MATHEMATICAL MODEL ON THYROID STIMULATING HORMONE (TSH)

PG AND RESEARCH DEPARTMENT OF MATHEMATICS JAMAL MOHAMED COLLEGE (AUTONOMOUS)

ACCREDITED WITH A++ GRADE BY NAAC (4th CYCLE) WITH CGPA 3.69 OUT OF 4.0 (AFFILIATED TO BHARATHIDASAN UNIVERSITY)

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Introduction

The main purpose of this project work is to develop a fuzzy mathematical model for TSH which includes the secretion of Thyroid , to be able to detect the suffered patients and animals.

CHAPTER I

MATHEMATICAL MODEL ON THYROID STIMULATING HORMONE

PRESENTED BY : M.FAHMITHA FATHIMA

INTRODUCTION TO FUZZY

FUZZY LOGIC

Fuzzy logic is an approach to computing based on "degrees of truth" rather than the usual "true or false" (1 or 0) Boolean logic on which the modern computer is based.

The idea of fuzzy logic was first advanced by Lotfi Zadeh of the University of California at Berkeley in the 1960s. Zadeh was working on the problem of computer understanding of natural language. Natural language -- like most other activities in life and indeed the universe -- is not easily translated into the absolute terms of 0 and 1.

A fuzzy set is defined and denoted by

$$\tilde{A} = \sum \frac{\mu_A(\mathrm{xi})}{\mathrm{xi}}, \int_x^{\mu_A}(x)/x$$

The function $\boldsymbol{\mu_A}$(x) may take values in the interval [0,1], where $\boldsymbol{\mu_A}$(x) is a function called the membership function.

The membership function of a fuzzy set is a generalization of the indicator function in classical sets. In fuzzy logic, it represents the degree of truth as an extension of valuation.

FUZZY NUMBER & GENERALISED FUZZY NUMBER

A fuzzy set $\tilde{A}$, defined on the universal set of real numbers $\Re$, is said to be a fuzzy number if its membership function has the following characteristics:

(i) $\mu_A : \Re \longrightarrow [0,1]$ is continuous

(ii) μ_A (x) = 0 for all $x \epsilon (-\infty, a] \cup [d, \infty)$

(iii) μ_A strictly increasing on [a,b] and strictly decreasing on [c,d].

(iv) μ_A (x) = 1 for all $x \epsilon [b, c]$, where $a \leq b \leq c \leq d$.

A fuzzy set $\tilde{A}$, defined on the universal set of real numbers $\Re$, is said to be generalized fuzzy number if its membership function has the following characteristic:

(i) $\mu_A : \Re \longrightarrow [0,1]$ is continuous

(ii) μ_A (x) = 0 for all $x \epsilon (-\infty, a] \cup [d, \infty)$

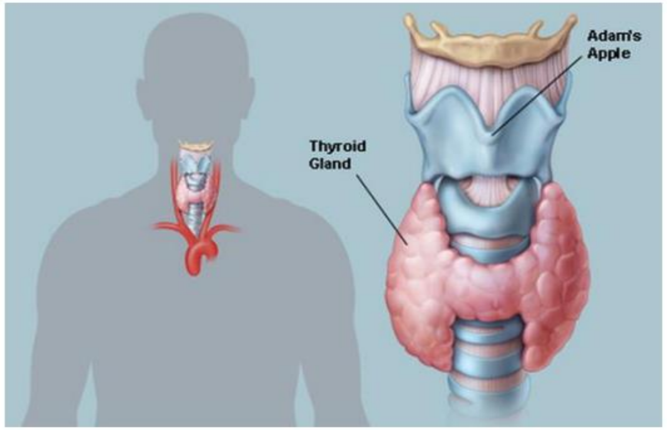
(iii) μ_A strictly increasing on [a,b] and strictly decreasing on [c,d].

(iv) μ_A (x) = ω for all $x \epsilon [b, c]$, where $0 < \omega \leq 1$.

THYROID STIMULATING HORMONE

HORMONE

Hormone is a regulatory substance produced in an organism and transported in tissue fluids such as blood or sap to stimulate specific cells or tissues into action.



TSH

SHAPE : butterfly shaped gland

LOCATION : seen on the front part of lower the neck. It is below Adam's apple.

HAS : abundant blood vessels and is brownish red in color.

THYROID SECRETES: thyroid hormones. The most important hormone is thyroxine and is called T_4.

HORMONE'S WORK : Thyroid hormones work in our body completely creating metabolism, development and maintaining our body temperature. Thyroid hormone is vital for the growth of our brain during infancy and childhood.

It is a pituitary hormone that stimulates the thyroid gland to produce thyroxine (T4).

Tri-iodothyronine (T3) stimulates the metabolism of almost every tissue in the body. The anterior pituitary gland which regulates the endocrine function of the thyroid, Glycoprotein hormone is produced and secreted by thyrotrope cells.

HORMONE LEVEL:

Normal levels of TSH with adults are between 0.4 and 4.2 micro-units per millilitre.

For children the levels are b/w 0.7 and 6.4.

The levels for the newborn are b/w 1 and 39.

TSH & THYROID DISORDER CLASSIFICATION

SECRETION OF TSH

Values that are indicated other than these results are problematic pituitary gland.

The hormone thyroxine (T4) is secreted by TSH through thyroid gland. It has little effect on metabolism.

(T3) (Tri-iodothyronine) is the active hormone which kindles metabolism. (T4) is converted into T3.

This conversion affects liver and the other organs above 80 %. The remaining 20 % affects the thyroid itself.

THYROID DISORDER / MENOPAUSE

Thyroid disorders can affect menstrual cycle and mood of the people gravely.

The symptoms are wrongly understood to be menopause.

The thyroid problem is caused by menopause or a thyroid illness or a combination of these two.

HYPOTHYROID & HYPERTHYROID

A blood test is adequate to find an answer if there is a suspect of thyroid disorder. This test makes us find out the level of TSH. It is a matter of hormone which controls the function of thyroid gland. When TSH is high, the thyroid function is very low, and is called hypothyroid. When TSH is low, the thyroid is overactive. It is termed as hyperthyroid. Studies such as imaging and biopsies are used to evaluate abnormality of thyroid.

Hyperthyroidism is common among women and hypothyroidism mostly affects women who are above 60 years old of age.

THYROID DISORDER DURING PREGNANCIES

THYROID DISORDER

SYMPTOMS OF HYPOTHYROIDISM

- Congestive heart failure
- Preeclampsia-a dangerous rise in blood pressure in late pregnancy
- Thyroid storm-a sudden, severe worsening of symptoms
- Miscarriage
- Premature birth
- Low birth weight

SYMPTOMS OF HYPERTHYROIDISM

- Preeclampsia
- Anaemia-too few red blood cells in the body, which prevents the body from getting enough oxygen
- Miscarriage
- Low birth weight
- Stillbirth
- Congestive heart failure, rarely

SUMMARY:

A mathematical model is developed to find the mean and variance to reach the threshold level, in the context of thyroid stimulating hormone. Fuzzy shock model with Rayleigh distribution has used to calculate the fuzzy expected time and fuzzy variance for the female patients suffered by hypothyroid female.

fuzzy cumulative damage models with fuzzy standard, periodic and continuous models are used to find the newborn thyroid stimulating hormone levels in relation to maternal age 17 and gestation at birth.

By the fuzzy survivor, linear fuzzy hazard rate functions and fuzzy Weibull hazard rate functions are used to develop interrelationships among serum thyroxine, triiodothyronine, and TSH in iodine deficient pregnant women.

Fuzzy exponentiated modified Weibull distribution is used to find fuzzy mean and fuzzy variance for pregnant and lactating rats which are affected by hypothyroidism on a hormone.

The fuzzy transmuted Dagum distribution with four parameters for fuzzy reliability and fuzzy hazard analysis was used to transient neonatal hyper thyrotrophinaemia.

The level of TSH secretion in the given time duration is analyzed, which is reasonably higher if unconditional probabilities of time interval in the equilibrium probabilities increase.

