


Modelling of Pre-Sex Selection: An Effective Method for Family Planning and Control of Overpopulation

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Abstract

Every couple would want to have balanced sex of babies and a given number of children. But in reality, most couples do not achieve it. Some end up bearing particular sex of baby, this has caused a lot of pressure and untold hardship for couples. In Nigeria, the preference for a son is so strong that any family that does not have a son does not belong. The reason for the preference is mainly for economic and continuation of family lineage. Inability to bear the desired sex of a baby makes couples bear more children than they could cater for. This has caused poverty, overpopulation and reduces life expectancy for many families in Nigeria. In this paper, we have developed a model that will help couples select the desired sex of their babies and avoid unwanted pregnancies. The method is easy to apply whether educated or not. The application of the method will help to reduce family-based violence due to imbalanced sex of babies.

Keywords

Sex Determination, Ovulation, Safe Period, Interval Estimator, Dispersion Matrix

1. Introduction

In many developing countries, especially Nigeria, there is preference for male over female children. Non-bearing of male child on time or no bearing at all leads to large family size that the couples may not be able to adequately cater for. This leads to poverty, overpopulation, low life expectancy. Every family would

like to have at least one male child, not because males care for their parents more but for economic purposes and to have a male that will continue the family (generation) when the parents have died. But it is on record that females care more for their parents. So many families are in disarray because they have no son. Some men who could have been content with one wife become polygamous because the first wife did not bear a son. Some have divorced because of the same reason. Families that have balanced children are happier than the ones that have single sex children. For this reason; we explore all available knowledge to save families from this trauma that breaks homes.

Preference for male child is not only in Nigeria. Sex selection in China is largely dependent on fetal abortion and most of the aborted fetuses are females. The sex of the baby is determined through ultrasound and once it is a female child, especially at the second birth, the couple aborts the fetus. If a female child is conceived at the first birth, it will not be aborted because the couples still have chances of giving birth to a boy child. The reason is that there is a preference for male child to the female child [1]. This is not the kind of sex pre-selection we are emphasizing on here. We discourage abortion in its entirety as a means of selecting the desired sex of a baby. We are also not interested in the use of ultrasound for sex selection because before it detects the sex of a baby, the baby has already formed and in this case it is no longer pre-sex selection but can be referred to as post-sex selection. The sex of a baby is determined at the time of fertilization. At fertilization, there is a one-to-one chance of a boy or a girl (that is, equal chances of having either a boy or a girl) [2].

It was observed that the vagina, cervix, and fallopian tubes undergo some changes in response to cyclical changes in levels of circulating ovarian hormones (estrogens and progesterone). Under the effect of estrogens, the cervical mucus turns from a thick, scant, highly viscous material in the pre-ovulation phase to a clear, watery, and abundant discharge that possesses the typical characteristic of being stretchy without breaking immediately before and after ovulation [3] [4]. This author [5] found that statistically significant changes in the sex ratio were related to the time of insemination within the menstrual cycle. The author opined that the study relates insemination to the shift in basal body temperature (BBT) as the indicator of ovulation rather than the usual day 14 of the menstrual cycle because BBT has been shown to be more reliable indicator of ovulation than day 14 of menstrual cycle. The author observes that it seems that ovulation occurs the day before the beginning of the rise in BBT, although there is some fluctuation around that point. He noted that the day of rising in BBT was determined by drawing a line above the pre-ovulation temperatures, excluding those abnormally high temperatures that may have been due to unusual circumstances. The day the temperature rose and stayed above the line was considered the day of the shift, or day 0. Any single insemination taking place in the period from four days before the shift (day -4) to two days after (day +2) was considered responsible for pregnancy. The majority of authors agree that the human ovum lives at most

24 hours after being released from the ovary. The rhythm method of family planning in which intercourse is limited to the post-ovulation period has been shown to be highly effective. Selecting two days after the thermal shift as the limit of the fertile period will well cover every eventuality. Designating the beginning of the fertile period as four days before the shift in BBT may appear in conflict with the currently held view that spermatozoa are only capable of fertilization for 24 hours. Again, it was observed that the environment of the cervix could either be acidic or alkaline. The author was of the opinion that if the hypothesis that alkalinity favors Y-bearing sperm is correct, the increasing alkalinity of the cervix as the thermal shift is approached could explain the rising proportion of males conceived when the semen is artificially deposited there. Similarly, the increasing acidity of the vagina as the thermal shift is approached could explain the declining proportion of males conceived at this time with natural insemination, since during intercourse the semen is exposed to the vaginal environment.

