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Survival analysis of gestational diabetes patients using a weighted Hamza distribution

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Abstract
In this study Survival Analysis of Gestational Diabetes Patients using a Weighted Hamza distribution has been proposed a new three-parameter distribution. The properties of a suggested distribution is studied, including probability density function, survival function, hazard function, moments, moment generating function and entropies. Graphs have been used to represent the behavior of a probability density function and hazard function. The known approach of maximum likelihood estimation is used to estimate its parameters. The performance of the proposed distribution has been proved using survival data from patients with gestational diabetes, and it is concluded that the generated distribution offers a better fit.

Keywords: Gestational diabetes, weighted Hamza distribution; moments; Moment generating function; survival function; Hazard function; Entropies; Maximum likelihood Estimation

Introduction

A review article-Gestational diabetes mellitus (2019), Maternal health is the subject of a lot of research because gestational diabetes mellitus poses a serious danger and has detrimental consequences on health. GDM is the condition that strikes pregnant women the most frequently. Up to 25% of pregnant women may be affected by the most common metabolic condition. The long-term health of both pregnant women and their unborn children is affected by pregnancy, which is a sensitive time. The major causes of illness and death worldwide are cancer and diabetes mellitus, and in particular, women with diabetes mellitus are more likely to acquire breast cancer (BC). Diabetes increases a woman's vulnerability to reproductive illnesses. The substantial risk and unfavorable health impacts of Gestational Diabetes Mellitus on maternal health have attracted a lot of scientific attention. The top health company is GDM. Diabetes-related reproductive dysfunctions are mostly ascribed to the presence of PCOS, obesity, hyperinsulinemia, and other conditions. Furthermore, it is well known that India is the world's diabetic capital and that pregnant and nursing women are among those who are most afflicted by diabetes. One-third (33%) of GDM patients in India had a history of maternal diabetes. The substantial risk and unfavorable health impacts of Gestational Diabetes Mellitus on maternal health have attracted a lot of scientific attention. The top health company is GDM. However, the most recent study indicates that gestational diabetes may potentially increase the risk of cardiometabolic disorders in both the mother and the foetus. The GDM poses a significant problem for healthcare practitioners in the twenty-first century. As the prognosis, prevalence, and prevention of GDM change, we want to investigate how diabetes affects female reproductive function at different phases of life.

The concept of weighted distributions can be used to address both the difficulty of model specification and the challenge of data interpretation jointly. The weighted distributions provide a way to fit models to the unknown weight function when samples can be obtained from both the original distribution and the generated distribution. The weighted distributions are used as a tool to aid in the selection of pertinent models for observed data, particularly when samples are created without an appropriate frame. Fisher (1934) proposed the idea of weighted distribution in reference to his studies on how ascertainment methods can alter the form of the distribution of recorded observations.

The Statistical distributions are crucial in biomedicine, engineering, economics, and other fields of study. The exponential and gamma distributions are common and are used to analyze statistical data as life time distributions. The exponential distribution is a one parameter distribution and other statistical properties such as memory less property and constant hazard function. Various modifications of these distributions have been proposed in the literature to provide more flexibility in the standard models. Aijaz *et al*. proposed Hamza distribution with its statistical properties and applications. Lindley distribution introduced by Lindley have been studied extensively in recent years and also one and two parameter distributions are developed for modeling complex data. Ghitney *et al*. examined the Lindley distribution in case of bank customer waiting times and revealed that Lindley distribution outperforms the exponential distribution. They also show that the Lindley distribution's hazard rate function is increasing; while as the mean residual life is dropping. They extended the Lindley distribution with the addition of new parameters and explained the performance of the expanded distribution through data sets, like Zakerzadeh and Dolati, Nadarajah *et al*. Many authors have contributed to the Lindley distribution in recent years in various ways. Merovci introduced and discussed the transmuted Lindley distribution and its features. Sharma *et al*. proposed the inverse of the Lindley distribution as well as its various properties. The Ishita distribution, created by Shanker *et al*., has been demonstrated to be superior to the exponential and Lindley distributions. Shukla proposed the Pranav distribution, and its different features were investigated. Transmuted inverse Lindley distributions were proposed by Ahmad *et al*., who also identified their properties. The objective of this study is to create a new, more adaptable three-parameter distribution that outperforms existing distributions in terms of results. Due to its adaptability in accepting many forms of the hazard function, the weighted Hamza distribution seems to be a more palatable distribution that may be used in many circumstances with fitting survival data. As a comparison to length-biased Lindley, Exponential, Devya, Shanker, and Pranav distributions, we will enter a dataset of gestational diabetes patients to fit the Weighted Hamza distribution before discussing the goodness of fit.

