar is more than 140 after two hours of taking food that time risk factor is very high (Fig. 8e) and more than 7. If the kidney is less damage or failure in any age it will be high risk in any age group and risk factor may high (Fig. 8f). If kidney function is affected and blood sugar is more than 140 after two hours of taking food that time risk factor is very high (Fig. 8e) and more than 7. If the kidney is less damage or failure in any age it will be high risk in any age group and risk factor may high (Fig. 8f).

Mayilvaganan and Rajeswari have not shown the 3D graphical representation of the parameters which they used in their study [39], but 3D graphical representation is one of the key factor to analysis the risk factor used in this study. After carefully examine it can be observed that if any diseases from blood pressure, blood sugar or kidney problem in any age group it will be risky for human health. If any human has carry blood pressure with blood sugar diseases than it will very risky and if human has carries all three diseases then risk factor will be very high and particular person is in danger and need to take action immediately.

S.N.	Blood Pressure	Blood Sugar	Age	Kidney Function (GFR)	Risk Factor out of 10
1	90	125	50	50	5
2	90	125	35	50	4.5
3	100	130	35	30	3.66
4	100	130	35	10	7.65
5	120	130	35	10	8.38
6	140	250	35	28	8.4
7	140	250	40	28	8.4
8	130	250	40	100	5
9	130	250	50	100	5
10	130	250	50	55	8.36
11	130	140	50	55	4.5
12	120	140	50	55	4.5
13	120	150	50	55	4.5
14	120	150	50	85	5
15	120	130	32	35	4.97
16	130	150	50	55	4.5
17	130	250	40	55	8.2
18	110	120	40	100	5
19	90	125	50	95	5
20	90	125	30	95	5
21	90	90	45	100	5
22	90	150	45	100	5
23	90	225	45	100	5
24	90	225	45	80	5.5
25	90	225	45	80	5.5
26	120	225	45	25	8.36
27	100	225	20	25	8.3
28	100	110	20	100	5

Table 1: Risk Factor in various conditions

Conclusion

The FCS has used for finding the risk factor of human health with input of three diseases with different age group. The control system utilizes arrangement rules dependent on membership degrees acquired from proof based medication and information base on the diseases. It permits utilizing delicate grouping decides that have covering levels of membership, which can be acquired from experience and from any human information. The present FCS catches every one of the varieties of the manifestations learned thus; it will be helpful to surmise the specific phase of patient danger according to the expert evidence. Overall the present study advocates that FCS used in this study has helpful to take legitimate choice at the perfect opportunity for offering treatment to the patients right away and advocate also such type of risk to change the way of life, food propensities, have checking from the treatment in future. This system may be used for some other purpose like finding the health risk factors of the workers in manufacturing industries, chamical industires, employees in IT sectors.

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