CHAPTER II

FUZZY SHOCK MODEL FOR THE SECRETION OF THYROID STIMULATING HORMONE (TSH)

SHOCK MODEL DESCRIPTION:

The two-parameter generalized Rayleigh distribution and the following cumulative distribution function for x>0

$$F\ (x;\ \alpha,\lambda) = [1 -\ e^{-\lambda x^2}]^{\alpha}\ ;\ x > 0;$$

and the corresponding probability density function is

$$f(x;\ \alpha,\lambda)\ = 2\alpha\lambda x e^{-\lambda x^2}[1\ -\ e^{-\lambda x^2}]^{\alpha-1};\ x > 0;$$

A three parameter Rayleigh distribution has the cumulative distribution function

$$F\ (x;\ \alpha,\lambda,\beta) = [1\text{-}\ e^{-(x-\beta)^2}]^{\alpha},\ x\ >\ \beta;\ \alpha,\lambda\ >\ 0;$$

And the corresponding Density function is

$$f(x;\ \alpha,\lambda,\beta) = 2\alpha\lambda\ (x - \beta)e^{-\lambda(x-\beta)^2}\ [1\ -\ e^{-\lambda(x-\beta)^2}]^{\alpha-1};$$

The corresponding survival function is

$$\tilde{H}(X) = 1 - \left[1 - e^{-\lambda(x-\mu)^2}\right]$$

$$= \left[e^{-\gamma(x-\mu)^2}\right]$$

The corresponding Mean and Variance is

$$E(\mathrm{T}) = \left\{\frac{\lambda^2 +\ \beta^2 + 2\beta^2\lambda + 2\beta^3 + \beta^3\lambda + 2\lambda^2\beta^3 +\ \beta^4 + 2\beta^4\lambda}{c[\ \beta^2 + 2\lambda^2\beta^3 - 2\beta^3 + 2\beta^3\lambda + \beta^4]}\right\}$$

$$V(\mathrm{T}) = \left\{\frac{[\lambda^2 +\ \beta^2 + 2\beta^2\lambda + 2\beta^3 + \beta^3\lambda + 2\lambda^2\beta^3 +\ \beta^4 + 2\beta^4\lambda]^2}{C^2[\ \beta^2 + 2\lambda^2\beta^3 - 2\beta^3 + 2\beta^3\lambda + \beta^4]^2}\right\}$$

1st APPLICATION

A 22- YEAR- OLD FEMALE

- who was severely hypothyroid and mentally retarded
- The thyroid was located in the normal position
- Serum T4 and T3 were below the sensitivity of the methods and serum TSH was highly elevated.
- Genetic analysis showed a homozygous inactivating mutation of the TSH receptor in the first extracellular loop
- After, 12 months of L-Thyroxine (2.6μg/kg/day) treatment TSH was 21 undetectable both basally and after TRH administration and serum totaled and free T4 and T3 were at the upper limit of normal range.

2nd APPLICATION

A 42 YEARS OLD WOMAN

- Suffered from autoimmune thyroiditis resulting in severe hypothyroidism
- She was treated for numerous years by district physician with the dose of 150 µg L-thyroxine daily.
- Since the level of was repeatedly high and no improvement of clinical signs had been observed
- Thyroid ultrasound showed remarkable diffuse hypoechogenicity, thyroid scintigraphy showed enlarged thyroid with low 99mTc uptake, TRH test are normal, thinned needle biopsy supported autoimmune thyroiditis.
- X-ray examination showed normal sellaturcica and no changes in the pituitary
- In spite of increasing the dose of peroral L-thyroxine to 300 µg/d and later to 500 µg/d the medical or clinical status and TSH level did not improve.
- The patient was originally suspected from malabsorption of thyroxine.
- The test with a large single peroral dose (1000 µg) of L-thyroxine showed a rapid decrease of TSH level (from 126 to 75 mU/l) and an increase of total T4 level (from 18 to 64nmol/l) within 4hr.
- After the patient had been treated with intravenous L-thyroxine (500 µg every 3-4 days for weeks) which resulted in the increase of T4 level to 80-100 nmol/l and the decrease of TSH level to 10 mU/l.
- The problem was a poor compliance of the patient who apparently did not actually took the medication

SUMMARY

Data collected from longitudinal studies of infected people and are used to generate the hypothesis and how infectiousness varies through the time from the point of infection. By this fuzzy mathematical shock model, we show that the fuzzy mean and fuzzy variance for the patients with autoimmune thyroiditis with severe hypothyroidism resistant after TSH treatment it increased in the upper α cuts and decreased in the lower α cuts

CHAPTER III

Fuzzy Cumulative Damage Model for TSH in Gestation Birth

PRESSENTED BY : A S SHIHANA FATHIMA

Cumulative Damage Models Description :

* A Cumulative damage model for failures caused by fatigue is mostly used by Milner's rule.

* It states that if there are different stress level and average number of cycles to failure at the i^{th} stress S_i, is N_i, then the damage fraction C, is:

* $\sum_{i=1}^{k} \frac{n_i}{N_i}$ = C

* Where n_i is the number of cycles accumulated at stress S_i.

* C is the fraction of life consumed by exposure to the cycles at the different stress levels. In general, when the damage fraction reaches 1, failure occurs.

Model-I: Fuzzy standard model:

The alpha cut of fuzzy mean is $E\{\tilde{Z}(t)\} = [\tilde{E}_l(t), \tilde{E}_u(t)]$

$$\tilde{E}_l\{\tilde{z}(t)\} = \min\{\tilde{\mu}\sum_{j=1}^{\infty}\tilde{F}^{(j)}(t)\}$$

$$= \min\{\tilde{\mu}\tilde{M}\tilde{F}(t)\}$$

$$= \min\{\tilde{\mu}\tilde{\emptyset}(x)\}$$

$$\tilde{E}_u\{\tilde{Z}(t)\} = \max\{\tilde{\mu}\sum_{j=1}^{\infty}\tilde{F}^{(j)}(t)\}$$

$$= \max\{\tilde{\mu}\tilde{M}\tilde{F}(t)\}$$

$$= \max\{\tilde{\mu}\tilde{\emptyset}(x)\}$$

And the alpha cut of fuzzy variance is $\tilde{V}\{\tilde{Z}(t)\} = [\tilde{V}_l(t), \tilde{V}_u(t)]$

$$\tilde{V}_l\{\tilde{Z}(t)\} = min\{\tilde{\lambda}^3 t(\tilde{\mu}^2\tilde{\sigma}_F^2 + \frac{\tilde{\sigma}_G^2}{\tilde{\lambda}^2})\}$$ and

$$\tilde{V}_u\{\tilde{Z}(t)\} = \max\{\tilde{\lambda}^3 t(\tilde{\mu}^2\tilde{\sigma}_F^2 + \frac{\tilde{\sigma}_G^2}{\tilde{\lambda}^2})$$

Application for Fuzzy Standard Model:

- Totally 170 newborns have been analyzed for the study population ,median and mean maternal age was 28 years (range from 19 to 41 years).
- All neonates were born at median 40 of gestational weeks ranging from 35 to 41 weeks. The study sample consists of 96 male and 74 female births. Median birth weight range was 2176g to 4700g.
- Three fuzzy cumulative damage models are performed to test the relation between mean neonatal TSH levels and gestational age.

The triangular fuzzy number for the scale parameter and the location parameters are

$[\alpha] = [37,38,39]$

$\tilde{\sigma}_F[\alpha] = [2,2.16,3]$

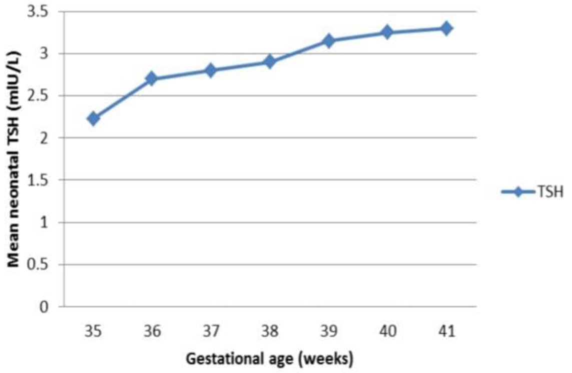
$\tilde{\mu}[\alpha] = [2,2.89,3]$

The corresponding α cuts are

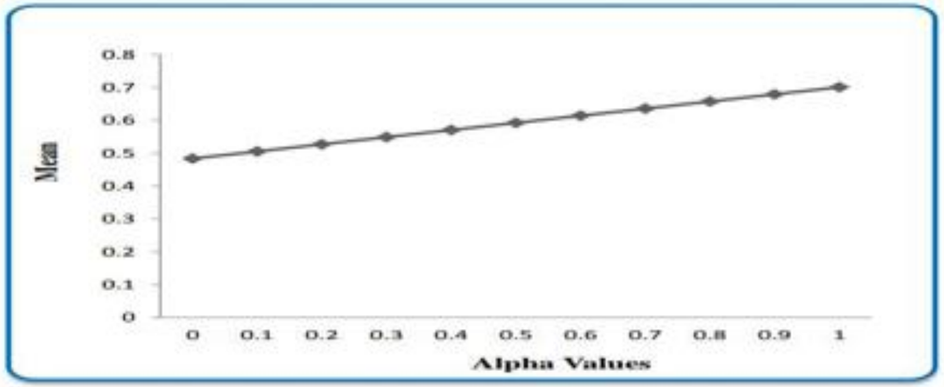
$[\alpha] = [37.0 + 1.0\alpha,\ 39.0 - 1.0\alpha]$

$\tilde{\sigma}_F[\alpha] = [2.0 + 0.16\alpha,\ 3.0 - 0.84\alpha]$

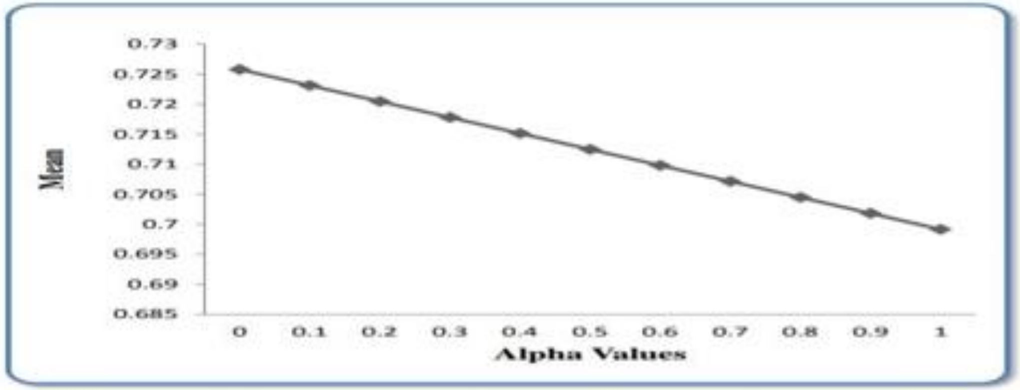
$\tilde{\mu}[\alpha] = [2.0 + 0.89\alpha, 3.0 - 0.11\alpha]$

