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A Novel Method for the Fuzzy Survival and Fuzzy Hazard Models of the Corticosterone Effect

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Abstract

To ascertain the significance of corticosterone release scores, theoretical research was conducted. We offer formulas for fuzzy Two-Parameter Weibull distributions, fuzzy Survival and Hazard functions, and related alpha-cut sets. We showed that, using fuzzy survival and hazard models based on two-parameter Weibull distributions, the smaller fuzzy survival model for the impact of corticosterone release increases and the higher fuzzy hazard model for the impact of corticosterone release decreases as the experiment termination alpha value increases. When the alpha value of the test's termination grows, the greater fuzzy survival scenario for the effect of corticosterone release decreases while the smaller fuzzy hazard models with the same effect increase.

Keywords: Fuzzy Survival Model, Hypothesis testing, Log-Logistic distribution, Exponential distribution, Weibull distribution.

1. Introduction

The use of the theory of fuzzy sets for fuzzy system analysis of survival has been the subject of numerous studies. The survival functions are the ones that are most frequently employed in lifetime data analysis. This function calculates the likelihood that a device will perform properly for a specific period of time. Numerous techniques and models used in traditional survival theory use the assumption that all lifespan density function parameters are accurate. However, in real life, randomness as well as fuzziness is combined over the system's lifetime.

Zadeh [9] proposed fuzzy set theory in 1965. Later, fuzzy set theory and mathematics were developed and used in a variety of scientific domains. The authors of Chen, on the other C.H. and others [3], Chen, S.M. is [4], the authors of Cai et al. [6], as well as [7], which adjusted the system's assumptions and precisely characterized its success or failure based on the fuzzy indicate assumption, introduced and developed the concept of fuzzy Survival. The system may be in either the fuzzy success state possibility assumption or as the fuzzy failure level possibility assumption at any one time. The actions of a system can be fully described by possibility measurements. An introduction to systems failures and its use of fuzzy technique was provided by Cai [7]. In [6] and [7], a method for fuzzy system survival analysis using fuzzy numbers was presented. A technique of fuzzy system estimation of survival as well as alpha-cut operation on fuzzy numbers was presented by Chen S.M. [4]. Fuzzy survival function mathematical models that depend on the the Weibull distribution were described by Zdenek Karpisek as well as others [10]. For the investigation of fuzzy reliability in diverse systems, Utkin et al. [8] established a set of functional equations. The fuzzification value of 0.5 is the cross-over point. Any fuzzy value greater than 0.5, implies that the original phenomenon's value may be a member of the set. It's probable that the original phenomenon's result is a member of the set when the fuzzification values decrease below 0.5. Potentially, the values are not a component of the set [1], [2].

The Section 2 of the text, which was set up as follows, is where the introductory data that has been employed on this article was presented; Log-Logistic distribution, Exponential distribution and Weibull distribution were used to introduce the various types of fuzzy mathematical models in Section 3. We were able to assess the impact of corticosterone on section 4 by employing the models previously addressed and calculating the rate of survival and the hazard values. In Section 5, using hypothesis testing, we investigate the chance of survival and hazard estimates of the various scenarios. Section 6 provides a succinct conclusion.

Notation

λ	-	Scale parameter of LLD
ϕ	-	Shape parameter of LLD
η	-	Scale parameter of WD
μ	-	Shape parameter of WD
β	-	Scale parameter of ED
χ	-	Shape parameter of ED
$\overline{\lambda}[x_S^H]$	-	Alpha cut of Scale value in GGD
$\overline{\phi}[x_S^H]$	-	Alpha cut of Shape value in GGD
$\overline{\eta}[x_S^H]$	-	Alpha cut of Scale value in LLD
$\overline{\mu}[x_S^H]$	-	Alpha cut of Shape value in LLD
$\overline{\beta}[x_S^H]$	-	Alpha cut of Scale value in RD and GRD
$\overline{\chi}[x_S^H]$	-	Alpha cut of Shape value in RD and GRD
$S[x_S^H]$	-	Survival Value of X
$H[x_S^H]$	-	Hazard Value of X
$\overline{S}[x_S^H]$	-	Fuzzy Survival Value of X
$\overline{H}[x_S^H]$	-	Fuzzy Hazard Value of X

2. Preliminaries

2.1 Definition:

Assume that the lifetime X_S^H is a random variable that is continuous with the cumulative hazards function $F_S^H(\gamma)$ as well as $[0,\infty)$ the interval hazard function $f_S^H(\gamma)$. Its survival mechanism is

$$S_S^H(\gamma) = 1 - F_S^H(\gamma) = P_S^H\{\Gamma > \gamma\} = \int_{\gamma}^{\infty} f_S^H(\upsilon)d\upsilon$$

2.2 Properties:

- Every Survival function $S_S^H(\gamma)$ is monotonically decreasing, $S_S^H(\upsilon) \le S_S^H(\gamma), \text{ for all } \upsilon > \gamma$ $S_S^H(\gamma)$
- Since CDF is a right-continuous function, the survival function $S_S^H(\gamma) = 1 - F_S^H(\gamma)$ is also right-continuous.
- The Expected Survival time $\mathrm{E}(\gamma) = \int_0^{\infty} S_S^H(\gamma)d\gamma$
- The density function of probability $f_S^H(\gamma)$ as well as the hazard function $H_S^H(\gamma)$ can be connected to the survival function.

$$f_S^H(\gamma) = -\frac{d}{d\gamma}\left(S_S^H(\gamma)\right)$$

$$H_S^H(\gamma) = -\frac{d}{d\gamma}\left(\log S_S^H(\gamma)\right)$$

So that $S_S^H(\gamma) = \exp\left[-\int_0^{\gamma} H_S^H(\gamma^1)\right]d\gamma^1$

2.3 Definition:

A hazard is a risky phenomena, substance, behavior, or circumstance. It might result in environmental harm, the loss of life, injuries, or other adverse health effects, as well as property damage, loss for livelihoods and services, social unrest, and economic upheaval.

