

*Full Length Research Paper*

# Empirical analysis of factors associated with neonatal length of stay in Sunyani, Ghana

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**Postpartum length of stay (LOS) in hospital continues to be a subject of intense discourse and research, especially for mothers of neonates born with low birth weight (LBW). This study investigates the association of total LOS (pre and postpartum) with a range of factors related to geo-demographics, maternal health and pregnancy history. It also provides simple estimates of likely duration of neonatal hospital length of stay based on data from two public hospitals at Sunyani, Brong Ahafo Region, Ghana. The LOS is affected by maternal age, parity (number of children ever born), neonate birth weight, maternal employment and income status. Smoking and consumption of locally brewed alcoholic drinks were also found to significantly prolong the total LOS. The Log-normal model was the best parametric model for total LOS.**

**Key words:** Postpartum, neonates, Length of stay, log-normal, 2000 AMS subject classification, 62J12, 62P10.

## INTRODUCTION

Hospital length of stay (LOS) is considered a reliable and valid proxy for measuring the consumption of hospital resources. Prolonged postpartum LOS results in an overstretching of hospital resources and bed blocking to new admissions. While the average length of stay is easy to quantify, it does not reflect the nature of the underlying distributions. The clinical care of neonates poses a huge challenge when the birth weight is less than 2.5 kg because it can be cost (direct and indirect) intensive and often associated with prolonged stay in hospital (Vasilakis and Marchall, 2005).

There has been a steady decrease in postpartum LOS and a review of literature on effect of this decrease on mothers and neonates shows no detrimental effects on maternal morbidity (for normal deliveries) but an increase in neonatal mortality and morbidity (Sareer et al., 2008; Shah et al., 2012). Disadvantages also include delayed breastfeeding, manifestation of new conditions affecting new-borns after early discharge and improper discharge planning. The proponents of early postpartum discharge often argue that it aids prevention of possible iatrogenic infection, promotes family bonding and attachment,

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**Table 1.** Univariate analysis of maternal age and LOS.

| Age   | Mean         | Median | IQR |
|-------|--------------|--------|-----|
| <20   | 7.61 ± 1.147 | 5.0    | 14  |
| 20-24 | 6.27 ± 1.225 | 3.5    | 24  |
| 25-29 | 3.96 ± 0.442 | 3.0    | 20  |
| 30-34 | 4.88 ± 0.542 | 4.0    | 21  |
| 35-39 | 7.37 ± 1.29  | 4.0    | 20  |

reduces hospitalization care and patient costs (Farhat and Rajab, 2011). Early discharge is referred to as a postpartum hospital stay of  $\leq 48$  h, as per the guidelines of American Academy of Pediatrics (AAP). Mothers discharged at less than 48 h postpartum are less likely to be readmitted to hospital than those discharged at more than 48 h. They are also less likely to suffer from depression and anxiety than those who stay longer. The neonate who is discharged at less than 48 h is however at greater risk of readmission especially when the neonate is born with a birth weight below 2.5 kg (Shah et al., 2012).

Discharge at any time  $< 72$  h significantly increases the risk for readmission to hospital and the risk for readmission with hyperbilirubinemia when compared with discharge after 72 h (Maisels and Kring, 1998; Mishra et al., 2005). Shah et al. (2012) in an Eritria based study found hypothermia, pneumonia, younger gestational age, 1 min Apgar score and small size for gestational age as significantly associated with mortality and longer length of stay in the Eritrean specialized neonatal intensive care unit (Shah et al., 2012).

In developing countries, hospital resources are often stretched thin in caring for mothers and new-borns; especially for those born with birth weights less than 2.5 kg or gestational age  $< 36$  weeks and requiring specialized care. Knowing how long the required postpartum stay will be allows for proper planning and parsimonious allocation of resources.