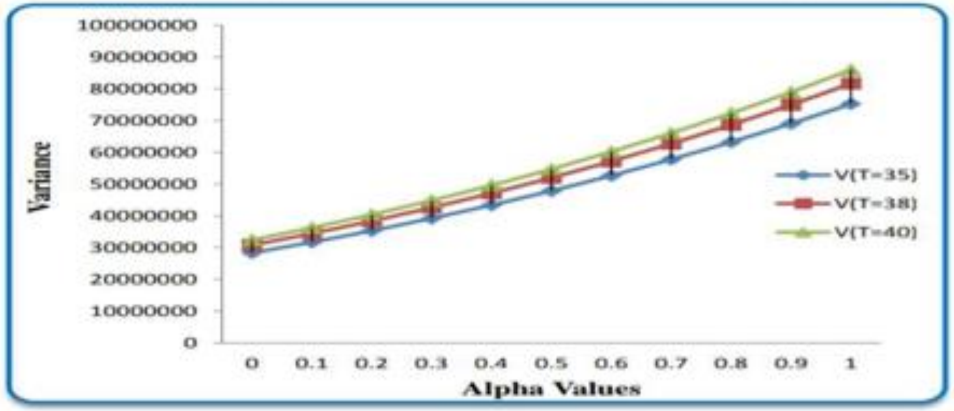


Lower alpha cut from the fuzzy mean in fuzzy standard

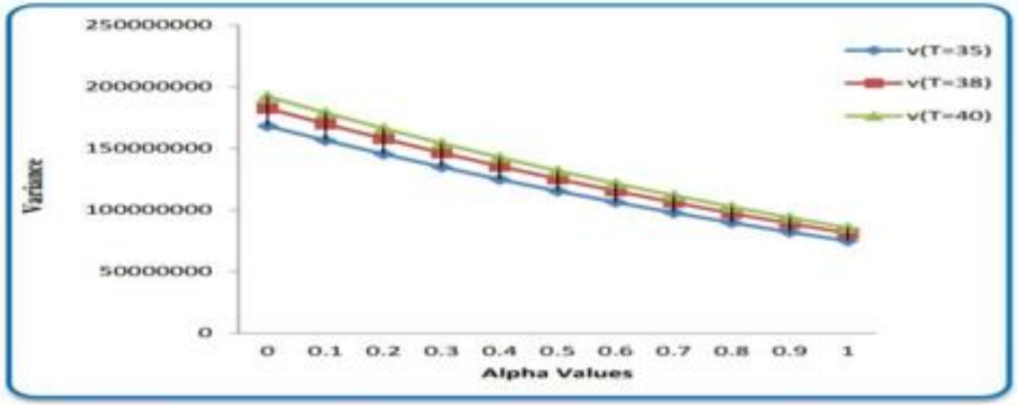


Upper alpha cut from the fuzzy mean in fuzzy standard model





Lower alpha cut of the fuzzy variance in fuzzy standard model



Upper alpha cut of the fuzzy variance in fuzzy standard model

SUMMARY:

Finally we calculated the fuzzy variance for the newborns with thyroiditis
And with severe hypothyroidism resistant.

Since the birth weight is depend on gestational age, there is a significant amount of damage at any period.

CHAPTER III

Fuzzy Cumulative Damage Model for TSH in Gestation Birth

PRESSENTED BY : L NAMEEERA FATHIMA

Model –II: Fuzzy Periodic Model:

The alpha cut of fuzzy mean is

$$\tilde{E}\{\tilde{Z}(t)\} = [\tilde{E}_l(t), \tilde{E}_u(t)]$$

$$\tilde{E}_l\{\tilde{Z}\ (nT_0)\} = min\{n\tilde{\mu}T\}$$ and

$$\tilde{E}_u\{\tilde{Z}\ (nT_0)\} = max\{n\tilde{\mu}\ T\}$$

And the alpha cut if fuzzy variance is

$$\tilde{V}\{\tilde{Z}\ (t)\} = [\tilde{V}_l(t), \tilde{V}_u(t)]$$

$$\tilde{V}_l\{\tilde{Z}(nT_0)\} = \min\ \{n\tilde{\sigma}_T^2\}$$ and

$$\tilde{V}_u\{\tilde{Z}(nT_0)\} = \max\ \{n\tilde{\sigma}_T^2\}$$

Application for Fuzzy periodic Model:

The triangular fuzzy number of scale parameter and the location parameters are

$$\tilde{\mu}[\alpha]=[2,2.89,3]$$

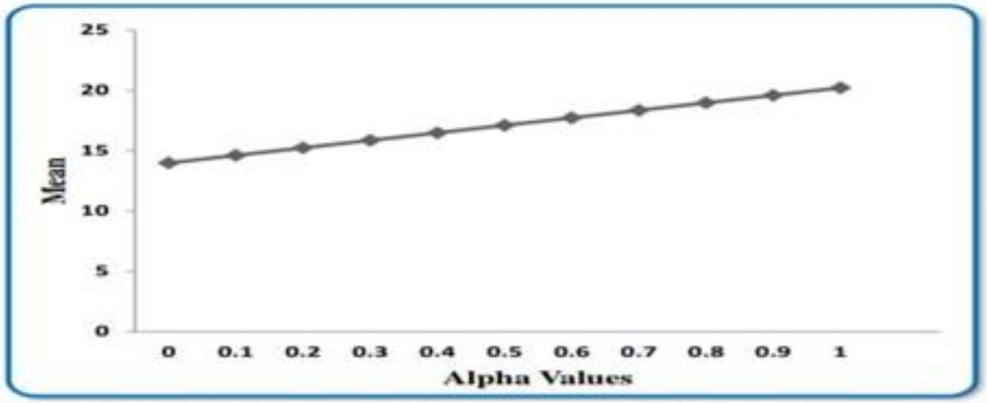
$$\tilde{\sigma}_G[\alpha]=[0,0.36,1]$$

The corresponding α cuts are

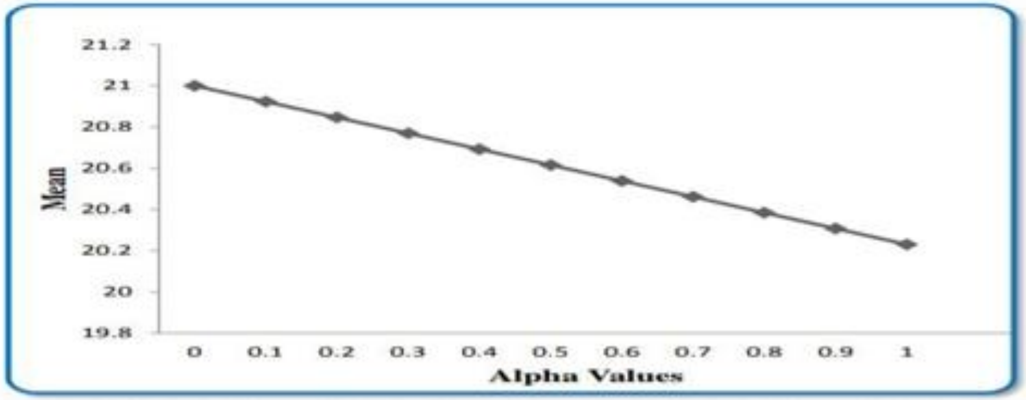
$$\tilde{\mu}[\alpha] = [2,2.89\alpha,3.0\text{-}0.11\alpha]$$

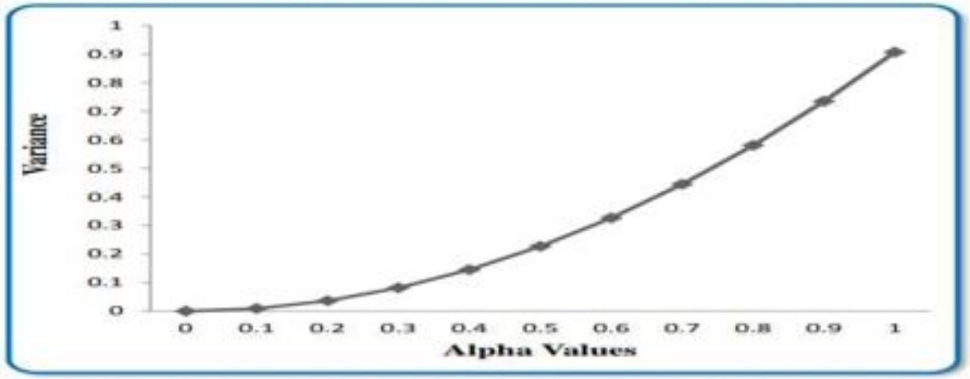
$$\tilde{\sigma}_G[\alpha] = [0,0.36\alpha, 1.0\text{-}0.64\alpha]$$

