Testing for Randomness in a System

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Abstract. This paper examines the mode of child delivery (Cesarean-section and normal i.e vaginal delivery) in Divine Hospital and Maternity Awka (the test group) and Nnamdi Azikiwe University Teaching Hospital Nnewi (the control group) using the runs test. A sample of one year record (Jan 2015 – Dec 2015) of delivery arranged in months were used for the study from both hospitals. The findings revealed that, the average number of birth per month for both hospitals were 36 and 38, the sex ratio at birth (SRB) per month were 113.34 and 97.17 male and female respectively. Each had an equal chance of occurrence. It also revealed that a total of 68.7% mode of delivery were normal for Divine Hospital DHM and 56.9% for NAUTH, Nnewi ,while that of Caesarian-section were 31.3% and 43.1% for both hospital. The sequence at birth (Caesarean-section and normal) for both hospital were non random. The median test was employed to test if there were significant difference in the birth distribution of both hospital and it was discovered that there were no significant difference.

Keywords: Natality, Runs Test, Sequence, Runs Caesarean section, Sex ratio at birth (SRB), Vaginal delivery, Rate of normal delivery (RND), Median test.

1 INTRODUCTION

Natality can be defined as the production of young children. It is one of the factors used in studying population growth. They are two different kinds of delivery in human being viz- the cesarean delivery and the normal delivery i.e vaginal delivery.

The cesarean delivery, also known as the cesarean section is a major abdominal surgery involving two (2) incisions (cuts), one, an incision through the abdominal wall and the second is an incision involving the uterus to deliver the baby. Some of the reasons for increased use of the cesarean childbirth include the following:

i. Baby positioned in a manner other than the head first
ii. Woman's Preference for repeated cesarean sections
iii. Use of heart rate monitors to evaluate the fatal heart rate pattern
iv. Labour does not progress to delivery
v. Mother has an active genital herpes infection (baby needs to avoid potential exposure through the birth canal)
vi. Using some criterion other than patients best interest (such as Financial gain)
vii. Mother has HIV infection
viii. Malpractice concerns
ix. Obesity.
x. Woman's higher level of education and social status.

In defining normal births, two factors must be taken into consideration: the risk of the pregnancy and the course of labour and delivery. A pregnant woman who is at low risk when labour starts may eventually have a complicated delivery. On the other hand, many high risk pregnant women ultimately have uncomplicated course of labour and delivery. We may define normal birth as : spontaneous in onset, low risk at the start of labour and remaining so throughout labour and delivery. The runs test used in this paper is a non-parametric statistical tool. The use of non-parametric methods may be necessary when data have a ranking but no clear numerical interpretation. The runs test is frequently used to determine whether a sequence of values has the property of randomness. It can be defined as a statistical procedure used to determined whether the pattern of occurrences of types of observation is determined by a random process. In any ordered sequence with two types of symbols, a runs is defined as a succession of one or more identical symbols, which are followed and preceded by a different symbol or no symbol at all. For example the male and female in a line can have patterns such as MFMFMFMF and MMMMFFFF, which have 8 and 2 runs, respectively. Both the number of the runs and their length can be used as a measure of the randomness of the ordered symbol sequence. Too few runs, too many runs, a run of excessive length, etc., are very rare in a true random sequence and therefore they can serve as statistical criteria for the rejection of the null hypothesis.

2 MATERIALS AND METHOD

This work covered all registered births in Divine Hospital and Maternity Awka and Nnamdi Azikiwe University Teaching Hospital Nnewi both in Anambra State within the period of January to December 2015. It is important to note that the rates and ratios here are for reported cases only (Clinical records). This is because some of the birth occurred outside the hospital. The data obtained includes, all registered births form January-December 2015, the sex of birth and the mode of delivery of the babies**.**