2.4 Definition:

Chronic stress, also referred to as ongoing, unresolved stress, is another name for survival mode. Every human has undergone some level of stress at some point, yet while in a state of survival, stress is so intense that it makes it difficult to unwind. The brain's fear-related regions are hyperactive.

2.5 Definition:

The hazard function, abbreviated h, or hazard rate, is created by computing the failure rate in progressively smaller time intervals. As gets closer to zero, the following becomes the instant failure rate, or as we say instant hazard rate:

$$H_S^H(\gamma) = \lim_{\Delta\gamma \to 0} \frac{R_S^H(\gamma) - R_S^H(\gamma + \Delta\gamma)}{\Delta\gamma * R_S^H(\gamma)}$$

2.6 Definition:

The very existence of the failure distribution, $F_S^H(\gamma)$, and that is a cumulative distribution function that expresses the likelihood for failure (at least) up to and beyond period γ, is a prerequisite for a continuous failure rate.

$$P_S^H\{\Gamma \le \gamma\}, \gamma \ge 0 = F_S^H(\gamma) = 1 - R_S^H(\gamma)$$

Γ - Stands for the failure rate.

The failure density function's integral represents the failure distribution $f_S^H(\gamma)$

$$F_S^H(\gamma) = \int_0^{\gamma} f_S^H(\tau) d\tau$$

$$H_S^H = \frac{f_S^H(\gamma)}{1 - F_S^H(\gamma)} = \frac{f_S^H(\gamma)}{R_S^H(\gamma)}$$

2.7 Log -Logistic Distribution

The parameter $\lambda > 0$ is a scale parameter and is also Median of the distribution. The parameter $\phi > 0$ is a shape parameter. The distribution is unimodel when $\phi > 1$ and its dispersion decreases as ϕ increases.

The cumulative distribution function is

$$F(\gamma : \lambda, \phi) = \frac{1}{1 + \left(\frac{\gamma}{\lambda}\right)^{-\phi}}$$

$$F(\gamma : \lambda, \phi) = \frac{\left(\frac{\gamma}{\lambda}\right)^{\phi}}{1 + \left(\frac{\gamma}{\lambda}\right)^{\phi}}$$

$$F(\gamma : \lambda, \phi) = \frac{(\gamma)^{\phi}}{(\lambda)^{\phi} + (\gamma)^{\phi}}$$

Where $\gamma > 0, \lambda > 0, \phi > 0$

The probability density function of Log-Logistic Distribution is

$$f(\gamma : \lambda, \phi) = \frac{\left(\frac{\phi}{\lambda}\right)\left(\frac{\gamma}{\lambda}\right)^{\phi-1}}{\left(1 + \left(\frac{\gamma}{\lambda}\right)^{\phi}\right)^2}, \gamma > 0, \lambda > 0, \phi \ge 1$$

The Survival function of Log -Logistic distribution is

$$S(X_S^H) = \left[1 + \left(\frac{\gamma}{\lambda}\right)^{\phi}\right]^{-1}, \lambda \in \lambda(\alpha), \phi \in \phi(\alpha)$$

The Hazard function of Log -Logistic distribution is

$$H(X_S^H) = \frac{\left(\frac{\phi}{\lambda}\right)\left(\frac{\gamma}{\lambda}\right)^{\phi-1}}{1 + \left(\frac{\gamma}{\lambda}\right)^{\phi}} \quad \lambda \in \lambda(\alpha), \phi \in \phi(\alpha)$$

2.8 Exponential Distribution

A continuous random variable X_S^H with Exponential distribution $\varepsilon(\beta, \chi)$ where, $\chi > 0$ is shape parameter and $\beta > 0$ is scale parameter has the probability density function is given by

$$f_S^H(\gamma : \beta, \chi) = \beta^{-1} e^{-\beta(\gamma - \chi)}, \gamma > 0, \beta \geq 0, \chi \geq 0$$

The following gives the formula for the two-parameter exponential cumulative density function

$$F_S^H(\gamma : \beta, \chi) = Q_S^H(\gamma) = 1 - e^{-\beta(\gamma - \chi)}$$

The Survival function of Log -Logistic distribution is

$$S_S^H(X_S^H) = e^{-\beta\chi\gamma\gamma}, \beta \geq 0, \chi \geq 0$$

The Hazard function of Log -Logistic distribution is

$$H_S^H(X_S^H) = \beta\chi\gamma, \beta \geq 0, \chi \geq 0$$

2.9 The Weibull distribution's probability density function

A continuous random parameter X_S^H having a Weibull distribution with two parameters $\omega(\eta, \mu)$ has a probability density function, where $\mu > 0$ is the shape parameter and $\eta > 0$ is the scale parameter

$$f_S^H(\gamma : \eta, \mu) = \left\{ \mu \eta^{-\mu} (\gamma)^{\mu - 1} e^{-\left(\frac{\gamma}{\eta}\right)^{\mu}}, \gamma \geq 0, \mu \geq 0, \mu \geq 0 \right\}$$

The following formulas provide the Weibull distribution's cumulative distribution function (CDF)

$$F_S^H(\gamma : \eta, \mu) = 1 - e^{-\left(\frac{\gamma}{\eta}\right)^{\mu}}$$

The Survival function of two parameter weibull distribution is

$$S_S^H(\gamma) = e^{-\left(\frac{\gamma}{\eta}\right)^{\mu}}, \gamma > 0, \eta \geq 0, \mu \geq 0.$$