Lower alpha cut from the fuzzy mean in fuzzy periodic model

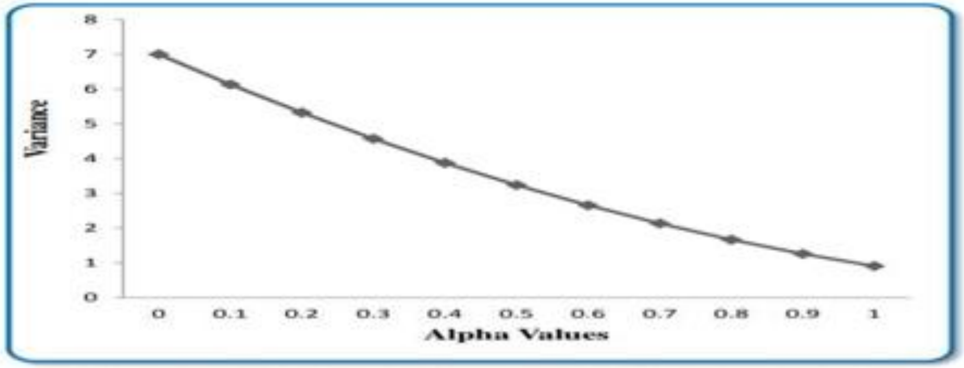


Upper alpha cut from the fuzzy mean in fuzzy periodic model





Lower alpha cut from the fuzzy variance in fuzzy periodic model



Upper alpha cut from the fuzzy variance in fuzzy periodic model

Model-III: Fuzzy continuous Model:

Case(i):

The alpha cut of fuzzy mean is $\tilde{E}\{\tilde{Z}(t)\} = [\tilde{E}_l(t), \tilde{E}_u(t)]$

$\tilde{E}_l\{\tilde{Z}(t)\} = \min\{at\}$ and

$\tilde{E}_u\{\tilde{Z}(t)\} = \max\{at\}$

And the alpha cut of fuzzy variance is $\tilde{V}\{\tilde{Z}(t)\} = [\tilde{V}_l(t), \tilde{V}_u(t)]$

$\tilde{V}_l\{\tilde{Z}(t)\} = \min\{\tilde{\sigma}_B^2\}$ and

$\tilde{V}_u\{\tilde{Z}(t)\} = \max\{\tilde{\sigma}_B^2\}$

Case(ii):

The alpha cut of fuzzy mean is $\tilde{E}\{\tilde{Z}(t)\} = [\tilde{E}_l(t), \tilde{E}_u(t)]$

$\tilde{E}_l\{\tilde{Z}(t)\} = \min\{at\}$

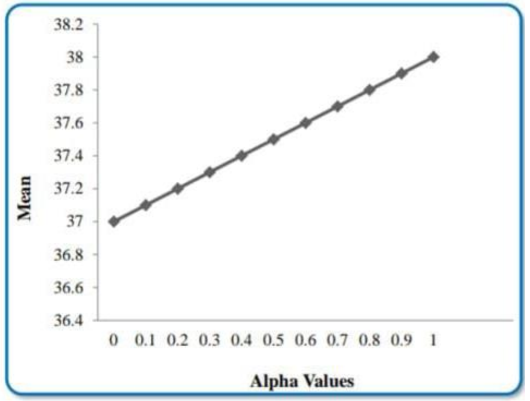
$\tilde{E}_u\{\tilde{Z}(t)\} = \max\{at\}$

And the alpha cut of fuzzy variance is $\tilde{V}\{\tilde{Z}(t)\} = [\tilde{V}_l(t), \tilde{V}_u(t)]$

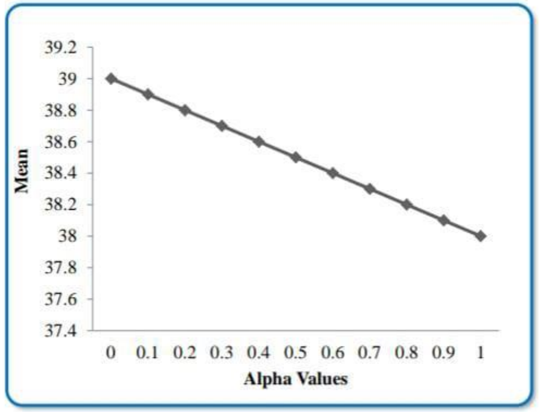
$\tilde{V}_l\{\tilde{Z}(t)\} = \min\{\tilde{\sigma}_A^2 t\}$

$\tilde{V}_u\{\tilde{Z}(t)\} = max\{\tilde{\sigma}_A^2 t\}$

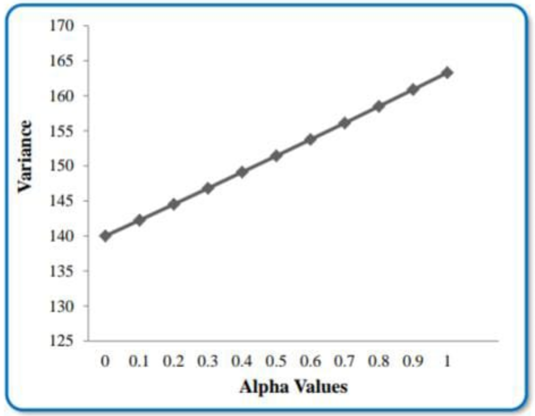
Application for Fuzzy Continuous Model:



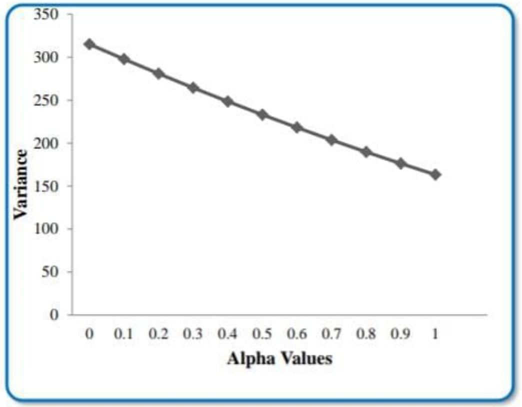
Lower and upper values for fuzzy mean and fuzzy variance of autoimmune thyroiditis at a = 1 and T = 35 value for case: (i)



Lower alpha cut from the fuzzy variance in fuzzy continuous model for case (i) and case (ii)

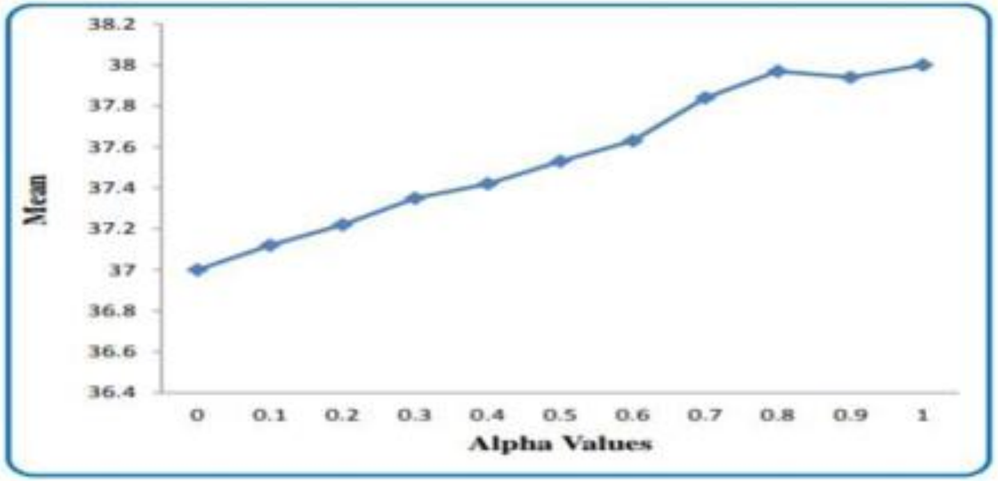


Upper alpha cut from the fuzzy mean in fuzzy continuous model for case (i) and case (ii)