Table 1 Divine Hospital and Maternity Awka

	Normal delivery			**Caesarean section**			**Total of male and female**		**Total of c-section and normal**
Months	M	F	T	M	F	T	M	F	
Jan	12	11	23	3	2	5	15	13	28
Feb	15	13	28	4	5	9	19	18	37
Mar	12	9	21	6	5	11	18	14	32
April	13	11	24	10	8	18	23	19	42
May	15	17	32	7	6	13	22	23	45
Jun	11	9	20	8	8	16	19	17	36
Jul	8	11	19	6	5	11	14	16	30
Aug	13	7	20	5	6	11	18	13	31
Sept	8	11	19	7	5	12	15	16	31
Oct	17	13	30	3	1	4	20	14	34
Nov	16	11	27	1	9	20	27	20	47
Dec	14	15	29	2	4	6	16	19	35
Total			292			136			

Table 2: Nnamdi Azikiwe University Teaching Hospital Awka

	Normal delivery			Caesarean section			Total of male and female		Total of c-section and normal
Months	M	F	T	M	F	T	M	F	
Jan	14	14	28	8	9	17	22	23	45
Feb	17	19	36	6	9	15	23	28	51
March	9	8	17	9	6	15	18	14	32
April	7	9	16	8	5	13	15	14	29
May	6	8	14	7	5	12	13	13	26
Jun	10	8	18	4	12	16	14	20	34
Jul	14	10	24	10	8	18	24	18	42
Aug	8	10	18	9	6	15	17	16	33
Sept	9	12	21	8	9	17	17	21	38
Oct	5	13	18	11	10	21	16	23	39
Nov	6	12	18	12	6	18	18	18	36
Dec	15	21	36	9	5	14	24	26	50
Total			264			191			

3 DATA ANALYSIS

3.1 Estimating Average Monthly Number of Birth

In estimating the average number of births in the hospital between January 2015 – December 2015, we used the arithmetic mean as the estimate, thus

$\overline{x} = \frac{\Sigma xi}{N}$

Here *xi* = number of births per month

Σxi =total number of births between January 2015-Dec. 2015

N = total number of months

Therefore for DHM we have

$\overline{x} = \frac{428}{12} = 35.667 \simeq 36$ births per month

This implies that the hospital DHM had approximately 36 birth per month.

Using the same method for NAUTH Nnewi we have

$\overline{x} = \frac{455}{12} = 37.917 \simeq 38$ births per month

Also implies that NAUTH had approximately 38 birth per month.

3.2 Sex Ratio At Birth SRB

The general sex ratio is the ratio of male to female in a given population. Here our concern is sex ratio at birth i.e the ratio of male birth to female birth ie.

$SRB = {}^{m}/_{f} \times 100$

where M = total births over the period F= total births over the same period

To estimate for the month of January, we have

$SRB_J = {}^{15}/_{13} \times 100 = 115.4$ males per 100 females

SRB for the month of January – December 2015 are given in the table below

Table 3: Monthly sex ratio at birth for 2015 DHM

Months	DHM SRB (males per 100 female)	NAUTH SRB (Males per 100 female)
Jan	115. 4	95.7
Feb	105 .6	82.1
Mar	128.1	128.6
April	121.1	107.1
May	95.7	100
Jun	111.8	70
July	87.5	133.3
Aug	138.5	106.3
Sept	93.8	81.0
Oct	142.9	69.6
Nov	135	.100
Dec	84.2	92.3

The average SRB for the twelve months for both hospital therefore is 113.34 and 97.17 respectively.

3.3 Test for trend

In testing for trend in SRB over the twelve month we have a mean of 113.34 and 97.17 for DHM and NAUTH and thus have a table of + and – signs denoting the values above and below the mean respectively .