The Hazard function of two parameter weibull distribution is

$$H_S^H(\gamma) = \mu e^{-\left(\frac{\gamma}{\eta}\right)^{\mu}}, \gamma > 0, \eta \geq 0, \mu \geq 0.$$

3. New finding

3.1 Fuzzy Expected Value and Fuzzy Variance Value of Fuzzy Log-Logistic Distribution Model

A random variable X_S^H follows Fuzzy Log-Logistic Distribution is denoted by

$X_S^H \sim FLLD(\gamma, \overline{\lambda}, \overline{\phi})$, where $\overline{\lambda}$ and $\overline{\phi}$ are fuzzy parameters

The Survival value of $X_S^H \sim FGRD(\gamma, \overline{\lambda}, \overline{\phi})$ is given by

$$\overline{S}(X_S^H) = \left\{ S(X_S^H)[\alpha], \mu_{S(X_S^H)} \mid S(X_S^H)[\alpha] = S_L(X_S^H)[\alpha], S_U(X_S^H)[\alpha], \mu_{S(X_S^H)}(X_S^H) = \alpha \right\}$$

$$\overline{S}_L(X_S^H)[\alpha] = Inf\left\{S(X_S^H) \mid \overline{\lambda} \in \overline{\lambda}(\alpha), \overline{\phi} \in \overline{\phi}(\alpha)\right\}$$

$$\overline{S}_U(X_S^H)[\alpha] = Sup\left\{S(X_S^H) \mid \overline{\lambda} \in \overline{\lambda}(\alpha), \overline{\phi} \in \overline{\phi}(\alpha)\right\}$$

$$\overline{S}(X_S^H) = \left[1 + \left(\frac{\gamma}{\overline{\lambda}}\right)^{\overline{\phi}}\right]^{-1}, \overline{\lambda} \in \overline{\lambda}(\alpha), \overline{\phi} \in \overline{\phi}(\alpha)$$

The Hazard value for $X_S^H \sim FLLD(\gamma, \overline{\lambda}, \overline{\phi})$ is given by

$$\overline{H}(X_S^H) = \left\{H(X_S^H)[\alpha], \mu_{H(X_S^H)} \mid H(X_S^H)[\alpha] = H_L(X_S^H)[\alpha], H_U(X_S^H)[\alpha], \mu_{H(X_S^H)}(X_S^H) = \alpha\right\}$$

$$\overline{H}_L(X_S^H)[\alpha] = Inf\left\{H(X_S^H) \mid \overline{\lambda} \in \overline{\lambda}(\alpha), \overline{\phi} \in \overline{\phi}(\alpha)\right\}$$

$$\overline{H}_U(X_S^H)[\alpha] = Sup\left\{H(X_S^H) \mid \overline{\lambda} \in \overline{\lambda}(\alpha), \overline{\phi} \in \overline{\phi}(\alpha)\right\}$$

$$\overline{H}(X_S^H) = \frac{\left(\frac{\overline{\phi}}{\overline{\lambda}}\right)\left(\frac{\gamma}{\overline{\lambda}}\right)^{\overline{\phi}-1}}{1 + \left(\frac{\gamma}{\overline{\lambda}}\right)^{\overline{\phi}}}, \overline{\lambda} \in \overline{\lambda}(\alpha), \overline{\phi} \in \overline{\phi}(\alpha)$$

3.2 Fuzzy Survival Value and Hazard Value of Fuzzy Exponential Distribution

A continuous random variable X_S^H with Exponential distribution $\varepsilon(\overline{\beta}, \overline{\chi})$ where, $\overline{\beta} > 0$ is shape parameter and $\overline{\chi} > 0$ is scale parameter has the probability density function is given by

$$f_S^H(\gamma : \overline{\beta}, \overline{\chi}) = \overline{\beta}^{-1} e^{-\overline{\beta}(\gamma - \overline{\chi})}, \gamma > 0, \overline{\beta} \geq 0, \overline{\chi} \geq 0.$$

The following gives the formula for the two-parameter exponential cumulative density function

$$F_{\omega}(t) = Q_{\varepsilon}(t) = 1 - e^{-\gamma(t-\eta)}$$

A random variable X_S^H as follows Fuzzy Exponential distribution (FED) with the fuzzy numbers $\overline{\beta}, \overline{\chi}$ is indicated by $X_S^H \sim FED(\gamma, \overline{\beta}, \overline{\chi})$.

The Survival value for $X_S^H \sim FED(\gamma, \overline{\beta}, \overline{\chi})$ is

$$\overline{S}(X_S^H) = \left\{S(X_S^H)[\alpha], \mu_{S(X_S^H)} \mid S(X_S^H)[\alpha] = S_L(X_S^H)[\alpha], S_U(X_S^H)[\alpha], \mu_{S(X_\gamma^U)}(X_S^H) = \alpha\right\}$$

$$\overline{S}_L(X_S^H)[\alpha] = Inf\left\{S(X_S^H) \mid \overline{\beta} \in \overline{\beta}(\alpha), \overline{\chi} \in \overline{\chi}(\alpha)\right\}$$

$$\overline{S}_U(X_S^H)[\alpha] = Sup\left\{S(X_S^H) \mid \overline{\beta} \in \overline{\beta}(\alpha), \overline{\chi} \in \overline{\chi}(\alpha)\right\}$$

$$\overline{S}_S^H\left(X_S^H\right) = e^{-\overline{\beta}\overline{\chi}\gamma\gamma}, \overline{\beta} \geq 0, \overline{\chi} \geq 0$$

