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ANALYSIS OF NEONATES GENDER AND MODE OF DELIVERY USING PEARSON'S CORRELATION

*[1]Friday Zinzendoff Okwonu, [2]Nor Aishah Ahad and [1]Joshua Sarduana Apanapudor

[1]Department of Mathematics, Delta State University, Abraka Nigeria
[2]Institute of Strategic Decision Modeling, School of Quantitative Sciences, Universiti Utara Malaysia, Malaysia

*Corresponding Author Email Address: fokwonu@gmail.com

ABSTRACT
This paper investigates whether neonate gender determines the mode of maternal delivery. The Pearson correlation technique and the *t*-statistic were applied to ascertain whether neonate gender is a determinant of the mode of maternal delivery. The neonate rate of delivery based on gender and mode of delivery was also investigated. The study relied on secondary data from a general hospital in Nigeria. The study consists of 6,491 live births from 2010 to 2017. The analysis showed that 74.9% accounted for normal births while 25.1% for surgical births. The gender analysis showed that 47.5% of males and 52.5% of females were normal births while 47.8% of males and 52.2% of females were delivered via surgical mode. The study showed that 47.6% of males and 52.4% of females were delivered for the period under review. The correlation value $\bar{r} = 0.5$ suggests that neonates irrespective of gender can be delivered via a normal or surgical procedure. The analysis based on the *t*-statistic failed to reject the null hypothesis implying that neonate gender does not determine the mode of maternal delivery but maternal lifestyle during pregnancy.

Keywords: Normal delivery, Surgical delivery, Neonate, Gender, Pearson correlation.

INTRODUCTION

Childbirth is an integral part of a woman's life accompanied by pain and pleasure with the joyful question "Where is my baby?". "It's simply the process of giving birth to a child". Childbirth can be categorized as normal (vaginal) birth or surgical (cesarean section) birth. Neonate birth is a birth process where a neonate (newborn) passes through the birth canal while surgical birth is expert-based birth through the abdominal and uterus incision. The normal delivery is advantageous to the newborn because the mother breastfeeds the infant within the first 24 hours of life and the infant can enjoy maternal warmth provided the infant is healthy. The neonate is unable to be breastfed within the first 24 hours of life and lacks immediate maternal warmth. It has implications for future pregnancies and probably reduces the number of childbearing. The state of the system (womb) where the neonate lies has determining factors that may lead to either a normal or surgical delivery process (Apanapudor *et al*., 2023).

Surgical delivery separates the newborn from the mother due to abdominal surgery and other complications that may arise (Huang *et al.,* 2011; Gregory *et al.,* 2011; Betran *et al.,* 2016). Surgical delivery is "lifesaving" and its primarily a suggested mode of delivery if there is mal-presentation, prolong labour, celphalo-pelvic disposition, fetal-distress, poor maternal effort, based on the set preeclampsia or elective or if the mother or child lives in danger (Garmaroudi *et al.,* 2002; Nassar *et al.,* 2006).

Surgical delivery is on the increase globally (Baicker *et al.,* 2006; Nassar *et al.,* 2006; Barber *et al.,* 2011; Goer *et al.,* 2012; Melamed *et al.,* 2013; Mousavi *et al.,* 2013; Zhao *et al.,* 2013; Li *et al*., 2017; Shams-Ghahfarokhi *et al.,* 2016; Qi *et al.,* 2018). The World Health Organization (WHO) suggested a benchmark of ten to fifteen surgical deliveries per every one hundred live births (Moore, 1985; Chalmers, 1992; Molina *et al.,* 2015; WHO, 2015a,b,c; Betran *et al.,* 2016; Kosan *et al.,* 2019*;* Maswime, 2019). In practice, this benchmark is not achievable globally due to life-threatening births, voluntary surgical delivery, and other human-induced factors (Declereq *et al.,* 2011). Attempts are made daily to balance the situation and as such several measures (procedures) being canvassed need to be implemented successfully (Apanapudor *et al*., 2020). Surgical delivery depends on many factors such as gestational hypertension, the woman's age, gestational age of more than 41 weeks, malposition, and placenta previa (D'Orsi *et al*., 2006; Todman, 2007; Essex *et al*., 2013; Ehtisham *et al*., 2014).