But *in vitro* studies have failed to demonstrate any differential action of different pH concentrations of Tyroides solution on the proportion of X and Y sperm, see [6]. Other researchers [7] reported that Y sperm migrate faster than X sperm in the cervical mucus. In a similar study, it was reported that Y-bearing sperm are actively concentrated in a medium containing Bovine-Serum Albumin in different concentrations [8]. These findings support the hypothesis that a factor present in the female environment may cause a differential effect on the population of spermatozoa. Another important study [9] observed that there is an exceedingly large amount of evidence that human males aggress more than females in a wide variety of situations. Sex differences in aggression represent the manifestation of biological causation. Generally speaking, the author substantiated some existing evidence to the effect that males are more aggressive than females beyond childhood. This aggressiveness stems from sex chromosome. The Y chromosomes are always faster in movement and short-lived than the X chromosomes.

In this paper, we have developed an estimator that determines the female fertile days: from where we determine; the day for male conception, the day for female conception and the safe period to avoid conception. We developed multivariate analysis model for the problem and test the hypothesis for the developed estimator. We stated and proof proposition backing the estimator and finally make inference about the determination of sex of a baby. The paper is divided into five sections. Section one above gives the general introduction of the work. Section two is devoted to literature review. Section three takes care of materials and methods. Section four takes care of data presentation and analysis while section five treats results and discussions.

2. Literature Review

The hallmark of conception is at the period of ovulation; some researchers [10] used Bayesian model to detect ovulation in women. They observed that the hormonal changes leading to the occurrence of ovulation are the same for most nor-

mally menstruating women. But before ovulation, the plasma estrogen concentrations are known by relatively low constant levels followed by a gradual rise to a peak that occurs one to three days prior to ovulation. The rise in estrogen induces a cycle surge of luteinizing hormone (LH) to a peak, with ovulation following this. Ovulation, in turn, is followed closely by a sharp rise in plasma progesterone. The jump in progesterone causes an increase in basal body temperature (BBT) to a higher level. Hence, the prediction and detection of ovulation can be accomplished by the detection of the change-points in estrogen and BBT. The main goal here is to detect the change-point as quickly as possible so that the problem is essentially sequential in nature, which is primarily the concern of their work. The authors were of opinion that their work was successful when applied to predict and detect ovulation in women. However, if the problem is concerned with detecting the change-point for estrogen and BBT during the next cycle of a woman randomly chosen from the population of normally menstruating women, a Bayesian approach is applicable. Also, this group of researchers [11] observed that longitudinal epidemiologic studies of menstrual and reproductive function are more informative if one can identify day of ovulation. They initially developed a method which relied on the relative concentrations of estrogen and progesterone metabolites in daily first-morning urine specimens. They describe the application of the method to a large number of menstrual cycles of women. Ovulation provides a biomarker of ovarian function. The clinical practice of using the peak concentration of plasma luteinizing hormone (LH) as a marker of ovulation requires daily blood collection and it is impractical for field studies. On the other hand, daily first-morning urine collection is feasible, and urinary estrogen and progesterone metabolites provide an excellent profile of ovarian changes during the menstrual cycle. Their method was based on the ratio of urinary estrogen and progesterone metabolites. From application, they demonstrated that the estimated day was in agreement with the day of peak urinary (LH). The method estimated a credible day of ovulation in 88% of cycles including missing values.

Another researcher [12] observed that 87 percent of conceptions occurring on the presumed day of ovulation or the day before were males, whereas 85 percent of conceptions occurring three or more days before the presumed day of ovulation were females. He claimed that the women he studied were "nearly regular" in their menstrual cycles. His approach was that he subtracted 14 from the expected day of menstruation to determine the day of ovulation; however, since ovulation may easily fluctuate by some days in either direction, his method is not reliable for pinpointing the day of ovulation. But these researchers [13] claimed that natural insemination on the day before the temperature shift will increase the probability of a male birth. Furthermore, this researcher [14] used the day of maximal cervical mucorrhea as an indicator of ovulation and noted no significant difference in the sex ratio within the menstrual cycle. In many countries, there is strong preference for sons [15]. These countries include the many coun-

tries in Africa and Middle East, Jordan and Syria while there is moderate preference for sons in Egypt, Morocco, Algeria, Tunisia and Lebanon. The author was of the opinion that this preference for sons could be related to economic advantage and social prestige of male children. In contrast, in western countries, such as United States, evidence shows a preference for a balanced sex composition, rather than a preference for one sex over the other. The author observed that one important issue concerning sex preferences is that, in developing countries with high fertility, strong son preference is one of several factors that could hold back the decline in fertility. Thus, because of traditional attitudes toward son preference, high levels of fertility may continue some time after socioeconomic conditions make lower fertility more desirable.

