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A Fuzzy Mathematical Model for the Effect of Corticosterone

A. Venkatesh [1], P. Senthil Kumar [2]
[1]*Assistant Professor of Mathematics, A. V. V. M. Sri Pushpam College, Poondi, Thanjavur(Dt), Tamilnadu, India.*
[2]*Assistant Professor of Mathematics, Dhanalakshmi Srinivasan College of Engineering, Perambalur, Perambalur (Dt), Tamilnadu, India.*

Abstract: *The theoretical study of the effect of Corticosterone release scores was determined. Formulae of fuzzy two parameter Weibull distribution, fuzzy Survival and fuzzy hazard rate function and its α-cut sets were presented. Using fuzzy survival and hazard rate model based on two parameter Weibull distributions, we showed that in the test termination, if the fuzzy Survival value increases then the fuzzy hazard rate value decreases in the lower α-cuts and if the fuzzy Survival value decreases then the fuzzy hazard rate value increases in the upper α-cuts.*

Keyword: *Fuzzy Survival model, Fuzzy Hazard Model, Corticosterone, Weibull distribution.*
Mathematics Subject Classification 2010: *94D05, 60A86, 62A86, 62E86*

I. Introduction

Many researches focused on using fuzzy set theory for the fuzzy system Survival analysis. The most frequently used functions in lifetime data analysis are survival function. This function gives the probability of an item operating for a certain amount of time without failure. Many methods and models in classical Survival theory assume that all parameters of lifetime density function are precise. But in the real world, randomness and fuzziness are mixed-up in the lifetime of the system.

In 1965, Zadeh [9] introduced fuzzy set theory. Subsequently, the theory and the mathematics of fuzzy sets were fleshed-out and applied in many research fields .The theory of fuzzy Survival was proposed and developed by Chen, C.H. et.al [3], Chen. S.M.[4], Cai et al [6], [7] modified the assumptions of the system is precisely defined as success or failure to fuzzy state assumption. At any time, the system may be either in the fuzzy success state or fuzzy failure state possibility assumption. The system behavior can be fully characterized by possibility measure. Cai[7] presented an introduction to system failure and its use of fuzzy methodology. In [6], [7], [8] a method for fuzzy system Survival analysis using fuzzy number was presented. Chen S.M [4] presented a method for fuzzy system Survival analysis and alpha cuts operations of fuzzy number. Zdenek Karpisek et al[10] described fuzzy Survival function models that are based on weibull distribution. In Utkin et al[8] presented a system of functional equations for fuzzy reliability analysis of various systems. 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. As the fuzzification values go below 0.5, it is likely that the original phenomenon's value is a member of the set. The values may not be the part of the set.

Corticosterone is a steroid hormone, secreted by the adrenal cortex that is involved in regulation of energy, immune reactions and stress response of our body. Many findings have demonstrated that the response of the Corticosterone to stress is also under rhythmic control, depending on the time of day the stress occurs. It has been generally accepted that the amount of birds affected with Corticosterone stress hormone has been decreasing. Thus, there is an important require for hen diagnosis, monitoring and antiretroviral therapy. In this paper a mathematical model is developed to obtain the Survival and Hazard to reach the threshold level, in the context of corticosterone stress hormone with the assumptions that the times between decision epochs are independent and identically distributed random variable, the number of exits at each period time are independent and identically distributed, random variables and that the threshold level is a random variable following Fuzzy Three parameter weibull distribution [1], [2].

II. Notation

λ	–	Scale parameter
ϕ	–	Shape parameter
$\bar{\lambda}[\alpha]$	–	Alpha cut of scale value
$\bar{\phi}[\alpha]$	–	Alpha cut of shape value
$S(t)$	--	Survival model

$H(t)$ -- Hazard model

$\overline{S}(t)$ -- Fuzzy Survival model

$\overline{H}(t)$ -- Fuzzy Hazard model

t – Test termination time

III. Fuzzy Mathematical Model

The Weibull distribution is widely used in statistical method for life data. Among all statistical techniques it may be in use for engineering analysis with smaller sample sizes than any other method. A continuous random variable T with two parameter Weibull distribution $W(\lambda,\phi)$ where $\phi > 0$ is the shape parameter, $\lambda > 0$ is scale parameter has the probability density function

$$f(t) = \phi\lambda\left(\frac{t}{\lambda}\right)^{\phi-1} e^{-\left(\frac{t}{\lambda}\right)^{\phi}}, t > 0, \lambda \geq 0, \phi \geq 0.$$