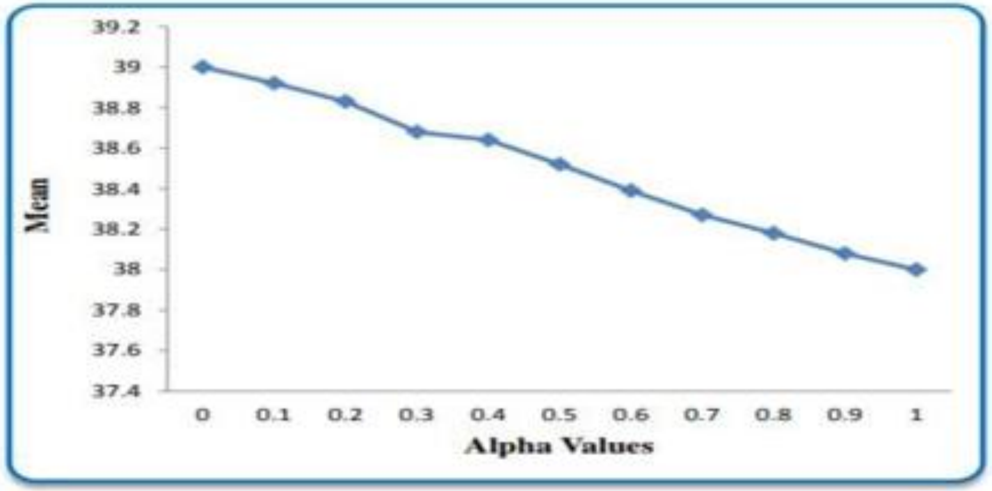


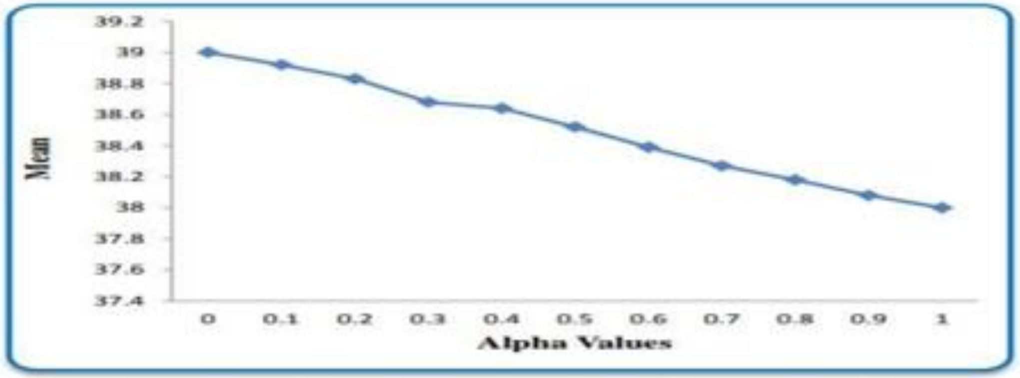
Lower alpha cut from the fuzzy variance in fuzzy continuous model in case (i) and case (ii)

Lower alpha cut from the fuzzy mean in fuzzy continuous model for case (ii)

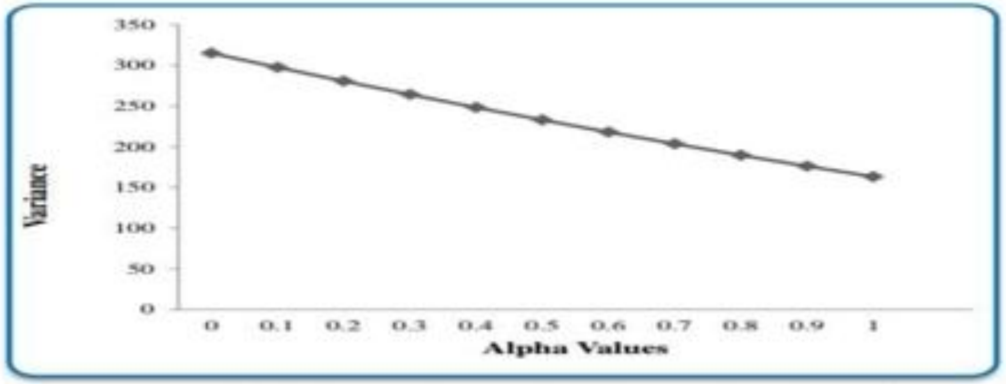


Upper alpha cut from the fuzzy mean in fuzzy continuous model for case (ii)





Lower alpha cut from the fuzzy variance in fuzzy continuous model for case (ii)



Upper alpha cut from the fuzzy variance in fuzzy continuous model for case (ii)

SUMMARY:

This results indicates the variance and mean amount of damage to TSH increase with an increase in Gestation age.

It is found that older maternal age in pregnancy and longer Gestation birth is associated with elevated newborn blood spotted TSH levels.

CHAPTER IV

APPLIATION OF FUZZY EXPONENTIATED MODIFIED WEIBULL DISTRIBUTION FOR HYPOTHYROID IN PREGNANT RATS AND LACTATING RATS

PRESENTED BY: A FATHIMA BEEBI

FUZZY EXPONENTIATED MODIFIED WEIBULL DISTRIBUTION (FEMWD) MODEL DESCRIPTION

- ❖ Introduced a generalized modified Weibull distribution by powering a positive real number to the cumulative distribution function(cdf).
- ❖ This forms a new family of distribution called exponentiated modified Weibull distribution.
- ❖ The distribution has many useful properties; its hazard rate function (HRF) is flexible in accommodating all the shapes of HRF.
- ❖ This property enables this distribution to fit into various types of lifetime data.

The alpha cut of fuzzy mean lifetime is $\tilde{E}(T) = [\tilde{E}_l(T), \tilde{E}_u(T)]$, where

$$\tilde{E}_l(T) = min\left\{\frac{3\tilde{\mu}+2(\tilde{\theta}+\widetilde{\gamma})}{2c(\tilde{\theta}+\tilde{\gamma})}, \tilde{\mu} \in \tilde{\mu}[\alpha], \tilde{\theta} \in \tilde{\theta}[\alpha], \tilde{\gamma} \in \tilde{\gamma}[\alpha]\right\}$$

And

$$\tilde{E}_u(T) = max\left\{\frac{3\tilde{\mu}+2(\tilde{\theta}+\tilde{\gamma})}{2c(\tilde{\theta}+\tilde{\gamma})}, \tilde{\mu}\epsilon\tilde{\mu}[\alpha], \tilde{\theta}\epsilon\tilde{\theta}[\alpha], \tilde{\gamma}\epsilon\tilde{\gamma}[\alpha]\right\}$$

The alpha cut of fuzzy variance is $\tilde{V}(T) = [\tilde{V}_l(T), \tilde{V}_u(T)]$, where

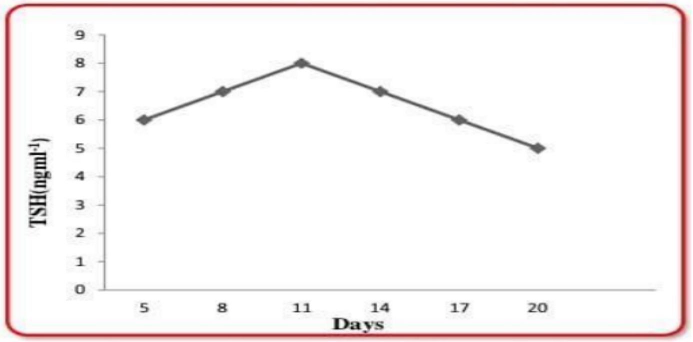
$$\tilde{V}_l(T) = \min\left\{\frac{5\tilde{\mu}^2+4(\tilde{\theta}^2+\tilde{\gamma}+12\tilde{\mu}(\tilde{\theta}+\tilde{\gamma})+8\tilde{\theta}\tilde{\gamma})}{4c^2(\tilde{\theta}+\tilde{\gamma})}, \tilde{\mu}\epsilon\tilde{\mu}[\alpha], \tilde{\theta} \in \tilde{\theta}[\alpha], \tilde{\gamma}\epsilon\tilde{\gamma}[\alpha]\right\}$$

And

$$\tilde{V}_u(T) = max\left\{\frac{5\tilde{\mu}^2+4(\tilde{\theta}^2+\tilde{\gamma}^2+12\tilde{\mu}(\tilde{\theta}+\tilde{\gamma})+8\tilde{\theta}\tilde{\gamma})}{4c^2(\tilde{\theta}+\tilde{\gamma})^2}, \tilde{\mu} \in \tilde{\mu}[\alpha], \tilde{\theta} \in \tilde{\theta}[\alpha], \tilde{\gamma} \in \tilde{\gamma}[\alpha]\right\}$$

APPLICATION FOR FEMWD ON PREGNANT RATS

The effects of hypothyroidism during a pregnancy on serum hormone parameters were examined. Propylthiouracyl was administered in the drinking water at a concentric of 0.1 g / l for 20 days.