Weighted Hamza Distribution

The probability density function (pdf) of Hamza distribution is given by

$$f(x,\alpha,\beta)=\frac{\beta^6}{\alpha\beta^5+120}\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x} \quad ; \quad x>0,\alpha,\beta>0, \qquad (1)$$

And the cumulative distribution function (cdf) of Hamza distribution is given by

$$F(x,\alpha,\beta)=1-\left[1+\frac{x\beta\left(x^5\beta^5+6x^4\beta^4+30x^3\beta^3+120x^2\beta^2+360x\beta+720\right)}{6\left(\alpha\beta^5+120\right)}\right] \qquad (2)$$

If X has a non-negative probability density function f(x) and a non-negative weight function w(x), the probability density function of the weighted random variable (X_w) is given as

$$f_w(x)=\frac{w(x)f(x)}{E\left(w(x)\right)}$$

Where is the weight function w(x), that is not negative and $E\left(w(x)\right)=\int w(x)f(x)dx<\infty.$

This study will obtain the weighted form of the Hamza distribution. As we can see, altering w(x weight)'s function produced several weighted distributions. Consequently, the distribution that results when $w(x)=x^c$is referred to as a weighted distribution with pdf equal to

$$f_w(x)=\frac{x^c f(x)}{E(x^c)} \qquad (3)$$

Where,

$$E(X^c)=\int_0^\infty x^c f(x)dx$$

$$E(X^c)=\int_0^\infty x^c\left(\frac{\beta^6}{\alpha\beta^5+120}\right)\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x}dx \qquad (4)$$

On simplification, we get

$$E(x^c)=\frac{x^c\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x}\beta^{c=6}}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}$$

Equations (1) and (4) can be substituted for equation (3) to obtain the necessary pdf (WH) distribution.

$$f_w(x,\alpha,c,\beta)=\frac{\beta^{c+6}}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}x^c\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x}\quad \alpha>0,c,\beta,x>0, \qquad (5)$$

And from that, the WH distribution (cdf) is calculated as

$$F_w(x,\alpha,\beta,c)=\int_0^x f_w(x,\alpha,\beta,c)dx$$

$$=\int_0^x\frac{\beta^{c+6}}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}x^c\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x}dx$$

$$F_w(x)=\frac{\beta^{c+6}}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}\int_0^x x^c\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x}dx$$

We shall obtain the Weighted Hamza distribution's cdf after simplification.

$$F_w(x,c,\alpha,\beta)=\left(\frac{1}{6\ (6\alpha\beta^5\Gamma c+1+\Gamma c+7))}\right)\left(\alpha\beta^5\ \gamma(c+1,\beta x)+\gamma(c+7,\beta x)\right) \quad (6)$$