The aim of this study is to propose an empirical model of postpartum length of stay in Sunyani, Ghana. Sunyani municipality, Brong Ahafo Region of Ghana has a population of 79,165 (Ghana Statistical Service, 2011) and the Regional Hospital (a not-for-profit Ghana Health Facility) provides 24 h service and has a monthly average of 15,950 outpatients and 1,120 inpatients. The region recorded high incidence of low birth weight (LBW) in 2007 and thus experiencing a high demand for bed spaces in the neonatal units. The Regional Hospital is the referral hospital that serves Brong-Ahafo Region while the Municipal Hospitals serves the residents of the municipality and its immediate environs and thus the data captured is not limited to Sunyani.

Brong-Ahafo region is the second largest of the ten

regions of Ghana and lies within longitude  $0^{\circ}15'E$  to  $3^{\circ}W$  and  $8^{\circ}45'N$  to  $7^{\circ}30'S$ . It shares latitude boundary with Cote d'Ivoire and has an area of 39,557sq km with highest elevation point of 712.6 m above sea level. Figure 1 presents the map of Ghana showing Brong-Ahafo region within.

## MATERIALS AND METHODS

This is a retrospective study of singleton live births carried out at the Sunyani Regional and Municipal Hospitals. The data comprise questionnaire responses collected from 180 single birth mothers from the total of mothers delivered during the study period irrespective of birth-status and gestational age. The questionnaires were administered between February and March, 2010 after obtaining their consent to participate in the study. Sixty seven of the neonates had birth weight below 2.5 kg.

The questionnaire elicited information on maternal, child and health care factors. The maternal variables included socio-economic, environmental, anthropometric, lifestyle and medical history. The child variables were weighed at birth, Apgar score, sex of baby and gestation age. The health care factors were number of antenatal visits and place of delivery. This study has been conducted in public hospitals and there is no proper system that can record the maternal history at home and due to the non availability of databases this study had to recruit patients prospectively from the two main public hospitals in Sunyani. This necessarily excludes births in private hospital, clinics and at home. Due to limited voluntary participation of clinicians and budgetary constraints, it was not possible to collect information from all mothers admitted for delivery in the two hospitals from February to March. It should be noted that pregnancy registration was used as a proxy for prenatal care. We were also unable to collect data on nutritional values of the meals taken by the mothers. This might be one of the important factors as reported by others in developing countries (Kramer, 2003) but the number of meals per day was used as a proxy. This study sought to provide baseline information which could help with possible intervention regarding maternal and new-born health Ghana.

The exploratory statistical analyses carried out include descriptive statistics, graphical plots, correlation analysis and cross tabulation. The empirical data on total length of stay (TOS) was modelled using log-normal distribution. The lognormal distribution provides a good description for skewed data originating from time dependent phenomenon.

## RESULTS AND DISCUSSION

Teenage mothers are well known to suffer from adverse pregnancy outcomes (SOGC Policy Statement, 2007). In this study, teenage mothers were associated with longer LOS compared to middle age mothers as reported in Table 1 and depicted by the boxplots in Figure 2. An outlier with LOS (17 days) was observed in the 35 to 39 age group. Furthermore, teenage mothers were associated with low body mass index (BMI) and had lower family income compared to the middle aged mothers. Mothers with parity  $> 4$  were found to be at a higher risk of prolonged hospital stay (Table 2). The average LOS was

**Table 2.** Average LOS for different values of parity.

| Parity | Mean          | Median | IQR |
|--------|---------------|--------|-----|
| 0      | 5.80 ± 0.628  | 4.0    | 6   |
| 1      | 5.00 ± 0.893  | 3.0    | 3   |
| 2      | 4.73 ± 0.779  | 3.0    | 3   |
| 3      | 3.81 ± 0.366  | 3.0    | 3   |
| 4      | 4.44 ± 1.156  | 3.0    | 4   |
| 5      | 10.86 ± 2.241 | 8.0    | 11  |
| 6      | 12.83 ± 3.390 | 12.5   | 17  |
| 7      | 17.00 ± 2.00  | 17.0   | -   |

