

# **A Comparative Study of Health Status Index Using Vague Sets and Interval Valued Vague Sets**

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**ABSTRACT:** In this Paper, we have used vague sets and interval valued vague sets approach for interpretations of various factors that affect human health. We used these as tools to determine a functional status of human body in terms of health status index, using absorption of quantities of iron, iodine, vitamins and folic acid. Medical research showed that becoming depleted in even one nutrient can cause us to suffer a variety of ailments and can certainly predispose us to infection, allergies and even cancer. This study may be useful for those human beings, who are more concerned about their health status. If an individual knows the status of iodine, iron, vitamin A, and folic acid in his body through pathological examinations, he would be able to know the index of his health status.

**KEYWORDS:** Vague, Set, Interval Valued, Health Index,

## **I. INTRODUCTION**

Studies confirm that becoming depleted in even one nutrient can cause us to suffer a variety of ailments and can certainly predispose us to infection, allergies and even cancer. Our adolescent and elderly population is especially at risk. In order to devise an operation health status index; it is necessary to develop the concept of health status. An individual belongs to one of several alternative health statuses, but it is difficult to clearly identify which status is better because the boundaries of statuses are not sharply defined. We introduce the concept of fuzziness and vague multiple criteria of health status. As doctors or patients often diagnose patients health statuses using the information from imprecise multiple criteria, based on their medical knowledge and their subjective judgment, we try to express the health status in the same way using the vague/interval valued vague integral.

In this paper, we deal with health status as an intrinsically imprecise and multi-dimensional expression which is determinable through some subjective judgment.

### **Micronutrients**

Micronutrients i.e., minerals and Vitamins are essential elements that enable the body to produce enzymes, hormones and other substances essential for proper growth and development. They are needed only in minuscule amounts. Following micronutrients have been included for the study involved in this paper:

#### **(a) Iron:**

Iron is needed to make healthy red blood cells, which supply the body with oxygen. Without enough iron, immune function and energy levels decline.

#### **b) Iodine:**

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Iodine is required for the synthesis of thyroid hormones which in turn are needed for the regulation of metabolic activities of all cells throughout the life cycle. They are also required to ensure normal growth, especially of the brain, which occurs from fetal life to the end of the third postnatal year.

### (c) Vitamin A:

Vitamin A is primarily represented by cyclic polyene alcohol vitamin A1 (retinal) whose other active forms are retinal, retinoic acid etc. Beta-carotene is a precursor of vitamin A and is converted to vitamin A as and when needed by the body.

### (d) Vitamins/Minerals:

Vitamins cannot be assimilated without the aid of minerals. Adequate amounts of vitamins A, C, D and B complex are provided besides a judicious combination of supplements of boost the metabolic activities of the human body.

### e) Folic Acid:

Folic acid is a water-soluble vitamin needed for DNA synthesis. Folic acid is essential for cellular replication and differentiation. Folic acid is named after the green leafy foliage that is the richest source for this nutrient. Folic acid is needed for the health of gums, red blood cells, skin, and gastrointestinal tract. It prevents birth defects, cancer, and heart disease, and is important for a strong immune system.

### Micronutrient malnutrition

Micronutrients are deficient in the diets of all age groups particularly in preschool children. Micronutrient deficiencies like iodine, iron and vitamin A are prevalent and are preventive measures for the occurrence of the incidence. More than two billion people (i.e. one in three persons worldwide) suffer from micronutrient deficiency. Vitamin E and Zinc deficiency are also serious causes of concern. Micronutrient malnutrition is practically unknown in developed countries owing to inexpensive interventions such as food fortification, supplementation, and dietary diversification. Iron deficiency 'anemia' is a serious problem among all vulnerable groups and in all regions of India. Antioxidants (A, C and E) can help prevent or delay cataract growth.

## II. VAGUE HEALTH STATUS CONCEPTS

Let  $S$  be an arbitrary non-vague set which is treated in the ordinary sets theory, and let  $s_i$  be an element of  $S$ . A vague subset  $H$  on  $S$  is characterized by a mapping

$$\mu_H: S \rightarrow [0, 1],$$

and is denoted as a set of ordered pairs,

$$\{(s_i/\mu_H(s_i))\}, \text{ for any } s_i \in S,$$

Where,  $\mu_H(s_i)$  is the grade or degree of membership of  $s_i$  in  $H$  and  $\mu_H$  is called the membership function.

Using a vague subset and considering the expression of health status, we can give fundamental criteria of health  $S_i$  a grade of membership in  $H$ , the complete health status. A health status  $S_i$  is composed of some fundamental criteria of health such as body temperature, blood pressure and so on. We can conceive a health status by judging these criteria. When a grade of membership is unity, we call the status complete health, and if it is zero, we call it death.