The Survival function of two parameter weibull distribution is

$$S(t) = e^{-\left(\frac{t}{\lambda}\right)^{\phi}}, t > 0, \lambda \geq 0, \phi \geq 0.$$

The Hazard function of two parameter weibull distribution is

$$H(t) = \phi\lambda\left(\frac{t}{\lambda}\right)^{\phi-1}, t > 0, \lambda \geq 0, \phi \geq 0.$$

The shape parameter gives the flexibility of Weibull distribution by changing the value of shape parameter. However sometimes we face situations when the parameter is imprecise. Therefore we consider the Weibull distribution with fuzzy parameters by replacing the scale parameter λ into the fuzzy number $\overline{\lambda}$, shape parameter ϕ into $\overline{\phi}$.

For $\alpha \in [0,1]$, the alpha cuts of fuzzy survival model with two parameter weibull distribution is $\overline{S}[\alpha] = [\overline{S_1}[\alpha], \overline{S_2}[\alpha]]$

Where

$$\overline{S_1}(t) = Inf\{e^{-\left(\frac{t}{\overline{\lambda}}\right)^{\overline{\phi}}}, t > 0, \overline{\lambda} \in \overline{\lambda}[\alpha], \overline{\phi \in \phi}[\alpha]\}$$

$$\overline{S_2}(t) = Sup\{e^{-\left(\frac{t}{\overline{\lambda}}\right)^{\overline{\phi}}}, t > 0, \overline{\lambda} \in \overline{\lambda}[\alpha], \overline{\phi \in \phi}[\alpha]\}$$

For $\alpha \in [0,1]$, the alpha cuts of fuzzy hazard model with two parameter weibull distribution is $\overline{H}[\alpha] = [\overline{H_1}[\alpha], \overline{H_2}[\alpha]]$

Where

$$\overline{H_1}(t) = Inf\{\overline{\phi\lambda}\left(\frac{t}{\overline{\lambda}}\right)^{\overline{\phi}-1}, t > 0, \overline{\lambda} \in \overline{\lambda}[\alpha], \overline{\phi \in \phi}[\alpha]\}$$

$$\overline{H_2}(t) = Sup\{\overline{\phi\lambda}\left(\frac{t}{\overline{\lambda}}\right)^{\overline{\phi}-1}, t > 0, \overline{\lambda} \in \overline{\lambda}[\alpha], \overline{\phi \in \phi}[\alpha]\}$$

IV. Application

We consider an experiment conducted by J.A.Downing et al. [5]. By 10 minutes after initially being handled the plasma corticosterone had reached its peak concentration and was significantly greater than the concentration prior to handling. The corticosterone remained significantly higher at the 20, 30 and 40 minute sampling times but by the 60 minute sampling time the concentration was similar to the pre-handling concentrations. Fig. 4.1 shows the pattern of corticosterone in Plasma following a one hour handling episode.

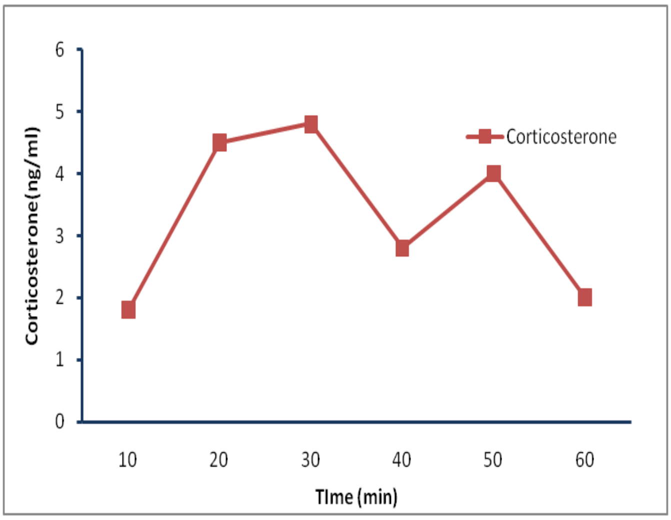

Fig 4.1: The Mean Plasma Concentration of Corticosterone handled for one hour.

