

# Analysis on Categories of Health Problems Due To Consumption of Junk Foods Using Augmented Fuzzy Cognitive Map

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**Abstract-** 'Eat healthy food is the basic requirements for long lifespan'. In modern world, the consumption of foods has harmful effects on health. Junk foods are rich in calories, salt, and fats. School canteens are providing high-fat foods and sugar which are actually contributing to the weight gain along with other problems like infections, food poisonings, and dental diseases. The practice of high consumption of junk foods like instant foods, burgers, popcorn, potato chips, carbonated drinks, chocolates, icecreams etc. have become a common feature of the adult diet throughout the world. According to WHO, in India, more than 3 percent of the population is in the obese category. This paper presents the results of the health problem for having junk food on daily basis. Fuzzy cognitive mapping model is one of the suitable tools to deal with these problems. FCMs can successfully represent knowledge and human experience, introducing concepts to represent the essential elements and the cause and effect relationships among the concepts to model the behavior of any system.

Keywords: Junk foods, Health problems, Fuzzy Cognitive Map (FCM), Augmented FCM

## 1. INTRODUCTION

In a society that works at a high speed, fast food has immediately been adopted as the preferred food of choice. Fast food shops and their advertisements are permeating our neighborhoods, schools, television, and culture [9]. Junk food is an empty calorie food which lacks in micronutrients such as vitamins, minerals, or amino acids, and fiber. These foods contain the lower nutritional values that human body ought to stay healthy. Ingredients which are used in junk food is considered as unhealthy when eaten regularly. Michael Jacobson (1972), Director of the Center for Science, Washington D.C proposed the term junk food. Junk food contains high levels of sugar, trans fat and polyunsaturated fat and numerous food additives. At the same time, it is defective in essential minerals, proteins and other health factors. On the other hand, junk food is easy to purchase and consume. In general, a junk food is made in an attractive way by adding colors to enhance flavor, texture and food preservatives for increasing long shelf life [1].

As we enter the new millennium, obesity is becoming the largest public health concern, especially among children. Obesity increases the risk of high cholesterol and fatty streak development, which translates into a greater risk of cardiovascular diseases. Drinking soft

drinks add dangerous toxins in the human body. It affects the bones, skin and kidney.

Fuzzy Cognitive Maps (FCMs) is a complex modeling systems, which follows an approach similar to human reasoning and human decision-making process. FCMs can effectively represent human knowledge and experience, introducing new notions to represent the essential elements and the cause and effect relationships among the concepts to model the behavior of any system [17].

The Augmented Fuzzy Cognitive Map is an advancement of FCM. Various approaches could be used in order to reach a consensus among the experts. Augmented FCM approach is a methodology to combine human knowledge. The augmented adjacency matrix is built by adding the adjacency matrices of each expert [12].

## 2. LITERATURE REVIEW

Effects of Junk Food & Beverages on Adolescent's Health – a Review Article (Geeta Arya, Sunita Mishra). This paper discusses about for changing the food habits without affecting their sentiments [9]. A case study on the impact of advertisements on Junk foods in Children (Mrs.V.G.Jisha, Ashmi. R, Sruthy. Menon) [11]. Fast Foods and their Impact on Health (Ashakiran & Deepthi R). This paper reviews from various resources on junk food and its impact on health and have been

systematically presented [1]. Knowledge Regarding Health Hazards of Junk Foods among Adolescents (More Ujwala Ramchandra, Avinash H. Salunkhe, V. R. Mohite). It is the case study to find out association between selected demographic variables and health hazards among adolescents [10]. Student's perspective on junk foods: Survey (Vinay Gopal J., Sriram S., Kannabiran K. and Seenivasan R.). This Study was useful to know about junk food eating habits of students, their ingredients, nutritive value and their impact on human health [20]. Factors that Affect Fast Food Consumption: A Review of the Literature (yuchu song). This paper summarizes the disadvantages of fast food on people's health, reveals common people's average fast food consumption [16] Modern Diet and its Impact on Human Health (Shridhar G, Rajendra N, Murigendra H, Shridevi P, Prasad M, Mujeeb MA, Arun S, Neeraj, Vikas S, Suneel D and Vijay K) This study aims to strengthen our knowledge regarding the dietary requirements, food sources, and potential benefits, Modern food and its impact on human health. The main scope of the present study is to give one of the optimal solutions for the health problems of having junk foods [14].

