2

ESTIMATION OF THE OVERALL AGE GROUP OF THE PEOPLE AFFECTED BY ENDOSULFAN USING FUZZY MATRICES

2.1 Introduction

In this section an algebraic approach to the problem of determining the age group of patients affected by endosulfan is dealt with. The study is significant for it can be adopted to any place where endosulfan is used. The analysis is done for 101 affected people of the area Kasargod and Palakkad district in Kerala. The peak age group of endosulfan victims by their exposure through spraying and by breathing is determined. The new raw data are obtained from 101 subjects in our study. From the data collection eight specific diseases having affected the Endosulfan victims are choosen. The initial raw data matrix having these eight diseases against six ranges of age groups from 0-60 is obtained. The Average Time Dependent matrix (ATD) = (a_{ij}) is obtained from the initial matrix by dividing each entry by the range of the age. A matrix named as the Refined Time-dependent Data (RTD) matrix = (e_{ij}) where e_{ij} is calculated using the following formula:

$$\text{if } a_{ij} \leq (\mu_j - \alpha \cdot \sigma_j) \text{ then } e_{ij} = -1 \text{ else}$$
$$\text{if } a_{ij} \in (\mu_j - \alpha \cdot \sigma_j, \mu_j + \alpha \cdot \sigma_j) \text{ then } e_{ij} = 0 \text{ else}$$
$$\text{if aij} > (\mu_j + \alpha \cdot \sigma_j) \text{ then } e_{ij} = 1$$

Where μ_j and σ_j are the mean and the standard deviation of the j^{th} column of the ATD matrix respectively and α is a parameter taken from the interval [0, 1]. The row sum matrix of each ATD matrix is obtained by adding the entries of each row.The row sum gives the number of victims belonging to the age group. A graph is drawn for each parameter. At the next stage using the RTD matrix the Combined Effect Time-dependent Data matrix (CETD matrix) is derived by adding all RTD matrices which gives the cumulative effect of all these entries. In the final stage the row sums of the CETD matrix are obtained. All these are represented by graph and they play a vital role in exhibiting the data by the simplest means, which can be even understood by laymen. A program in C++ language (Appendix III(a)) is written which easily estimates all these five stages.

2.2: Estimation of Maximum Age Group Victims of Endosulfan Using Fuzzy Matrices

Using the patients information sheet (Appendix II) of 101 victims of Endosulfan the following diseases are selected for the study.

X_1 Skin diseases

X_2 Handicapped

X_3 Eye sight disorders

X_4 Defects in sex hormone

X_5 Kidney, liver, heart diseases

X_6 Mentally retorted

X_7 Growth retardations

X_8 Epilepsy, Cerebral Palsy

From 101 questionnaires the initial raw data matrix of order 6x8 is constructed with the eight diseases concepts as the columns the range of age groups 0-10, 11-20, 21-30, 31-40, 41-50 and 51-60 as the rows. The entries of the matrix are filled by the number of victims having certain disease under the corresponding age group.

2.2.1: Initial Raw Data Matrix

Age Group	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
0-10	2	11	2	0	3	22	1	2
11-20	4	5	3	0	0	15	1	5
21-30	0	0	0	0	0	4	2	2
31-40	2	1	1	2	0	1	1	0
41-50	3	0	0	1	0	0	0	1
51-60	1	0	0	0	0	0	0	3

Table 2.1

2.2.2: Average Time Dependent Matrix (ATD Matrix)

The ATD matrix is obtained by dividing each entry by the range of the age i.e., 10

Age Group	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
0-10	0.2	1.1	0.2	0	0.3	2.2	0.1	0.2
11-20	0.4	0.5	0.3	0	0	1.5	0.1	0.5
21-30	0	0	0	0	0	0.4	0.2	0.2
31-40	0.2	0.1	0.1	0.2	0	0.1	0.1	0
41-50	0.3	0	0	0.1	0	0	0	0.1
51-60	0.1	0	0	0	0	0	0	0.3

Table 2.2

For each component X_1, X_2, X_3……X_8, the mean and the SD are calculated and listed below:

2.2.3: The Mean and Standard Deviation Of The Above ATD Matrix

	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8
Mean	0.2	0.28	0.1	0.05	0.05	0.7	0.08	0.22
S.D	0.129	0.4059	0.1155	0.0764	0.1118	0.8485	0.1519	0.1573

Table 2.3

RTD matrix is calculated using the following formula for different parameters α=0.15, α=.35and α=.75 using the C++ computer program(Appendix III(a))

$$\text{if } a_{ij} \leq (\mu_j - \alpha \cdot \sigma_j) \text{ then } e_{ij} = -1 \text{ else}$$

$$\text{if } a_{ij} \in (\mu_j - \alpha \cdot \sigma_j, \mu_j + \alpha \cdot \sigma_j) \text{ then } e_{ij} = 0 \text{ else}$$

$$\text{if } a_{ij} > (\mu_j + \alpha \cdot \sigma_j) \text{ then } e_{ij} = 1$$

The sum of each row is calculated and the corresponding row sum matrix is obtained.