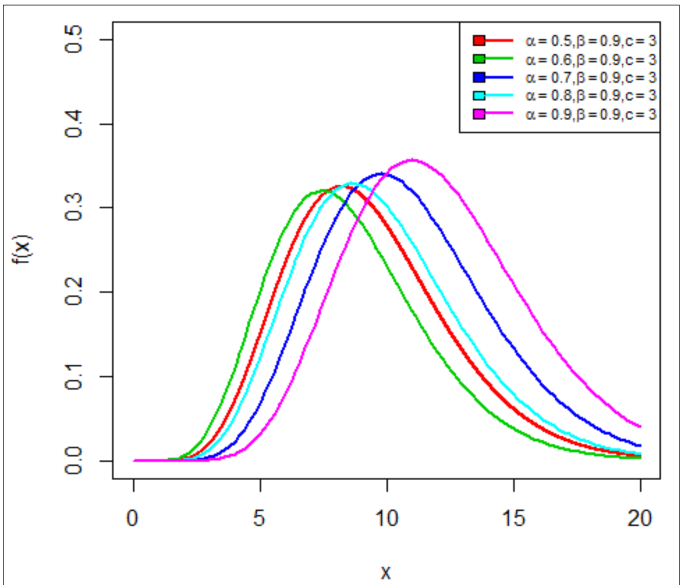


Fig.1 pdf plot of Weighted Hamza distribution

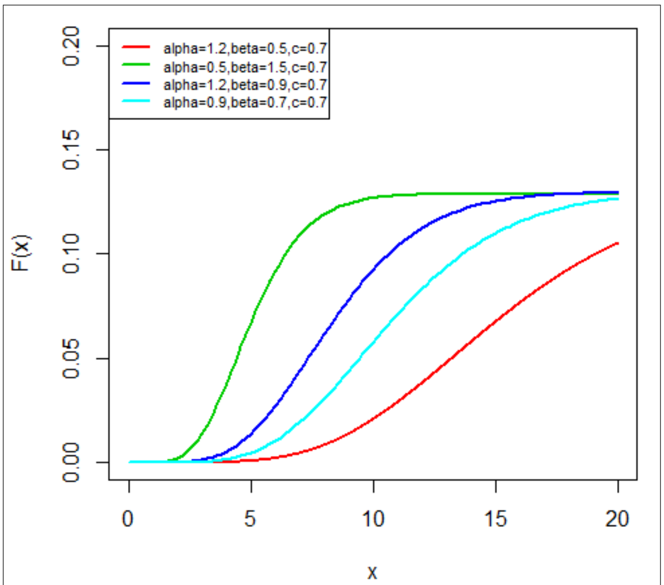


Fig.2 Cdf plot of Weighted Hamza distribution

Survival analysis

The survival function, hazard function, reverse hazard rate, and mills ratio of the weighted hamza (WH) distribution will be covered in this section.

Survival function

The WH distribution's survival function is provided by

$$s(x)=1-\left(\frac{6(6\alpha\beta^5\Gamma c+1+\Gamma c+7)-6\alpha\beta^5\gamma(c+1,\beta x)+\gamma(c+7,\beta x)}{6(6\alpha\beta^5\Gamma c+1+\Gamma c+7)}\right)$$

Hazard function

The associated hazard function is provided by

$$h(x)=\frac{x^c\beta^{c+6}\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x}}{\left(6\alpha\beta^5\Gamma c+1+6\Gamma c+7\right)-\left(6\alpha\beta^5\gamma(c+1,\beta x)+\gamma(c+7,\beta x)\right)}$$

