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Acceptance Sampling Model for the Effects of Plasma Ghrelin using Fuzzy Exponential Distribution

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Abstract
In statistical quality control one of the most significant tools is the acceptance sampling plan. It plays an essential role in solving the problems involving the theory of probability distribution and fuzzy probability distribution. Ghrelin expression in the stomach and Ghrelin levels in plasma are increased after prolonged fasting and decreased in response to feeding. The results are reliable and we have shown that by means of acceptance sampling model using fuzzy exponential distribution, there is a considerable change of Ghrelin levels in plasma.
Keywords: Acceptance Sampling, Fuzzy Exponential distribution, Ghrelin
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1. Introduction

The term lifetime distribution is used to signify the collection of statistical distributions which is used in life data analysis. The life data analysis can be derived, namely the reliability function, mean time function, failure rate function and median rate function, etc. All of these are obtained directly by the different types of distributions exist, such as the normal, exponential etc. These distributions definitions can be found in many references. Some distributions tend to better representation of life data analysis are commonly called life time distributions. One of the simplest and commonly used distributions is exponential distribution.

An Acceptance sampling is one of the methods, which consists of sampling, observation and inference to obtain the acceptance or rejection. Acceptance sampling plans by attributes and by variables are the two classifications of Acceptance sampling. It consists of the single sampling plan, double sampling plan, continuous sampling plan, sequential sampling plan, etc. The acceptance sampling number and its sample size are the parameters of the single sampling plan.

Most of the Researchers and Scholars used truncated life tests which are discussed and developed by many authors. Acceptance sampling for exponential distribution was studied by Sobel and Tischendrof [1] which are extended by Goode and Kao[2] for the Weibull distribution. Again sampling plan for the lifetime plan under the gamma distribution were studied by Gupta and Groll[3] and log normal distributions by Gupta[4]. Single Sampling attributes plan were developed by Soundararajan[5] and Hald[6]. A design for sampling attribute plan, based on fuzzy set theory was discussed by Kanagawa and Ohta[7]. Sampling inspection plans by attributes for a fuzzy design was considered by Tamaki, Kanagawa and Ohta[8]. Hryniewisz[9] discussed the Statistical acceptance sampling with uncertain information from a sample and fuzzy quality criteria. Determination of single sampling attribute plans, based on membership functions were given by Ohta and Ichihashi[10]. More recently Al-Nasser and Al-Omari[15] developed the acceptance sampling plans for Generalized Exponential distribution.

Ghrelin Secretagogue receptor [11], is a 28-amino-acid peptide which is secreted by the stomach. Ghrelin is a circulating Orexigen and food intake increases after administration of exogenous Ghrelin in both rodents and human [12]. Ghrelin expression in the stomach and Ghrelin levels in plasma are increased after prolonged fasting, and circulating concentrations decrease in response to feeding or the infusion of nutrients. One of the proposed functions of Ghrelin is to stimulate hunger and initiate meals. These findings have led to a consensus that Ghrelin is a natural stimulant of food intake [14]. The plasma Ghrelin rises before and falls soon after each meal [13].

2. Notations

N - Sample Size
C - Acceptance number
λ - Scale Parameter of Exponential distribution
m - Mean time between failures
$\overline{p}$ - Probability of acceptance
$\overline{\lambda[\alpha]}$ - α cut of Scale Parameter

$\overline{p[\alpha]}$ - α cut of the Acceptance Probability

3. Fuzzy Exponential Distribution

The exponential distribution is a commonly used distribution for its simplicity, which may tend to its use in inappropriate situations. It is used to measure and analyze the characteristics of the units that have a constant failure rate. An exponential distribution measures the time interval between the occurrences of events that happen independently at a constant rate, according to a Poisson distribution with average number of occurrences being specified as λ.