3. Materials and Methods

In this paper, we adopt median interval approach to determine the time of ovulation. The earlier study which centered on day 14 of menstrual cycle as ovulation day was deceptive because the menstrual length differs from one woman to the other. Some women have short and others have long menstrual cycle. But from theoretical and empirical studies, it was observed that ovulation takes place approximately two weeks from the start of the menstrual cycle. Hence, a woman with 28 days menstrual cycle is expected to ovulate on the 14th day of her menstrual cycle. Note that 14th day of menstrual cycle is not the same as 14th day of the month. This implies that the median of the menstrual cycle with length 28 days is 14th day. Since it is not certain that ovulation will occur exactly at the median but could vary because of some changes in the body, we develop a median interval estimate with 95% confidence that ovulation will occur within a given period. This period is divided into the lower and upper bound (L,U). The lower bound is used for the selection of female child and the upper bound if used for the selection of the male child. The idea is that the deposition of sperm days before the release of ovum (ova) will result to female child and the deposition of sperm close and after the release of ovum (ova) will result to male child. From the literatures in this field, it was known that Y-carrying chromosome is faster and have shorter life span than the X-carrying chromosome. If the sperm is deposited some days earlier in the female genitals before the release of the ovum (ova), the tendency is that the Y-carrying sperms must have died or become inactive to fertilize the ovum (ova), while the X-carrying sperm which are slower with longer life span will then fertilize the ovum (ova). Hence, if Y-carrying sperm first meet the egg (ovum) that has a constant X, we have XY, which will develop to a male child. But if X-carrying sperm first meet the egg, we have XX, which will develop to a female child. From the study of the natural method of family planning, it was observed that menstrual cycle and ovulation timing determines the sex of a baby. Our method is so easy and does not require education. Anybody, whether educated or not can apply it successfully and obtain the desired result. All that is required is to chart the menstrual cycle for at least three

consecutive time (months) and determine the cycle length. We demonstrate this simple method here for easy understanding.

3.1. Method/Source of Data Collection

The type of data suitable for this kind of research is a secondary data because we want to deal with reality. We collected menstrual cycle charts of some selected women over a period of six months.

3.2. Method of Data Analysis

We developed a median interval estimator for the study. Our interest is to estimate the exact day of ovulation and if that is determined, then we can be sure that conception will take place at that day. From the motility of spermatozoa, we have stated that Y-carrying sperm moves faster but dies shortly, while the X-carrying sperm is sluggish and last longer. The problem now is to pin-point the day the ovum is released. Since we cannot be 100% sure of the day of ovulation due to variation in the human body, we need an estimator that will detect up to 95% the day of ovulation. Hence we constructed a median interval estimator at 5% level of significance. This gives us 95% confidence that ovulation will occur within the period. This period was divided into two regions, the lower and upper region (bound).

We also developed multivariate analysis model for the problem, since each individual's menstrual cycles (samples) was collected for six variables (months). Each of the samples has six characteristics (variates) that need to be analyzed at the same time and their effects compared simultaneously; therefore, multivariate analysis provides the best model for such a problem. The multivariate analysis here is basically for inference, while the median interval estimator is the statistic to be tested. We determined the Hotelling's T^2 statistic; Mahalanobi's D^2 statistic and F-distribution for the problem. We test the null hypothesis that there are no significant differences among the median of the respective months and between the median of the first and the second samples (that is, ovulation occurs at the median of the menstrual cycle) against the alternative hypothesis which states the contrary (that is, ovulation occur close to the median). As we have stated, some circumstances due deviate ovulation from the centre; therefore, it can occur at the median (centre) or near the median, hence the need for interval estimator. An estimator is a statistic or a random variable that is used to determine the location of a parameter [16]. The test statistics are stated bellow as follows:

$$T^2 = \frac{n_1 n_2}{n_1 + n_2} D^2 \quad (1)$$

where T^2 is the Hotelling's T^2 distribution; n_1 is the sample data from the first sample; n_2 is the sample data from the second sample respectively, and D^2 is the Mahalanobi's D^2 statistic. Since the samples are from normal population, the mean and median coincides; hence, we can use both interchangeably.

$$D^2 = (\bar{X}_1 - \bar{X}_2)^T S^{-1} (\bar{X}_1 - \bar{X}_2) \quad (2)$$

where $(\bar{X}_1 - \bar{X}_2)^T$ is the difference in the mean vector of the sample mean vectors; the superscript T denote the transpose of the difference in mean vectors; and S^{-1} denote the inverse of dispersion matrix [17].

$$F_{cal} = \frac{(n_1 + n_2 - p - 1)}{p(n_1 + n_2 - 2)} \cdot T^2 \quad (3)$$

where F_{cal} denote F-calculated and p denote the parameters being estimated.

$$F_{tab} = F(\alpha); p, (n_1 + n_2 - p - 1) \quad (4)$$

where F_{tab} denotes F-tabulated, this is the value of F as it is stated in the standard F statistical tables and (α) denotes the level of significance under which we make our inference. "VS" denotes versus. In this study, we test the hypothesis at 5% level of significance.

We determine the correlation between different menstrual cycles and make our inference.

In trying to achieve the above, we state some hypothesis that should be tested as follows:

1) Hypothesis:

Ho: $\mu_1 = \mu_2$ VS H_1 : $\mu_1 \neq \mu_2$.

