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The Study of Univariate Normal Distribution Mathematical Model for Analyzing the Effects of Melatonin on Menstrual Cycle

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Abstract: *The theory of creating bivariate normal distributions is illustrating the consideration of the reliability analyst. Amongst those methods, the classification approach and the modeling approach are very interesting. In fact classification approach is of concentration part to both theoreticians and applied workers. Here we have used a bivariate normal distribution for application from Multivariate normal distribution through classification approach. In our application we have considered days of Menstrual Cycle with Melatonin hormone as variable of women stress effects.*

Keywords**:** *Melatonin*

I. Introduction

More recently, it has been discovered that an imbalance of reactive oxygen species, or 'oxidative stress', can have a negative impact on the success of infertility treatments, and furthermore, researchers have started mentioning possible mechanisms of avoiding these effects with the use of novel oxygen scavengers such as melatonin. It can also be seen that the methods specified gives a positive impact on fertility success rates following IVF treatment. [3]

Melatonin: Melatonin is the hormone secreted by the little gland present in the brain. Melatonin helps control our sleep and wake cycles. Very small amount of it are found in foods such as meats, grains, fruits, vegetables. Our body has its own internal clock that controls our natural cycle of waking & sleeping hours. Melatonin levels begin to rise from mid to late evening, remain high for the night and then drop in the early morning hours.[2]

Melatonin has been recognized as a input feature in the instruction of circadian rhythms and the sleep-wake cycle [3,4]. Long coverage to simulated lighting leads to a decrease in endogenous melatonin exposure [1]. Melatonin is thus associated with sleep conflicts including several diseases, and much of the writing is alerted in this respect.

II. Material And Methods

In humans, the only data on cyclical melatonin changes comes from women undergoing ovarian stimulation. Levels of melatonin reach a lowest point in the preovulatory phase and peak in the luteal phase (clearly seen in Figure) [1,2]. This implies that the variable melatonin depends on all the phases of menstrual cycle.

It is also well known that shift-workers are more likely than daytime workers to experience circadian disruption and longer menstrual cycles, more menorrheal and dysmenorrheal. These results are documented by a very large group study, which also found that duration of shift work was modestly associated with menstrual cycle irregularity. A study says that the melatonin levels diversified radically between night and day shift workers, while LH and FSH levels did not, suggesting that the menstrual irregularity associated with shift-work could be explained by melatonin fluctuations. [12]