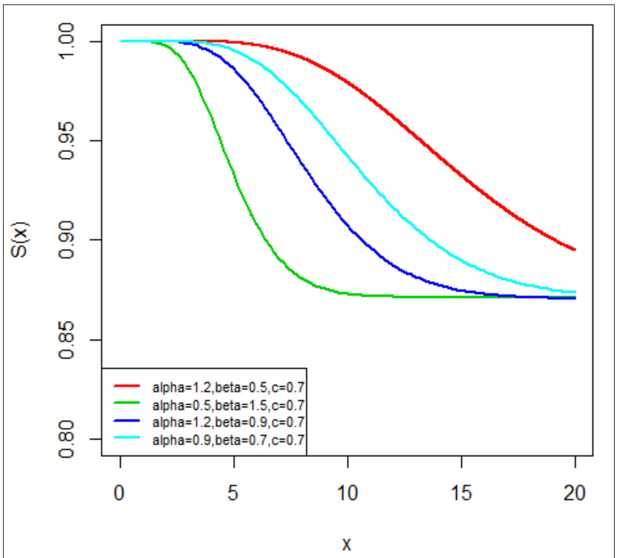


Fig.3 Survival plot of Weighted Hamza distribution

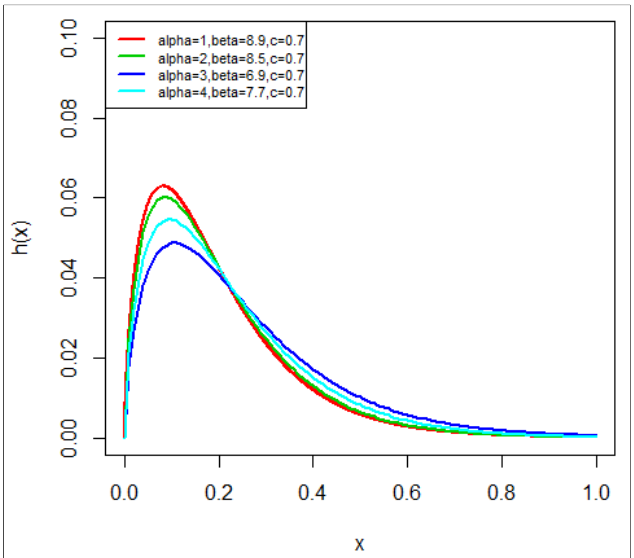


Fig.4 Hazard plot of Weighted Hamza distribution

Reverse hazard rate function

The (RH) rate is given by

$$h_r(t)=\frac{\left(6\alpha\beta^5\Gamma c+1+6\Gamma c+7\right)-6\alpha\beta^5\gamma(c+1,\beta x)+\gamma(c+7,\beta x)}{x^c\beta^{c+6}\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x}}$$

Mill's ratio

Mill's ratio of the (WH) distribution is written as

$$M_R(t)=\frac{1}{h_r(t)}$$

$$M_R(t)=\frac{1}{\frac{\left(6\alpha\beta^5\Gamma c+1+6\Gamma c+7\right)-6\alpha\beta^5\gamma(c+1,\beta x)+\gamma(c+7,\beta x)}{x^c\beta^{c+6}\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x}}}$$

Statistical Properties

In this section we will discuss some statistical properties of weighted hamza distribution.

Moments

Let's say that X stands for a random variable with a WH distribution. The rth instant, shown by, $\mu_r^{'}$ is then provided by

$$E(X^r)=\mu_r^{'}=\int_0^\infty X^r f(x,\alpha,\beta,c)\,dx$$

$$\mu_r^1=\int_0^\infty\left(\frac{\beta^{c+6}}{6\alpha\beta^5\Gamma c+1+\Gamma c+7}\right)x^c\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x}dx$$

$$=\frac{\beta^{c+6}}{6\alpha\beta^5\Gamma c+1+\Gamma c+7}\left[\alpha\int_0^\infty x^r e^{-\beta x}dx+\frac{\beta}{6}\int_0^\infty x^{r+c+6}e^{-\beta x}dx\right] \qquad (8)$$

On simplification of equation (8), we will obtain the r[th] moment of proposed distribution.

$$\mu_r^{'}=\left[\frac{6\alpha\beta^5\Gamma r+c+1+\Gamma r+c+1}{6\beta^\gamma\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}\right] \qquad (9)$$

By substituting values for r=1,2,3,... in equation (9) we may get the distribution's moments.

$$\mu_1' = \frac{6\alpha\beta^5\,\Gamma c+2+\Gamma c+8}{6\beta\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}$$

$$\mu_2' = \frac{6\alpha\beta^5\,\Gamma c+3+\Gamma c+9}{6\beta\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}$$

$$\mu_3'' = \frac{6\alpha\beta^5\,\Gamma c+4+\Gamma c+10}{6\beta\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}$$

Variance

$$\mu_2 = \mu_2' - \left(\mu_1'\right)^2$$

$$\mu_2 = \frac{6\alpha\beta^5\,\Gamma c+3+\Gamma c+9}{6\beta\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)} - \left(\frac{6\alpha\beta^5\,\Gamma c+2+\Gamma c+8}{6\beta\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}\right)^2$$

$$S.D(\sigma) = \sqrt{\frac{6\alpha\beta^5\,\Gamma c+3+\Gamma c+9}{6\beta\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)} - \left(\frac{6\alpha\beta^5\,\Gamma c+2+\Gamma c+8}{6\beta\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}\right)}$$

