World Journal of Engineering Research and Technology
WJERT
www.wjert.org
SJIF Impact Factor: 3.419

PREDICTIVE MODELING AND OPTIMIZATION OF PHYSIOLOGICAL VARIABLES IN HUMANS FROM CONCEPTION TO MATURITY

[1]Kamalu C. I. O., [2]Obibuenyi J.I., [3]Dozie I.N.S., [*4]Obijiaku J.C., [5]Nwakaudu M.S., [6]Oghome P., [7]Uzondu F.N., [8]Okolie I.J.

[1,2,4,5,7,8]Department of Chemical Engineering, Federal University of Technology, Owerri, Nigeria.

[3]Dean, School of Health Technology, Federal University of Technology, Owerri, Nigeria.

Article Received on 28/05/2016 Article Revised on 17/06/2016 Article Accepted on 08/07/2016

***Corresponding Author**
Obijiaku J.C.
Department of Chemical Engineering, Federal University of Technology, Owerri, Nigeria.

ABSTRACT

In this work, physiological variation with its variable parameters from conception maturity of a foetus, was modeled using general growth logistic model. Physiological data from conception to maturity via gestation were obtained through the internet from WHO and research institutions for the validation of the developed models. It was seen that the physiological variable parameters, like the variable parameters of natural growth models, fitted the model very well, with accuracies ranging from 96.96 to 99.93%, which goes to reveal that the physiological activities obey natural growth models. The optimum result obtained are as follows; 20 million sperm count can make 2.4% pregnancy with an accuracy of 98.62%. 17 million sperm count can make 1.12% not pregnant with an accuracy of 98.14%. 1.27% egg penetration is achieved in 7 minutes with an accuracy of 99.93%. An optimum of 0.12 sperm per egg per minute is made in 130 minutes with an accuracy of 99.57%. Also, an optimum value of 0.45 embryo score per pregnancy rate is made with 32% pregnancy with the accuracy of 96.96%. A foetus can weigh 201g per week in 33 weeks with an accuracy of 99.93%. An optimum of 2cm growth for foetus per week for every 22 weeks with 98.69% accuracy. These findings can be applied in so many hospitals, pregnancy care

centers and maternities etc, to predict certain variables during physiological activities in humans.

KEYWORDS: Physiological variables parameters, conception, gestation, maturity, modeling, optimization, humans.

1. INTRODUCTION

1.1 Background of the study

According to Chiou et al (2013), Kippley et al (1996), routine semen analysis is widely performed as a major test for male fertility potential by assessing sperm concentration, motility and morphology of the spermatozoa. However, these results do not provide accurate diagnostic or prognostic information about human fertility either in Vivo or in Vitro. Sperm function may not be predicted by semen analysis, as the fertilization process involves a large number of biochemical events not measured by these parameters. Nearly a third of male infertility etiologies remain idiopathic. Clinically, these patients with unexplained infertility have difficult deciding which of the assisted reproductive technologies (ART) would be the best option to assist them to achieve pregnancy with lower cost and less invasive procedure, Chiou et al (2013), Abdulahi et al (1997).

A poor predictive value of routines semen analysis for sperm fertilizing ability is not because of a large variation of semen parameters between ejaculates. It is mostly because routine semen analysis only determines sperm concentration, motility and morphology but cannot detect many other aspects of sperm function such as nuclear maturity, DNA normality and the ability of sperm to interact with oocytes. Hence, many tests such as sperm penetration assay (SPA) have been developed. However, most of these tests are time consuming and costly. Therefore, there is need for a more economically and technically easier alternative for assessing sperm function, Perdrix and Rivers (2013), Xiao and Mrux (2013).

The sperm HBA that has been developed as a commercial diagnostic kit for assessing sperm maturity and function is simple, short and less costly test. This test is based on previous studies that hyaluronic acid (HA) can selectively bind to mature sperm with intact acrosome and better morphology. As we know, HA has a natural sperm-selective function. HA is normally present in the extracellular matrix (ECM) of the cumulus oophorus surrounding the oocyte in the natural human fertilization process. the ECM is a formidable barrier that only matures spermatozoa that have extruded their specific receptors to bind to and digest, HA can

overcome to reach and penetrate the zona pellucid and fertilise the occyte. HBA is a simple technique to predict sperm performance and fertilization potential, Chiou et al (2013), Aman (1989).

According to Wikipedia (2015), spermatogenesis is the process in which spermatozoa are produced from male primordial germ cells by way of mitosis and meiosis. The initial cells in this pathway are called spermatogonia, which yield primary spermatocytes by mitosis. The primary spermatocyte divides meiotically (meiosis I) into two secondary spermatocytes, each secondary spermatocyte divides into spermatids by (meiosis II). These develop into mature spermatozoa, also known as sperm cells. Thus, the primary spermatocyte gives rise to two cells, the secondary spermatocyte, and the two secondary spermatocytes by their subdivision produce four spermatozoa (I), Wikipedia (2015), Bodnar (1996).

Spermatozoa are the mature male gametes in many sexually reproducing organisms. Thus; spermatogenesis is the male version of gametogenesis. In mammals it occurs in the seminiferous tubules of the male testes in a stepwise fashion. Spermatogenesis is highly dependent upon optimal conditions for the process to occur correctly and is essential for sexual reproduction. DNA methylation and histone modification have been implicated in the regulation of this process. It starts at puberty and usually continues uninterrupted until death, although a slight decrease can be discerned in the quantity of produced sperm with increase in age, Waddel and Smith (2006), Wikipedia (2015), Ananya (2014).

Because of advances in microsurgical techniques, it is now possible to bypass most cases of epididymal obstruction with a high incidence of technical success. Whether or not sperm which have not traversed all the epididymis are capable of fertilization in the human can be ideally studied with this clinical model. In every animal that has been studied, sperm from the capus epididymis are only capable of weak circular motion at most and are not able to fertilize. Sperm from the corpus epididymis can occasionally fertilize, but the pregnancy rate is low. Few of these previous animal studies allowed the sperm time to mature and thereby possibly develop fertilizing capacity. Sperm were simply aspirated from specific regions of the epididymis and then promptly inseminated. In studies where the epididymis was legated to determine if time alone could allow sperm maturation, the obstructed environment was so pathologic that no conclusions could be reached, Sherman and Silber (1989), Hadley et al (2007).