Table 4: Table For Run Test

Months	**DHM sign**	**NAUTH Signs**
Jan	+	-
Feb	-	-
Mar	+	+
Apr	+	+
May	-	+
Jun	-	-
Jul	-	+
Aug	+	+
Sept	-	-
Oct	+	-
Nov	+	+
Dec	-	-

We now state our hypothesis

H_o: A random process generates the sequence of SRB

H_1: A non random process generates the sequence of SRB

At $\alpha = 0.05$

n_+ = Values above the mean =6

n_- = values below the mean=6

r_1 = numbers of runs =8 for DHM

r_2= number of runs = 7 for NAUTH

Since $N_+ N_-$ = 6, critical values = 3 and 11,

Decision Rule

for DHM, if $3 \leq r = 8 \leq 11$ or $r \leq 3$ or $r \geq 11$, For NAUTH, if $3 \leq$ **r = 7 $\leq$ 11 or r $\leq$ 3 or r $\geq$ 11, reject H_o.**

3.4 Conclusion

Since r = 8 for DHM and 7 for NAUTH, we do not reject the null hypothesis, we therefore conduced that the sequence of SRB for both hospital is random. This means that the difference in the ratio of males and female are due to chance, each sex has equal chance of occurring or not occurring. Since there are no trend values according to our test result we have no need to estimate the trend values.

3.5 Estimation of the Rate of Normal Deliveries (RND)

We estimate the rate of Normal deliveries (RND) as follows

$$RND = \frac{\text{Total number of normal deliveries in a month}}{\text{Total number of birth in the same month}}$$

For January (DHM) we have

RND = 23/28 x 100 = 82.1%

The values of the rest of the months in given in the table below.

Table 5: Distribution Of RND For DHM And NAUTH

Months	DHM Rate of RND (%)	NAUTH Rate of RND (%)
Jan	82.1	62.2
Feb	75.7	70.5
Mar	65.6	53.1
Apr	57.1	55.2
May	71.1	53.8
Jun	55.6	52.9
Jul	63.3	57.1
Aug	64.5	54.3
Sept	61.3	55.3
Oct	88.2	55.3
Nov	57.4	46.2
Dec	82.9	72.0
Total	824-8	682.8

The average RND for the twelve months is 68.7% for DHM and 56.9% for NAUTH.

3.6 Estimation of the rate of caesarian section RCS

$$RCS = \frac{\text{Total number of c-section in a month}}{\text{Total number of births in the same months}}$$

For January (DHM) we have.

CS $= {}^{5}/_{28}$ x 100 = 17.9

From similar computations for other months for DHM and NAUTH we generated the table below:

Table 6: Table of the rate of caesarian section

MONTH	RATE % OF CS	DATE % OF CS
Jan	17.9	37. 8
Feb	24.3	29.4
Mar	34.4	46.9
Apr	42.9	44.8
May	28.9	46.1
Jun	44.4	47.1
Jul	36.7	42.9
Aug	35.3	45.5
Sept	38,7	44.7
Oct	11.8	44.7
Nov	42.2	50.0
Dec	17.1	28.0
Total	375.2	517.0

The average RCS for the twelve months is 31.3 for DHM and 43.1 for NAUTH.
To determine if the sequence of birth is random for NAUTH. The births were donated as C for C- section and N for normal. The intent is to use these data to determine whether the sequence of c-section and normal birth is random.
The sequence is as follows for NAUTH
NNN C NN CCCC NNNNNNNN C NN CCC NNNN CCCC NNN C NC NNNN CC NNNNNNN CCC NNNNN CCC NNN CCCC CCCC NNNNN N CCCC NN C NC NNNNNNNN CCC NNNN C N C CCC NNNNN, CCCC NNNN CCCC N CCC NN CCCCC NNNNN C NNN CC NNN C NNNN CC NNNNN C NNN CCC NNNNN CCC NNNNN C NNNN CCC NNNN CC NNNNNNNNNN CC NNNNN CC NNN CCCC NNNNNNNN CCC NNNN CCCCC NNNNN CCCCCCCC NNN C NN CC NNNNN C N CC NN CCC NNN CCC NNN CCC NNNN CC NNN CCCC NNN CC NNN C N CC NN CCC NN CCC NNNN CCC NNN CCC NNN CCC NNN CCCCC NN CC NNNN CCC NNNN CCC NNNN CCCC NNN CC NNNN N NN CCC NNNN CCC NNNNNNNN CNNNNN CCC NNNN CC NN NNNNN CCC NNNNN CCC NNN CCC NNN
We state our hypothesis as follows:

Hypothesis

H_o: Sequence of delivery is random
H_1: The sequence of delivery is non random

The number of N's and C's are $N_1 = 262$ and $N_2 = 191$ respectively and the number of run is r=145, Thus the mean and variance are obtain as follows:

$$\mu_r = \frac{2N_1N_2}{N_1+N_2} + 1 \text{ .... } (*)$$

$$\sigma_r{}^2 = \frac{2N_1N_2(2N_1N_2 - N_1 - N_2)}{(N_1N_2)^2(N_1+N_2)} \text{ ....} (**)$$

Using equation (*), we have

$$\mu_r = \frac{2\,(264)\,(191)}{264+191} + 1 = 222.64$$

Using equation (**), we have

$$\sigma_r{}^2 = \frac{2(264)(191)[\,2(264)(191) - 264 - 191]}{(264+191)^2(264+191-1)}$$

For a two – tailed test at 0.05 level, we would accept the hypothesis H_o of randomness if –1.96 $\leq Z \leq$ 1.96 and would reject, if otherwise. Since the z score corresponding to r = 145 is

$Z = \frac{r-\mu_r}{\sigma_r} = \frac{145-222.64}{10.379} = -7.48$

and -7.48 < - 1.96, we reject H_0 at 0.05 level and thus we conclude that sequence of delivery is non-random

To determine of the sequence if birth for DHM is random. We also denoted C as C section and N for normal delivery. The data generated for DHM is given;

NNNNN CC NNNNN C NNNNN C NNNNN C NNN C NNN C NNNN CC NNNNN C NN C NNNNN CC NNNN C NNNNNN CCC NNNNNNN C N CC NNNNN C NNN C NNN CCC NNNN CC NNNN CCC NN C NNNNN CCC NNN CCC NN CC NN C N C NNNNN CC NNN C NNN CC NNNN CC NN C NNNNN C NNNNN C NN CC NN CCCC NNN CC NN C NNN CCC NNN CC NN C NNNNN CC NN C NNN CCC NNN CC NNNNN C NNNNCC NNNNN CC NNN C NNNN CC NNNNN CCC NN CC NNN CCC NN CC NN C NNNNNN C NNNNNN C NNNNNN C NNNNNNNNNNNN CCC NNN CCCC NNNN CC NNN CCC NNN C NN C NNN C NNN CC NNNN CC NNNN CC NNNNNN C NNNNN C NNNNN C NNNNN C NNNN C

Hypothesis

We state the hypothesis

H_o: The sequence of birth in random

H_1: The sequence of birth in non-random

$\mu_r = \frac{2\,(136)\,(292)}{136+292} + 1 = 186.6$

$\sigma_r{}^2 = \frac{2(136)(292)[\,2(136)(292) - 136 - 292]}{(136+292)^2(136+292-1)}$

$= 80.212$

$\therefore\ \sigma_r = 8.956$

$Z = \frac{158-186.6}{8.956} = -3.19$

And – 3.19 < - 1.96, we reject H_o at 0.05 level and conclude that the sequence of delivery is non-random

Median test for two independent random samples

We used the median test to investigate whether the distribution of birth in DHM and NAUTH differ.

For a 2 x 2 contingency table, we have;

		Sample
Observation	A	B
Above median	a	b
Below median	c	d

Where a is the number of observation above the combined median of sample B, c, d are the respective number of observation below the combine median in sample A and B.

Table 7: Testing for difference in Birth distribution of DHM and NAUTH

	DHM	NAUTH	TOTAL
Above median	5	7	12
Below median	7	5	12
Total	12	12	24

Median = 35.5

Hypothesis:

H_o: There is no difference in birth distribution of DHM and NAUTH

H_1: There is significant difference in birth distribution of DHM and NAUTH.

$X^2 = \frac{n\,(/ad-bc/1-n/2)^2}{(a+b)(a+c)(b+d)(c+d)} = 1.5$

Since x_{i^2} = 1.5 is less than $x^2_{0.05}$ = 3.841

H_o is accepted and we conclude that there is no significant difference in birth distribution of DHM and NAUTH.