The Hazard value for $X_S^H \sim FED(\gamma, \overline{\beta}, \overline{\chi})$ is

$$\overline{H}(X_S^H) = \left\{H(X_S^H)[\alpha], \mu_{H(X_S^H)} \mid H(X_S^H)[\alpha] = H_L(X_S^H)[\alpha], H_U(X_S^H)[\alpha], \mu_{H(X_\gamma^U)}(X_S^H) = \alpha\right\}$$

$$\overline{H}_L(X_S^H)[\alpha] = Inf\left\{H(X_S^H) \mid \overline{\beta} \in \overline{\beta}(\alpha), \overline{\chi} \in \overline{\chi}(\alpha)\right\}$$

$$\overline{H}_U(X_S^H)[\alpha] = Sup\left\{H(X_S^H) \mid \overline{\beta} \in \overline{\beta}(\alpha), \overline{\chi} \in \overline{\chi}(\alpha)\right\}$$

$$\overline{H}_S^H\left(X_S^H\right) = \overline{\beta}\overline{\chi}\gamma, \overline{\beta} \geq 0, \overline{\chi} \geq 0$$

3.3 Fuzzy Survival Value and Hazard Value of Fuzzy Weibull Distribution

We consider the Weibull distribution with fuzzy parameters by replacing the scale parameter η into the fuzzy number $\overline{\eta}$ and shape parameter μ into $\overline{\mu}$

The Fuzzy Probability density function of Weibull Distribution is

$$\overline{f_\gamma}\left(\gamma : \overline{\eta}, \overline{\mu}\right) = \left\{ \overline{\mu}\overline{\eta}^{\overline{\mu}} (\gamma)^{\overline{\mu}-1} e^{-\left(\frac{\gamma}{\overline{\eta}}\right)^{\mu}} \right\}$$

A random variable X_S^H follows Fuzzy Weibull Distribution is denoted by

$X_S^H \sim FWD(\gamma, \overline{\eta}, \overline{\mu})$, where $\overline{\eta}$ and $\overline{\mu}$ are fuzzy parameters

The Survival value of $X_S^H \sim FWD(\gamma, \overline{\eta}, \overline{\mu})$ is given by

$$\overline{S}(X_S^H) = \left\{S(X_S^H)[\alpha], \mu_{S(X_S^H)} \mid S(X_S^H)[\alpha] = S_L(X_S^H)[\alpha], S_U(X_S^H)[\alpha], \mu_{S(X_S^H)}(X_S^H) = \alpha\right\}$$

$$\overline{S}_L(X_S^H)[\alpha] = Inf\left\{S(X_S^H) \mid \overline{\eta} \in \overline{\eta}(\alpha), \overline{\mu} \in \overline{\mu}(\alpha)\right\}$$

$$\overline{S}_U(X_S^H)[\alpha] = Sup\left\{S(X_S^H) \mid \overline{\mu} \in \overline{\eta}(\alpha), \overline{\mu} \in \overline{\mu}(\alpha)\right\}$$

$$\overline{S}(X_S^H) = e^{-\left(\frac{\gamma}{\overline{\eta}}\right)^{\overline{\mu}-1}}, \overline{\eta} \in \overline{\eta}(\alpha), \overline{\mu} \in \overline{\mu}(\alpha)$$

The Hazard value for $X_S^H \sim FWD(\gamma, \overline{\lambda}, \overline{\phi})$ is given by

$$\overline{H}(X_S^H) = \left\{H(X_S^H)[\alpha], \mu_{H(X_S^H)} \mid H(X_S^H)[\alpha] = H_L(X_S^H)[\alpha], H_U(X_S^H)[\alpha], \mu_{H(X_S^H)}(X_S^H) = \alpha\right\}$$

$$\overline{H}_L(X_S^H)[\alpha] = Inf\left\{H(X_S^H) \mid \overline{\eta} \in \overline{\eta}(\alpha), \overline{\mu} \in \overline{\mu}(\alpha)\right\}$$

$$\overline{H}_U(X_S^H)[\alpha] = Sup\left\{H(X_S^H) \mid \overline{\eta} \in \overline{\eta}(\alpha), \overline{\mu} \in \overline{\mu}(\alpha)\right\}$$

$$\overline{H}(X_S^H) = \overline{\mu}e^{-\left(\frac{\gamma}{\overline{\eta}}\right)^{\overline{\mu}-1}}, \overline{\eta} \in \overline{\eta}(\alpha), \overline{\mu} \in \overline{\mu}(\alpha)$$

4. APPLICATION

Let us consider an example for concentration of Corticosterone were determined in blood samples of rat, with free access to food and water under the condition of constant temperature and fixed 12-hours light/12-hours dark photoperiod (light on from 07.30 am to 19.30 hours) for at least two weeks prior to surgery. During this time, the rats were accustomed to the presence of the experimenter by daily handling. The experiments were carried out in early spring. The effects of Corticosterone release in rats were measured [5].

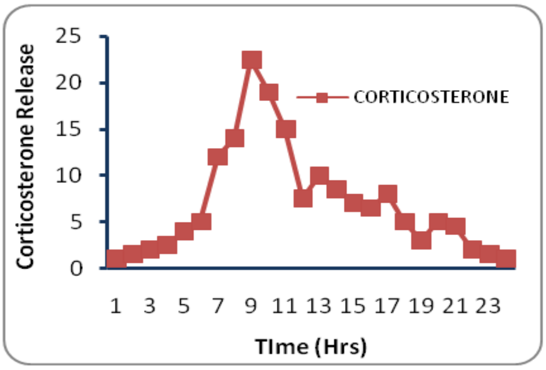

Fig. 4.1 Corticosterone releases of rats over a 24- hour light/dark period.

In some situations the value of the scale and shape parameters of the two parameter Weibull distribution are not known precisely. Therefore we consider triangular numbers for the scale and shape parameter. The triangular fuzzy number of the scale and the shape parameters respectively are $\bar{\lambda} = [2, 2.106, 2.5]$ and $\bar{\phi} = [3.5, 3.519, 4]$.