The probability density function of one parameter Exponential distribution is given by

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

Where, λ the scale parameter is the constant rate, in failures per unit and $\lambda = 1/m$, Here m is the mean time between failures and t is the operating time. The mean time to failure is denoted by $\overline{T}$ and is defined by

$$\overline{T} = \int_0^\infty t.f(t)dt = \int_0^\infty t.e^{-\lambda t} dt = \frac{1}{\lambda} = m.$$

The cumulative distribution function is the probability that the variable takes a value less than or equal to x. *ie*, $F(x) = P(X \leq x)$. For a continuous distribution, this can be expressed as $F(x) = \int_{-\infty}^{x} f(\mu)d\mu$.

4. Acceptance Sampling Model

The method of membership function in fuzzy set theory plays a vital role to specify the various fuzzy sets. Triangular fuzzy number and Trapezoidal are the frequently used fuzzy number among the various types of fuzzy number system. The Triangular fuzzy number is represented by a triplet A = (a, b, c) with the conditions, (i) a ≤ b ≤ c (ii) 'a' to 'b' is an increasing function (iii) 'b' to 'c' is a decreasing function. A Triangular fuzzy number is defined by the membership function

$$\mu_A(x) = \begin{cases} \frac{x-a}{b-a}, & a \leq x \leq b \\ \frac{b-x}{c-b}, & b \leq x \leq c \\ 0, & elsewhere \end{cases}.$$

The interval of confidence by α – cut of a fuzzy number is denoted by M(α) and it can be written as M(α) = {a + (b – a)α , c – (c – b)α} ,where the α – cut of a fuzzy number $\overline{A}$ is a non – empty fuzzy set defined as M(α) = $\{x \in R : \mu_A(x) \geq \alpha\}$. To find the lower and upper acceptance level for the probability that a sample fails before time t_0, which is denoted by p and determined by P = F(t_0). The Acceptance probability for lower and upper limits are denoted by ' P_{AL} ' and ' P_{AU} ' and defined as

$$P_{AL} = \sum_{r=k}^{N} \binom{N}{r} P_{LOW}^r \left(1 - P_{LOW}^r\right)^{N-r}$$

$$P_{AU} = \sum_{r=k}^{N} \binom{N}{r} P_{UP}^r \left(1 - P_{UP}^r\right)^{N-r}$$

An Acceptance single sampling plan with fuzzy parameters is defined by the sample size 'N' and the acceptance number 'c'. If the number of observations of defective item is greater than 'c' then the sample lot will be rejected, otherwise accepted. Let F(x) be the cumulative distribution function associated with the failure rate (mean) 'λ'.

5. Application

Plasma Ghrelin profiles were generated in meal-fed rats trained to consume their daily calories over a 4-hour period in the light phase. In meal-fed rats anticipating a large meal of either chow or ensure at their usual feeding time, plasma Ghrelin (pg/ml) increased steadily over the 2-hour preceding the meal to peaks of 2192 ± 218 and 2075 ± 92 pg/ml, respectively. These findings indicate that anticipation of eating, as well as feeding status. Before the food intake Plasma Ghrelin increased significantly between the first every fifteen minute up to one

hour thirty minutes, starting at a baseline of 1072 ± 63pg/ml and reaching a peak of 2192 ± 218pg/ml. After one hour thirty minutes, food consumption makes plasma Ghrelin decreased towards the baseline 1151 ± 65pg/ml at the end of two hour thirty minute. Fig. 5.1 shows the level of Ghrelin plasma after and before the food intake.

5.1 Solution by Fuzzy Exponential distribution

From Fig.1, the scale parameter of the exponential distribution is λ = 0.001and the fuzzy triangular numbers for the scale parameter is given by

$$\overline{\lambda} = [0.0007, 0.001, 0.0013]$$

The alpha cut of the scale parameter 'λ' is given by

$$\overline{\lambda[\alpha]} = [0.0007 + 0.0003\alpha,\ 0.0013 - 0.0003\alpha]$$

The Table-1, shows the acceptance probability of different values for 'λ' according to the α- cut of the scale parameter for different values of 'α' varies from 0 to1. Here we assume that the value of 'c' is 1 and the sample size 'n' is 6.