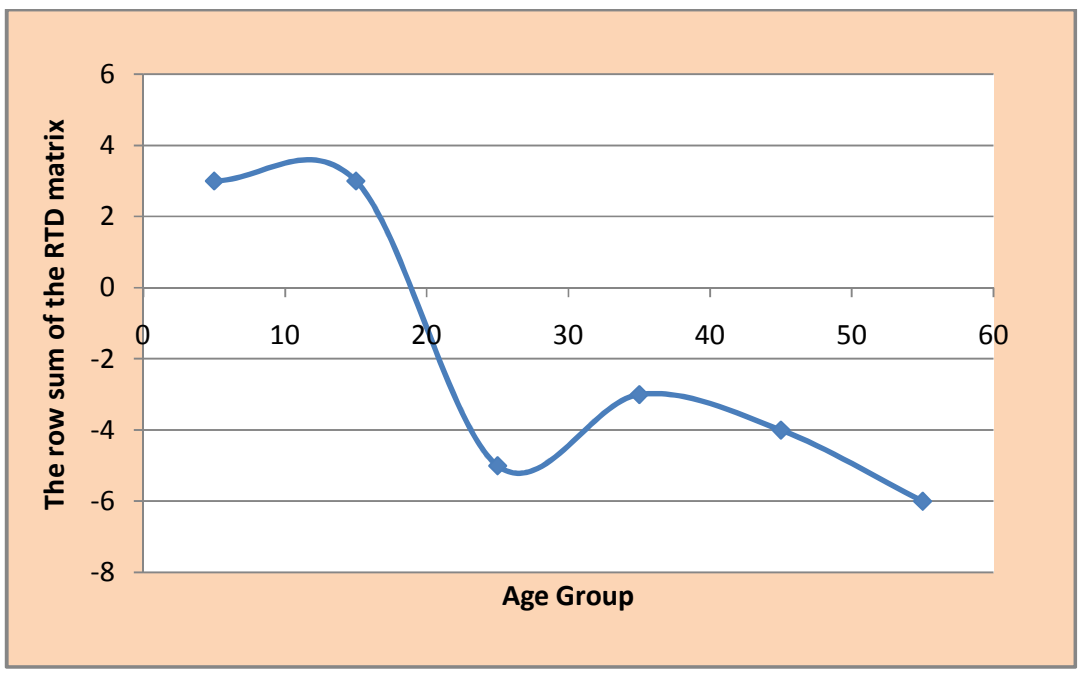
RTD matrix for α= 0.15

$$\begin{pmatrix} 0 & 1 & 1 & -1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & -1 & -1 & 1 & 0 & 1 \\ -1 & -1 & -1 & -1 & -1 & -1 & 1 & 0 \\ 0 & -1 & 0 & 1 & -1 & -1 & 0 & -1 \\ 1 & -1 & -1 & 1 & -1 & -1 & -1 & -1 \\ -1 & -1 & -1 & -1 & -1 & -1 & -1 & 1 \end{pmatrix}$$

The row sum matrix

$$\begin{pmatrix} 3 \\ 3 \\ -5 \\ -3 \\ -4 \\ -6 \end{pmatrix}$$

Graph depicting maximum age group of victims of endosulfan for α=0.15.



Graph 2.2.1

Using the table 2.3 and considering the parameter α=0.35, RTD matrix and the row sum matrix are calculated using the formula given earlier.