Ho: denote the null hypothesis which states that the (mean) median vector of sample 1 is the same as sample 2, this implies that ovulation occur at the median of menstrual cycle of every healthy woman in each sample, while H_1 : stand for the alternative hypothesis which states the contrary (that is, the ovulation occurs close to the median).

2) Decision rule:

Accept Ho: if $F_{cal} < F_{tab}$ and reject if otherwise.

The above statement means that if the calculated value of F-distribution is less than the tabulated value of the F-distribution, we shall accept the null hypothesis (Ho:) and if the contrary, we accept the alternative hypothesis (H_1 :) at 5% level of significance.

3) Conclusion:

Since $F_{cal} > F_{tab}$ ($F_{cal} < F_{tab}$), we reject Ho (accept Ho) and conclude that ovulation occurs close to the median (at the median). That is, there is significant difference between the two sample mean (median) vectors when ovulation occurs close to the median and there is no significant difference between the two sample mean (median) when ovulation occur at the median.

3.3. Proposition

Conception of male child occurs at the upper bound (U) and conception of the female child occurs at the lower bound (L) and the boundary between L and U are the fertile days. Within this interval, a woman will see some signs that tell her that she is fertile and can conceive should she have unprotected sexual inter-

course.

$$\left(\frac{n+1}{2} - K \leq \theta \leq \frac{n+1}{2} + K \right) = (L \leq \theta \leq U)$$

Proof:

Since we are not certain that the point estimator (median) will coincide with the population parameter (the exact day of ovulation), we replace it with interval estimator, that is, with the intervals for which we can assert with a reasonable degree of certainty that they will contain the parameter (the day of ovulation) under consideration.

Suppose that we have a large random sample, $n \geq 30$, from a population with the unknown mean μ and unknown variance σ^2 , where n is the sample size.

Then we have

$$\Pr \left(-Z_{\alpha/2} < \frac{\bar{x} - \mu}{\frac{\sigma}{\sqrt{n}}} < Z_{\alpha/2} \right) = 1 - \alpha$$

$$\Pr \left(-Z_{\alpha/2} * \frac{\sigma}{\sqrt{n}} < \bar{x} - \mu < Z_{\alpha/2} * \frac{\sigma}{\sqrt{n}} \right) = 1 - \alpha$$

$$\Pr \left(\mu - Z_{\alpha/2} * \frac{\sigma}{\sqrt{n}} < \bar{x} < \mu + Z_{\alpha/2} * \frac{\sigma}{\sqrt{n}} \right) = 1 - \alpha$$

We estimate the population standard deviation, σ , with the sample standard deviation, S , and let $\theta = \bar{x}$. Since our point estimator is the median, we have

$$\Pr \left(\frac{n+1}{2} - Z_{\alpha/2} * \frac{S}{\sqrt{n}} < \theta < \frac{n+1}{2} + Z_{\alpha/2} * \frac{S}{\sqrt{n}} \right) = 1 - \alpha \quad (5)$$

Equation (5) is the 95% confidence interval for θ that ovulation lies between the period (L, U) . Where Pr stand for probability; $\frac{n+1}{2}$ stand for the median; $Z_{\alpha/2}$ stand for Z-value for two tail test from the standard normal distribution; θ stand for ovulation day; $\frac{n+1}{2} - Z_{\alpha/2} * \frac{S}{\sqrt{n}}$ stand for lower bound (L); $\frac{n+1}{2} + Z_{\alpha/2} * \frac{S}{\sqrt{n}}$ stand for upper bound (U) and $1 - \alpha$ stand for confidence interval.

4. Data Presentation and Analysis

4.1. Data Presentation

The raw data for this work are presented in Appendix 1 and 2 respectively. In **Table 1**, we present the raw data from Appendix 1, where the serial numbers (S/N) represent the cycle days, the total number of the cycle days is the cycle length and X_1, \dots, X_6 represent months. Similarly, in **Table 2**, we present the raw data from Appendix 2.

Table 1. Six months menstrual cycle from an individual (1).

S/N	Sample 1 (n_1)					
	X_1	X_2	X_3	X_4	X_5	X_6
1	24	24	25	26	28	28
2	25	25	26	27	29	29
3	26	26	27	28	30	30
4	27	27	28	1	31	1
5	28	28	29	2	1	2
6	29	29	30	3	2	3
7	30	30	31	4	3	4
8	1	31	1	5	4	5
9	2	1	2	6	5	6
10	3	2	3	7	6	7
11	4	3	4	8	7	8
12	5	4	5	9	8	9
13	6	5	6	10	9	10
14	7	6	7	11	10	11
15	8	7	8	12	11	12
16	9	8	9	13	12	13
17	10	9	10	14	13	14
18	11	10	11	15	14	15
19	12	11	12	16	15	16
20	13	12	13	17	16	17
21	14	13	14	18	17	18
22	15	14	15	19	18	19
23	16	15	16	20	19	20
24	17	16	17	21	20	21
25	18	17	18	22	21	22
26	19	18	19	23	22	23
27	20	19	20	24	23	24
28	21	20	21	25	24	25
29	22	21	22	26	25	26
30	23	22	23	27	26	27
31	24	23	24	28	27	28
32		24	25		28	
33		25	26			

Table 2. Six months menstrual cycle from an individual (2).