**Table 3.** LOS by birth weights.

| Birth weight (kg) | Mean         | Median | IQR |
|-------------------|--------------|--------|-----|
| <2.5              | 9.25 ± 0.799 | 3.0    | 2   |
| ≥2.5              | 3.42 ± 0.146 | 8.0    | 12  |

**Table 4.** Moments of TOS.

| Parameter                | 180           | Variance | 25.2937 |
|--------------------------|---------------|----------|---------|
| Mean                     | 5.589 ± 0.374 | Kurtosis | 3.715   |
| Standard deviation       | 5.029         | Median   | 3.00    |
| Skewness                 | 2.045         | Mode     | 2.00    |
| Coefficient of variation | 89.987        | Range    | 24.00   |

from 5.80 ± 0.628 to 17.00 ± 2.00 for parity of 0 and 7, respectively. The scatter plot of TOS and parity is presented as in Figure 3.

Low birth weight (LBW) is considered as a major multifaceted public health concern and serves as a reliable indicator in monitoring and evaluating the success of maternal and child health programs. It is estimated that worldwide 15.5% of all live births per year are LBW and more than 95% of LBW infants are born in developing countries. Several studies have associated LBW neonates with longer LOS (Mishra et al., 2005). The univariate analysis of TOS and birth weight shows that mothers of LBW neonates stayed an average of 5.5 longer than those of normal birth weight neonates. The summary statistics are presented in Table 3.

There was no significant difference between LOS when marital status was considered. The type of residence was also used as an indicator of wealth and the poorer women required longer hospital stay. This is further corroborated by the average LOS when employment status is considered. Employed women recorded the shortest average LOS while housewives recorded the longest TOS. The median length of days and IQR was 3.0 (3), 6.5 (9), 8.0 (10), 3.0 (3) for employed, unemployed,

housewives and self-employed, respectively. Type of fuel was also found to affect the TOS with women using biofuel (firewood) requiring longest TOS. Mishra et al. (2005) studied the effect of cooking smoke and tobacco smoke on the likelihood resulting in a still birth in India and found that both were contributory factors.

Also, women who smoked during pregnancy stayed an average of 11 ± 4.0 days in hospital while the non-smoking mothers stayed an average of 5.50 ± 0.375 days with 3.0 ± 4 and 15.0 ± 12 as the respective medians (IQR). Consumption of alcohol/fermented drinks was found to be associated with longer postpartum stay in hospital. The correlation between some maternal and child covariates were explored to determine the existence (or nonexistence) of correlation among these covariates and LOS, as well as an investigation of linear model fits. Birth weight is positively correlated with gestation age with  $r = 0.77$  ( $p < 0.001$ ) but a line plot did not indicate the presence of a linear relationship. The LogLOS and birth weight were negatively correlated with  $r = -0.512$  ( $P < 0.001$ ), logLOS and gestation age also have a negative correlation of  $r = -0.55$  ( $P < 0.001$ ).