The alpha cut of scale, shape and location parameters respectively are

$\bar{\lambda}[\alpha] = [2 + 0.106\alpha, 2.5 - 0.394\alpha]$ $\bar{\phi}[\alpha] = [3.5 + 0.519\alpha, 4 - 0.481\alpha]$

Table 4.1: α-cut of Fuzzy Survival Model

α	FLLD	FED	FWD	FLLD	FED	FWD
	Lower α-cut			**Upper α-cut**		
0	0.99981986	1	1	0.99999999	1	1
0.1	0.99981964	0.995325	0.999997378	0.99999998	0.987465	1
0.2	0.99982008	0.989805	0.999987331	0.99999997	0.975936	1
0.3	0.99982016	0.983449	0.99996728	0.99999986	0.965383	1
0.4	0.99982024	0.976267	0.999925906	0.99999975	0.955776	0.99999997
0.5	0.99927248	0.968272	0.999833277	0.99999777	0.947089	0.999999238
0.6	0.99789587	0.959479	0.99961079	0.99998588	0.939298	0.999989156
0.7	0.99513548	0.949907	0.999041833	0.99993168	0.932382	0.999896236
0.8	0.99040435	0.939574	0.997498483	0.99972833	0.926323	0.999257671
0.9	0.98317475	0.928502	0.993071629	0.99906998	0.921105	0.99575206
1	0.9730519	0.916714	0.979721037	0.99717291	0.916714	0.979721037

Table 4.2: Lower α-cut of Fuzzy Hazard Model

α	FLLD	FED	FWD	FLLD	FED	FWD
	Lower α-cut			**Upper α-cut**		
0	0	0	4	0	0	14.1
0.1	0.00000002	0.004686	5.007686868	0	0.012614	14.0977
0.2	0.00000325	0.010247	6.015323792	0.00000002	0.024358	14.0954
0.3	0.00005324	0.01669	7.022870204	0.00000068	0.03523	14.09309999
0.4	0.00033664	0.02402	8.030204969	0.00000884	0.045232	14.09079958

0.5	0.00127952	0.032243	9.036993075	0.0000662	0.054363	14.08848927
0.6	0.00355434	0.041364	10.04228992	0.00035026	0.062623	14.08604725
0.7	0.00799979	0.051391	11.04330851	0.00145854	0.070012	14.0824386
0.8	0.01550086	0.062329	12.03142771	0.00509729	0.076532	14.07114682
0.9	0.0268727	0.074183	12.97875104	0.01557722	0.082181	14.01949198
1	0.04277145	0.08696	13.79153303	0.04277145	0.08696	13.79153303

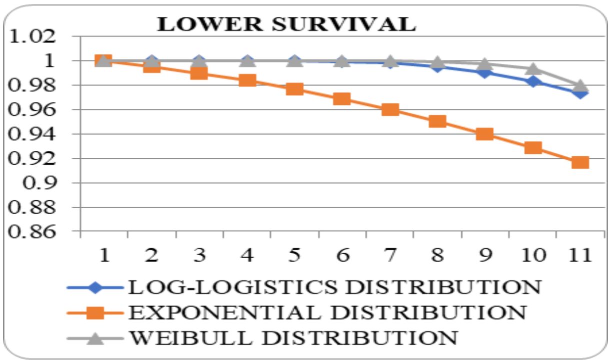

Fig: 4.2 Lower α-cut of Survival Model

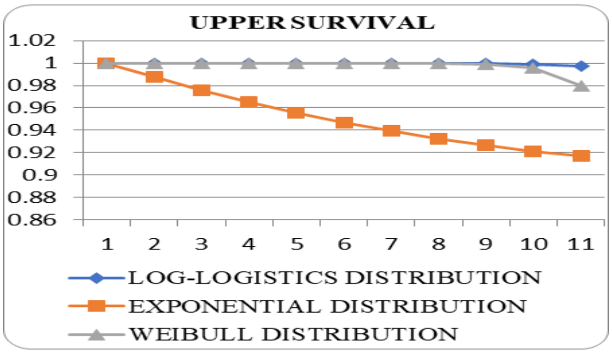

Fig: 4. 3 Upper α-cut of Fuzzy Survival Model

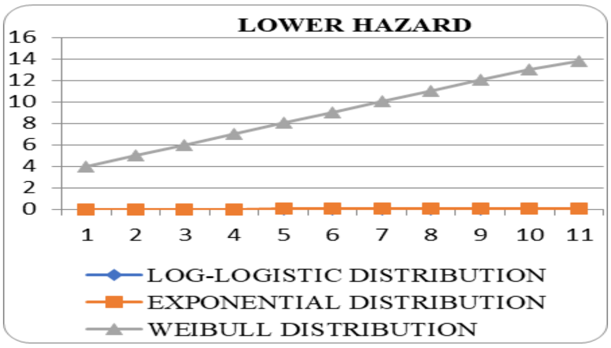

Fig: 4.4 Lower α-cut of Fuzzy Hazard Model

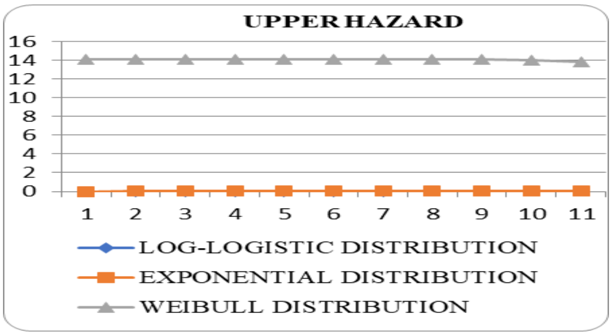

Fig: 4. 5 Upper α-cut of Fuzzy Hazard Model

5. Testing of Hypothesis:

Testing of hypotheses is a procedure used to determine the degree of trial validity and provides a strategy for population-related decision-making, i.e., it conveys a method for acknowledging the consistency with which one can extrapolate experimental results from the sample under examine to the larger population that from which the population being studied was drawn. We start by defining a hypothesis, which is a specific statement of the population's parameters.