It is yet to be realized through extensive studies whether the factors governing the maturation process of sperm are intrinsic to the sperm themselves and just require time or sperm must transit the whole length of the epididymis. It was entirely possible that aging alone might mature the sperm, and that sperm might not need to pass through all of the epididymis to develop the capacity to fertilize, Cooper et al (2010), Harrison and Weiner (1949).

Although, there are knowledge relating certain variable parameters between human physiological activities, (conception and maturation) to one another but these knowledge though documented in different forms has not been stratified by any mathematical model, so that the behaviourial scenario as a trend will be established and used as prediction of future occurrences. There have been natural and computed tabulations about the relationship between these parameters but to know mathematical models to help for exact answer or behavour of other variable parameters in human physiological activities as one varies. The variable parameters involved are pregnancy rate, total sperm count, cumulative embro score, percentage eggs penetrated, time post-insemination, time foetus growth, weight of foetus and size of foetus. If these relations are connected mathematically, it will help reduce the number of laboratory tests. The most common reason for laboratory semen analysis in humans are as part of a couple's infertility investigation and after a vasectomy to verify that the procedure was successful. It is also commonly used for testing human donors for sperm donation, and for animal semen analysis is commonly used in studying farming and farm animal breeding.
It is important to have a documented relationship between variable parameters in human physiological activities (conception through foetus growth down to maturation). This will serve as firsthand information within what is happening in the interaction between the sperm and ova, foetus growth and maturation. So that certain information can be correlatively obtained correctly without resorting to laboratory test each time in this genetic engineering.
The objective of this study is to mathematically correlate through modeling certain variable parameters and there profile scenario, so that they can be obtained without resorting to series of laboratory tests. These variable parameters are pregnancy rate, total sperm count, cumulative embryo score, percentage eggs penetrated, time post-insemination, time foetus growth, weight of foetus and size of foetus.

This work only covers the mathematical modeling and validation of variable within human physiological activities (conception, foetus growth down to maturation) and nothing else.

2. THEORY OF THE SUBJECT AND MODELING

2.1 Theory of the subject

A semen analysis (plural: semen analyses) evaluates certain characteristics of a males semen and the sperm contained therein. It is done to help evaluate male fertility whether for those seeking pregnancy or verifying the success of vasectomy. Depending on the measurement method, just a few characteristics may be evaluated (such as with a home kit) or many characteristics may be evaluated (generally by a diagnostic laboratory). Collection techniques and precise measurement method may influence results, Jequier (2002), Hadley et al (2007). The most common reasons for laboratory semen analysis in human are as part of a couple's infertility investigation and after vasectomy to verify that the procedure was successful. It is also commonly used for testing human donors for sperm donation and for animals semen analysis is commonly used in stud farming and farm animal breeding, Parmagiani et al (2010), Slama et al (2002).

Occasionally, a man will have a semen analysis done as part of routine pre-pregnancy test. At the laboratory level this is rare, as most healthcare providers will not test the semen and sperm unless specifically requested or there is a strong suspicion of pathology in one of these areas discovered during the medical history or during the physical examination. Such testing is very expensive and time consuming, and in the U.S. is likely to be covered by insurance, WHO (1992), Wylie (2005).

According to Wikipedia (2015), examples of parameters measured in a semen analysis are: sperm count, motility, morphology, volume, fructose level and pH.

Approximate pregnancy rate varies with amount of sperm used in an artificial insemination cycle values are for intrauterine insemination, with sperm number in total sperm count, which may be approximately twice the total motile sperm count, Wikipedia (2015), Saddler (2010). Sperm count, or sperm concentration to avoid confusion with total sperm count, measures the concentration of sperm in a man's ejaculate, distinguished from total sperm count, which is the sperm count multiplied with volume. Over 15 million sperm per milliliter is considered normal, according to WHO (1999). Older definitions state 20 million. A lower sperm count is considered oligozospermia. A vasectomy is considered successful if the sample is azoospermic. Some define success with rare non-motile sperm observed (fewer than 100,000 per milliliter). Others advocate obtaining a second semen analysis to verify that the counts are not increasing (as can happen with re-canalization) and others still may perform a repeat

vasectomy for this situation. The average sperm count today is between 20 -40 million per milliliter in the western world, having decreased by 1-2% per year from substantially higher number, decades ago, Wikipedia (2015).

Chips for home used are emerging that can give an accurate estimation of sperm count after three (3) samples taken on different days. Such a chip may measure the concentration of sperm in a semen sample against a control liquid filled with polystyrene beads, Wikipedia 2015), WHO (1999).

The WHO (1999) has a value of 50% and this must be measured within 60mins of collection. WHO (1999) also has a parameter of vitality, with a lower references limit of 60% live spermatozoa. A man can have a total number of sperm far over the limit of 20 million sperm cells per milliliter, but still have bad quality because too few of the are motile. However, if the sperm count is very high, then a low motility (for example less than 60%) might not matter, because the fraction might still be more than 8 million per milliliter. In the other way round, a man can have a sperm count far less than 20 million sperm cells per milliliter and still have good motility, if more than 60% of those observed sperm cells show good forward movement. Also, sperm cells with tail-tip swelling patterns generally have lower frequency of aneuploidy, Wikipedia (2015), WHO (1992), Johnsen (1970), Dozie et al (2015).

Semen volumes between 1.0ml and 6.5ml are normal, WHO (1999) regards 1.5ml as the lower reference limit. Low volume may indicate partial or complete blockage of the seminal vesicles, or that the man was born without seminal vesicles. In clinical practice, a volume of less than 2ml in the setting of infertility and absent sperm should prompt an evaluation for obstructive azoospermia. A caveat to this is to be sure it has been at least 48hrs since the last ejaculation to time of sample collection, Wikipedia (2015), WHO (1999).