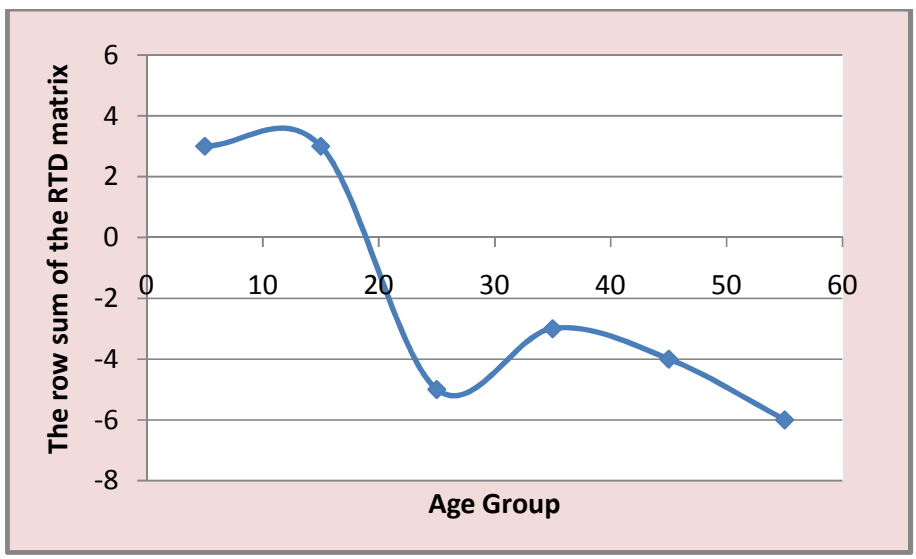
RTD matrix for α= 0.35

$$\begin{pmatrix} 0 & 1 & 1 & -1 & 1 & 1 & 0 & 0 \\ 1 & 1 & 1 & -1 & -1 & 1 & 0 & 1 \\ -1 & -1 & -1 & -1 & -1 & -1 & 1 & 0 \\ 0 & -1 & 0 & 1 & -1 & -1 & 0 & -1 \\ 1 & -1 & -1 & 1 & -1 & -1 & -1 & -1 \\ -1 & -1 & -1 & -1 & -1 & -1 & -1 & 1 \end{pmatrix}$$

The row sum matrix

$$\begin{pmatrix} 3 \\ 3 \\ -5 \\ -3 \\ -4 \\ -6 \end{pmatrix}$$

Graph depicting maximum age group of victims of endosulfan for α=0.35



Graph 2.2.2

Using the table 2.3 and considering the parameter α=0.75, RTD matrix and the row sum matrix are calculated using the formula given earlier.

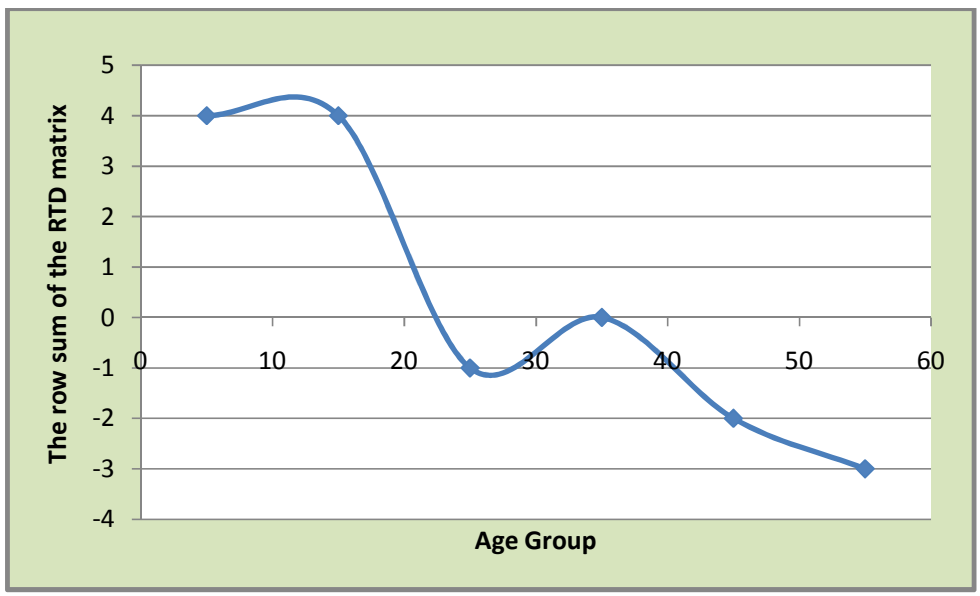
RTD matrix for α= 0.75

$$\begin{pmatrix} 0 & 1 & 1 & 0 & 1 & 1 & 0 & 0 \\ 1 & 0 & 1 & 0 & 0 & 1 & 0 & 1 \\ -1 & 0 & -1 & 0 & 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 & -1 \\ 1 & 0 & -1 & 0 & 0 & -1 & 0 & -1 \\ -1 & 0 & -1 & 0 & 0 & -1 & 0 & 0 \end{pmatrix}$$

The row sum matrix

$$\begin{pmatrix} 4 \\ 4 \\ -1 \\ 0 \\ -2 \\ -3 \end{pmatrix}$$

Graph depicting maximum age group of victims of endosulfan for α=0.75.