Conventionally, surgical delivery is a suggested mode of delivery if that is the best option to save the life of the mother and neonate (Zamani-Alavijeh *et al.,* 2018). In recent times, the rate of surgical delivery is on the increase which if not abated might be the easiest option for modern women. Modern women or career women adduce reasons for voluntary surgical delivery such as body image, genital structure, weakness of genital wall, and reduced sexual intimacy (Moore, 1985; Kacerauskiene *et al.,* 2013; Mohammaditabar *et al*., 2014; Stoll *et al.,* 2017; Siabani *et al.,* 2019). Modes of conception such as in-vitro fertilization (IVF) and fear during labor may have contributed to the high request for surgical delivery by intending mothers, especially for twin delivery (Eberhard-Gran *et al*., 2008; Alehagen *et al.,* 2001; Liu *et al*., 2012*)*, high- and countries with an estimated 6.3 million surgical birth annually (Gibbons, *et al,* 2010; Zhao & Chen, 2013; He*, et al.,* 2016). Studies have shown that surgical delivery is common and increasing among women with higher educational qualifications (Liu, *et al.,* 2012). Different factors such as social status, peer group, and professional influence are some contributing factors to the increasing rate of surgical delivery globally (Lin & Xirasagar, 2004; Linton *et al.,* 2004; Zweeker *et al.,* 2011; Mi & Liu, 2014).

This paper is organized as follows. The next section describes the literature review followed by the methodology that contains data collection, Pearson correlation, and the *t*-statistic method. Results and discussion are presented after this section, followed by the conclusion in the last section.

LITERATURE REVIEW

In developing countries, surgical delivery is lower compared to developed and middle-income countries (Villar *et al.,* 2006; Shah *et al.,* 2009; Lumbiganon *et al.,* 2010). The Dominican Republic has the highest surgical birth of 56.4% and Iceland, Finland, and Norway have surgical birth below 15% (McCulloch, 2020). Table 1

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contains a list of countries with the highest surgical birth details.

Table 1: Countries with the highest surgical delivery (Tapia *et al.,* 2016; McCulloch, 2020)

Country	Surgical birth (%)	Country	Surgical birth (%)
Dominion republic	56.4	Brazil	55.6
Iran	47.9	China	47
Chile	44.7	Maldives	41.1
Georgia	36.7	Korea republic	36.6
Hungary	35.3	Portugal	35
Bulgaria	33.1	Paraguay	33.1
Switzerland	32.2	Germany	30.9
Peru	30.1	Albania	30
Armenia	29.1	Austria	28.8
Canada	26.3	United Kingdom	26.2
Egypt	51.8	Turkey	50.4
Colombia	45.7	Mexico	45.2
Ecuador	40.6	Uruguay	39.9
Romania	36.3	Italy	36.1
Poland	34.6	Malta	33.5
Australia	33	USA	32.2
Slovak republic	30.7	Sri Lanka	30.5
El Salvador	29.8	Argentina	29.1
Luxembourg	28.8	Ireland	28.5
Czech Republic	26.1	New Zealand	25.9

In 2008, Brazil (≈46%), Iran (≈42%), and Chad had the lowest surgical delivery (4%) lower than South Sudan (<8%) (Gibbons *et al*., 2010), 40% in China and 48.1% in Turkey in 2013 (Betran *et al*., 2007; Klemetti *et al.,* 2010; Oner *et al.,* 2016*;* Maswime, 2019). The rate of surgical delivery is increasing as the year goes by. In 2003 the rate of surgical delivery was 21.2%, 36.7% in 2008 and 48% in 2013, and up to 53% in 2017 (Stoll *et al.,* 2017; OECD, 2019). Surgical delivery is becoming an epidemic that requires the World Health Organization to intervene vigorously by abating the rate of increase. It is a staged epidemic that may alter the natural birth process in the next 100 years if not controlled by the appropriate health agencies.

Previous studies relating to normal and surgical births applied logistic regression, multiple logistic regression, analysis of variance, chi-square, and Pearson correlation to analyze demographic information. Literature search has shown that correlation has been applied to investigate maternal-fetal attachment (Shrestha *et al.,* 2010; Lumbanraja *et al.,* 2013; Maddahi *et al.,* 2016; Dahake & Shaikh, 2019) and gestational weight gain and birth weight for gestational age (Sato & Miyasaka, 2019). Another study applied correlation analysis to investigate the chest circumference of newborn foot length at gestation age (Dimitriev *et al.,* 2006). They focused on birth weight, length, and height at different ages and equally the correlation technique. Relying on existing literature search, no research work has investigated whether neonate gender determines the mode of maternal delivery. The objectives of this study are: 1) to determine the correlation of combined gender modes of birth and 2) to determine whether neonate gender determines the maternal mode of delivery. To achieve this, we applied the Pearson correlation technique and *t*-statistic to determine whether the null hypothesis was accepted or rejected.