WHO (1992) specifies a normal level of 13µmol per sample. Absence of fructose may indicate a problem with the seminal vesicles.

WHO (1999) criteria specify normal pH value as 7.2-7.8 acidic ejaculate (lower pH value) may indicate one or both of the seminal vesicles are blocked. A basic ejaculate (higher pH value) may indicate an infection. A pH value outside of the normal range is harmful to sperm. The liquefaction is the process when the gel formed by proteins from seminal vesicles is broken up and the semen becomes more liquid. It normally takes 20mins for the sample to change from thick gel into a liquid, Wikipedia (2015), Johnsen (1970), Dozie et al (2015).

MOT is a measure of how many million sperm cells per ml are highly motile, that is approximately of grade a (>25 micrometer per 5sec. at room temperature). Total motile spermatozoa (TMS) or total motile sperm count (TMSC) is a combination of sperm count, motility and volumes, measuring how many million sperm cells in an entire ejaculate are motile (WHO, 1992; Zhu et al, 1996).

Abnormalities (Sadler, 2010; Ye et al, 2006)

- Aspermia: absence of semen
- Azoospermia: absence of sperm
- Hypospermia: low semen volume
- Oligozoospermia: low sperm count
- Asthenozospermia: poor sperm motility
- Teratozoospermia: sperm carry more morphological defects than usual.
- Necrozoospermia: all sperm in the ejaculate are dead.
- Leucospermia: a high level of white blood cells in semen.

2.2 Model Development

The variable parameters between conception and gestation in human physiology will most of the time obey natural biochemical laws.

Sperm count and pregnancy rate

The rate of change of pregnancy is directly proportional to the cumulative sperm count. But just like in biochemical engineering, there will be inhibition to such growth. That is, the rate of change of pregnancy is also proportional to the square of the sperm count, as caused by the inhibition.

If pregnancy rate is Y and cumulative sperm count is X, then

$$\frac{dy}{dx} = ax - bx^2 \qquad (1)$$

The percentage of egg penetrated as a function of post-insemination time will also obey the above equation (1), so will be many functions like pregnancy rate as a function of cumulative embryo score, weight of foetus as a function of time of pregnancy, and, size of foetus as a function of time of pregnancy in foetal growth.

If a = k, and b = kγ then the model will be

$$\frac{dy}{dx} = ky - k\gamma y^2 \qquad (2)$$

with a solution of

$$y = \frac{y_0 e^{kx}}{1-\gamma y_0(1-e^{kx})} \qquad (3)$$

If we differentiate rate of pregnancy (y) with respect to cumulative sperm count (x), we obtain rate of change of pregnancy with respect to sperm count as equation (4) below.

$$\frac{dy}{dx} = p = \frac{ky_0(1-\gamma y_0)e^{kx}}{[1-\gamma y_0(1-e^{kx})]^2} \qquad (4)$$

Which will give the optimum value of sperm count and corresponding optimal value rate of pregnancy. The peak of the model occurs at;

$$Xpk = \frac{1}{K} In \frac{1-\gamma y_0}{\gamma y_0} \qquad (5)$$

These analytical solutions (equations 3, 4, 5) are the operating equations and the independent variable is x while the dependent variable is y.

2.3 Data collection and curve fitting

Data for the validation of these physiological models were obtained from the internet and WHO, as indicated (cited) below.

These data were used in plotting scatter diagrams and the developed model (3) was super-imposed on them using MATLAB 7.9 version package on a laptop to ascertain the goodness of fit of the model, on the test data.

Table 1: Relationship of postoperative sperm count of pregnancy rate (Sherman and Silber, 1989).

Sperm count		Cumulative % pregnancy		Cumulateive% not pregnant
0	0	0	0	0
1×10^6	2	2	1	1
5×10^6	5	7	3	4
10×10^6	11	18	6	10
20×10^6	6	24	6	18
40×10^6	17	41	4	20
50×10^6	32	73	11	31

Table 2: Percentage egg penetration versus time post-insemination (Krutskikh et al, 2012).

Time (min)	0	30	60	90	120	150	180
% egg penetrated	0	0	5	21	57	79	89

Table 3: Sperm per egg versus time post-insemination (Krutskikh et al, 2012)

Time (min)	0	30	60	90	120	150	180
Sperm per egg	0	0	0.20	0.80	2.35	6.00	6.80

Table 4: Pregnancy rate versus cumulative embryo score (Philippe et al, 2001)

Cumulative embryo score	0	1	2	3	4	5	6	7	8
% pregnancy Rate	0	3.75	7	10	12.5	18.75	22.5	25	27.5

Cumulative embryo score	9	10	11	12	13	14	15	16
% pregnancy Rate	30	33.75	36	38.75	33.75	40	42.5	40

Table 5: Averaged sizes of a growing baby during the 38 weeks of pregnancy, from WHO (1999), NICE (2013), Rothmann et al (2013).

Time from conception	Weight in metric	Size in metric
2 weeks		0.1 to 0.2mm
3 weeks		0.2 to 0.5mm
4 weeks		4 to 5mm
5 weeks		5 to 7mm
6 weeks	1.5g	9 to 14mm
7 weeks	2g	17 to 22mm
8 weeks	3g	3.0cm
9 weeks	10g	5.5cm
10 weeks	20g	7.5cm
11 weeks	30g	8.5cm
12 weeks	45g	10.0cm
13 weeks	65g	12.0cm
14 weeks	110g	14.0cm
15 weeks	135g	16.0cm
16 weeks	160g	17.5cm
17 weeks	200g	19.0cm
18 weeks	250g	20.0cm
19 weeks	270g	21.0cm
20 weeks	380g	22.0cm
21 weeks	450g	24.0cm
22 weeks	500g	26.0cm
23 weeks	550g	28.0cm
24 weeks	650g	30.0cm
25 weeks	750g	32.0cm
26 weeks	850g	33.0cm

27 weeks	1000g	34.0cm
28 weeks	1150g	35.0cm
29 weeks	1300g	36.0cm
30 weeks	1500g	37.0cm
31 weeks	1700g	39.0cm
32 weeks	1900g	40.5cm
33 weeks	2100g	42.0cm
34 weeks	2300g	43.0cm
35 weeks	2500g	45.0cm
36 weeks	2700g	46.5cm
37 weeks	2900g	48.0cm
38 weeks	3000g	50.0cm

3. RESULT PRESENTATION AND DISCUSSION

3.1 Result Presentation

The results of the curve-fitting done in the previous section is presented herein from figures 1a and b to 7a and b, and figure 8 with their corresponding Table 6a.