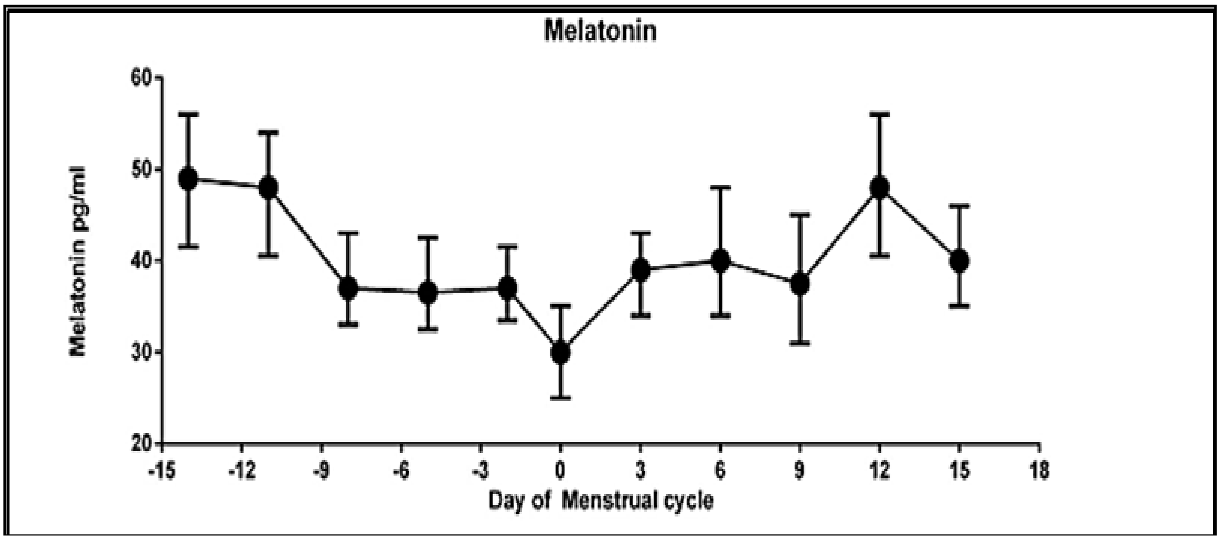

Fig : Melatonin : Relative concentrations of Plasma Melatonin treated with respective day of menstrual cycle[4]

III. Mathematical Model

The generalized formula for n-dimensional function is given by;

$$f_{\underline{X}}(x_1, \dots, x_n) = \frac{1}{(\sqrt{2\pi})^n} \frac{1}{\sqrt{\det K}} \exp\left[-\frac{1}{2}(\underline{x} - \underline{\mu})' K^{-1} (\underline{x} - \underline{\mu})\right]$$

Where E(X) = μ and K is the covarient matrix of X. We specialize to the case n = 2

$$K = \begin{bmatrix} \sigma_1^2 & \sigma_{12} \\ \sigma_{12} & \sigma_2^2 \end{bmatrix} = \begin{bmatrix} \sigma_1^2 & \rho\sigma_1\sigma_2 \\ \rho\sigma_1\sigma_2 & \sigma_2^2 \end{bmatrix}, \quad \sigma_{12} = \mathrm{Cov}(X_1, X_2);$$

$$K^{-1} = \frac{1}{\sigma_1^2\sigma_2^2(1-\rho^2)} \begin{bmatrix} \sigma_2^2 & -\rho\sigma_1\sigma_2 \\ -\rho\sigma_1\sigma_2 & \sigma_1^2 \end{bmatrix} = \frac{1}{1-\rho^2} \begin{bmatrix} 1/\sigma_1^2 & -\rho/\sigma_1\sigma_2 \\ -\rho/\sigma_1\sigma_2 & 1/\sigma_2^2 \end{bmatrix}$$

Thus the function of X_1 and X_2 is

$$\frac{1}{2\pi\sigma_1\sigma_2\sqrt{1-\rho^2}} \exp\left\{-\frac{1}{2(1-\rho^2)}\left[\left(\frac{x_1-\mu_1}{\sigma_1}\right)^2 - 2\rho\left(\frac{x_1-\mu_1}{\sigma_1}\right)\left(\frac{x_2-\mu_2}{\sigma_2}\right) + \left(\frac{x_2-\mu_2}{\sigma_2}\right)^2\right]\right\}.$$

The moment-generating function of X is

$$M_{\underline{X}}(t_1, t_2) = \exp(\underline{t}'\underline{\mu}) \exp\left(\frac{1}{2}\underline{t}'K\underline{t}\right)$$

$$= \exp\left[t_1\mu_1 + t_2\mu_2 + \frac{1}{2}\left(\sigma_1^2 t_1^2 + 2\rho\sigma_1\sigma_2 t_1 t_2 + \sigma_2^2 t_2^2\right)\right]$$

If X_1 and X_2 are jointly Gaussian and uncorrelated, then ρ = 0, so that $f(x_1, x_2)$ is the product of a function $g(x_1)$ of x_1 alone and a function $h(x_2)$ of x_2 alone. It follows that X_1 and X_2 are independent.