S/N	Sample 2 (n_2)					
	X_1	X_2	X_3	X_4	X_5	X_6
1	2	3	1	1	28	27
2	3	4	2	2	29	28
3	4	5	3	3	30	29
4	5	6	4	4	1	30
5	6	7	5	5	2	31
6	7	8	6	6	3	1
7	8	9	7	7	4	2
8	9	10	8	8	5	3
9	10	11	9	9	6	4
10	11	12	10	10	7	5
11	12	13	11	11	8	6
12	13	14	12	12	9	7
13	14	15	13	13	10	8
14	15	16	14	14	11	9
15	16	17	15	15	12	10
16	17	18	16	16	13	11
17	18	19	17	17	14	12
18	19	20	18	18	15	13
19	20	21	19	19	16	14
20	21	22	20	20	17	15
21	22	23	21	21	18	16
22	23	24	22	22	19	17
23	24	25	23	23	20	18
24	25	26	24	24	21	19
25	26	27	25	25	22	20
26	27	28	26	26	23	21
27	28	29	27	27	24	22
28	29	30	28	28	25	23
29	30	31	29		26	24
30	1	1	30		27	
31	2		1			
32	3					

4.2. Data Analysis

Layout of dispersion matrix for individual samples

$$(n_i - 1)S_i^2 = \begin{bmatrix} X_{11} & X_{12} & X_{13} & X_{14} & X_{15} & X_{16} \\ X_{21} & X_{22} & X_{23} & X_{24} & X_{25} & X_{26} \\ X_{31} & X_{32} & X_{33} & X_{34} & X_{35} & X_{36} \\ X_{41} & X_{42} & X_{43} & X_{44} & X_{45} & X_{46} \\ X_{51} & X_{52} & X_{53} & X_{54} & X_{55} & X_{56} \\ X_{61} & X_{62} & X_{63} & X_{64} & X_{65} & X_{66} \end{bmatrix}$$

where the variances are:

$$X_{11} = \sum_1^{31} X_1^2 - n\bar{X}_1^2; \quad X_{22} = \sum_1^{33} X_2^2 - n\bar{X}_2^2; \quad X_{33} = \sum_1^{33} X_3^2 - n\bar{X}_3^2;$$

$$X_{44} = \sum_1^{31} X_4^2 - n\bar{X}_4^2; \quad X_{55} = \sum_1^{32} X_5^2 - n\bar{X}_5^2; \quad X_{66} = \sum_1^{31} X_6^2 - n\bar{X}_6^2$$

and covariance are:

$$X_{12} = \sum_{X_1=1}^{31} \sum_{X_2=1}^{33} X_1 X_2 - n\bar{X}_1 \bar{X}_2; \quad X_{13} = \sum_{X_1=1}^{31} \sum_{X_3=1}^{33} X_1 X_3 - n\bar{X}_1 \bar{X}_3;$$

$$X_{14} = \sum_{X_1=1}^{31} \sum_{X_4=1}^{31} X_1 X_4 - n\bar{X}_1 \bar{X}_4; \quad X_{15} = \sum_{X_1=1}^{31} \sum_{X_5=1}^{32} X_1 X_5 - n\bar{X}_1 \bar{X}_5;$$

$$X_{16} = \sum_{X_1=1}^{31} \sum_{X_6=1}^{31} X_1 X_6 - n\bar{X}_1 \bar{X}_6; \quad X_{23} = \sum_{X_2=1}^{33} \sum_{X_3=1}^{33} X_2 X_3 - n\bar{X}_2 \bar{X}_3;$$

$$X_{24} = \sum_{X_2=1}^{33} \sum_{X_4=1}^{31} X_2 X_4 - n\bar{X}_2 \bar{X}_4; \quad X_{25} = \sum_{X_2=1}^{33} \sum_{X_5=1}^{32} X_2 X_5 - n\bar{X}_2 \bar{X}_5;$$

$$X_{26} = \sum_{X_2=1}^{33} \sum_{X_6=1}^{31} X_2 X_6 - n\bar{X}_2 \bar{X}_6; \quad X_{34} = \sum_{X_3=1}^{33} \sum_{X_4=1}^{31} X_3 X_4 - n\bar{X}_3 \bar{X}_4;$$

$$X_{35} = \sum_{X_3=1}^{33} \sum_{X_5=1}^{32} X_3 X_5 - n\bar{X}_3 \bar{X}_5; \quad X_{36} = \sum_{X_3=1}^{33} \sum_{X_6=1}^{31} X_3 X_6 - n\bar{X}_3 \bar{X}_6;$$