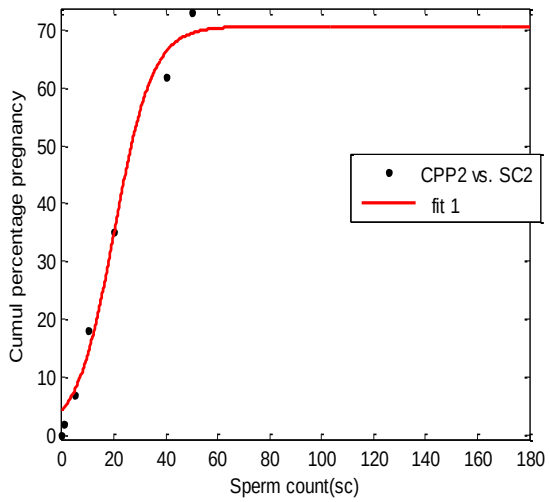

Figure 1a: Cumulative percentage pregnancy versus sperm count in millions

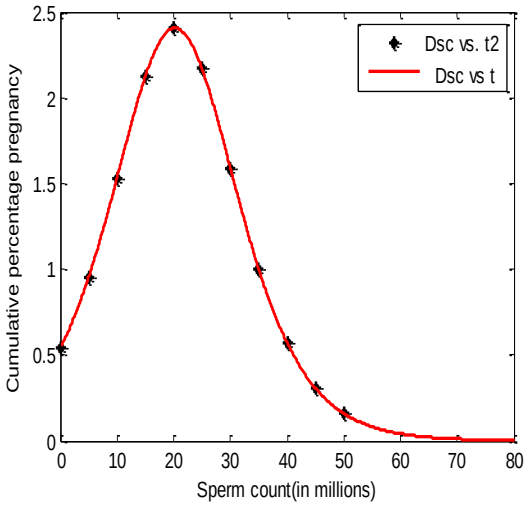

Figure 1b: Cumulative percentage pregnancy per million sperm versus sperm count

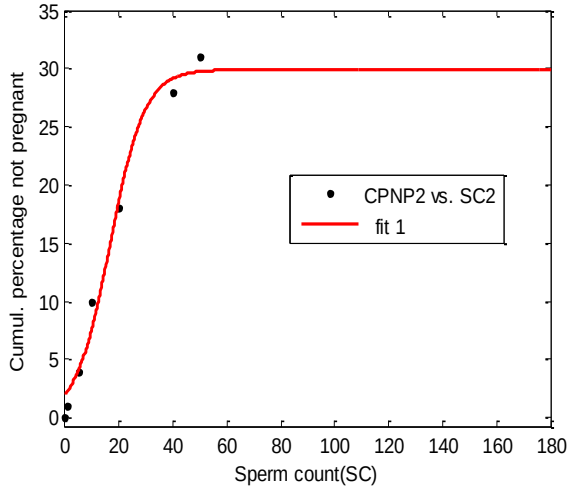

Figure 2a: Cumulative percentage not pregnant versus sperm count in millions.

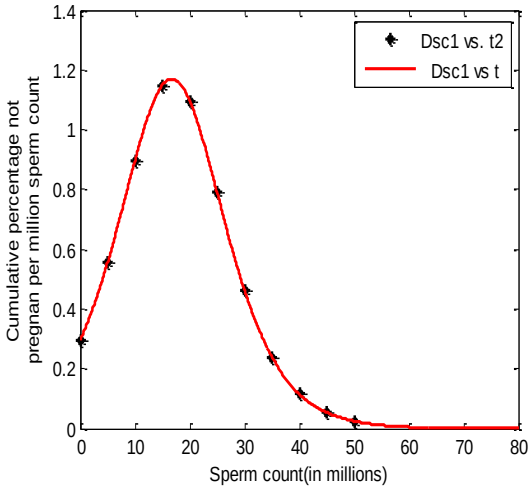

Figure 2b: Cumulative percentage not pregnant per million sperm count versus sperm count.