Moment generating function

In the event that X_w exhibits a weighted Hamza distribution, the moment generating function (mgf) of X is determined to be

$$M_x(t) = E(e^{tx}) = \int_0^\infty e^{tx} f(x)dx$$

$$M_x(t) = \int_0^\infty \left(1+tx+\frac{(tx)^2}{2!}+\ldots\right) f(x)dx$$

$$= \int_0^\infty \sum_{i=0}^{\infty} \frac{(tx)^j}{j!} f(x)\,dx$$

$$M_x(t) = \sum_{i=0}^{\infty} \frac{t^j}{j!} \mu_j'$$

$$M_x(t) = \sum_{j=0}^{\infty} \frac{t^i}{j!} \left(\frac{6\alpha\,\beta^5\,\Gamma j+c+1+\Gamma j+c+1}{6\beta^j\left(6\alpha\,\beta^5\Gamma c+1+\Gamma c+7\right)}\right) \qquad (10)$$

A similar definition is given for the characteristic function of the weighted Hamza distribution:

$$\phi_x(t) = M_x(it) = E(e^{itx}) = \int_0^\infty e^{itx} f(x)\,dx$$

$$\phi_x(it) = \sum_{j=0}^{\infty} \frac{(it)^j}{j!} \left(\frac{6\alpha\,\beta^5\,\Gamma j+c+1+\Gamma j+c+1}{6\beta^j\left(6\alpha\,\beta^5\Gamma c+1+\Gamma c+7\right)}\right) \qquad (11)$$

Entropies

In several disciplines, including probability, statistics, physics, and communication theory, and economics, entropy is a crucial concept. Entropies are units used to quantify a system's diversity, unpredictability, or randomness. An indicator of variational uncertainty is the entropy of a random variable, or X.

Renyi Entropy

In statistics and ecology, the Renyi entropy is employed as a diversity index. Due to the fact that it may be applied as an entanglement metric, it is also crucial in quantum information. For a given probability distribution, the Renyi entropy is provided by.

$$R(\delta)=\frac{1}{1-\delta}\log\int_0^\infty f_w^{\delta}(x)\,dx$$

$$=\frac{1}{1-\delta}\log\int_0^\infty\left[\frac{\beta^{c+6}x^c\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x}}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}\right]^{\delta}dx$$

$$=\frac{1}{1-\delta}\log\int_0^\infty\left(\frac{\beta^{c+6}}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}\right)^{\delta}x^{\delta c}\left(\alpha+\frac{\beta}{6}x^6\right)^{\delta}e^{-\delta\beta x}dx$$

$$=\frac{1}{1-\delta}\log\left(\frac{\alpha\,\beta^{c+6}}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}\right)^{\delta}\sum_{r=0}^{\infty}\binom{\delta}{r}\left(\frac{\beta}{6\alpha}\right)^{r}\int_0^\infty x^{8c+6r+1-1}e^{-\delta\beta x}dx$$

$$=\frac{1}{1-\delta}\log\left(\frac{\alpha\beta^{c+6}}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}\right)^{\delta}\sum_{r=0}^{\infty}\binom{\delta}{r}\left(\frac{\beta}{6\alpha}\right)^{r}\frac{\Gamma\delta c+6r+1}{(\beta\delta)^{\delta c+6r+1}}\qquad(12)$$

Tsallis Entropy

Boltzmann-Gibbs (B-G) statistical mechanics generalisation by Tsallis has drawn a lot of interest. The mathematical expression for a continuous random variable known as the Tsallis entropy (Tsallis, 1988), which is defined as follows, was initially proposed in order to introduce this generalisation of B-G statistics.

$$s(\lambda)=\frac{1}{1-\lambda}\left[1-\int_0^\infty f(x)dx\right]$$

.

$$s(\lambda)=\frac{1}{1-\lambda}\left[1-\int_0^\infty\left(\frac{\beta^{c+6}x^c}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}\right)^{\lambda}\left(\alpha+\frac{\beta}{6}x^6\right)^{\lambda}e^{-\lambda\beta x}dx\right]$$

$$=\frac{1}{1-\lambda}\left[1-\left(\frac{\beta^{c+6}\alpha}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}\right)^{\lambda}\int_0^\infty x^{c\lambda}\left(\alpha+\frac{\beta}{6}x^6\right)^{\lambda}e^{-\lambda\beta x}dx\right]$$