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 fuzzy 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 and shape parameters respectively are

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

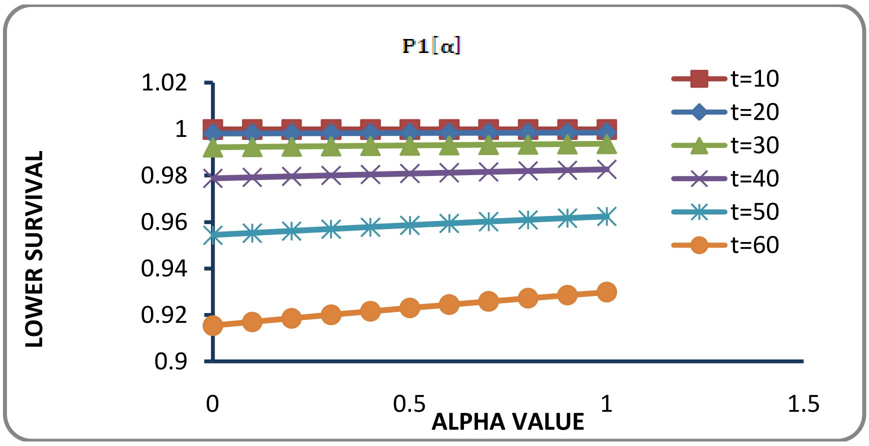

Fig:4.2 Lower α-cut of Fuzzy Survival Model

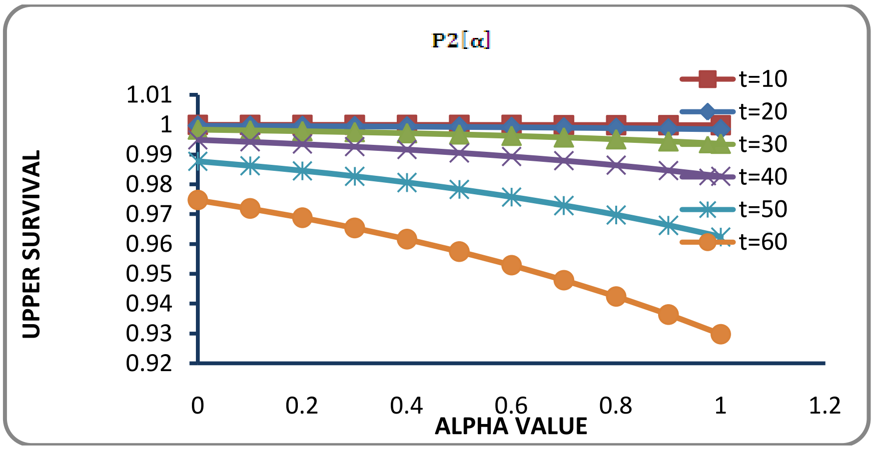

Fig:4. 3 Upper α-cut of Fuzzy Survival Model

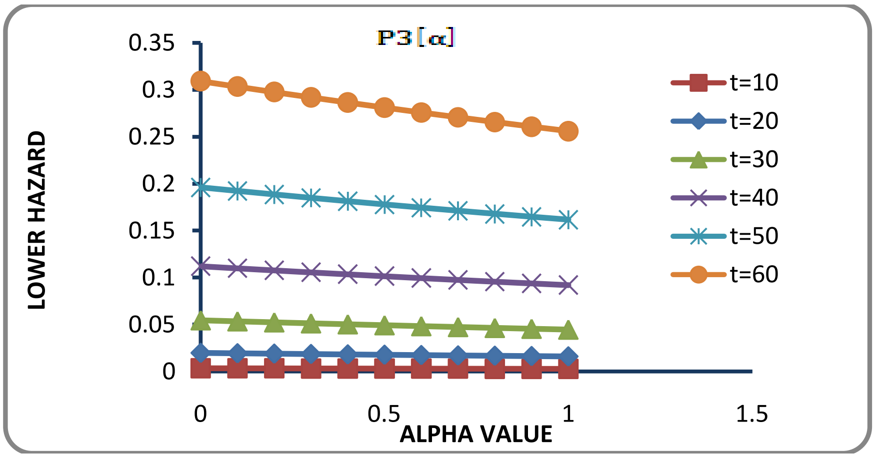

Fig:4.4 Lower α-cut of Fuzzy Hazard rate Model

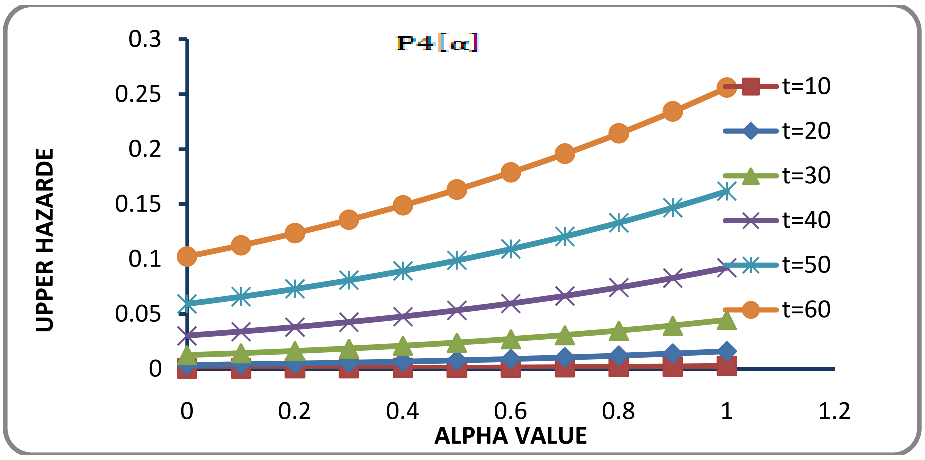

Fig:4. 5 Upper α-cut of Fuzzy Hazard rate Model

Fuzzy Survival model for Lower and Upper α-cut values (Fig. 4.2, Fig 4.3) and Fuzzy Hazard model for Lower and Upper α-cut values (Fig. 4.4, Fig 4.5) with two parameter weibull distribution for the effect of release of corticosterone with t = 10,20,30,40,50,60 were given.

V. 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 for different time intervals 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 in the test termination, if the fuzzy Survival value increases then the fuzzy hazard rate value decreases in the lower α-cuts and if the fuzzy Survival value decreases then the fuzzy hazard rate value increases in the upper α-cuts.

References

[1] Beuving G Vooder gma. Daily rhythm of corticosterone is laying hens influence of egg laying. *J Reprod Fert , 51,* 1977, 169-173.