MATERIALS AND METHODS

Several studies have reported the astronomical increase in surgical delivery, however, not much has been discussed in the literature whether neonate gender is responsible for the astronomical increase in surgical delivery. Several silent factors such as economic status, maternal request, the safety of neonate and mother have been adduced, and medical malpractice by some health practitioners have been given as some reasons for the global epidemic of modern ways of childbirth. The data set used in this study covers from January to December 2010 to 2017. The information was obtained from the data record of the general hospital in a semi-urban university town, Abraka, Delta State, Nigeria. We apply the Pearson correlation and the t-statistic to determine whether there is a relationship between neonates' gender and maternal mode of delivery. The flowchart of the research activities can be referred to in Figure 1.

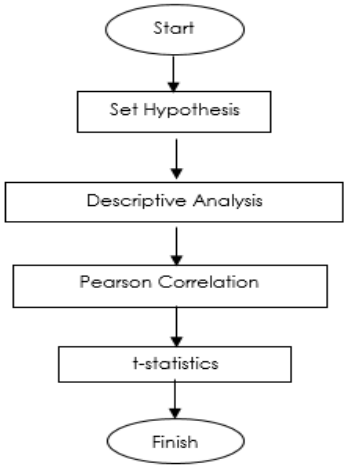

Figure 1: Flowchart of the research activities

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Data Collection

The study relied on secondary data obtained in Abraka General Hospital (a secondary health care facility) in a semi-urban university community surrounded by more than ten villages. The data set was obtained with the strict permission of the hospital management for study purposes from the data record section. The data set consists of yearly information from 2010 to 2017. The data used is an annual birth summary for the mode of delivery. The average age of the mothers is 28.5 years, with an age bracket between 18 years to 40 years, respectively. The mothers are primiparous and multiparous. For the period under review, 6,491 live births were recorded with 35.59% male and 39.36% female through normal delivery, and 11.99% male and 13.06% female for surgical delivery. The data showed that about 47.57% of male and 52.43% of female live births were recorded. For the period under review, the number of female live births was higher by 4.9% than males. In all, 74.9% of live births were normal delivery, and 25.1% were surgical delivery.

Pearson Correlation Method

The Pearson correlation method is applied to measure the degree of association or linear relationship between variables of interest. The value of the correlation coefficient (*r*) lies between ±1 (Okwonu & Zahayu. 2020). Sometimes the variables we study may be independent of each other as such the correlation value (*r*) may be zero which implies that there is no association between the variables. Studies have also shown that *r* may be zero, but the variables are not independent, (Okwonu *et al.,* 2021). Correlation does not determine cause and effect relationship; it simply determines the association or linear relationship between variables of interest. The Pearson sample correlation coefficient *r* is described mathematically as Equation (1).

$$r = \frac{S(XY)}{\sqrt{S(XX)}\sqrt{S(YY)}}, \quad (1)$$

where

$$S(XY) = \sum_{i=1}^{k}(x_i - \bar{x})(y_i - \bar{y}),$$

$$S(XX) = \sum_{i=1}^{k}(x_i - \bar{x})^2$$

$$S(YY) = \sum_{i=1}^{k}(y_i - \bar{y})^2$$

$\bar{x} = \frac{\sum_{i=1}^{k} x_i}{k}$, and $\bar{y} = \frac{\sum_{i=1}^{k} y_i}{k}$.

Although, the sample mean in Equation (1) is often influenced by outliers (Okwonu & Othman, 2013a,b; Najeeha Najdi *et al*., 2022; Okwonu *et al*., 2012; Apanapudor *et al*., 2023). Based on Equation (1) we define the *t*-statistic as follows

$$T_r = \frac{r\sqrt{k-2}}{\sqrt{1-r^2}}, \quad (2)$$

k-2 denotes the degrees of freedom (*df*) for the *t* distribution. Let T_t be the critical value at a particular significance level of α and T_r as defined above based on Equation (2). The mean correlation is given as

$$\bar{r} = \frac{\sum_{i=1}^{n} r_i}{n}, \quad (3)$$

as such Equation (2) translates to

$$\bar{T}_r = \frac{\bar{r}\sqrt{k-2}}{\sqrt{1-\bar{r}^2}} \quad (4)$$

The statement of the null hypothesis (H_0) implies that neonate gender does not determine the maternal mode of delivery while the alternate hypothesis (H_1) implies that neonate gender determines the maternal mode of delivery. This statement translates to inference by comparing the computed statistic with the critical value. As such, if the computed value exceeds the critical value ($T_r > T_t$), we reject the null hypothesis otherwise if the computed value is less than the critical value ($T_r < T_t$), we do not reject the null hypothesis.