**Cognitive Maps**

FCMs constitute Neuro-fuzzy systems, which are able to integrate experts' knowledge. FCM describes a cognitive map model with two characteristics. Firstly, causal relationships between nodes have different intensities, represented by a number from 0 to 1. However, an FCM substitutes the signs by a fuzzy value between -1 and +1 where the zero value indicates the absence of causality. Secondly, it involves Feedback, where the effect of a change in a concept node may affect other concept nodes [13].

**2.1. FCM Methodology**

To obtain cause and effect relationships between variables effectively and to acquire design knowledge from domain experts in the design process systematically [12], Augmented FCM has been proposed by Jose L. Salmeron (2009).

**2.2. Systematic Construction of FCM**

A causal model based on the knowledge elicited from a domain expert includes two basic elements: *domain variables*, which constitute factors relevant to the problem and a *causal structure*, which describes the relationship between these variables [12].

**2.3. Combined FCM**

Finite number of FCMs can be combined together to form the joint effect of all the FCMs. Let  $E_1,$

$E_2, \dots, E_n$  is the connection/adjacency matrices of the FCMs with nodes/concepts  $C_1, C_2, \dots, C_n$  then the combined FCM is got by adding all the adjacency matrices  $E_1, E_2, \dots, E_n$ .

We denote the combined FCM adjacency matrix  $M = M_1, M_2, \dots, M_n$  [19].

**2.4. Combining target matrices with different structures**

In general, FCM matrices have unequal sizes and sets of variables. Even when they share a common set, the variables may be in different order. As a result, the target matrices could not be added entry-wise to create the combination matrix. Kosko suggested the idea of augmenting the structure of target matrices into the structure of the combination matrix, which is their least common super-structure. This subsection addresses this idea, describing the process of matrix augmentation, and the accumulation of matrices with different structures [4].

**2.5. Augmented FCM**

It is possible to represent the different relationships among factors/variables, by means of a matrix (A), called the adjacency matrix:

$$A = \begin{pmatrix} \dots & \dots & \dots \\ \dots & e_{ij} & \dots \\ \dots & \dots & \dots \end{pmatrix}$$

$e_{ij} \in [-1, +1] \mid$  for every  $i, j$

$e_{ij}$  indicates the relationship between the  $i$  and  $j$  concepts, enabling us to obtain values between  $[-1, 1]$ . Three types of relationships can be seen:

(1)  $e_{ij} > 0$ , indicating a positive relationship,

(2)  $e_{ij} < 0$ , indicating a negative one, and

(3)  $e_{ij} = 0$ , where no relationship exists.

Therefore, when an expert assigns a value  $e_{ij}$ , three issues must be considered. Firstly, the  $e_{ij}$  intensity to indicate how strong the  $i$  concept is on  $j$ . Secondly, the sign (+/-) of  $e_{ij}$  must be decided to indicate if the relationship between the  $i$  and  $j$  concepts is direct or inverse. Lastly, the causality relationship needs to be indicated to establish if the  $i$  concept is a cause of  $j$  or vice versa [13].

Various methodologies could be used in order to reach a consensus among the experts. Finally, the Augmented FCM approach has been adopted, because it doesn't need that experts change slightly their judgment for consensus as Delphi methodology. The augmented adjacency matrix is built by adding the adjacency matrix of each expert. Let us consider two FCMs with no common nodes.  $FCM_A$  with  $c_i^A$  as nodes  $FCM_A = \{C_i^A\}$  and  $FCM_B$  with  $c_j^B$  as nodes  $FCM_B = \{C_j^B\}$ . The Adjacency matrix of  $FCM_A$  is  $A_A = (W_{ij}^A)$ ; and the adjacency matrix of  $FCM_B$  is  $A_B = (W_{ij}^B)$ . The augmented adjacency matrix is

$$A = \begin{bmatrix} W_{ij}^A & 0 \\ 0 & W_{ij}^B \end{bmatrix}$$

If there are common nodes, then the element  $W_{ij}^{Aug}$  in the augmented matrix is

$$W_{ij}^{Aug} = \frac{\sum_{k=1}^n W_{ij}^k}{n}$$

$n$  being the number of FCMs added, one by an expert,  $k$  the identifier of each expert, and  $i$  and  $j$  the identifier of the relationships [13].