An example of such a hypothesis is H_0. Here, we define H_0 in the following manner:

$H_0 : \bar{\mu}_{Inf1} - \bar{\mu}_{Inf2} > 0$ There is significant difference in $\bar{\mu}_{Inf1}$ than $\bar{\mu}_{Inf2}$

$H_1 : \bar{\mu}_{Inf1} - \bar{\mu}_{Inf2} \leq 0$

Test statistics for Lower alpha values is defined by

$$\tau_{Inf} = \left[\frac{\overline{\mu}_{Inf1} - \overline{\mu}_{Inf2}}{\sqrt{\frac{\delta^2_{Inf1}}{n_{Inf1}-1} + \frac{\delta^2_{Inf2}}{n_{Inf2}-1}}} \right]$$

$$\delta^2_{Inf1} = \left[\frac{\sum\left(\mu_{Inf} - \overline{\mu}_{Inf1}\right)}{n_{Inf}-1} \right] \text{ and } \delta^2_{Inf2} = \left[\frac{\sum\left(\mu_{Inf1} - \overline{\mu}_{Inf2}\right)}{n_{Inf2}-1} \right]$$

Test statistics for Upper alpha values is defined by

$$\tau_{Sup} = \left[\frac{\overline{\mu}_{Sup1} - \overline{\mu}_{Sup2}}{\sqrt{\frac{\delta^2_{Sup1}}{n_{Sup1}-1} + \frac{\delta^2_{Sup2}}{n_{Sup2}-1}}} \right]$$

$$\delta^2_{Sup1} = \left[\frac{\sum\left(\mu_{Sup} - \overline{\mu}_{Sup1}\right)}{n_{Sup1}-1} \right] \text{ and } \delta^2_{Sup2} = \left[\frac{\sum\left(\mu_{Sup} - \overline{\mu}_{Sup2}\right)}{n_{Sup2}-1} \right]$$

5.1 Lower Fuzzy Survival

Null hypothesis H_{LLEL0} : The LFS in FLLD and FED do not differ much from one another.

Alternative hypothesis $H_{LLEL1} : \mathrm{H}_1 \neq \mathrm{H}_2$

Null hypothesis H_{EWL0} : The LFS among FED and FWD does not significantly differ.

Alternative hypothesis $H_{EWL1} : \mathrm{H}_1 \neq \mathrm{H}_3$

Null hypothesis H_{WLLL0} : The LFS from FWD and FLLD is not significantly different from each other.

Alternative hypothesis $H_{WLLL1} : \mathrm{H}_2 \neq \mathrm{H}_3$

Table 5.1 Calculation of Sample Means and Standard Deviations of Lower Fuzzy Survival

α	X1	X2	X3	S1*S1	S2*S2	S3*S3
0	0.99981986	1	1	0.0419512	0.01565001	0.0001664
0.1	0.99981964	0.995325	0.999997378	0.0419511	0.014502181	0.0001663
0.2	0.99982008	0.989805	0.999987331	0.0419513	0.013203159	0.0001661
0.3	0.99982016	0.983449	0.99996728	0.0419513	0.011782885	0.0001656
0.4	0.99982024	0.976267	0.999925906	0.0419513	0.010275269	0.0001645
0.5	0.99927248	0.968272	0.999833277	0.0417272	0.00871833	0.0001621
0.6	0.99789587	0.959479	0.99961079	0.0411667	0.007153607	0.0001565
0.7	0.99513548	0.949907	0.999041833	0.0400542	0.00562605	0.0001426
0.8	0.99040435	0.939574	0.997498483	0.0381829	0.004182726	0.0001081
0.9	0.98317475	0.928502	0.993071629	0.0354097	0.002873174	0.0000357

1	0.9730519	0.916714	0.979721037	0.0317025	0.001748411	0.0000544

Calculated value of $|t_{LLE}| = 3.099255, |t_{EW}| = 0.538719181, |t_{WLL}| = 3.124980659$

At a 5% level of significance, the tabulated value of 11+11-2=20 d.f. is 2.080.

Calculated t_{LLE} bigger than Tabulated t_{LLE}

The null hypothesis H_{LLE0} is rejected.

11+11-2=20 d. f. has a tabulated value of 2.080 at the 5% level of significance.

Calculated value of t_{EW} is Less than the value of t_{EW} in the table.

The null hypothesis H_{EW0} is accepted.

At a 5% level of significance, the tabulated value of 11+11-2=20 d.f. is 2.080.

Calculated value of t_{LLW} is higher than the value t_{LLW} of in the table.

We do accept the null theory H_{LLW0}.

5.2 Upper Fuzzy Survival

Null hypothesis H_{LLEU0} : The UFS in FLLD and FED are not significantly different from one another.

Alternative hypothesis $H_{LLEU1} : \mathrm{I}_1 \neq \mathrm{I}_2$

Null hypothesis H_{EWU0} : This UFS for FED and FWD are identical, and this is a significant distinction.

Alternative hypothesis $H_{EWU1} : \mathrm{I}_1 \neq \mathrm{I}_3$

Null hypothesis H_{WLLU0} : Its UFS in the FLLD and FWD are identical, and this is a significant distinction.