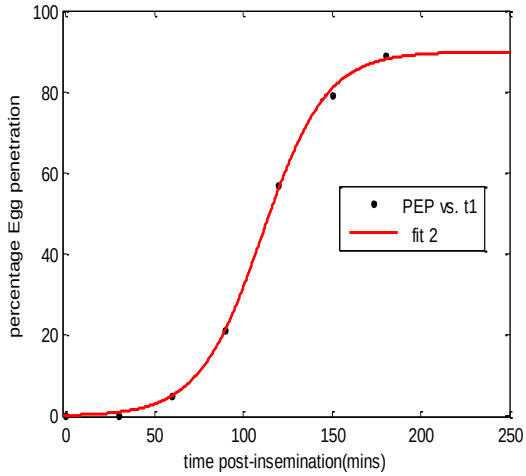

Figure 3a: Percentage egg penetration versus Time post-insemination

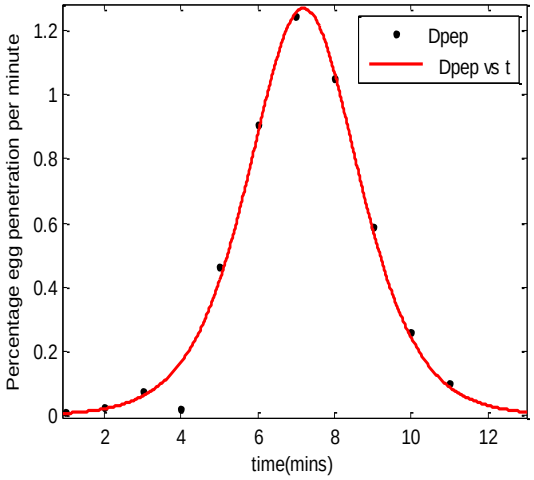

Figure 3b: Percentage egg penetration per minute versus time

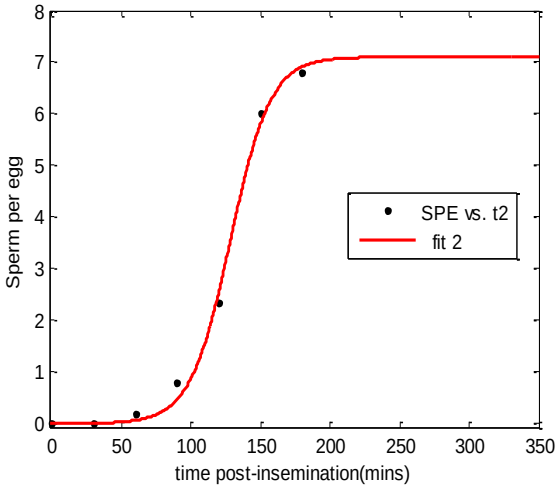

Figure 4a: Sperm percentage egg versus time Post-insemination

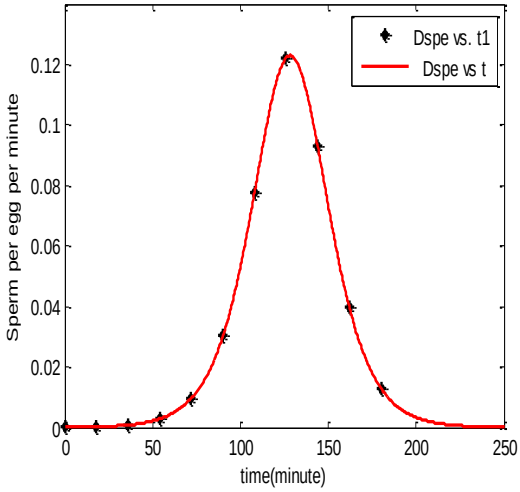

Figure 4b: Sperm percentage egg per minute versus time

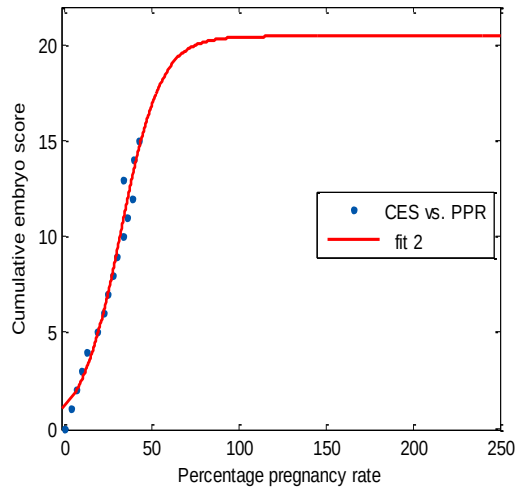

Figure 5a: Cumulative embryo score versus percentage pregnancy rate.

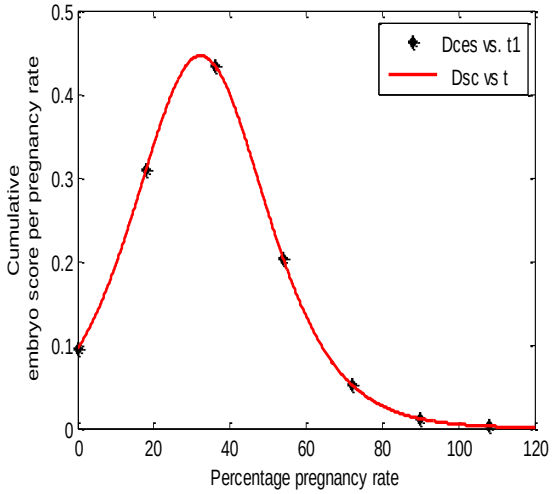

Figure 5b: Cumulative embryo score percentage rate versus percentage pregnancy rate.