The scale parameter of exponential distribution for the TSH and its triangular fuzzy number is

$$\tilde{\mu}[\alpha]=[0,0.167,1],$$

$$\theta[\alpha] = [6,6.356,7],$$

$$\tilde{\gamma}[\alpha] = [7,7.428,8]$$

and the corresponding $\propto$ cuts are

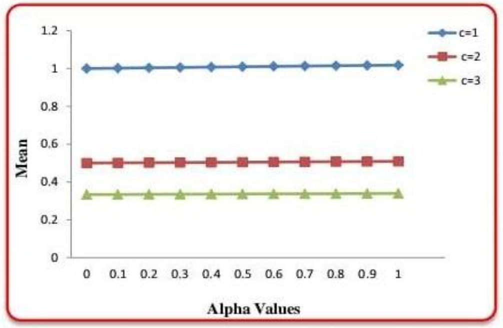
$$\tilde{\mu}[\alpha] = [0 + 0.167\alpha,\ 1 - 0.833\alpha],$$

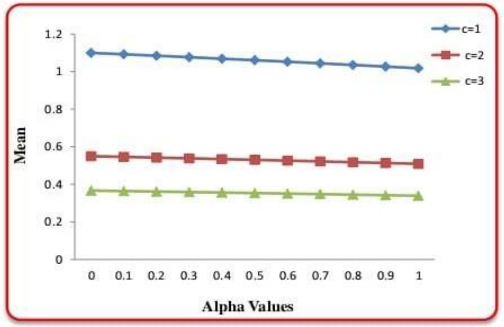
$$\theta[\alpha] = [6 + 0.356\alpha,\ 7 - 0.644\alpha],$$

$$\tilde{\gamma}[\alpha] = [7 + 0.428\alpha,\ 8 - 0.572\alpha]$$

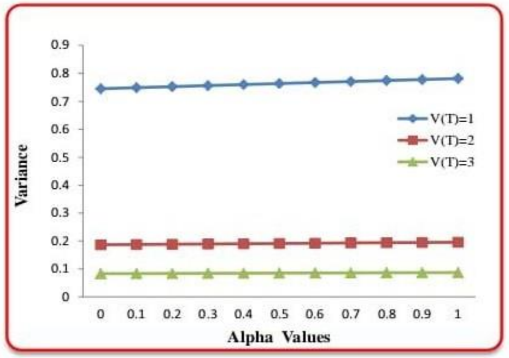
Based on the alpha cut values, the fuzzy expected value for the TSH various c=1, 2, 3 values are calculated from $\tilde{E}(T) = [E_l(T), E_u(T)]$ and also the fuzzy variances are calculated from 43 $\tilde{V}(T) = [V_l(T), V_u(T)]$. The fuzzy mean and fuzzy variance for the various c values are shown in fig: 4.2 and fig: 4.3 and the related lower and upper fuzzy variances are in fig: 4.4 and fig: 4.5 respectively.

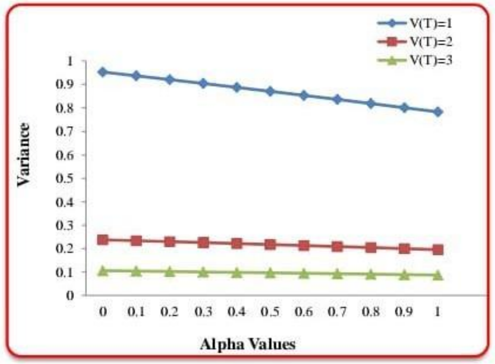
α	c = 1		c = 2		c = 3	
	$\tilde{E}_l(T)$	$\tilde{E}_u(T)$	$\tilde{E}_l(T)$	$\tilde{E}_u(T)$	$\tilde{E}_l(T)$	$\tilde{E}_u(T)$
0.0	1.0000	1.1000	0.5000	0.5500	0.3333	0.3667
0.1	1.0019	1.0924	0.5009	0.5462	0.3340	0.3641
0.2	1.0038	1.0847	0.5019	0.5423	0.3346	0.3616
0.3	1.0057	1.0769	0.5028	0.5384	0.3352	0.3589
0.4	1.0075	1.0689	0.5038	0.5345	0.3358	0.3563
0.5	1.0094	1.0608	0.5047	0.5304	0.3365	0.3536
0.6	1.0112	1.0526	0.5056	0.5263	0.3371	0.3508
0.7	1.0130	1.0442	0.5065	0.5221	0.3376	0.3481
0.8	1.0147	1.0357	0.5074	0.5178	0.3382	0.3452
0.9	1.0164	1.0270	0.5082	0.5135	0.3388	0.3423
1	1.0182	1.0182	0.5091	0.5091	0.3394	0.3394





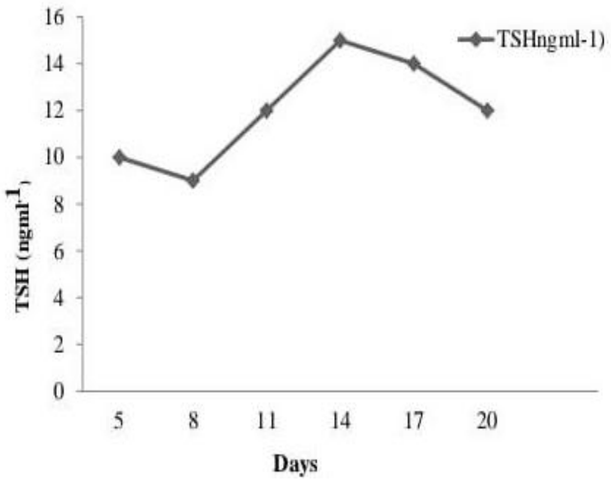
LOWER AND UPPER ALPHA CUT VALUES FROM THE FUZZY MEAN AND VARIANCE IN FEMWD ON PREGNANT RATS





APPLICATION FOR FEMWD ON LACTATING RATS

- It may help in explaining a system and to study the effects of different works, and to make predictions about the behaviour.
- Thyroid dysfunctions can produce reproductive problems.
- The formula for a mean and variance of fuzzy exponentiated modified Weibull distribution was developed and usedto find the effect of Thyroid stimulating hormone in lactating rats.
- The effects of hypothyroidism during lactation on serum hormonal parameters were examined.
- The effects of hypothyroidism during lactation are compared with its effects on virginrats that are subjected to 30 or 50 days of propylthiouracyl treatment, corresponding to the approximate duration of treatment at the end of lactation.



The scale parameter of exponential distribution

for the TSH and its triangular fuzzy number is

$$\tilde{\mu}[\alpha] = [0,0.087,1]$$

$$\tilde{\theta}[\alpha] = [12,12.723,13]$$

$$\tilde{\gamma}[\alpha] = [3,3.773,4]$$

And the corresponding α cuts are

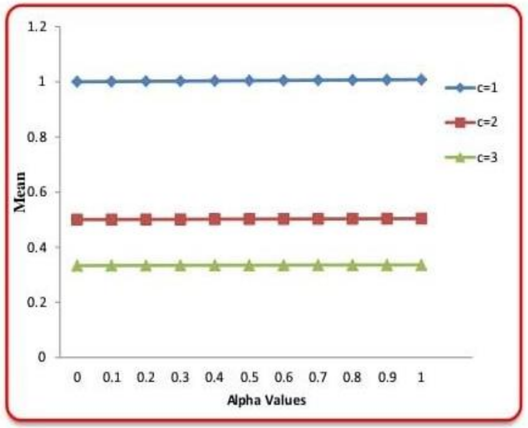
$$\tilde{\mu}[\alpha] = [0 + 0.087\alpha, 1 - 0.913\alpha]$$

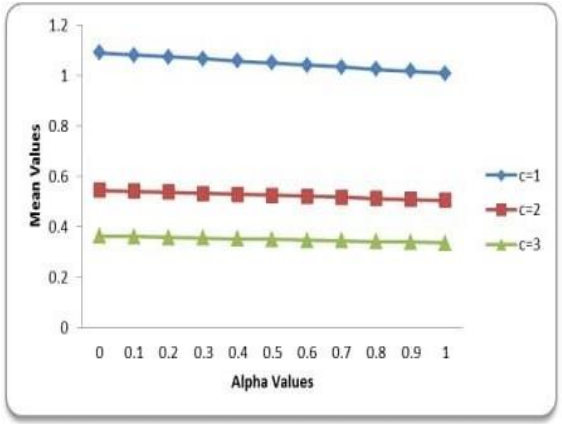
$$\tilde{\theta}[\alpha] = [12 + 0.723\alpha, 13 - 0.277\alpha]$$

$$\tilde{\gamma}[\alpha] = [3 + 0.773\alpha, 4 - 0.227\alpha]$$

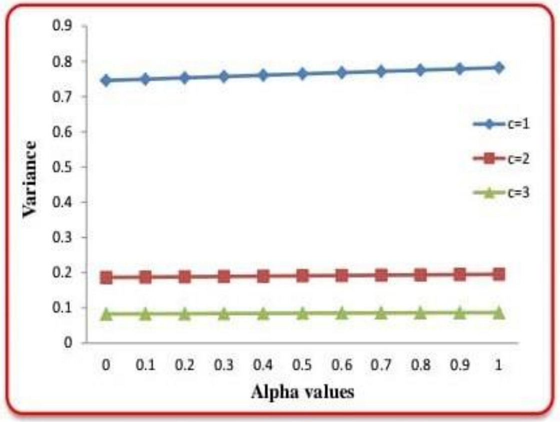
Under the alpha cut values, the fuzzy expected value for the TSH various c= 1,2,3 values are calculated from$\widetilde{E}(t) = [\widetilde{E}_l(t), \widetilde{E}_u(t)]$ and also the fuzzy variances are calculated from$\widetilde{V}(t) = [\widetilde{V}_l(t), \widetilde{V}_u(t)]$ and the related mean are shown in fig:4.7 and fig:4.8 and its related lower and upper fuzzy variance are shown in fig:4.9 and fig:4.10 respectively.