$$X_{45} = \sum_{X_4=1}^{31} \sum_{X_5=1}^{32} X_4 X_5 - n\bar{X}_4 \bar{X}_5; \quad X_{46} = \sum_{X_4=1}^{31} \sum_{X_6=1}^{31} X_4 X_6 - n\bar{X}_4 \bar{X}_6;$$

$$X_{56} = \sum_{X_5=1}^{32} \sum_{X_6=1}^{31} X_5 X_6 - n\bar{X}_5 \bar{X}_6$$

and symmetric entries of the matrix are

$$X_{21} = X_{12}; \quad X_{31} = X_{13}; \quad X_{32} = X_{23}; \quad X_{41} = X_{14}; \quad X_{42} = X_{24};$$

$$X_{43} = X_{34}; \quad X_{51} = X_{15}; \quad X_{52} = X_{25}; \quad X_{53} = X_{35}; \quad X_{54} = X_{45};$$

$$X_{61} = X_{16}; \quad X_{62} = X_{26}; \quad X_{63} = X_{36}; \quad X_{64} = X_{46}; \quad X_{65} = X_{56}.$$

Mean vectors from the first and second samples (n_1 and n_2) are:

$$\bar{X}^{(1)} = \begin{bmatrix} \bar{X}_1 \\ \bar{X}_2 \\ \bar{X}_3 \\ \bar{X}_4 \\ \bar{X}_5 \\ \bar{X}_6 \end{bmatrix} = \begin{bmatrix} 15.7742 \\ 16.5152 \\ 16.5758 \\ 15.7097 \\ 16.3750 \\ 15.9032 \end{bmatrix}$$

$$\bar{X}^{(2)} = \begin{bmatrix} \bar{X}_1 \\ \bar{X}_2 \\ \bar{X}_3 \\ \bar{X}_4 \\ \bar{X}_5 \\ \bar{X}_6 \end{bmatrix} = \begin{bmatrix} 14.6875 \\ 16.4667 \\ 15.0323 \\ 14.5000 \\ 15.5000 \\ 15.3448 \end{bmatrix}$$

$$\bar{X}^{(1)} - \bar{X}^{(2)} = \begin{bmatrix} 1.0867 \\ 0.0485 \\ 1.5435 \\ 1.2097 \\ 0.8750 \\ 0.5584 \end{bmatrix}$$

The dispersion (variance-covariance) matrix from the first sample (n_1) is:

$$(n_1 - 1)S_1^2 = \begin{bmatrix} 2317.4131 & -7305.0926 & -6786.0395 & -5714.0465 & -5595.5295 & -4819.6680 \\ & 2616.1896 & -7941.8375 & -6723.3628 & -6686.1830 & -5808.6249 \\ & & 2650.0142 & -7298.8270 & -7263.4336 & -6384.4644 \\ & & & 2252.3651 & -7092.2596 & -6268.8695 \\ & & & & 2619.5000 & -7186.0694 \\ & & & & & 2398.7351 \end{bmatrix}$$

The dispersion (variance-covariance) matrix from the second sample (n_2) is:

$$(n_2 - 1)S_2^2 = \begin{bmatrix} 2564.8750 & -6533.4943 & -5524.7876 & -4553.0625 & -4756.3438 & -4353.3676 \\ & 2277.4337 & -6773.1315 & -5559.2474 & -5827.0155 & -5179.0074 \\ & & 2450.9287 & -5558.0663 & -5769.5198 & -5138.0291 \\ & & & 1827.0000 & -5644.7500 & -5052.2386 \\ & & & & 2247.5000 & -6106.4098 \\ & & & & & 2286.5763 \end{bmatrix}$$

The pooled sample is:

$$(n_1 + n_2 - 2)S = \begin{bmatrix} 4882.2881 & -13838.5869 & -12310.8271 & -10267.1090 & -10351.8733 & -9173.0356 \\ & 4893.6233 & -9714.9690 & -12282.6102 & -12513.1985 & -10987.6323 \\ & & 5100.9429 & -12856.8933 & -13032.9534 & -11522.4935 \\ & & & 4079.3651 & -12737.0096 & -11321.1081 \\ & & & & 4867 & -13292.4792 \\ & & & & & 4685.3114 \end{bmatrix}$$

The dispersion (variance-covariance) matrix for the two samples is:

$$S = \begin{bmatrix} 81.3715 & -230.6431 & -205.1805 & -171.1185 & -172.5312 & -152.8839 \\ & 81.5604 & -161.9162 & -204.7102 & -208.5533 & -183.1272 \\ & & 85.0157 & -214.2816 & -217.2159 & -192.0416 \\ & & & 72.9894 & -212.2835 & -188.6851 \\ & & & & 81.1167 & -221.5413 \\ & & & & & 78.0885 \end{bmatrix}$$