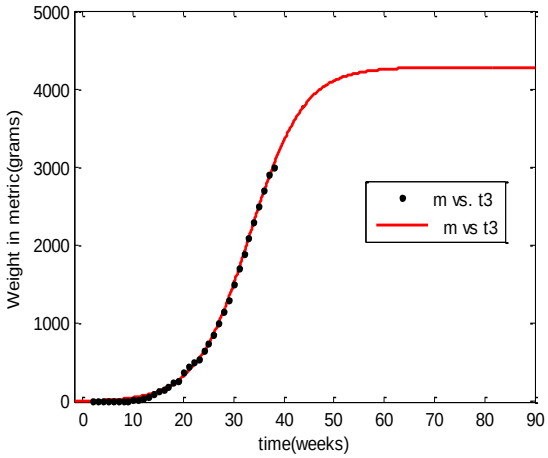

Figure 6a: Weight in metric versus time from conception

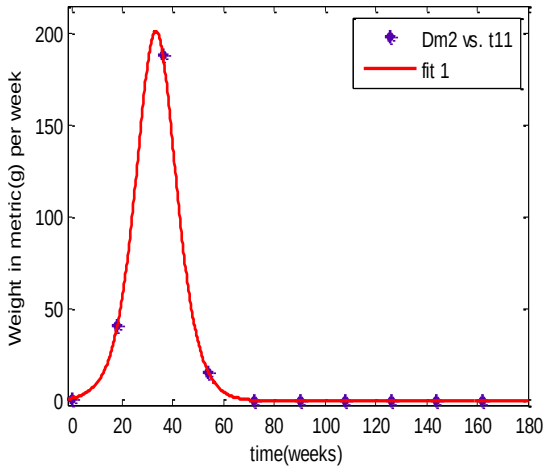

Figure 6b: Weight in metric per week versus time

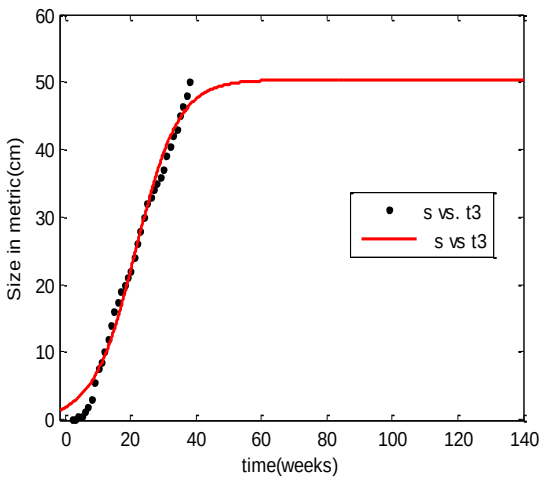

Figure 7a: Size in metric versus time from Conception

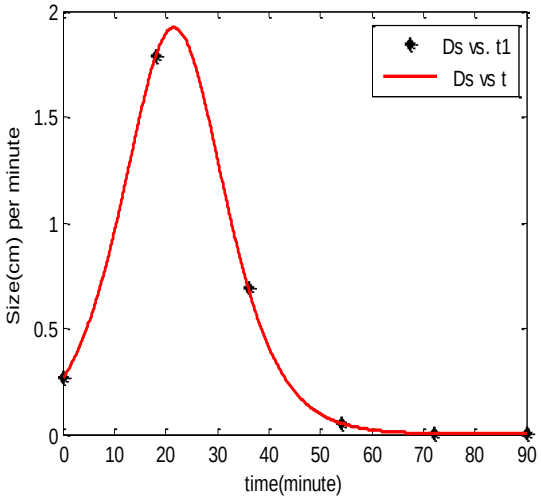

Figure 7b: Size per minute versus time

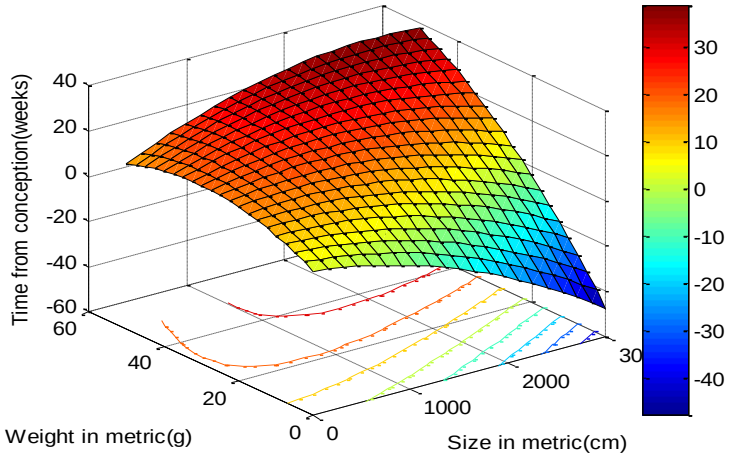

Figure 8: Time from conception versus weight and size of a growing baby

Also looking at bird-like mesh, it is seen that both weight and size interact with time in weeks as the foetus matures.

Table 6: Coefficient and goodness of fit of sperm count versus cumulative percentage pregnancy.

Coefficient with 95% confidence bounds	Goodness of fit
K = 0.1363 γ = 0.01416 y_0 = 4.221 u:f (121.5) = 70.615 Epk:f (20) = 2.405	SSE = 72.13 R^2 = 0.9862 R^2 Adjusted = 0.9793 RMSE = 4.246

Table 7: Coefficient and goodness of fit of sperm count versus cumulative percentage not pregnant.

Coefficient with 95% confidence bounds	Goodness of fit.
K = 0.1564 γ = 0.03343 y_0 = 2.039 u:f (102.8) = 29.9112 Epk:f (16.90) = 1.16947	SSE = 14.47 R^2 = 0.9854 R^2 Adjusted = 0.9778 RMSE = 1.902

Table 8: Coefficient and goodness of fit of percentage egg penetrated versus time.

Coefficient with 95% confidence bounds	Goodness of fit
K = 0.05562 γ = 0.01113 y_0 = 0.1879 u:f (3655) = 89.8276 Epk:f (7.19) = 1.26833	SSE = 5.959 R^2 = 0.9993 R^2 Adjusted = 0.999 RMSE = 1.221

Table 9: Coefficient and goodness of fit of sperm per egg versus time.

Coefficient with 95% confidence bounds	Goodness of fit
K = 0.06927 γ = 0.1408 y_0 = 0.0009797 u:f (344) = 7.10148 Epk:f (130) = 0.12257	SSE = 0.221 R^2 = 00.9957 R^2 Adjusted = 0.9935 RMSE = 0.335

Table 10: Coefficient and goodness of fit of cumulative embryo score versus percentage pregnancy rate.

Coefficient with 95% confidence bounds	Goodness of fit
K = 0.08718 γ = 0.04887 y_0 = 1.159 u:f (175) = 20.4619 Epk:f (32.2) = 0.446007	SSE = 10.34 R^2 = 0.9696 R^2 Adjusted =0.9649 RMSE = 0.892

Table 11: Coefficient and goodness of fit of metric weight (grams) versus time in weeks.

Coefficient with 95% confidence bounds	Goodness of fit
K = 0.188 γ = 0.0002337 y_0 = 8.269 u:f (133) = 4278.09 Epk:f (33.3) = 201.095	SSE = 2.222 x 104 R^2 = 0.9993 R^2 Adjusted = 0.9993 RMSE = 25.56

Table 12: Coefficient and goodness of fit of size in metric (cm) versus time in weeks.