Alternative hypothesis $H_{WLLU1} : \mathrm{I}_2 \neq \mathrm{I}_3$

Table 5.2 Calculation of Sample Means and Standard Deviations of Upper Fuzzy Survival

α	Y1	Y2	Y3	S1*S1	S2*S2	S3*S3
0	0.99999999	1	1	0.0091585	0.00948676	0.45306361
0.1	0.99999998	0.987465	1	0.0091585	0.012085704	0.45306361
0.2	0.99999997	0.975936	1	0.0091585	0.014753503	0.45306361
0.3	0.99999986	0.965383	1	0.0091585	0.017428488	0.453063611
0.4	0.99999975	0.955776	0.99999997	0.0091585	0.020057357	0.453063651
0.5	0.99999777	0.947089	0.999999238	0.0091589	0.022593397	0.453064636
0.6	0.99998588	0.939298	0.999989156	0.0091612	0.024996242	0.453078208
0.7	0.99993168	0.932382	0.999896236	0.0091716	0.02723094	0.453203308
0.8	0.99972833	0.926323	0.999257671	0.0092106	0.02926734	0.454063484
0.9	0.99906998	0.921105	0.99575206	0.0093374	0.031079927	0.458800231
1	0.99717291	0.916714	0.979721037	0.0097076	0.032647431	0.480774387

Calculated value of $|t_{LLEU}| = 3.442251, |t_{EWU}| = 0.778690192, |t_{WLLU}| = 3.501450021$

For the 11+11-2=20 d.f., the tabulated value of t_{LLEU} is 2.080 at the 5% level of significance.

Value of t_{LLEU} higher than calculated value of t_{LLEU} in the table

Rejected is the null hypothesis H_{LLERU0}.

At a 5% level of significance, the tabulated value of 11+11-2=20 d.f. is 2.080.

Calculated value of t_{EWU} is bigger than the tabulated value of t_{EWU}

We reject the null hypothesis H_{EWU0}.

11+11-2=20 d.f. has a tabulated value of 2.080 at the 5% level of significance.

Calculated value of t_{WLLU} > Tabulated value of t_{WLLU}

We do not accept the null hypothesis H_{WLLU0}.

5.3 Lower Fuzzy Hazard

Null hypothesis H_{LLELV0} : The LFH in FLLD and RED do not differ much from one another.

Alternative hypothesis $H_{LLELV1} : \mathrm{H}_1 \neq \mathrm{H}_2$

Null hypothesis H_{EWLV0} : The LFH among FED and FWD does not significantly differ.

Alternative hypothesis $H_{EWLV1} : \mathrm{H}_1 \neq \mathrm{H}_3$

Null hypothesis H_{WLLLV0} : The LFH from FWD and FLLD is not significantly different from each other.

Alternative hypothesis $H_{WLLLV1} : \mathrm{H}_2 \neq \mathrm{H}_3$

Table 5.3 Calculation of Sample Means and Standard Deviations of Lower Fuzzy Hazard

α	X1	X2	X3	S1*S1	S2*S2	S3*S3
0	0	0	4	0.632025	0.76545001	9.0775664
0.1	0.00000002	0.004686	5.007686868	0.632025	0.757272406	16.1651188
0.2	0.00000325	0.010247	6.015323792	0.6320198	0.74762481	25.2830345
0.3	0.00005324	0.01669	7.022870204	0.6319404	0.736524404	36.4305220
0.4	0.00033664	0.02402	8.030204969	0.6314899	0.723996774	49.6053276
0.5	0.00127952	0.032243	9.036993075	0.6299922	0.71007082	64.8007785
0.6	0.00355434	0.041364	10.04228992	0.6263862	0.694782263	81.9964644
0.7	0.00799979	0.051391	11.04330851	0.6193693	0.678167073	101.1273297
0.8	0.01550086	0.062329	12.03142771	0.6076189	0.66027163	121.9771745
0.9	0.0268727	0.074183	12.97875104	0.5900195	0.641147714	143.7996946
1	0.04277145	0.08696	13.79153303	0.5658478	0.620849444	163.9535053

Calculated value of $|t_{LLDV}| = 1.57484, |t_{EWV}| = 2.081386209, |t_{WLLV}| = 2.723051839$

At a 5% level of significance, the tabulated value of 11+11-2=20 d.f. is 2.080.

Calculated t_{LLELV} less than value t_{LLELV}'s tabulated

The null hypothesis H_{LLEV0} is acceptable.

11+11-2=20 d.f. has a tabulated value of 2.080 at the 5% level of significance.

Calculated value of t_{EWV} is bigger than the value of t_{EWV} in the table.

The null hypothesis H_{EWV0} is rejected.

At a 5% level of significance, the tabulated value of 11+11-2=20 d.f. is 2.080.

Calculated value of t_{WLLLV} is higher than the value of t_{WLLLV} in the table.

We do not accept the null theory H_{WLLV0} .

5.4 Upper Fuzzy Hazard

Null hypothesis H_{LLEVL0} : The UFH in FLLD and FED are not significantly different from one another.

Alternative hypothesis $H_{LLEVVL1} : \mathrm{I}_1 \neq \mathrm{I}_2$

Null hypothesis H_{EWVL0} : This UFH for FED and FWD are identical, and this is a significant distinction.

Alternative hypothesis $H_{EWVL1} : \mathrm{I}_1 \neq \mathrm{I}_3$

Null hypothesis H_{WLLVL0} : Its UFH in the FWD and FLLD are identical, and this is a significant distinction.