### 2.6. Combining causal knowledge of multiple experts

It is often desirable to combine the causal knowledge of multiple experts to obtain a representation of their consensus in a particular problem domain. Matrix representation of FCMs means that it is a relatively simple procedure to merge multiple FCMs for creating an aggregate representation of knowledge elicited from multiple experts [5]. Merging FCMs provides a means of progressively accumulating knowledge as new expertise and ideas become available. It also increases the reliability of an FCM by incorporating the opinions of several domain experts. In this section, Kosko's model is adopted, in which consensus is modeled as the average of the experts' opinions [6,7,8]. The combination of FCMs is done iteratively, combining two matrices at a time. This is an incremental process analogous to the accumulation of human knowledge.

### 3. Selection of the panel experts

For the purpose of obtaining the relevant factors of the task ie., Health problems of Junk food, questionnaire method and the interviews were conducted from a panel of 4 experts. The experts belong to the field of food service management, Dietary, Pediatrics. This panel suggests many

factors about the health problems of junk food. A total of 14 factors were identified.

### 3.1. Categories of health problems of junk food Selection

As mentioned earlier, 14 factors are considered as the major problems by intake of junk food. Once the factors are identified, 14 factors are categorized into four constructs ie., Fast Foods, Snacks & Desserts, Carbonated beverages, Sugary cereals. These four categories are considered to be the main factors for the present scenario.

**Fast Food** : Pizza, Burger, Fried chicken, Noodles, Pasta etc.,

**Snacks & Desserts** : Hot – dogs, Donnuts, Potato chips, French Fries, Popcorn, Sweets, cookies etc.,

**Carbonated Beverages** : Coke, fizzy drink, Fizzy juice, Cool drink, Soda, tonic, Mineral etc.,

**Sugary Cereals** : Chocolate cheerios, Frosted cheerios, corn, Chocolate Donutz, Icecream, cakes etc.,

### 3.3. Relevant Factors for the task.

According to the open-ended questions, interviews from the creative professionals and referred the journals [2,15,18], the following factors have been determined :

- P1 Type 2 diabetics & fluctuation in blood sugar level.
- P2 Digestive Problems
- P3 Depression among teenagers
- P4 Increased risk of heart disease
- P5 Kidney disease.
- P6 Damage of the liver
  
- P7 Memory and Learning problems.
- P8 Risk of Dementia (Brain disease)
- P9 Impatient behavior and uncontrollable craving.
- P10 Effects on hi-tech society.
- P11 Lack of family gathering.
- P12 Dental distress.
- P13 Fatigue and Weakness.
- P14 Risk of cancer

### 3.4. Method of analysis:

For the purpose of eliciting causal structure between variables, four domain experts (creative professionals) have been chosen from the food service management and dietetics. They have drawn FCM matrices respectively.

<b>Factors/Categories</b>	<b>Fast Foods</b>	<b>Snacks &amp; Desserts</b>	<b>Carbonated Beverages</b>	<b>Sugary Cereals</b>
Type 2 diabetics & Fluctuation in blood sugar level	0.6	0.5	0.3	0.8
Digestive Problems	0.6	0.3	-0.5	-0.90
Depression among teenagers	-0.9	0.8	-0.95	-0.62
Increase to risk of heart disease	0.8	0.9	0.25	-0.96
Kidney Disease	0.35	0.45	-0.895	-0.56
Damage of the liver	0.97	0.5	0.4	0
Memory and learning problems	0.60	0.75	0.26	-0.62
Risk of dementia (Brain disease)	-0.93	-0.8	-0.91	-0.64
Impatient behavior and uncontrollable craving	0.80	-0.53	0.64	-0.51
Effects on hi – tech society	0.8	0.93	1	-0.57
Dental distress	0.56	0.69	1	0.79
Fatigue and weakness	1	0.87	0	-0.54
Risk of cancer	0.99	0.89	0.67	-0.62