### Fitting the lognormal model to LOS

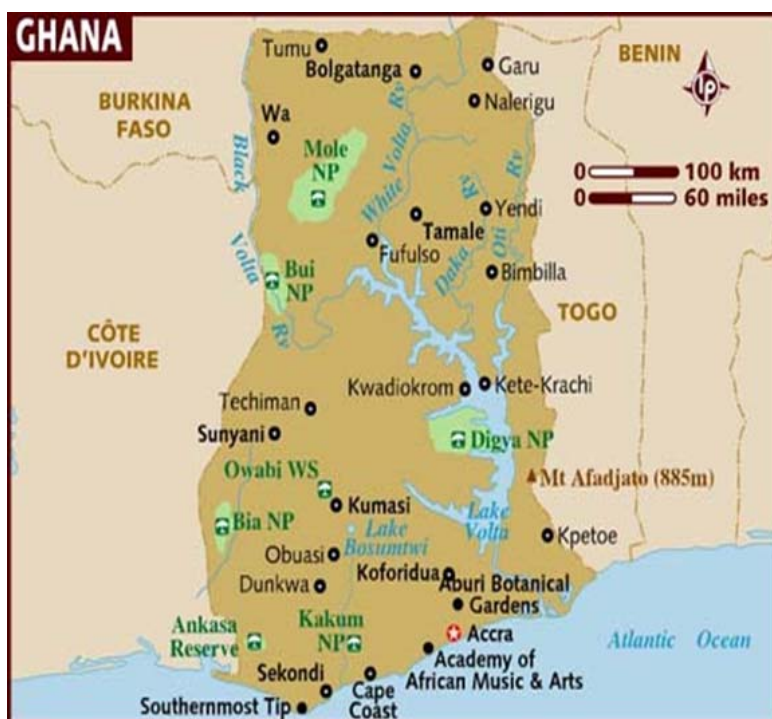
The focus of this study is to evaluate the factors affecting neonatal length of stay in hospital and also to postulate a model that adequately describes the distribution of total LOS. The results for the model fit of TOS considering the exponential, lognormal and Weibull distributions shows the lognormal as providing the best parametric fit of the three distributions considered. The lognormal distribution is used in a wide range of applications, when the multiplicative scale is appropriate and the log-transformation removes the skew and brings about symmetry of the data distribution. Normality is the preferred distributional assumption in many contexts, and logarithm is often the first transformation that an analyst considers to promote it. Linear models are convenient to specify and all the relevant moments are easy to calculate and operate with on the log-scale. One of the most useful concepts in probability distribution theory is that of expectation (moments) of a random variable. The expected value may be viewed as the balance point of distribution of probability on the real line, or in common language, the average. The moments generate the mean, variance, skewness and kurtosis which together, gives a complete picture of the distribution. The moments for TOS are presented in Table 4 and the results of the model adequacy are presented in Table 5.

### DISCUSSION

In this study, the modelling of pre and postpartum LOS,

**Table 5.** Tests of model effects.

| Source    | Type I           |            |    |              | Type III         |            |    |              |
|-----------|------------------|------------|----|--------------|------------------|------------|----|--------------|
|           | Likelihood Ratio | Chi-Square | df | Significance | Likelihood ratio | Chi-Square | df | Significance |
| Intercept | 1810.210         |            | 1  | 0.000        | 135.801          |            | 1  | 0.000        |
| Matage    | 0.167            |            | 1  | 0.683        | 3.010            |            | 1  | 0.083        |
| Gesage    | 249.931          |            | 1  | 0.000        | 105.759          |            | 1  | 0.000        |
| Nvisits   | 19.849           |            | 1  | 0.000        | 19.706           |            | 1  | 0.000        |
| Nchld     | 5.479            |            | 1  | 0.019        | 5.479            |            | 1  | 0.019        |

**Figure 1.** Map of Ghana.

the lognormal model gave the best fit for describing and predicting total LOS. The significance of some maternal and socio economic determinants was also observed. The maternal factors are parity, poverty level and type of cooking fuel. Cooking smoke from biofuel are been identified as a risk factor for pregnancy resulting in stillbirth. In Farhat and Rajab (2011), it was observed that hospital discharge at any time  $\leq 48$  h significantly increased the risk for readmission as well as the risk for readmission due to hyperbilirubinemia. Planning and implementing a structured program for follow up of infants who are discharged  $\leq 48$  h was determined as vital to decreasing the risk for readmission, morbidity and neonatal mortality. This is similar to the findings of Maisels and Kring (1998) that discharge at any time  $< 72$

h significantly increases the risk for readmission to hospital and the risk for readmission with hyperbilirubinemia when compared with discharge after 72 h.

Shah et al. (2012), with the conclusions that younger gestational age, 1 min Apgar score and small size for gestational age are significantly associated with mortality and longer length of stay. The American Academy of Pediatrics recommends that infants discharged  $< 48$  h should be seen by a health care professional within 2 to 3 days of discharge. Our observations, as well as those of others, suggest that this recommendation should also be extended to those discharged at  $< 72$  h after birth. Effective breastfeeding should also be established before discharge as a means of reducing the risk of readmission and neonatal morbidity and mortality.