Graph 2.2.3

The CETD matrix formulated in which each entry is the sum of the corresponding entry in the three RTD matrices for the values of α= 0.15,α=0.35, α=0.75 and the row sum of CETD is calculated.

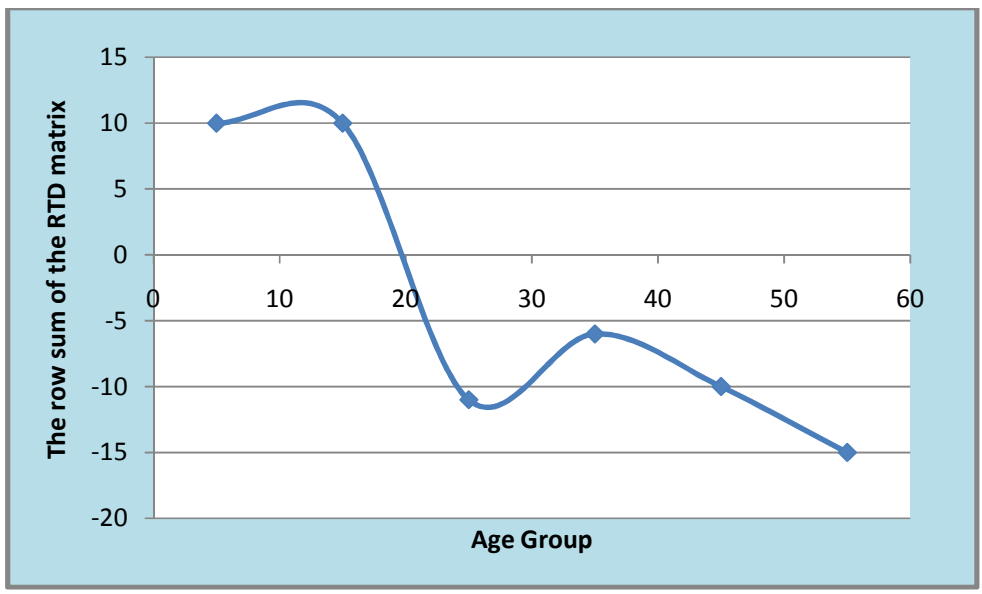
CETD matrix

$$\begin{pmatrix} 0 & 3 & 3 & -2 & 3 & 3 & 0 & 0 \\ 3 & 2 & 3 & -2 & -2 & 3 & 0 & 3 \\ -3 & -2 & -3 & -2 & -2 & -2 & 3 & 0 \\ 0 & -2 & 0 & 3 & -2 & -2 & 0 & -3 \\ 3 & -2 & -3 & 2 & -2 & -3 & -2 & -3 \\ -3 & -2 & -3 & -2 & -2 & -3 & -2 & 2 \end{pmatrix}$$

The row sum of CETD matrix

$$\begin{pmatrix} 10 \\ 10 \\ -11 \\ -6 \\ -10 \\ -15 \end{pmatrix}$$

The graph depicting maximum age group of endosulfan victims for CETD matrix



Graph 2.2.4

2.3 Conclusions

From the above CETD matrix analysis the maximum endosulfan victims are in the age group of 0-20. It has not changed with the change in values of the parameter from 0 to 1 .But the age group 21-60 are negative because only few people became victims of Endosulfan at this age group. Endosulfan was sprayed since 1980. The effects of

Endosulfan were found in Kasargod and Palakkad from 1990 only, the children born after 1990 were the victims of the residues of endosulfan in the land and water. Hence people of age below 20 are main victims of the chronic effect of spraying endosulfan. The infants are affected as they are breastfed by mothers, who work in the field having Endosulfan residues in their milk. The school going children are exposed to the aerial spraying of endosulfan and by the drinking water from the open well which is left uncovered during the aerial spraying of endosulfan.The teenage and adolescent group victims have acquired these diseases since birth and had severe physical and mental retardation. The higher age groups are less affected due to the immunity level. If at all they are affected by direct exposure, they get treated immediately. The congenital problems occur only for the children born between 1986 and 2015. The diseases X_1 to X_8 occur mainly due to the usage of endosulfan in the field. Remedial measures are discussed in Chapter V in detail.