**Adjacency Matrix for the first expert’s causal knowledge, M1[i,j]**

<b>Factors/Categories</b>	<b>Fast Foods</b>	<b>Snacks &amp; Desserts</b>	<b>Carbonated Beverages</b>	<b>Sugary Cereals</b>
Type 2 diabetics & Fluctuation in blood sugar level	0.6	0.55	0.76	1
Digestive Problems	0.65	0.23	0.37	0.90
Depression among teenagers	0.99	0.33	0.27	0.95
Increase to risk of heart disease	0.92	0.81	0.90	1
Kidney Disease	0.25	0.30	0.5	0.79
Damage of the liver	0.3	0.49	0.78	0.42
Risk of dementia (Brain disease)	0.53	0.28	0.57	0.46
Impatient behavior and uncontrollable craving	1	0.9	0.79	0.63
Effects on hi – tech society	0.52	0.63	0.23	0.79
Lack of family gathering	1	0.59	0.68	0.6
Dental distress	0.99	0.79	0.58	1
Fatigue and weakness	0.56	0.42	0.62	0.79
Risk of cancer	0.7	0.25	0.62	0.57

**Adjacency Matrix for the second expert's causal knowledge, M2[i,j]**

<b>Factors/Categories</b>	<b>Fast Foods</b>	<b>Snacks &amp; Desserts</b>	<b>Carbonated Beverages</b>	<b>Sugary Cereals</b>
Type 2 diabetics & Fluctuation in blood sugar level	1	0.55	0.8	0.97
Digestive Problems	0.82	0.65	-0.89	0.25
Depression among teenagers	0.92	0.8	0.87	1
Increase to risk of heart disease	1	0.99	0.82	0.92
Kidney Disease	0.9	-0.92	0.79	-0.54
Damage of the liver	0.9	0.82	0.79	1
Memory and learning problems	-0.62	0.33	-0.61	0
Risk of dementia (Brain disease)	-0.5	-0.92	0	-0.94
Impatient behavior and uncontrollable craving	0.3	0.32	0.25	0.49
Effects on hi – tech society	1	0.9	0.82	0.5
Lack of family gathering	0.99	0.82	0.91	0.65
Dental distress	0.57	0.62	0.79	0.95
Fatigue and weakness	0.9	1	0.87	0.80
Risk of cancer	0.95	0.88	0.80	0.86

Adjacency Matrix for the third expert's causal knowledge, M3[i,j]

<b>Factors/Categories</b>	<b>Fast Foods</b>	<b>Snacks &amp; Desserts</b>	<b>Carbonated Beverages</b>	<b>Sugary Cereals</b>
Type 2 diabetics & Fluctuation in blood sugar level	-0.5	-0.62	0	-0.82
Digestive Problems	0.25	0.4	-0.57	-0.65
Increase to risk of heart disease	0.59	0.72	-0.62	-0.59
Kidney Disease	-0.65	-0.67	-0.79	-0.72
Damage of the liver	0.59	0.61	0.79	0.57
Memory and learning problems	0.6	0.52	0.77	0.69
Risk of dementia (Brain disease)	0.23	0.45	0.33	0.40
Impatient behavior and uncontrollable craving	-0.80	-0.92	0	0.59
Effects on hi – tech society	0.25	0.35	0.4	0.39
Lack of family gathering	0.34	0.39	0.45	0.23
Dental distress	-0.5	-0.62	0.62	0.79
Fatigue and weakness	0.25	0.49	0.35	0.37
Risk of cancer	0.55	0.69	0.72	0.62

Adjacency Matrix for the forth expert's causal knowledge, M4 [i,j]