A kind of vague health status pattern selected from a medical and social point of Health Status is  $S_i$  ( $i$ =Severe, Moderate, Mild, Normal)

## III. INTERVAL VALUED VAGUE HEALTH STATUS CONCEPT

Let  $S$  be an arbitrary non-vague set which is treated in the ordinary sets theory, and let  $s_i$  be an element of  $S$ . Then a membership  $\mu_H$  of  $H$  and  $S$  is characterized by a mapping

$$\mu_H: S \rightarrow [0, 1],$$

and a non-membership  $\nu_H$  of  $H$  and  $S$  is characterized by a mapping

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$$v_H : S \rightarrow [0, 1],$$

and is denoted by a set of ordered pair  $\{(s_i, \mu_H(s_i), v_H(s_i))\}$ , for any  $s_i \in S$ ,

$$0 \leq \mu_H(s_i) + v_H(s_i) \leq 1$$

Then the amount  $\pi_H(s) = 1 - [\mu_H(s_i) + v_H(s_i)]$  is called the hesitation part which may cater either membership value or non-membership value.

Using an interval valued vague subset and considering the expression of health status, we can give fundamental criteria using the membership and non-membership for a medical and social point of health status using various factors. Such interval valued vagueness stems from such adjectives as “severe”, “moderate”, “mild” and “normal”.

Considering some reasonable number of health status  $S_i$  belonging to each individual for membership  $\mu_H(S_i)$  and non-membership  $v_H(S_i)$ .

## IV. VAGUE ANALYSIS

**Vagueness of factors causing health status index:** These precipitating factors may be associating adequate vague set to these factors. This facilitates in quantifying the contribution of a particular factor by a vague number.

Let  $f_i$  be the factor, causing the failure of a system. Then this factor may be vaguefied as below.

$$f_i(x) = \begin{cases} 0 & \text{for } x \leq a \text{ or } x \geq d \\ \frac{x-a}{b-a} & \text{for } a \leq x \leq b \\ 1 & \text{for } b \leq x \leq c \\ \frac{d-x}{d-c} & \text{for } c \leq x \leq d \end{cases}$$

Where  $x$  denote the crisp value of factor  $i$ . This factor  $i$  may be assigned any other vague number i.e., triangular / trapezoidal vague number or vague number of any other type. The vaguefication of these factors depends on the nature of occurrence during any experimental or functioning mode.

In our study we classified the factors which will give the health status index in various modes such as (i) Severe (ii) Moderate (iii) Mild and (iv) Normal modes.

In the present study these factors have been vaguefied on assigning them trapezoidal vague numbers of distinct shapes. The shapes of these vague numbers depends upon the nature of the involved factor i.e., what sort of behavior it imparts on health status with the change in their numerical value.

**(i) Iron:**

As per the Recommended Dietary Allowances (RDA) by the National Nutrition Monitoring Bureau (NNMB) of ICMR, the food value of Iron lies in the range  $\{12- 50 \text{ mg/cu/day}\}$ . The vaguefication of this factor with MATLAB function is given below. We get the following vague number.

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$$S_1 = f_{Iron}(x) = \begin{cases} 0 & \text{for } x \leq 0 \text{ or } x \geq 75 \\ \frac{x}{15} & \text{for } 0 \leq x \leq 15 \\ 1 & \text{for } 15 \leq x \leq 45 \\ \frac{75-x}{30} & \text{for } 45 \leq x \leq 75 \end{cases}$$

**(ii) Iodine:**

The Recommended Dietary Allowances (RDA) by the National Nutrition Monitoring Bureau (NNMB) of ICMR, the food value of Iodine lies in the range {70- 150 mg/cu/day}.

$$f_{Iodine}(x) = \begin{cases} 0 & \text{for } x \leq 0 \text{ or } x \geq 200 \\ \frac{x}{70} & \text{for } 0 \leq x \leq 70 \\ 1 & \text{for } 70 \leq x \leq 140 \\ \frac{200-x}{60} & \text{for } 140 \leq x \leq 200 \end{cases}$$

**(iii) Vitamin A:**

The Recommended Dietary Allowances (RDA) by the National Nutrition Monitoring Bureau (NNMB) of ICMR, the food value of Iron lies in the range {400- 600 mcg} and the expression for the vagueification of this factor on the given range is given as

$$f_{VitaminA}(x) = \begin{cases} 0 & \text{for } x \leq 200 \text{ or } x \geq 800 \\ \frac{x-200}{200} & \text{for } 200 \leq x \leq 400 \\ 1 & \text{for } 400 \leq x \leq 600 \\ \frac{800-x}{200} & \text{for } 600 \leq x \leq 800 \end{cases}$$

**(iv) Folic acid:**

The Recommended Dietary Allowances (RDA) by the National Nutrition Monitoring Bureau (NNMB) of ICMR, the food value of Folic acid lies in the range {50- 200 µg/cu/day} and the expression for the vagueification of this factor on the given range is given as

$$f_{Folicac.}(x) = \begin{cases} 0 & \text{for } x \leq 0 \text{ or } x \geq 200 \\ \frac{x}{50} & \text{for } 0 \leq x \leq 50 \\ 1 & \text{for } 50 \leq x \leq 150 \\ \frac{200-x}{50} & \text{for } 150 \leq x \leq 200 \end{cases}$$

