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A New Three Parameter Log-Logistic Model for Survival Data Analysis

Bilal Ahmad Para[1,*], *Tariq Rashid Jan*[2] *and Mir Subzar*[3]

[1]Department of Mathematical Sciences, Islamic University of Science and Technology, Awantipora, J&K, India
[2]Department of Statistics, University of Kashmir, Srinagar, J&K, India
[3]Jammu and Kashmir Institute of Mathematical Sciences (JKIMS), J&K, India

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Abstract: In this paper, a new three parameter generalized Log-logistic distribution is introduced for modeling survival data. Some properties and characteristics of the newly introduced model are studied. Finally, the initiated model and some other related distributions are fitted to real life data sets of lifetimes, and are compared for their ability to describe the data.

Keywords: Quadratic rank transmutation, Survival Analysis, Reliability, Robust skewness, Medical Sciences.

1 Introduction

Quadratic Rank Transmutation Map (QRTM) given by Shaw and Buckley [1] is one of the techniques for generalizing probability models. Recently, a lot of research has been done in the field of transmutation. Aryal and Tsokos [2, 3] introduced a new generalization of Weibull distribution and developed the transmuted Extreme valve distribution using quadratic rank transmutation map technique. Hussain [4] studied the transmuted Exponentiated Gamma distribution. Merovci [5] proposed the transmuted Lindley distribution. Para and Jan [6] introduced two parameter Transmuted Log-logistic distribution with applications in medical sciences and other applied fields.

In this paper, we explore three parameter transmuted Log-logistic distribution in order to find out its different characteristics as well as the structural properties.
A random variable X is said to have transmuted distribution if its cumulative distribution function is given by

$$F(x) = (1+\lambda)G(x) - \lambda G(x)^2 \qquad ,|\lambda| \le 1 \tag{1}$$

where $G(x)$ is the cdf of the base distribution. If we put $\lambda = 0$ in equation (1), we get the base distribution.

In probability theory, the Log-logistic distribution is a continuous probability distribution used in survival analysis as a parametric model for events whose rate increases initially and decreases later, for example mortality rate from cancer following diagnosis or treatment. The inverse version of Log-logistic model also provides greater flexibility in survival data sets.
The probability density function (pdf) of the Log-logistic (ILL) distribution is defined as

$$g(x;\alpha,\beta) = \frac{\alpha\beta^{\alpha}}{x^{(1-\alpha)}\left(1+\left(\frac{x}{\beta}\right)^{\alpha}\right)^2} \qquad x>0, \alpha>0, \beta>0 \tag{2}$$

and its corresponding cumulative distribution function (cdf) is given by

$$G(x;\alpha,\beta) = \frac{\beta^{-\alpha}}{\beta^{-\alpha}+x^{-\alpha}} \qquad x>0, \alpha>0, \beta>0 \tag{3}$$

*Corresponding author e-mail: parabilal@gmail.com