Alternative hypothesis $H_{WLLVL1} : \mathrm{I}_2 \neq \mathrm{I}_3$

Table 5.4 Calculation of Sample Means and Standard Deviations of Upper Fuzzy Hazard

α	Y1	Y2	Y3	S1*S1	S2*S2	S3*S3
0	0	0	14.1	1.2005585	1.20428676	154.4278436
0.1	0	0.012614	14.0977	1.2005585	1.176760666	154.3706852
0.2	0.00000002	0.024358	14.0954	1.2005584	1.151419134	154.3135373
0.3	0.00000068	0.03523	14.09309999	1.200557	1.128205109	154.2563998
0.4	0.00000884	0.045232	14.09079958	1.2005391	1.1070575	154.1992628
0.5	0.0000662	0.054363	14.08848927	1.2004134	1.087926183	154.1418907
0.6	0.00035026	0.062623	14.08604725	1.1997911	1.07076344	154.0812594
0.7	0.00145854	0.070012	14.0824386	1.1973644	1.055526103	153.9916844
0.8	0.00509729	0.076532	14.07114682	1.1894143	1.042171473	153.711565
0.9	0.01557722	0.082181	14.01949198	1.1666652	1.030669618	152.433395
1	0.04277145	0.08696	13.79153303	1.1086585	1.020988994	146.8564192

Calculated value of $|t_{LLVL}| = 1.551309, |t_{EWVL}| = 2.4171770988, |t_{WLLVL}| = 3.158069152$

For the 11+11-2=20 d.f., the tabulated value of t_{LLEU} is 2.080 at the 5% level of significance.

Value of t_{LLEU} less than calculated value of t_{LLEU} in the table

Accepted is the null hypothesis H_{LLEVL0} .

At a 5% level of significance, the tabulated value of 11+11-2=20 d.f. is 2.080.

Calculated value of t_{EWVL} is bigger than the tabulated value of t_{EWVL}

We reject the null hypothesis H_{EWVL0} .

11+11-2=20 d.f. has a tabulated value of 2.080 at the 5% level of significance.

Calculated value of t_{WLLVL} > Tabulated value of t_{WLLVL}

We do not accept the null hypothesis H_{WLLVL0} .

Table 5.5: Paired sample t-test for fuzzy Survival Model for the effect of Corticosterone

Generalized Rayleigh Test	Calculated value		Table Value	Hypothesis		d. f	Result
	Lower Fuzzy Hazard	Upper Fuzzy Hazard		Lower Fuzzy Hazard	Upper Fuzzy Hazard		
t_{LLEVL}	0.431655	0.946061	2.086	Accepted	Accepted	5%	The Fuzzy Hazard in the Log-Logistic distribution and the Exponential distribution do not differ significantly from one another.
t_{EWVL}	1.105102	0.231919	2.086	Accepted	Accepted		The Fuzzy Hazard in the Exponential distribution and the Weibull distribution differ significantly.
t_{WLLVL}	0.044039	0.009859	2.086	Accepted	Accepted		The Weibull distribution's fuzzy Hazard and the Log-Logistic distribution differ significantly.
t_{LLEVL}	0.431655	0.946061	2.845	Accepted	Accepted	1%	The Fuzzy Hazard in the Log-Logistic distribution and the Exponential distribution do not significantly differ from one another.
t_{EWVL}	1.105102	0.231919	2.845	Accepted	Accepted		The Fuzzy Hazard in the Exponential distribution and the Weibull distribution do not differ significantly from one another.
t_{WLLVL}	0.044039	0.009859	2.845	Accepted	Accepted		The Fuzzy Hazard in the Weibull distribution and the Log-Logistic distribution are very different from one another.

Table 5.6: Paired sample t-test for fuzzy Hazard Model for the effect of Corticosterone

Test	Calculated value		Table Value	Hypothesis		d. f	Result
	Lower Fuzzy Survival	Upper Fuzzy Survival		Lower Fuzzy Survival	Upper Fuzzy Survival		

t_{LLE}	0.076463	0.101402	2.086	Accepted	Accepted	5%	The Fuzzy Survival in the Log-Logistic distribution and the Exponential distribution differ significantly from one another.
t_{EW}	3.278995	3.920347	2.086	Rejected	Rejected		The Fuzzy Survival in the Exponential distribution and the Weibull distribution do not differ significantly.
t_{WLL}	3.291040	3.931538	2.086	Rejected	Rejected		The Weibull distribution distribution's Fuzzy Survival and the Log-Logistic distribution differ significantly.
t_{LLE}	0.076463	0.101402	2.845	Accepted	Accepted	1%	The Fuzzy Survival in the Log-Logistic distribution and the Exponential distribution significantly differ from one another.
t_{EW}	3.278995	3.920347	2.845	Rejected	Rejected		The Fuzzy Survival in the Exponential distribution and the Weibull distribution do not differ significantly from one another.
t_{WLL}	3.291040	3.931538	2.845	Rejected	Rejected		The Fuzzy Survival in the Weibull distribution and the Log-Logistic distribution are very different from one another.

5. Conclusion:

In this paper, Fuzzy Survival and Hazard model with two parameter weibull distribution for the effect of release of Corticosterone with different alpha values were discussed. Using two parameter weibull distributions, it is clear that the α-cut for the Lower fuzzy Survival and Upper fuzzy Hazard values increases for alpha value increases. Similarly the α-cut for the Upper fuzzy Survival and Lower fuzzy Hazard values decreases when alpha value increases. This shows that if the test termination alpha value increases, the Lower fuzzy Survival Model for the effect of release of Corticosterone increases and Upper fuzzy Hazard model for the effect of release of Corticosterone decreases and if the test termination alpha value increases, the upper fuzzy Survival Model for the effect of release of Corticosterone decreases and lower fuzzy Hazard model for the effect of release of Corticosterone increases.Also by estimating the Fuzzy Survival and the Fuzzy Hazard of FLLD, FED and FWD, we were able to successfully create the fuzzy model to calculate the effect of Corticosterone. Lower alpha cuts result in higher mean values, and for upper alpha cuts, lowered. The results of the testing of the hypothesis reveal a substantial difference between FLLD and FED, FED and FWD, FWD and FLLD. For assessing the impact of Corticosterone, FWD and FLLD work effectively.

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