The conditional distribution is;

$$E(X_2|X_1 = x_1) = \mu_2 - \frac{q_{21}}{q_{22}}(x_1 - \mu_1)$$

$$\frac{q_{21}}{q_{22}} = -\frac{\rho/\sigma_1\sigma_2}{1/\sigma_2^2} = -\frac{\rho\sigma_2}{\sigma_1}.$$

$$E(X_2|X_1 = x_1) = \mu_2 + \frac{\rho\sigma_2}{\sigma_1}(x_1 - \mu_1)$$

$$\mathrm{Var}(X_2|X_1 = x_1) = \frac{1}{q_{22}} = \sigma_2^2(1 - \rho^2).$$

For $E(X_1|X_2 = x_2)$ and $\mathrm{Var}(X_1|X_2 = x_2)$, interchange μ_1 and μ_2, and interchange σ_1 and σ_2.

The Univariate distribution is given by ;

$$p(x) = \frac{1}{\sqrt{2\pi\sigma^2}} \exp\left[-\frac{(x-\mu)^2}{2\sigma^2}\right]$$

IV. Discussion

For different values of shape & scale parameters we have following figures for the application part.

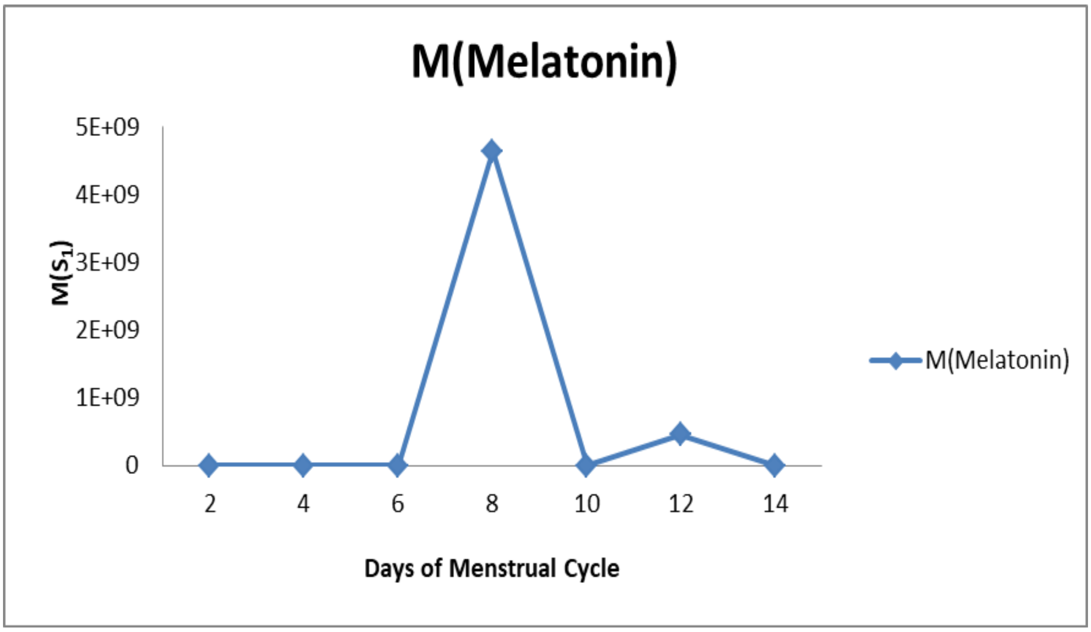

Figure Effects of Melatonin (M (s_1)) for Days of Menstrual Cycle

V. Conclusion

a. Mathematical Conclusion

Figure shows effects of Melatonin for days of Menstrual cycle. The graphical representation of the function mathematically shows that variable Melatonin has maximum effect during the ovulation period of the menstrual cycle and the effect gradually goes on decreasing as it attains the Luteal phase of the cycle. During the Luteal phase of the cycle the variable shows minimum effect in the cycle.

b. Medical Conclusion drawn from Mathematical Model

Medical conclusion suggests that effects of Melatonin gives us various changes during the days of the Menstrual cycle. Mathematical model in the form of bivariate normal distribution gives a proper distribution function i.e. (M(S1)) clearly seen in the mathematical graph for a given set of values of ρ. From the mathematical model it is clearly seen are the effects of Melatonin that varies gradually during the menstrual. This gives a good conclusion to the medical professionals to measure the level of Melatonin during each day of Menstrual cycle.

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