Coefficient with 95% confidence bounds	Goodness of fit
K = 0.1528 γ = 0.01987 y_0 = 1.793 u:f (108.6) = 50.327 Epk:f (21.5) = 1.92205	SSE = 120.9 R^2 = 0.9869 R^2 Adjusted = 0.9861 RMSE = 1.885

3.2 RESULT DISCUSSION

In figure 1a, a plot of cumulative percentage pregnancy versus sperm count in millions were made. Like growth sugmoidal profile, it has an ultimate value of approximately 71 percentage pregnancy in a total of 122 million sperm count. But when optimized (fig 1b), it is seen that 20mil sperm count can make 2.4% pregnancy as optimum (table 6) with an accuracy of 98.62%.

Likewise in figure 2a, a cumulative % not pregnant plot was made, which gave an ultimate of approximate 30 percent not pregnant in a total of 103 million sperm count (fig 2b). The optimization (fig 2b) gave a peak of 1.17% not pregnant in 17 million sperm count (table 7), with an accuracy of 98.14%.

In figure 3a, a cumulative plot of percentage egg penetration was made against post-insemination time. The sigmoidal profile gave an ultimate of approximately 90 percent egg penetration in a total of 365minutes post-insermination time. The optimization (fig 3b) gave 1.27% egg penetration at 7minutes (table 8) with an accuracy of 99.93%.

In figure 4a, cumulative sperm per egg was plotted against post-insermination time. It resulted in an ultimate of 7 sperm per egg in a total of 344mins. On optimization (4b), it yields a small fraction of (0.12%) sperm per egg per minute in 130minutes (table 9) with an accuracy of 99.57%.

In figure 5a, cumulative embryo score was plotted against percentage pregnancy rate in a sigmoidal profile, which gave an ultimate of 20.5 embryo score in a total of 175% pregnancy rate. In fig 5b the optimization gave approximately 0.45 embryo score per pregnancy rate in a total 32% pregnancy rate as optimum, with an accuracy of 96.96% as seen in table 10.

In figure 6a, the cumulative weight of foetus in grams was plotted against time in weeks, it gave an ultimate of 4278g in 113weeks. But on optimization (fig 6b) it was seen to give a weekly 201g in 33weeks with an accuracy of 99.93% as shown in table 11.

Likewise, in figure 7a, the cumulative size in centimeter of the foetus, was plotted against time in weeks to yield an ultimate of 50cm in 109 weeks. But an optimization (fig 7b), 2cm per week was optimum for 22weeks with an accuracy of 98.69% as seen in table 12.

In figure 8, a 3-D response plot of time in weeks versus metric weight in grams, and metric size in centimeter of a foetus, was made. The cursor-contour lines on the floor are curves, showing that weight and size of foetus interact seriously as the foetus matures.

APPENDIX A

$$\frac{dy}{dx} = ky - k\gamma y^2 \qquad (A_1)$$

The solution of the above ODE using bernoulis technique is.

$$y = \frac{y_0\, e^{kx}}{1-\gamma y_0(1-e^{kx})}$$

(A_2)

Taking the first derivative of (A_2) wrt x yields.

$$\frac{dy}{dx} = \frac{[1-\gamma y_0\,(1-e^{kx})]y_0\, ke^{kx} - y_0\, e^{kx}[0-\gamma y_0\,(0-ke^{kx})]}{[1-\gamma y_0(1-e^{kx})]^2}$$

$$= \frac{y_0\, e^{kx}k\{[1-\gamma y_0\,(1-e^{kx})]-[-\gamma\, y_0\,(-e^{kx})]\}}{[1-\gamma y_0(1-e^{kx})]^2}$$

$$= \frac{ky_0\, e^{kx}\{1-\gamma y_0 + \gamma y_0\, e^{kx} - \gamma y_0\, e^{kx}\}}{[1-\gamma y_0(1-e^{kx})]^2}$$

$$\frac{dy}{dx} = \frac{ky_0\, e^{kx}(1-\gamma y_0\,)}{[1-\gamma y_0(1-e^{kx})]^2} = \frac{ky_0\,(1-\gamma y_0\,)e^{kx}}{[1-\gamma y_0(1-e^{kx})]^2}$$

(A_3)

Taking the derivative of (A_3) wrt x and equating to zero yields.

$$\frac{d^2y}{dx^2} = 0 = [1-\gamma y_0(1-e^{kx})]^2 ky_0(1-\gamma y_0\,)ke^{kx} = ky_0(1-\gamma y_0\,)e^{kx}2$$

$$[1-\gamma y_0(1-e^{kx})][0-\gamma y_0\,(0-ke^{kx})]$$

$$[1-\gamma y_0(1-e^{kx})]ky_0(1-\gamma y_0\,)ke^{kx} = 2ky_0(1-\gamma y_0\,)e^{kx}(k\gamma y_0 e^{kx})$$

$$k[1-\gamma y_0(1-e^{kx})] = 2k\gamma y_0 e^{kx}$$

$$1-\gamma y_0 + \gamma y_0 e^{kx} = 2\gamma y_0 e^{kx}$$

$$1-\gamma y_0 = \gamma y_0 e^{kx}$$

$$e^{kx} = \frac{1-\gamma y_0}{\gamma y_0}$$

$$Kx = In\,\frac{1-\gamma y_0}{\gamma y_0}$$

$$Xpk = \frac{1}{K}\,In\,\frac{1-\gamma y_0}{\gamma y_0} \qquad (A_4)$$

4. CONCLUSION

In this work, physiological variation with its variable parameters from conception maturity of a foetus, was modeled using general growth logistic model. Physiological data from

conception to maturity via gestation were obtained through the internet from WHO and research institutions for the validation of the developed models. It was seen that the physiological variable parameters, like the variable parameters of natural growth models, fitted the model very well, with accuracies ranging from 96.96 to 99.93%, which goes to reveal that the physiological activities obey natural growth models. The optimum result obtained are as follows; 20 million sperm count can make 2.4% pregnancy with an accuracy of 98.62%. 17 million sperm count can make 1.12% not pregnant with an accuracy of 98.14%. 1.27% egg penetration is achieved in 7 minutes with an accuracy of 99.93%. An optimum of 0.12 sperm per egg per minute is made in 130 minutes with an accuracy of 99.57%. Also, an optimum value of 0.45 embryo score per pregnancy rate is made with 32% pregnancy with the accuracy of 96.96%. A foetus can weigh 201g per week in 33 weeks with an accuracy of 99.93%. An optimum of 2cm growth for foetus per week for every 22 weeks with 98.69% accuracy. These findings can be applied in so many hospitals, pregnancy care centers and maternities etc, to predict certain variables during physiological activities in humans.