6. Conclusion

The major component of Ghrelin secretion, both pre- and post-prandially, can be entrained by meal feeding independent of the state of fasting or feeding. In this study, we have shown the acceptance probability for the plasma Ghrelin rises before, and falls soon after, each meal by using fuzzy exponential distribution.

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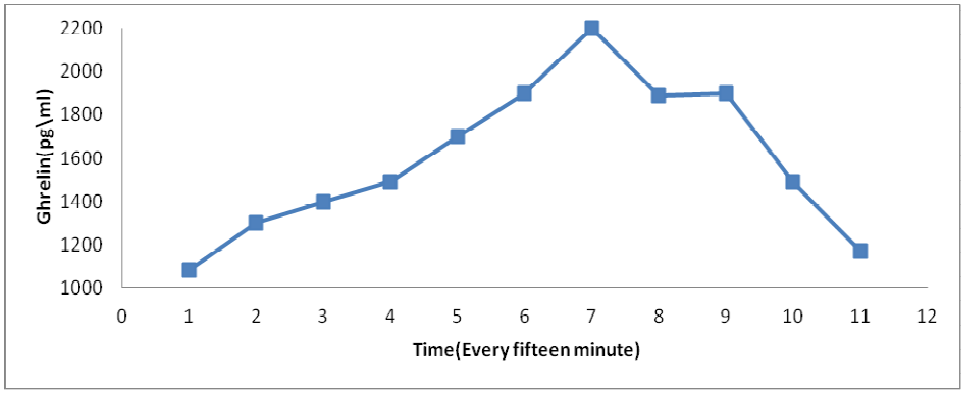

Fig.1: Level of Plasma Ghrelin

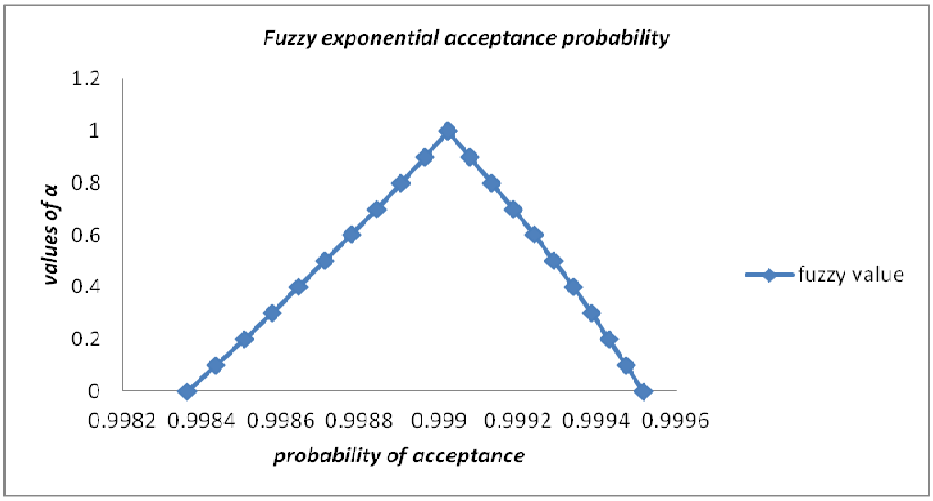

Fig. 2: Membership function for the acceptance sampling

α	P_{LOW}	P_{UP}	P_{AL}	P_{AU}
0	0.004191	0.007770	0.999516	0.998361
0.1	0.004370	0.007591	0.999474	0.998435
0.2	0.004550	0.007412	0.999431	0.998507
0.3	0.004729	0.007234	0.999386	0.998577
0.4	0.004908	0.007055	0.999339	0.998645
0.5	0.005087	0.006876	0.999290	0.998712
0.6	0.005266	0.006697	0.999240	0.998777
0.7	0.005445	0.006519	0.999188	0.998841
0.8	0.005624	0.006340	0.999134	0.998903
0.9	0.005803	0.006161	0.999079	0.998963
1	0.005982	0.005982	0.999022	0.999022

Table-1. Acceptance probability in fuzzy exponential distribution

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