$$=\frac{1}{1-\lambda}\left[1-\left(\frac{\alpha\beta^{c+6}}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}\right)^{\lambda}\sum_{r=0}^{\infty}\binom{\lambda}{r}\left(\frac{\beta}{6\alpha}\right)^{r}\int_0^\infty x^{(c+6r+1)}e^{-\lambda\beta x}dx\right]$$

$$=\frac{1}{(1-\lambda)}\left[1-\left(\frac{\alpha\beta^{c+6}}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)}\right)^{\lambda}\sum_{r=0}^{\infty}\binom{\lambda}{r}\left(\frac{\beta}{6\alpha}\right)^{r}\frac{\Gamma c\lambda+6r+1}{(\lambda\beta)^{c\lambda+6r+1}}\right]\qquad(13)$$

Order statistics

Take into account that $X_1, X_2,..., X_n$ represent the random samples and that $X_{(1)}, X_{(2)},..., X_{(n)}$ represent the order statistics of a random sample of size n taken from a continuous population with probability density function $f_x(x)$ and cumulative distribution function $F_X(x)$. The probability density function of the rth order statistics $X_{(r)}$ is then represented by the following formula.

$$f_{x(r)}(x) = \frac{n!}{(r-1)!\,(n-r)!}\; f_X(x)[F_X(x)]^{r-1}\;[1-F_X(x)]^{n-r} \qquad (14)$$

We can obtain the probability density function of the length biased power Shanker distribution's r_{th} order statistics by plugging equations (5) and (6) into equation (14).

$$f_{x(r)}(x) = \frac{n!}{(r-1)!\,(n-r)!}\;\frac{\beta^{c+6}}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)} x^c\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x}$$

$$\left[\left(\frac{1}{6\,(6\alpha\beta^5\Gamma c+1+\Gamma c+7))}\right)\left(\alpha\beta^5\,\gamma(c+1,\beta x)+\gamma(c+7,\beta x)\right)\right]^{r-1}$$

$$\left[1-\left(\frac{1}{6\,(6\alpha\beta^5\Gamma c+1+\Gamma c+7))}\right)\left(\alpha\beta^5\,\gamma(c+1,\beta x)+\gamma(c+7,\beta x)\right)\right]^{n-r}$$

The following is how to retrieve the Pdf of higher order statistics for n.

$$f_{x(r)}(x) = \left(\frac{\beta^{c+6}}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)} x^c\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x}\right)$$

$$\times\left[\left(\frac{1}{6\,(6\alpha\beta^5\Gamma c+1+\Gamma c+7))}\right)\left(\alpha\beta^5\,\gamma(c+1,\beta x)+\gamma(c+7,\beta x)\right)\right]^{n-1}$$

Additionally, one may obtain the pdf of first order statistics $X_{(1)}$ as

$$f_{x(r)}(x) = n\left(\frac{\beta^{c+6}}{\left(6\alpha\beta^5\Gamma c+1+\Gamma c+7\right)} x^c\left(\alpha+\frac{\beta}{6}x^6\right)e^{-\beta x}\right)$$

$$\times\left[\left(1-\frac{1}{6\,(6\alpha\beta^5\Gamma c+1+\Gamma c+7))}\right)\left(\alpha\beta^5\,\gamma(c+1,\beta x)+\gamma(c+7,\beta x)\right)\right]^{n-1}$$

Maximum likelihood method

In this section, we discuss the maximum probability of the parameters of the weighted Hamza distribution. Take into account a random sample of size n that is taken from a weighted hamza distribution. The likelihood function can be found in this section, we discuss the maximum probability of the parameters of the weighted Hamza distribution. Take into account a random sample of size n that is taken from a weighted hamza distribution. The likelihood function can be found in

$$L(x;\beta,\alpha,c) = \prod_{i=1}^{n} f(x_i;\beta,\alpha,c)$$

$$L(x_i) = \prod_{i=1}^{n}\left(\frac{\beta^{c+6}}{6\alpha\beta^5\Gamma c+1+\Gamma c+7}\right)x_i^c\left(\alpha+\frac{\beta}{6}x_i^6\right)e^{-\beta x_i}$$

$$=\left(\frac{\beta^{c+6}}{6\alpha\beta^5\Gamma c+1+\Gamma c+7}\right)^n \prod_{i=1}^{n}\left(\alpha+\frac{\beta}{6}x_i^{\,6}\right)x_i^c\,e^{-\beta x_i}$$