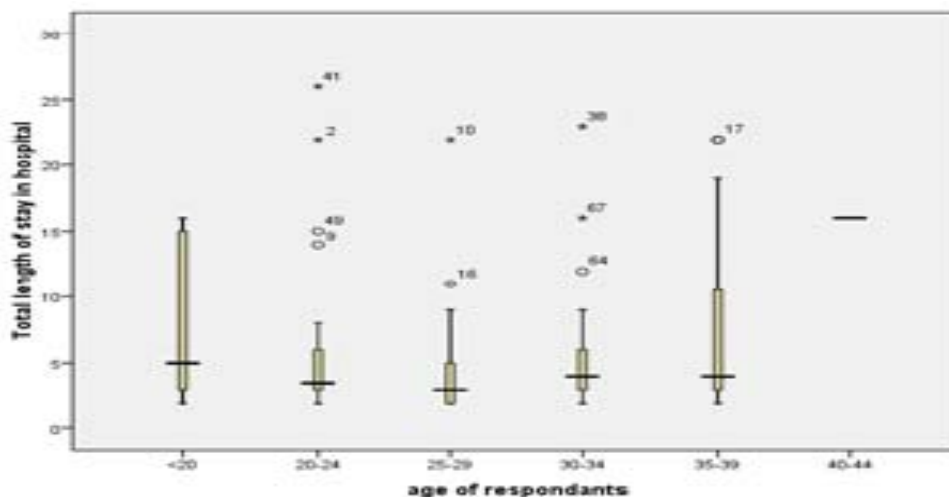


Figure 2. Total length of stay (TOS) and maternal age.

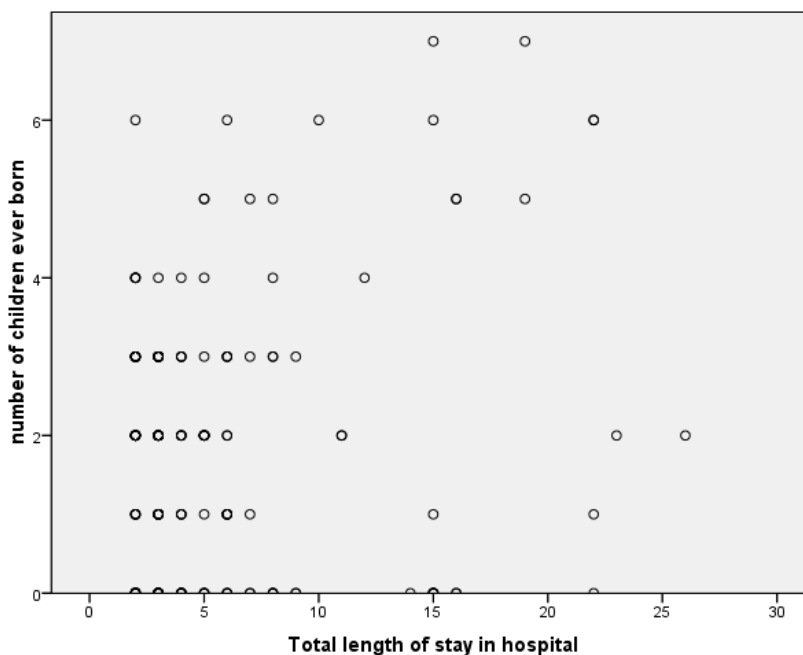


Figure 3. A scatter plot of TOS and parity.

**Conclusion**

In addition to gestational age and birth weight, specific factors related to geo-demographics (maternal age, parity, employment status and income level) were significantly associated with the TOS at the two hospitals surveyed in Sunyani. The results also show that pregnancies exposed to cigarette smoke and alcohol also resulted in longer TOS.

**Conflict of interest**

The authors have no conflict of interest

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