RESULTS AND DISCUSSION

Relying on the data set for the period under review, the percentage of normal delivery (74.9%) is higher than the percentage of surgical delivery (25.1%). The result showed that the correlation between normal and surgical male delivery is 0.680 while the correlation between normal and surgical female delivery is 0.359. The analysis revealed that the correlation between normal male delivery and surgical female delivery is 0.646. The results revealed that

Table 2: Neonate gender and mode of delivery

Mode of Delivery	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**
Gender	M	M	F	F	M	F	F	M
R	0.68		0.36		0.65		0.31	
T_i	2.27		0.95		2.09		0.79	

N: normal delivery, S: surgical delivery, M: male, F: female

At 5% level of significance and six degrees of freedom (*df*), the critical value is T_t = 1.943. The analysis based on Table 2 implies that for both modes of delivery with the male neonate, the null hypothesis is rejected (2.27 > T_t) while for females for both modes of delivery, the null hypothesis was not rejected (0.95 < T_t). For normal delivery with male neonate and surgical delivery with the female neonate, the null hypothesis was rejected (2.09 > T_t) while for normal delivery with female neonate and surgical delivery with the male neonate, the null hypothesis was not rejected (0.79 < T_t). Based on the above analysis, the correlation between normal (male and female) and surgical (male and female) delivery is 0.349 while the computed statistic is T_r = 1.17. At 5% level of significance and six degrees of freedom (*df*), the critical value is T_t = 1.943. This implies that the computed value is less than the critical value, hence we failed to reject the null hypothesis implying that the neonate does not determine the mode of maternal delivery but simply maternal lifestyle during pregnancy. Relying on a careful analysis from Table 2 which may suggest that the correlation value influences the inference, we apply Equation (3) and Equation (4) to obtain $\bar{r} = 0.5$ and $\bar{T}_r = 1.41$. The value of $\bar{r} = 0.5$ implies that any gender can be delivered by normal or surgical procedure. Since $\bar{T}_r = 1.41$ is less than T_t = 1.943, this suggests that we failed to

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reject the null hypothesis which implies that the neonate gender cannot determine the maternal mode of delivery.

The findings revealed that there is a moderate to weak positive correlation on the mode of gender delivery. The analysis revealed the comparison between neonate gender based on the mode of delivery. Previous studies on the mode of delivery in Nigeria focused on university teaching hospitals which serve as referral centers for other secondary healthcare facilities such as the general hospital used in this study.

A five-year study on the mode of delivery in a specified tertiary health facility in Gwadalada, Abuja Nigeria revealed that 9,604 live births were recorded of which 78.6% and 21.4% were normal and surgical deliveries (Isah *et al.,* 2018). Another five-year study on the mode of delivery across Nigeria based on a national demographic and health survey in 2013 showed that normal and surgical births accounted for 97.9% and 2.1% (Adewuyi *et al.,* 2019). Another study showed 81.5% and 18.5% normal and surgical births (Eleje *et al.,* 2010). Table 3 contains previous studies on the method of deliveries and the number of years reported in specialist hospitals and secondary health facilities in Nigeria.

Table 3: Detail analysis of previous studies based on the number of years

Research period	References	Number of years	Number of deliveries	Normal delivery (%)	Surgical delivery (%)	Types of Health facilities
2013	Adewuyi *et al.,* 2019	5	31,171	97.9	2.1	NS
2013	Lumbanraja *et al.,* 2013	5	9.604	78.6	21.4	SP
2011	Ugwu *et al.,* 2011	5	3,554	73.3	26.7	SP
1988	Chukudebelu & Uzumba, 1988	10	47,361	-	-	SP
2005	Okafor & Okezie, 2005	4	3,926	77	23	SP
2007	Okezie *et al.,* 2007	4	2,922	74.7	25.3	SP
2002	Nkwo & Onah, 2002	2	3,626	75	25	SP
2004	Ibekwe & Tabansi, 2004	2	1,641	72.6	27.4	SP
2006	Iyoke & Onah, 2006	5	5,742	98.5	1.5	SP
2002	Aisien *et al.,* 2002	5	11,571	82	18	SP
2009	Geidam *et al.,* 2009	6	10,097	88.2	11.8	SP
2017	Maanongun *et al.,* 2017	7	2,445	81.5	18.5	HSC
2004	Khawaja *et al.,* 2004	6 month	1,424	78.9	21.1	SP
2017	Adelaiye *et al.,* 2017	5	9,388	76	24	SP
2019	Kanji *et al.,* 2019	3 month	1,211	50.3	49.7	SP
2001	Ijaiya & Aboyeji, 2001	10	30,267	90.9	9.1	SP
2014	Akinola *et al.,* 2014	3 month	641	59.9	40.1	SP
Present Study		8	6,491	74.9	25.1	SHC