The proposed distribution's log-likelihood function is provided by (15) as

$$\Rightarrow \log L = n(c+6)\log\beta - n\log(6\alpha\beta^5\Gamma c+1) + n\log\Gamma c+7 + \sum_{i=1}^{n}\log x_i^c - \beta\sum_{i=1}^{n}x_i + \sum_{i=1}^{n}\log\left(\alpha+\frac{\beta}{6}x_i^6\right) \quad (15)$$

To derive model parameters, differentiate equation (15) with regard to estimators, and c. Then, there is

$$\frac{\partial \log L}{\partial\beta} = \frac{n(c+6)}{\beta} - \frac{n6\alpha5\beta^4\Gamma c+1}{6\alpha\beta^5\Gamma c+1} - \sum_{i=1}^{n}x_i + \sum_{i=1}^{n}\frac{1}{\left(\alpha+\frac{\beta}{6}x_i^6\right)}\frac{x_i^6}{6} \quad (16)$$

$$\Rightarrow \frac{\partial \log L}{\partial c} = n\log\beta - \frac{n\psi(\Gamma c+1)}{\Gamma c+1} - \frac{n}{\Gamma c+7}\psi(c+7) + \sum_{i=1}^{n}\log x_i \quad (17)$$

$$\frac{\partial \log L}{\partial\alpha} = -\frac{n}{\alpha} + \sum_{i=1}^{n}\frac{1}{\left(\alpha+\frac{\beta}{6}x_i^6\right)} \quad (18)$$

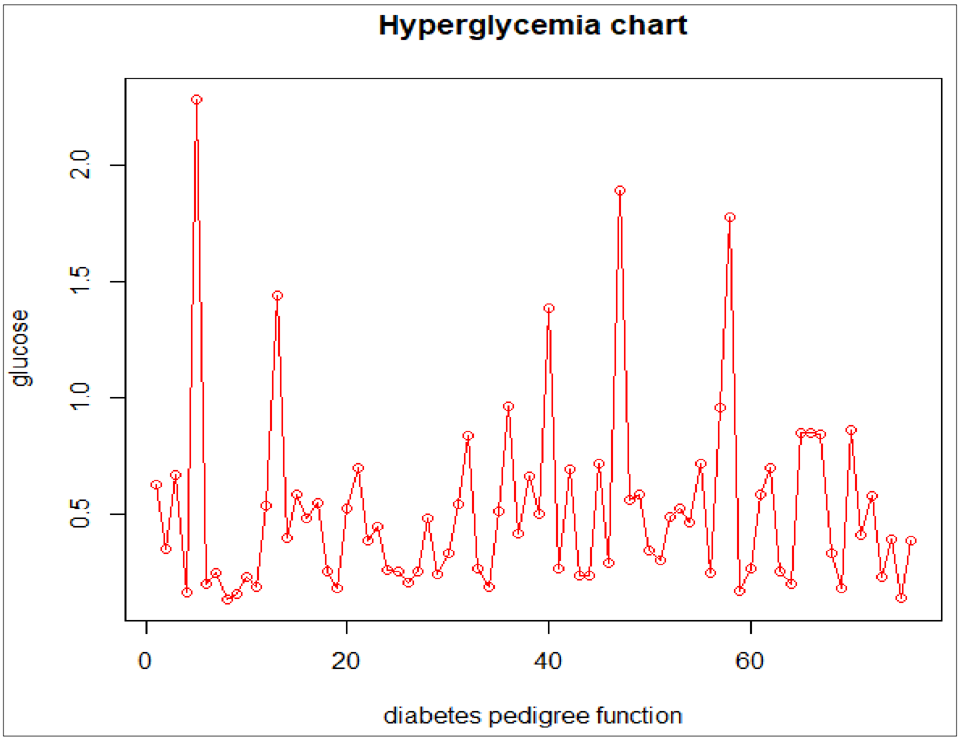
Because likelihood equations (16), (17), and have a complex form, the system of nonlinear equations is quite challenging to solve (18). In light of this, we estimate the necessary parameters using R and Wolfram Mathematica.