5. RECOMMENDATION

Couples who are having issues with infertility are advised to go for few physiological parameter test and then physiological parameter correlation process because it will reduce the series of tests to pass through and the huge amount of money involved.

REFERENCES

1. Abdullah R. B., Nor A. and Wan-Khadijah W. E. Effects of genotype, frequency of collection and frozen semen. Malaysia J. Animal Sci., 1997; 3: 52-56.
2. Amann R. P. Treatment of sperm to predetermine sex. Theriogenology, 1989; 311: 1-1.
3. Ananya M. Sperm-Male Reproductive Cells, September 8, 2014.
4. Bodnar K. I., Hejel P. and Bodnar E. Preliminary study on the effect of ejaculation frequently on some characteristics of rabbit semen, World Rabbit Congr., 1996; 2: 41-44.
5. Chiou F. and Xiao. Journal on spermatogenesis; origin and morphology, 2013.
6. Cooper T. C., Noonan E., VonEckardsteins. World Health Organization reference values for human semen characteristics, Human Repord. Update., 2010; 16(3): 231-45.
7. Dozie I. N. S., Nwoke B .E. B., Amadi A. N., Chukwuocha U. M., Dozie I. N. U., Ezelota J., Lerum N. I., Chidebelu P. E., Enweani E. O., Faro F. O., Nwabueze I. C. Ebola virus

disease – an emergent public health threat of the late 20th Century. Nigerian Journal of Pure and Applied Science, 2015; 6: 1-13.

8. Hadley, Mac E., Levine, John E. Endorcrinology (6th ed). Upper Saddle River, NJ: Prentice Hall., 2007; 369. ISBN 0-13-187606-6.
9. Harrison R. G., Weiner J. S. Vascular patterns of the mammalian testis and their functional significance". The journal of experimental biology., 1949; 26(3): 304-16, 2pl.
10. Jequier A. M. Is quality assurance in semen analysis still really necessary? A clinician's viewpoint, Human Reprod., 2002; 20: 2039-42.
11. Johnson S. G. Testicular biopsy score count- a method for registration of spermatogenesis in human testes: normal values and results in 335 hypogonadal males, Hormones, 1970; 1: 2-25.
12. Kippley J. The Art of Natural Family Planning (4th addition ed.) Cincinnati, OH: The Couple to couple league., 1996; 306-307. ISBN 0-926412-13-2.
13. Krutskikh A., Poliandri A., Cebrera-Sharp V., Dacheux J. L., Potanen M., Huhtaniemi I. Epididymal protein Rnase 10 is required for post-testicular sperm maturation and male fertility, The FASEB Journal and Research Communication., 2012.
14. NICE (2013). Fertility: assessment and treatment for people with fertility problems. NICE clinical guidance CG156-Issued: February, 2013.
15. Perdrix A., Rivers N. Mortile sperms organelle morphology examination (MSOME) and sperm head vacuoles: state of the art in 2013, Human Reproduction Update., 2013; 19(5): 527-541.
16. Permegiani L., Cognigni G. E., Bernardi S., Trolio E., Ciampeglia W., Filicori M. (2010). Physiologic ICSI: Hyaluronic acid(HA) favors selection of spermatozoa without DNA fragmentation and with normal nucleus, resulting in improvement of embryo quality. Fertil. Steril., 2010; 93: 598-604.
17. Philippe T. M. D., Christophe S., Claude G. M. D., Eric H., Jean-Louis S., Rogers R. M. D. Embryo score is a better predictor of pregnancy than the number of transferred embryos or female eggs, Fertility and sterility, American Society for Reproductive Medicine, Elsevier Science Inc., 2001; 75(3).
18. Rothmann S. A., Bort A. M., Quigley J., Pillow R. Sperm morphology classification; a rational method for schemes adopted by the world health organization, methods in molecular biology (Clifton N. J.)., 2013; 927: 27-37.
19. Sadler T. (2010). Landman's Medical Embryology (11th ed.) Philadelphia: Lippincott William and Wilkins P.30 ISBN 978-0-7817-9069-7.

20. Silber S. J. (1989). Role of epididymis in sperm maturation, sterility-fertility, Urology,1989; 33(1): P.49.
21. Slama R., Eustache F., Ducot B., Jensen T. K., Jorgensen N., Horte A. (2002). Time to pregnancy and semen parameters: a cross-sectional study among fertile couples from four European cities, Human Reprod., 2002; 17: 503-15.
22. WHO. World Health Organization, Lab. Manual for Examination of Human and Sperm-Cervical Mucus Interaction. 3rd edn, Cambridge Univ. Press, Cambridge., 1992.
23. WHO. World Health Organization, Lab. Manual for Examination of Human Semen and Semen-Cervical Mucus Interaction. Cambridge Iniv. Press, Cambridge., 1999; 1-20.
24. Wylie L. Essential anatomy and physiology in maternity care (Second edition) Edhninburgh: Churchill Livingstone., 2005; P.172 ISBN 9780443100413.
25. Xiao X., Mruk D. D., Cheng C. Y. "Intracellular adhesion molecules (ICAMs) and spermatogenesis". Human Reproduction Update., 2013; 19(2): 167-86.
26. Ye H., Huang G. N., Gao Y., Liu D. Y. Relationship between human sperm-hyaluronan binding assay and fertilization rate in conventional in vitro fertilization. Human Reprod., 2006; 21: 1545-50.
27. Zhu J., Tsirigotis M., Craft I. In vitro maturation of testicular spermatozoa, Human Reprod., 1996; 11: 231-232.