NS: National Study, SP: Special Hospital, SHC: Secondary Health Care

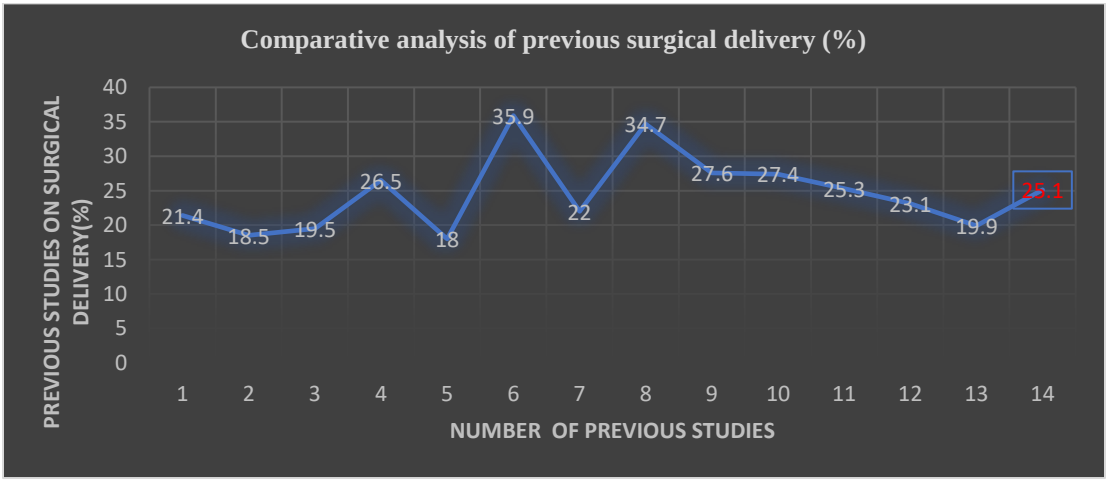

Figure 2: Comparative analysis of previous studies on surgical delivery

Figure 2 consists of thirteen previous and present studies of surgical delivery in different parts of Nigeria. The number (25.1%) in red in Figure 2 is comparable with previous studies. The result of this study is comparable to previous studies in different health

facilities and locations in Nigeria. The analysis from this investigation showed that normal birth accounted for 74.9% while surgical birth was 25.1% for the period under review. The findings of this study correlate with previous studies in Table 3.

The comparative analysis revealed that male neonate from both modes of delivery has a moderate positive correlation which suggests that the null hypothesis is rejected. The analysis also showed that normal male and surgical female delivery has a moderate positive correlation suggesting that the null hypothesis is rejected. The females from both modes of delivery with a weak positive correlation suggested that the null hypothesis should not be rejected while normal female birth and surgical male birth with a weak positive correlation suggest that the null hypothesis should not be rejected. Based on these different combinations of the mode of delivery by gender, correlation analysis for both modes of delivery irrespective of gender was computed. The correlation value $\bar{r} = 0.5$ suggests that neonates irrespective of gender can be delivered via a normal or surgical procedure. The study showed that we failed to reject the null hypothesis because $\bar{T}_r = 1.41$ is less than T_t = 1.943. This suggests that neonates cannot determine maternal modes of delivery.

Conclusion

The analysis based on the data set indicates that 25.1% of surgical delivery and 74.9% of normal delivery reported in this study are in accordance with previous studies. This result affirmed that the percentage of normal delivery is higher than that of surgical delivery. This finding corroborates previous reports by different researchers. The study showed that male delivery in both categories has a moderate positive correlation while female categories have a weak positive correlation. The test analysis revealed that the null hypothesis cannot be rejected indicating that neonate gender is not a determinant of the mode of delivery but strictly on lifestyle during pregnancy.

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