### V. MEASURE OF HEALTH STATUS INDEX USING DIFFERENT MODES

Since the failure causing factors have a very important role in system analysis. Therefore the measure of these factors is a matter of serious concern for system behavior (analysis). That is why these factors should be measured with

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the help of very effective tools. Though the best effective tools are usually used to measure these factors, yet at the time of manufacturing of these tools, a major part of uncertainties are avoided for sake of simplicity. But during the analysis of micro systems, where such deviation of the estimated value from exact value may create a serious problem, we cannot dare to avoid this problem and we require some more effective tools to measure the involved factors. This problem can be sorted out by using vague set theory. According to which a vague number is assigned to the concerned variable in place of crisp numbers. In the present paper we studied the functioning of these factors based on the four modes i.e., Severe (ii) Moderate (iii) Mild and (iv) Normal modes

### Membership Function for different modes:-

**(a) Iron Factor:** Iron can be categorized for different age groups in different modes as follows:

	1-3	4-6	7-9	10-12
= severe	.07	.08	.59	.62
moderate	.10	.12	.51	.55
mild	.13	.16	.48	.49
normal	.15	.25	.35	.45

**(b) Iodine factor:** Iodine can be categorized for different age groups in different modes as follows:

	1-3	4-6	7-9	10-12
= severe	.03	.04	.16	.17
moderate	.04	.05	.15	.16
mild	.05	.06	.14	.15
normal	.07	.10	.12	.14

**(c) Vitamin A factor:** Vitamin A can be categorized for different age groups in different modes as follows:

	1-3	4-6	7-9	10-12
= severe	.16	.18	.78	.80
moderate	.22	.23	.68	.76
mild	.32	.34	.62	.66
normal	.40	.45	.55	.60

**(d) Folic acid factor:** Folic acid can be categorized for different age groups in different modes as follows:

	1-3	4-6	7-9	10-12
= severe	.02	.03	.17	.18
moderate	.03	.04	.16	.17
mild	.04	.05	.15	.16
normal	.05	.08	.11	.15

After normalizing these matrices, we get the normalized matrix from which we will study them and we will get results from them.

**(e) Iron Factor:** Iron can be categorized for different age groups in different modes as follows:

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	1-3	4-6	7-9	10-12
severe	.051	.059	.434	.456
moderate	.078	.094	.398	.430
mild	.103	.127	.381	.389
normal	.125	.208	.292	.375

**(f) Iodine factor:** Iodine can be categorized for different age groups in different modes as follows:

	1-3	4-6	7-9	10-12
severe	.075	.100	.400	.425
moderate	.100	.125	.375	.400
mild	.125	.150	.350	.375
normal	.163	.233	.279	.325

**(g) Vitamin A factor:** Vitamin A can be categorized for different age groups in different modes as follows:

	1-3	4-6	7-9	10-12
severe	.083	.094	.406	.417
moderate	.116	.122	.360	.402
mild	.165	.175	.319	.341
normal	.200	.225	.275	.300

**(h) Folic acid factor:** Folic acid can be categorized for different age groups in different modes as follows:

	1-3	4-6	7-9	10-12
severe	.050	.075	.425	.450
moderate	.075	.100	.400	.425
mild	.100	.125	.375	.400
normal	.128	.205	.282	.385

Let D= (Factors for different modes for different age groups)

Let A be the Intuitionistic vague set of the set S (Containing Iron, Iodine, Vitamin A and Folic Acid) = (S<sub>1</sub>, S<sub>2</sub>, S<sub>3</sub>, S<sub>4</sub>), and R be a Vague set Relation from S to D between the factors and the different failure modes. Then max-min-max composition for HIS (S<sub>i</sub>) for the set S with Vague set R (S → D) denoted by S=S ◦ R signifies the Health Status Index ( HSI ) in terms of the factors affecting health in different modes with the different membership functions given by

$$\mu_S(d) = \bigvee_{s \in S} [\mu_s(S) \wedge \mu_R(s, d)]$$

Or we can say that this can also be written in the form that

$$HSI(s, \bar{d}) = \bigvee_{j=1}^m [h(s_j) \wedge \bar{g}(S^j \cap D)]$$

If the health status index of a given factor for a different mode is described in the form of a vague set, then everyone will be able to translate its own intuitionism involved in degrees of association between the factors and the modes affecting the human health status index.

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## VI. RESULT AND DISCUSSION

It is difficult to define the functional status of human body. In the present paper vague/interval valued vague approach has been proposed for the use in expressing the health status and its index. In our study health status has been divided into four factors and seems to be classified into four modes by using the favorable and non-favorable factors. This study may be useful for those human beings, who are more concerned about their health status. If an individual knows the status of iodine, iron, vitamin A, and folic acid in his body through pathological examinations, he would be able to know the index of his health status. Higher index value, that is closer to unity, indicates a good health in terms of the efficiency of the body and resistance to fight common diseases. A lower value nearing zero may alarm him to be concerned about his level of micronutrients and take necessary steps accordingly. This methodology can be applied to other areas of medical sciences.

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