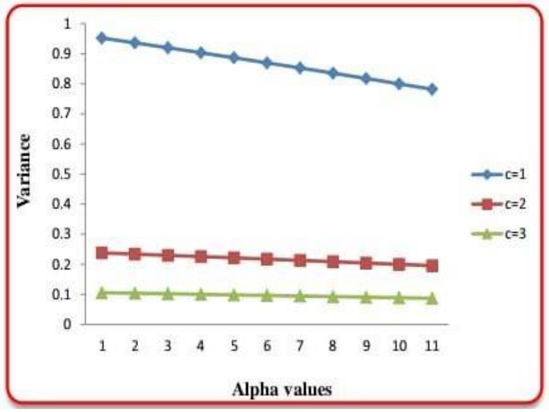
α	c = 1		c = 2		c = 3	
	$\tilde{V}_l(T)$	$\tilde{V}_u(T)$	$\tilde{V}_l(T)$	$\tilde{V}_u(T)$	$\tilde{V}_l(T)$	$\tilde{V}_u(T)$
0.0	0.7456	0.9522	0.1864	0.2381	0.0828	0.1058
0.1	0.7494	0.9361	0.1873	0.2340	0.0833	0.1040
0.2	0.7532	0.9199	0.1883	0.2299	0.0837	0.1022
0.3	0.7569	0.9034	0.1892	0.2258	0.0841	0.1004
0.4	0.7606	0.8867	0.1902	0.2217	0.0845	0.0985
0.5	0.7643	0.8698	0.1910	0.2174	0.0849	0.0966
0.6	0.7679	0.8527	0.1920	0.2132	0.0853	0.0947
0.7	0.7715	0.8353	0.1929	0.2088	0.0857	0.0928
0.8	0.7750	0.8178	0.1938	0.2044	0.0861	0.0909
0.9	0.7785	0.8000	0.1946	0.2000	0.0865	0.0889
1	0.7819	0.7819	0.1955	0.1955	0.0869	0.0869





LOWER AND UPPER ALPHA CUT VALUES FROM THE FUZZY MEAN AND VARIANCE IN FEMWD ON LACTATING RATS





SUMMARY

It has been showed here, that the fuzzy mean and fuzzy variance for the rats with autoimmune thyroiditis with severe hypothyroidism resistant after TSH treatment is decreased in the lower a cuts whereas they increase in the upper a cuts using fuzzy mathematical model. The appropriate decrease of thyroid stimulating hormone is response to increasing thyroxine level if the thyroxine is suitable, the rats will attain the thyroid level.

CHAPTER V

A FUZZY MATHEMATICAL MODEL FOR TSH IN IODINE DEFICIENT PREGNANT WOMEN

PRESENTED BY : V M ANOOTH HILMEYA

FUZZY SURVIVOR AND FUZZY WEIBULL HAZARD FUNCTION

FUZZY SURVIVOR FUNCTION :

The survival function is a function that gives the probability that a device, patient or other object of concern will survive beyond any given stated period.

$$S(t) = \int[0,t]\ \mu(u)\ du$$

In this formula, you integrate the membership degree $\mu(u)$ over the interval [0, t] to calculate the fuzzy survival function $S(t)$.

FUZZY WEIBULL HAZARD FUNCTION :

The Fuzzy Weibull Hazard Rate function is a mathematical expression used in fuzzy survival analysis, which combines the Weibull distribution with the concept of fuzziness to model uncertain or imprecise survival data.

$$\lambda(t) = \alpha * \beta * t^{(\beta - 1)} * \mu(t)$$

Where:

$\lambda(t)$ is the fuzzy hazard rate at time t.

α and β are parameters of the Weibull distribution, which determine the shape of the hazard rate.

t is the time variable.

$\mu(t)$ represents the membership degree

APPLICATION :

In pregnant women blood samples were obtained at different gestational ages. Data was collected for the women with sufficient iodine intake of iodine content in the water, seafood consumption, and access to iodized salt from the rural and urban areas. Many *I-D* women reports are similar to TSH and thyroid hormones.

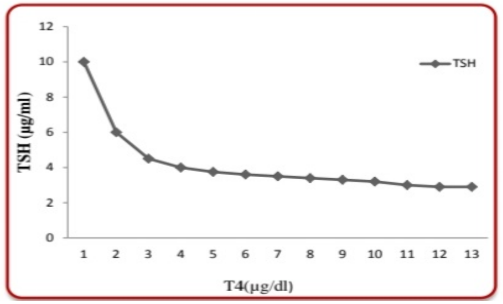
When, the serum TSH increases the serum T4 is low.

An inverse relationship between T4 and TSH concentrations is suggested,

but the relationship does not seem to be a simple linear one.

When serum T4 decrease below 6µg/dl, a steep increase

in TSH is expected in pregnant women



FUZZY LINEAR HAZARD RATE FUNCTION AND SURVIVAL FUNCTION:

The Fuzzy Linear Hazard Rate function is another mathematical expression used in fuzzy survival analysis, which combines a linear hazard rate with the concept of fuzziness to model uncertain or imprecise survival data.

$\lambda(t) = (\alpha + \beta t) * \mu(t)$

The linear hazard rate function is defined as $h(t) = \alpha+\beta t$ for $\alpha > 0$ and $\beta > 0$. The h(t) is unbounded when $\beta > 1$and from this distribution, survival rate function becomes

$$s(t) = e^{-t\left(\alpha+\beta\frac{t}{2}\right)}$$

The fuzzy linear hazard rate function is given by

$$\tilde{h}\{\tilde{z}(t)\} = \left[\tilde{h_l}(t), \tilde{h_u}(t)\right]$$

Where

$$\tilde{h_l}(t) = \min\{\tilde{\alpha} + \tilde{\beta} t\} \text{ and}$$

$$\tilde{h_u}(t) = \max\{\tilde{\alpha} + \tilde{\beta} t\}$$

The fuzzy survival function is given by

$$\tilde{s}\{\tilde{z}(t)\} = [\tilde{s_l}(t), \tilde{s_u}(t)]$$

Where $\tilde{s_l}(t) = \min\left\{e^{-t\left(\tilde{\alpha}+\tilde{\beta}\frac{t}{2}\right)}\right\}$

$$\tilde{s_u}(t) = \max\{ e^{-t}(\tilde{\alpha}+\tilde{\beta}\frac{t}{2})\}$$

The triangular fuzzy numbers for the scale and location parameters are:

$\tilde{\alpha}$ = [4.000, 4.754, 5.508]

$\tilde{\beta}$ = [2.000, 2.601, 3.202]

The corresponding alpha cut for the scale and location parameters are

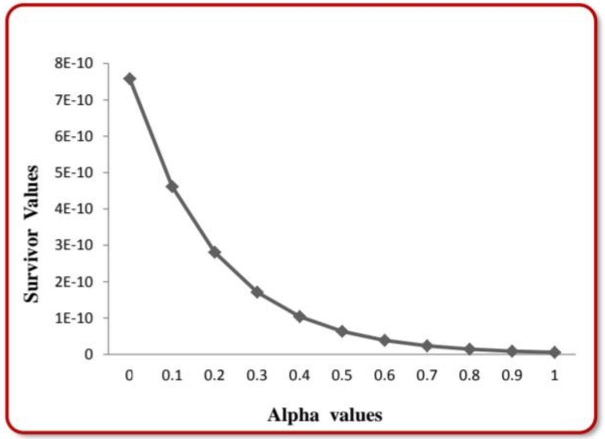
$\tilde{\alpha}$ = [4 + 0.754α, 5.508- 0.754α]

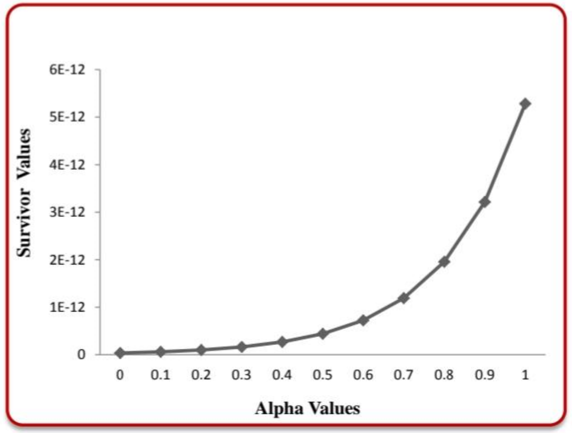
$\tilde{\beta}$ = [2 + 0.601α, 3.202- 0.601α]

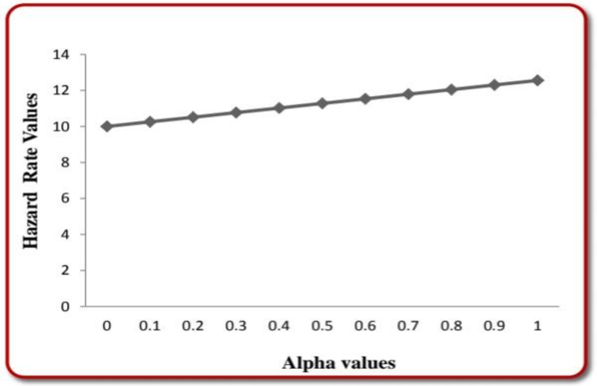
Under the alpha cut zero, the fuzzy survival values of the autoimmune thyroid response to the higher day for t = 3 is calculated from $\tilde{s}\{\tilde{z}(t)\}$ =[$\tilde{s}_l(t)$, $\tilde{s}_u(t)$]and the fuzzy linear hazard rate values of the autoimmune thyroidits response to the higher day for t = 3 is calculated from $\tilde{h}\{\tilde{z}(t)\}$ = [$\tilde{h}_l(t)$, $\tilde{h}_u(t)$]and is given in the table