[2] Birrenkott GP Wiggins M E, Determination of dexamethasone and corticosterone half lives in male broilers. *Poilt Sci , 63,* 1984, 1064-1068.
[3] Chen, C.H., Mon, L., Fuzzy System reliability analysis by interval of confidence, *Fuzzy sets and systems, 56*, 1993, 29-36.
[4] Chen. S. M., New method for fuzzy system reliability analysis, *Cybernetics and systems, 27,* 385-401.
[5] I.A.Downing, W.L.Bryden., Determination of corticosterone concentrations in egg albumen: A non-invasive indicator of stress in laying hens, *Physiology & Behavior, 95,* 2008, 381-387.
[6] K.Y.Cai, C. Y. Wen and M.L. Zhang, Fuzzy reliability modeling of gracefully degradable computing systems, *Reliability Engineering and systems safety, 33,* 1991, 141-157.
[7] K.Y.Cai, Wen and M.L. Zhang., Fuzzy variables as a basis for a theory of fuzzy reliability in the possibility context, *Fuzzy Sets and Systems, 42,* 1991, 145-172.
[8] Utkin. L. V and Gurov. S.V, A general formal approach for the fuzzy reliability analysis in the possibility context, *Fuzzy sets and systems*, *83*, 1996, 203-213.
[9] Zadeh,L.A., Fuzzy sets, *Information and control,8*, 1965, 338-352.
[10] Zdenek Karpisek,PertStepanek, PetrJunrak, Weibull fuzzy probability distribution for the reliability of concrete structures, *Engineering Mechanics*, *17,* 2010, 363-372.