The inverse of the dispersion matrix is:

$$S^{-1} = \begin{bmatrix} 0.003312 & -0.00017 & -0.00063 & -0.00104 & -0.00114 & -0.00122 \\ & 0.002928 & -0.00124 & -0.00081 & -0.00087 & -0.00095 \\ & & 0.002814 & -0.00064 & -0.00069 & -0.00074 \\ & & & 0.002841 & -0.00076 & -0.0008 \\ & & & & 0.002598 & -0.00045 \\ & & & & & 0.003172 \end{bmatrix}$$

The Hotelling's T^2 statistic is:

$$T^2 = \frac{n_1 n_2}{n_1 + n_2} (\bar{x}^{(1)} - \bar{x}^{(2)})^T S^{-1} (\bar{x}^{(1)} - \bar{x}^{(2)})$$

$$T^2 = \frac{32 \times 30}{62} (42.52789) = 658.4964$$

The calculated F statistic is:

$$F_{cal} = \frac{n_1 + n_2 - p - 1}{p(n_1 + n_2 - 2)} \cdot T^2$$

$$F_{cal} = \frac{32 + 30 - 6 - 1}{6(32 + 30 - 2)} \times 42.52789 = 6.4973$$

The Tabulated F statistic at 5% level of significance is:

$$F_{tab} = F_{6,60}(0.05) = F_{6,60}(0.05) = 2.2500$$

1) Hypothesis

Ho: $\bar{X}_{n1} = \bar{X}_{n2}$ Vs H_1 : $\bar{X}_{n1} \neq \bar{X}_{n2}$.

2) Conclusion

Since $F_{cal} > F_{tab}$ ($6.4973 > 2.2500$), we reject Ho: and accept H_1 ; and conclude at 5% level of significance or with 95% confidence that ovulation occur close to the median in a menstrual cycle.

3) Choice of Sex for a Baby

$$\theta = \frac{n+1}{2} \pm Z_{\alpha/2} * \frac{S}{\sqrt{n}}$$

$$\theta = \frac{n+1}{2} \pm \frac{Z_{0.05}}{2} * \frac{\sigma}{\sqrt{n}}$$

$$\left[\frac{n+1}{2} - \frac{1.96\sigma}{\sqrt{n}} < \theta < \frac{n+1}{2} + \frac{1.96\sigma}{\sqrt{n}} \right] = [L < \theta < U]$$

We substituted sample standard deviation (S) for population standard deviation (σ) to avoid confusing sample standard deviation (S) with dispersion matrix (S).

A couples who wish to select a female child should have intercourse on

$$[L < \theta] = \frac{n+1}{2} - \frac{1.96\sigma}{\sqrt{n}} \text{ days of the menstrual cycle.}$$

And a couples who wish to select a male child should have intercourse on

$$[\theta < U] = \frac{n+1}{2} + \frac{1.96\sigma}{\sqrt{n}} \text{ days of the menstrual cycle.}$$

Intercourse on $[\theta]$ day has equal chances of conceiving either of the sexes depending on whether ovulation has occurred or not. If ovulation has occurred on that day before intercourse, there is a high probability that a male child will be conceived but if sexual intercourse has occurred before ovulation, there is high probability that a female child will be conceived. In other words, a couple who wish to select a male child should have intercourse at the upper bound (U), and a couple who wish to select a female child should have intercourse at the lower bound (L).

4) Correlation Test

$$\text{Correlation}(\rho_{ij}) = \frac{\text{Covariance}(X_i, X_j)}{\sqrt{\text{Variance}(X_i) \cdot \text{Variance}(X_j)}}$$

$$\rho_{1,2} = \frac{-0.00017}{\sqrt{0.003312 \times 0.002928}} = -0.05459$$

$$\rho_{1,3} = \frac{-0.00063}{\sqrt{0.003312 \times 0.002814}} = -0.20598$$

$$\rho_{3,4} = \frac{-0.00064}{\sqrt{0.002814 \times 0.002841}} = -0.22635$$

$$\rho_{4,5} = \frac{-0.00076}{\sqrt{0.002841 \times 0.002598}} = -0.27974$$

$$\rho_{5,6} = \frac{-0.00045}{\sqrt{0.002598 \times 0.003172}} = -0.15676$$

5) Correlation Results

There is weak relationship between the respective months under study. Each month relate with the preceding month, that is, one month cycle enters into another month to complete its cycle, etc. Hence, each cycle is not independent of the other and their relationship is in the opposite direction.

5. Results and Discussions

5.1. Results

From the analysis we carried out in this work, we discovered with 95% confidence that ovulation occurs close to the median of the menstrual cycle. We were able to determine the interval estimator (θ) that estimates the range of fertile days. We determine the choice of sex for a baby at both lower and upper bound. Intercourse at the lower bound results in a female child with 95% confidence while intercourse at the upper bound results in a male child with 95% confidence. Intercourse on the day of ovulation has equal chances of getting either of the sexes depending on the timing of the intercourse, bearing in mind that Y-carrying sperm swim faster and die earlier. We observed that one menstrual cycle is dependent on the other cycle and they have weak inverse relationship.