Data analysis

Data set: The efficiency of the recently developed model is evaluated in this section using the gestational diabetes hyperglycemia data set. Additionally, we demonstrate that the established distribution outperforms the length-biased Pranav, Devya, Lindley, and Exponential and Power Shanker distributions. Table 1 displays the collection of data. Gestational Diabetes Hyperglycemia data set 0.627, 0.351, 0.672, 0.167, 2.288, 0.201, 0.248, 0.134, 0.158, 0.232, 0.191, 0.537, 1.441, 0.398, 0.587, 0.484, 0.551, 0.254, 0.183, 0.529, 0.704, 0.388, 0.451, 0.263, 0.254, 0.205, 0.257, 0.487, 0.245, 0.337, 0.546, 0.841, 0.267, 0.188, 0.512, 0.966, 0.42, 0.665, 0.503, 1.39, 0.271, 0.696, 0.235, 0.235, 0.721, 0.294, 1.893, 0.564, 0.586, 0.344, 0.305, 0.491, 0.526, 0.467, 0.718, 0.248, 0.962, 1.781, 0.173, 0.27, 0.587, 0.699, 0.258, 0.203, 0.855, 0.855, 0.845, 0.334, 0.184, 0.867, 0.411, 0.583, 0.231, 0.396, 0.14, 0.391, 0.37, 0.27, 0.307, 0.14, 0.102, 0.767, 0.237, 0.249, 0.324, 0.153, 0.165, 0.258, 0.445, 0.261, 0.255, 0.277, 0.761, 0.761, 0.266, 0.12, 0.323, 0.356, 0.356, 0.325, 1.222, 0.179, 0.262, 0.283, 0.93, 0.801, 0.201, 0.287, 0.336, 0.247, 0.199, 0.543, 0.192.

Table 1: Data analysis

Disease	long-term complications	Pregnancies worldwide affecting (%)	Affecting age group (%)
Gestational diabetes mellitus (GDM)	hyperglycemia, pre-eclampsia, macrosomia, type 2 diabetes	15–25%	The mean lifespan of women with GDM was 30.98± 5.97 years, with the largest frequency of the disease (18.6%) found in people under the age of 35.



The estimation of model comparison criterion values and the estimation of unknown parameters are both done using the R software application comparing the performance of the weighted hamza distribution with that of the Pranav, Lindley, Exponential, length-biased Shanker, and length-biased Devya distributions. AICC (corrected Akaike information criterion), BIC, and AIC (Akaike information criterion) are used to compare the aforementioned models (Bayesian information criterion). The distribution that is deemed to be better among those mentioned above is indicated by having lower values for AIC, AICC, BIC, and -2log L.

$$AIC = -2\ln l + 2k, BIC = -2\ln l + k\ln n, \quad AICC = AIC + \frac{2k(k+1)}{n-k-1}$$

If the sample size is n and there are k parameters.

Table 2: MLEs and comparative parameters

Distribution	Estimates	-2log L	AIC	BIC	AICC
WHD distribution	α= 0.258398 β= 0.333491 c= 0.997452	11.66304	17.66204	25.8442	19.6734
LBWD distribution	θ=0.419747 c= 0.341358	42.42966	44.42966	47.15704	41.3245
LBPSD distribution	θ= 0.612599 α= 0.254737	47.34764	49.21344	51.23564	45.4578
Lindley distribution	θ= 0.209266	52.56544	54.26524	57.59283	51.7823
Exponential distribution	θ= 0.1995484	56.04897	58.04897	60.77635	54.5698
Pranav distribution	θ= 0.9974524	56.05065	60.50542	65.50542	59.3478

Conclusion

We proposed a Weighted Hamza distribution and determine its features in this study. The weighted hamza distribution can be utilized for a wide range of applications, acknowledgement to the flexibility of the shape and scale parameters. From the domain of frequent estimation, the maximum likelihood estimation is implemented. Analyzing the data of a patient with gestational diabetic demonstrated the effectiveness of the distribution. Finally, the results indicated that the weighted hamza distribution shows better fit than the Lindley, Pranav, exponential, length biased shanker and length biased devya distributions.

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