Conclusion and Summary

From various analyses ran from the data collected we reached the following conclusion.

We observed that the recorded number of live births by the medical records department of DHM and NAUTH were 428 and 455 respectively between the period under study i.e. Jan – Dec. 2015. Here the average number of births per month for DHM and NAUTH were estimated to be 36 and 38 respectively.

Also the average sex ratio at birth (SRB) for DHM and NAUTH were found to be 113.34 and 97.17 male per 100 female respectively (for each month) with some months conforming to the Nigerian SRB of 103 and the world standard SRB of between 104 – 106.

We eventually discovered that from our test of randomness (SRB) that the SRB's for the 12 months: i.e. the distribution of male and female was due to chance i.e. each sex has an equal chance of occurring.

A total of 68.7% mode of deliveries were through normal for DHM and 56.9% for NAUTH while that of C-section were 31.3% and 43.1% for DHM and NAUTH respectively.

Finally, we observed that the sequence of birth (Normal and C-section) were non-random for both hospital and that there was no significant difference in birth distribution of DHM and NAUTH.

References

ACOG Practice bulletin no. 54 American college of obstetricians and Gynecologists. Vaginal birth after previous caesarian delivery. Obset Gynecol 2004.

BUHLING KJ, SCHMEDTS, ROBINSON JN, et al. rate of dyspareunia after delivery in primiparae according to mode of delivery. European Journal of obstetrics, Gynecology, and reproductive Biology 2000.

BLANCHETTE H, BLANCHETTE M, MC CABE J, VINCENT S. is vaginal birth after caesarian safe: J obset Gynecol 2000.

CAHILL, AG, STAMILIO DM, ODIBO AO, PEIPERT JF, RATCLIFFE SJ, STEVENS EJ, et al. is vaginal birth after casarean or elective repeat casarean safer in woman with a prior vaginal delivery. Am J obset Gynaecol 2006.

CHAUCHAN SP, MARTIN JN, HENRICHS CE, MORRISON J. C MAGAAN EG. Material and perinatal complications with uterine rupture in 142 075 patients who attempted vaginal birth after caesarean delivery a review of the literature. Am J obset Gynaecol 2003.

DEUTCHMAN M, ROBERTS RG. VBAC: Protecting patients, defending doctor. (Editorial) American family physician 2003.

DRIFE J. The start of life: a history of obstetrics. Postgraduate Medical Journal 2002.

FLAMM BL, NEWMAN LA, THOMAS S J, Fallon D. vaginal birth after cesarean delivery results of a 5 years multicenter collaborative study. Obset Gynecol 1990.

GREENE M.F. vaginal birth after caesarean Revisited. (Editorial) NESM 2004.

GRIFFITHS A, WATERMEYERS, SIDHU K, et al. female genital tract morbidity and sexual function following vaginal delivery or lower segment caesarean section. Journal of obstetrics and Gynaecology. 2006.

HICKS TL, GOODALL SF, QUATTRONE EM, et al. post partum sexual functioning and method of delivery: summary of the evidence. Journal of midwifery and women's health 2004.

J.D. GIBBON, non parametric methods for quantitative analysis NEW York Holt, Rinehart and Winston, 1976.

KLEIN K WPRDA C, LEIPOLD H, et al. does the mode of delivery influence sexual function after childbirth; journal of women's health 2009.

LANDON MB, LEINDECKARS, SPONG C Y, HAUTH J C, BLOOM S, VARNER MW, et al the MFMU caesarean registry: factors affecting the success of trial of labour after previous cesarean delivery. Am J obset Gynaecol 2005.

LANDON M B, HAUTH J C, LEVONO K J, SPONG C Y, LEINDECKER S, VARNER M W, et al. maternal and perinatal outcomes associated with trial of labour after prior cesarean delivery NEJM 2004.

MADUEKE (2006) Modern Biology senior secondary school series, New Edition African publishers limited Nigeria.