5.2. Discussions

With the model developed in this study, we determined that a female child can

be conceived on the interval, $[L < \theta] = \frac{n+1}{2} - \frac{1.96\sigma}{\sqrt{n}}$ with probability very close

to one and a male child can be conceived on the interval, $[\theta < U] = \frac{n+1}{2} + \frac{1.96\sigma}{\sqrt{n}}$

with probability very close to one. For women who want to avoid pregnancy, they should abstain from sexual intercourse on the interval

$\left[\frac{n+1}{2} - \frac{1.96\sigma}{\sqrt{n}} < \theta < \frac{n+1}{2} + \frac{1.96\sigma}{\sqrt{n}} \right]$, this interval represents the fertile days, and

any intercourse within this period (L, U) will result in pregnancy. In order not to make a mistake, a couple looking for a boy child should have intercourse at midnight of the determined day of ovulation (θ) or within 24 hours from (θ).

Our method is simple and should be followed carefully. First, determine the menstrual cycle length and determine the middle of it, which becomes the median. Secondly, determine the standard deviation of the cycle length. Thirdly, substitute the values in either (L) or (U) to determine the lower and upper bound. Our method has been tried on some selected women and the success rate was very impressive. If a couple was able to bear children with the desired balanced sex ratio, it will prevent the quest for more children. Many families bear more children when they are unable to get given sex of a child. With strict adherence to our model, family can avoid bearing more children than they can cater for, thereby reducing overpopulation. Pre-determining the sex of a baby and mastery of when to achieve and prevent pregnancy, the number of children and proper spacing between one pregnancy and another is termed family planning.

6. Practical Demonstration

To practically demonstrate our method using the variate X_1 from sample n_2 , we have the following parameters: median = 16; standard deviation is 9.1; $L = 13$ and $U = 19$. Hence, the estimator lies within this interval $[13 < \theta < 19]$. This implies that intercourse from 13th and close to 16th day of the menstrual cycle has 95% probability of conceiving a female child. Again, intercourse on the 16th day of the menstrual cycle has equal probability of conceiving either of the sexes. Finally, intercourse from the 17th to 19th day of the menstrual cycle has 95% probability of conceiving a male child. Therefore, with our model, natural family planning and control of overpopulation are made easy.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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Appendix 1: Sample 1

Month								N	O	V	E	M	B	E	R		D	E	C	E	M	B	E	R		2	0	1	8			
Cycle Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	24	27	28	29	20	31	
Date	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
Body sign	1	1	1	1	1			Menstruation					Days																			

Month								D	E	C	E	M	B	E	R		J	A	N	U	A	R	Y		2	0	1	9					
Cycle Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	24	27	28	29	20	31	32	33
Date	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Body sign	1	1	1	1	1			Menstruation					Days																				

Month								J	A	N	U	A	R	Y		F	E	B	R	U	A	R	Y		2	0	1	9					
Cycle Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	24	27	28	29	20	31	32	33
Date	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
Body sign	1	1	1	1	1			Menstruation					Days																				

Month								F	E	B	R	U	A	R	Y		M	A	R	C	H					2	0	1	9				
Cycle Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	24	27	28	29	20	31		
Date	26	27	28	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28		
Body sign	1	1	1	1	1			Menstruation					Days																				

Month								M	A	R	C	H		A	P	R	I	L									2	0	1	9				
Cycle Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	24	27	28	29	20	31	32		
Date	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28		
Body sign	1	1	1	1	1			Menstruation					Days																					

Month								A	P	R	I	L		M	A	Y												2	0	1	9				
Cycle Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	24	27	28	29	20	31				
Date	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28				
Body sign	1	1	1	1	1			Menstruation					Days																						

Appendix 2: Sample 2

Month									J	U	N	E		J	U	L	Y			2	0	1	8									
Cycle Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Date	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3
Body sign	1	1	1	1	1																											

Month									J	U	L	Y		A	U	G	U	S	T							2	0	1	8		
Cycle Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	
Date	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	
Body sign	1	1	1	1	1																										

Month									A	U	G	U	S	T												2	0	1	8			
Cycle Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1
Body sign	1	1	1	1	1																											

Month									S	E	P	T	E	M	B	E	R										2	0	1	8		
Cycle Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28				
Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28				
Body sign	1	1	1	1	1																											

Month									S	E	P	T	E	M	B	E	R		O	C	T	O	B	E	R					2	0	1	8
Cycle Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30			
Date	28	29	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27			
Body sign	1	1	1	1	1																												

Month									O	C	T	O	B	E	R		N	O	V	E	M	B	E	R					2	0	1	8
Cycle Days	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29			
Date	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24			
Body sign	1	1	1	1	1																											