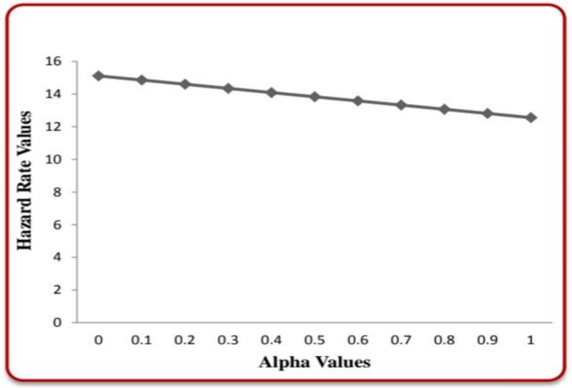
LOWER AND UPPER ALPHA CUT VALUESFOR THEFUZZY SURVIVOR AND FUZZY LINEAR HAZARD RATE FUNCTION AT t=3

α	$\tilde{s}_l(t)$	$\tilde{s}_u(t)$	$\tilde{h}_l(t)$	$\tilde{h}_u(t)$
0	7.6E-10	3.7E-14	10	15.114
0.1	4.6E-10	6E-14	10.2557	14.8583
0.2	2.8E-10	9.9E-14	10.5114	14.6026
0.3	1.7E-10	1.6E-13	10.7671	14.3469
0.4	1E-10	2.7E-13	11.0228	14.0912
0.5	6.3E-11	4.4E-13	11.2785	13.8355
0.6	3.9E-11	7.2E-13	11.5342	13.5798
0.7	2.3E-11	1.2E-12	11.7899	13.3241
0.8	1.4E-11	2E-12	12.0456	13.0684
0.9	8.7E-12	3.2E-12	12.3013	12.8127
1	5.3E-12	5.3E-12	12.557	12.557









FUZZY SURVIVOR AND FUZZY WEIBULL HAZARD RATE FUNCTION:

The Weibull hazard rate function is defined as $h(t) = \alpha\beta t^{\beta-1}$ for α > 0 and β > 0. The h(t) is unbounded when β >1and from this distribution survivor rate becomes $s(t) = e^{-\alpha t^{\beta}}$. On simplification, we get, the Weibull survivor function as $s(t) = e^{-\alpha t^{\beta}}$ and hazard rate function as $h(t) = \alpha\beta t^{\beta-1}$. Thus, the total damage Weibull function at time 't' is

$$\tilde{s_l}(t) = \min\left\{e^{-\tilde{\alpha} t^{\tilde{\beta}}}\right\} \text{ and}$$

$$\tilde{s_u}(t) = \max\left\{e^{-\tilde{\alpha} t^{\tilde{\beta}}}\right\}$$

$$\tilde{h_l}(t) = \min\{\tilde{\alpha}\tilde{\beta} t^{\tilde{\beta}-1}\}$$

$$\tilde{h_u}(t) = \max\{\tilde{\alpha}\tilde{\beta} t^{\tilde{\beta}-1}\}$$

The triangular fuzzy numbers on the scale and location parameters are:

$\tilde{\alpha}$ =[0.0, 0.276, 3.202]

β = [2.0, 2.430, 5.508]

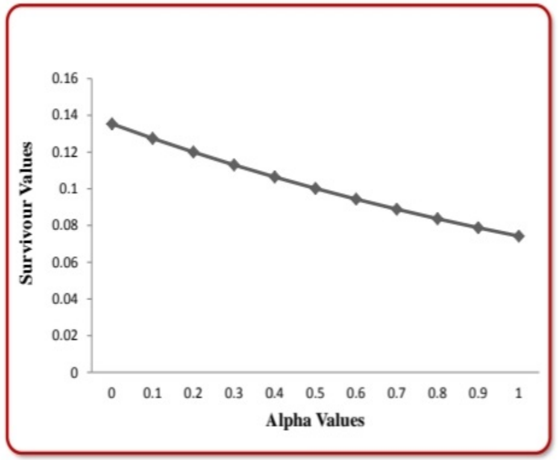
The corresponding alpha cut for the scale and location parameters are

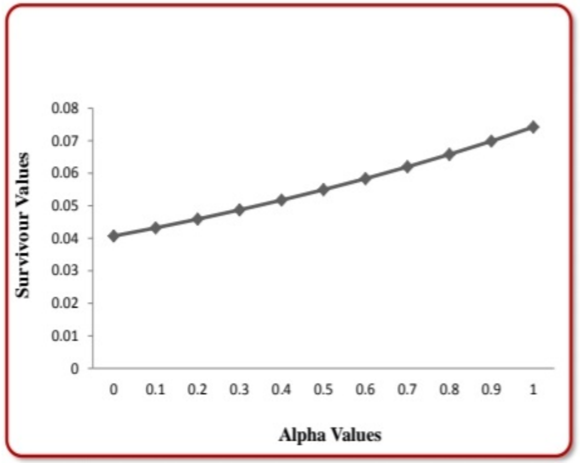
$\tilde{\alpha}$ =[2 + 0.601α ,3.202-0.601α]

β =[4 + 0.754α ,5.508-0.754α]

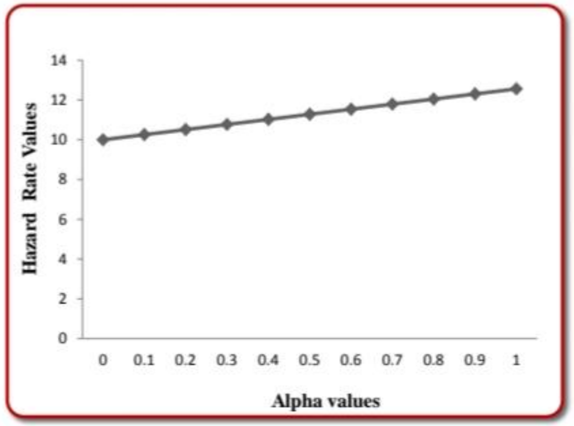
Under the alpha cut zero, the fuzzy survivor values of the autoimmune thyroid response to the higher day for t = 1 is calculated from $\tilde{s}\{\tilde{z}(t)\}$ =[$\tilde{s}_l(t)$, $\tilde{s}_u(t)$] and the fuzzy hazard rate values of the autoimmune thyroidits response to the higher day for t = 1 is calculated from $\hbar\{\tilde{z}(t)\}$ = [$\hbar_l(t)$, $\hbar_u(t)$]is shown in the following table

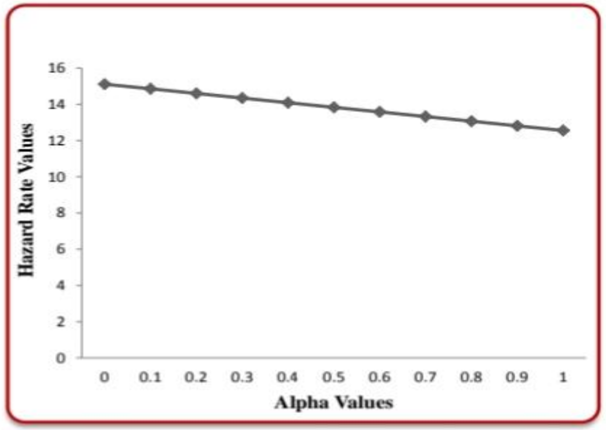
α	$\widetilde{s_l}(t)$	$\widetilde{s_u}(t)$	$\widetilde{h_l}(t)$	$\widetilde{h_u}(t)$
0	0.1353	0.0407	8.0000	17.6366
0.1	0.1274	0.0432	8.39573	17.0687
0.2	0.1200	0.0459	8.80053	16.5099
0.3	0.1130	0.0487	9.21438	15.9600
0.4	0.1064	0.0517	9.6373	15.4193
0.5	0.1002	0.0549	10.0693	14.8876
0.6	0.0944	0.0583	10.5103	14.3650
0.7	0.0889	0.0620	10.9604	13.8514
0.8	0.0837	0.0658	11.4196	13.3470
0.9	0.0788	0.0699	11.8879	12.8515
1	0.0742	0.074199	12.3652	12.3652





LOWER AND UPPER ALPHA CUT VALUESFOR THEFUZZY SURVIVOR AND FUZZY WEIBULL HAZARD RATE FUNCTION AT t=1





SUMMARY

By this fuzzy mathematical model, if the fuzzy survivor function decreases; then, the fuzzy hazard rate increases in the lower alpha cut values, and in upper alpha cut values if the fuzzy survivor functions increase; then ,the fuzzy hazard rate function decreases and when the serum T4 is low, then the serum TSH increases in iodine-deficient pregnancy.

CONCLUSION

In this project all essential concepts are systemically described.

Specifically, this work is used to analyze the expected level of the Thyroid Stimulating Hormone. This study has been developed with a specific utility point of view in real life situations with the patients suffered by TSH. It can be suitably used in practical purposes. The variation of decay parameter in Thyroid Stimulating Hormone is obtained by a mathematical model. If the variation of decay parameter is larger in Thyroid Stimulating Hormone, it is necessary to find the hyper and hypo secretion of Thyroid Stimulating Hormone in the human and animal being at suitable time after which the patients should be advised to seek vital medical attention.

THANK YOU