<b>Factors/Categories</b>	<b>Fast Foods</b>	<b>Snacks &amp; Desserts</b>	<b>Carbonated Beverages</b>	<b>Sugary Cereals</b>
Type 2 diabetics & Fluctuation in blood sugar level	0.43	0.25	0.47	0.49
Digestive Problems	0.59	0.39	-0.39	-0.1
Depression among teenagers	0.25	0.48	0.2	0.33
Increase to risk of heart disease	0.83	0.84	0.33	0.12
Kidney Disease	0.21	-0.21	-0.09	-0.26
Damage of the liver	0.69	0.61	0.69	0.49
Memory and learning problems	0.04	0.4	0.1	0.02
Risk of dementia (Brain disease)	-0.17	-0.59	-0.03	-0.2
Impatient behavior and uncontrollable craving	-0.08	-0.1	-0.42	0.3
Effects on hi – tech society	0.64	0.7	0.61	0.28
Lack of family gathering	0.59	0.45	0.51	0.37
Dental distress	0.41	0.37	0.75	0.88
Fatigue and weakness	0.68	0.69	0.46	0.36
Risk of cancer	0.79	0.68	0.7	0.36

Augmented Matrix M' combine [i,j]

#### **4. DISCUSSION OF THE STUDY**

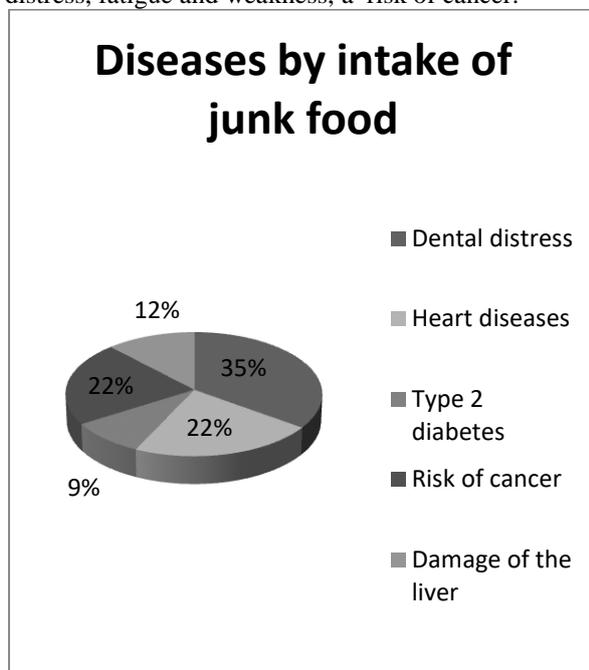
In the Augmented matrix, certain effective domino effects of our task is obtained. From the matrix, it is

observed that the number of positive degrees is in higher level while compared with the negative degrees. The reason is that there is a positive

influence between the list of relevant factors and the four constructs of junk food.

The above matrix reveals that the intake of Fast foods, Snacks & desserts increases the risk of heart disease with the degrees +0.83 and +0.84. Dental distress is caused by the intake of Carbonated Beverages and Sugary cereals with the degrees +0.75 and +0.88.

High impactful factor in the present study is dental distress with the high degree +0.88. Positive impactful factors are Type 2 diabetics & blood sugar level, depression among teenagers, increased risk of heart disease, damage of the liver, memory and learning problems, Effects on high-tech society, lack of family gathering, dental distress, fatigue and weakness, a risk of cancer.



The above study is compared with the case study on junk food conducted in march 12, which reveals that Cardiovascular diseases, Cancer, Liver problem, Diabetes are the most dangerous diseases caused by the intake of junk food.

Now coming to the work, our study also coincides with the case study results. In addition to that, it gives Dental distress, Depression among teenagers, Fatigue, and weakness which are also the health problems caused by for having junk food.

So it concludes that the above study gives the optimal solution for the present scenario.

## 5. CONCLUSION

This study highlighted the harmful effects of overconsumption of junk foods. Majority of people consume junk foods without knowing the health effects and long-lasting health implications.

Generally, diseases are caused by various types of germs including viruses, bacteria, and various unknown agents, whereas some of these diseases are caused by faulty ways of leading life. The importance of a regular diet and good eating habits are often ignored due to a host of reasons and lack of time. So the awareness programs targeted at parents and children are necessary. But a pleasant thing to share is that some people are aware of consuming healthy and nutritious food instead of junk food. However, this study provides a caution for people who enjoy instant food lifestyle knowingly or unknowingly about the health problems associated with.

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