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Burden and factors responsible for neonatal morbidity among Low-Birth-Weight infants in Kenya

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ABSTRACT

Kenya, like the rest of Sub-Saharan Africa and many other developing countries in the world, has made progress in improving newborn health, but did not meet the millennium development goal four for child health. Neonatal morbidity and mortality remains unacceptably high. The objectives of this study were to estimate the burden on neonatal morbidity and determine the socioeconomic and proximate factors responsible for neonatal morbidity in Kenya. A cohort study was carried out at Pumwani maternity hospital, Thika Level 5 hospital and Machakos Level 5 hospital with a sample of 343 stable LBW (≤2000g) infants. Informed by the concepts of Mosley and Chen (1984) analytical framework, several socioeconomic and proximate factors of neonatal morbidity and mortality were examined. Cross tabulations and multiple logistic regression analyses were done to determine the relationships between these factors and neonatal morbidity. The burden of neonatal morbidity was high, 61.5% (N=343) of the low-birth-weight infants. Micronutrient use, lower birth weight, pregnancy history, infant sex being male, birth complications and source of water as rivers, well and ponds were factors responsible for neonatal morbidity. Stakeholders should develop programs that address these factors to improve newborn health among birth-weight infants.

Keywords: Neonatal health; Neonatal morbidity; socioeconomic determinants; proximate determinants; low-birth weight-infants; newborn health

I. INTRODUCTION

Goal 3 of the United Nations Sustainable Development Goals (SDGs) is to ensure healthy lives and promote well-being for all at all ages [1]. Neonatal morbidity is the main cause of neonatal mortality [2]. Globally, it is estimated that neonatal sepsis accounts for 26%-32% of neonatal deaths while asphyxia account for 23%-29% of all neonatal deaths [2,3,4]. A review of exiting community studies showed that neonatal morbidity could be responsible for 42%-50% of neonatal deaths in the first week of life [2,5]. Other causes of neonatal deaths include low-birth-weight (less than 2500 g) which also has a causal relationship with neonatal morbidity [6,7,8,9,10].

The burden of neonatal morbidity is evidently very high. This has been demonstrated in several studies in developing countries [11,12,13]. Kenya, like the rest of Sub-Saharan Africa, has made notable progress in improving neonatal health outcomes. Despite the progress, Kenya did not achieve the Millennium Development Goals for child health [14]. The neonatal mortality in Kenya is 22 deaths per 1,000 live births [15,16]. Most of these neonatal deaths (30%), are caused by severe neonatal infections [34]. Addressing neonatal morbidity is therefore a health priority, to enable Kenya achieve the vision 2030 and goal 3 of the SDGs [1,17].

Currently, most neonatal infections in many developing countries stem from a failure to identify and address socioeconomic and other pertinent factors associated with the incidence of neonatal morbidity [2]. Mosley and Chen (1984) [31] developed an analytical framework for analyzing determinants of child health. According to the model, impact on morbidity and mortality is influenced by socioeconomic determinants (independent variables) that operate through a certain set of proximate determinants (intermediate variables). Socioeconomic determinants include variables that relate to productivity of mothers and fathers. Education level of parents influences their occupation and buying power of the household. Income influences neonatal survival through food choices, water (quantity and quality), housing, clothing, hygiene and sickness care among others [18,19]. Higher education levels are associated with better neonatal outcomes [20] High education, especially maternal, improves the status of women and access to information and health services. Mother's time is necessary for a healthy baby as she requires time for prenatal visits and breastfeeding among others. Traditions, norms and attitudes include factors that affect the economic and health related practices. These may include factors like power relationships within the household, value of children and belief about disease causation among others [21,22,23,24].

The proximate determinants that directly influence the risk of neonatal morbidity and mortality has been identified as maternal factors; environmental contamination; nutrient deficiency; injury; and personal illness control. Factors that affect maternal health has impact on neonal survival. These factors may include age, parity and birth interval. Synergism between these factors may also ocur and this differentially affect child health and survival especially when two or more such unfavorable factors occur together [21]. Household crowding, source of water supply, food handling practices, incidence of diarrhea and/or presence of latrines or toilettes are physical indices associated with environmental contamination. The contamination is directly associated with neonatal morbidity. Nutrient deficiency influence child survival based on the nutrients available to the neonate and the mother [18,21]. Nutrient deficiency during lactation can affect the quality of breastmilk. On the other hand, injuries reflect environmental risks that differ in socioeconomic and environmental contexts. Incidence of injuries whether intentional or accidental affect neonatal survival [18,21]. Personal illness control influences the rate of developing neonatal illness. Personal illeness control entail medical interventions like curative mesures of existing and diagnosed diseases. Timely access to quality medical interventions may be associated with favorable neonatal outcomes [1,25,26].

This study addresses one of the major areas of research needed to advance newborn health by investigating the risk factors of neonatal morbidity in low income countries. This knowledge is useful in tailoring interventions to curb the high neonatal mortality, especially among LBW infants which is an overriding factor contributing to the majority of neonatal deaths.

II. METHODS AND MATERIAL

A. Study Design and Setting

A cohort study was carried out at Pumwani Maternity hospital, Thika Level 5 hospital and Machakos Level 5 hospital. This study was done as part of a larger study on the effectiveness of early intermittent Kangaroo Mother Care; A quasi-experimental study. The facilities were roughly similar in patient population characteristics and the health care system. Pumwani hospital, located in Nairobi, is one of the largest public maternity referral hospitals in Kenya with 350 beds and 150 cots [21]. Thika Level 5 hospital is one of the largest public hospitals in Kiambu County with 265 beds and 24 cots while Machakos Level 5 hospital is the biggest public health facility in Machakos County with 375 beds and 57 cots [27]. The study population was all stable LBW infants weighing ≤2000 grams irrespective of their gestational age who were admitted at the three hospitals during the study period.

The sample size was 343 drawn from the three facilities by consecutively enrolling eligible LBW infants into the study. The inclusion criteria for the study was infants weighing ≤2000 grams irrespective of their gestational age, infants less than 72 hours of life, stable infants (not on oxygen or phototherapy, on full feeds and retaining, Oxygen saturation of >95%, Heart rate of >100 beats per minute, capillary refill <3 seconds) and willingness to give written consent. LBW infants with major congenital malformations or severe perinatal complications and cases where the caregiver was unwilling to give written consent were excluded from the study. The follow up period was the neonatal period (28 days).

B. Data Collection and Procedures

Data was collected between June 2016 to June 2017 using structured tools which were guided by the concepts of the Mosley and Chen (1984) analytical framework [21] and from literature review (Fig. 1).

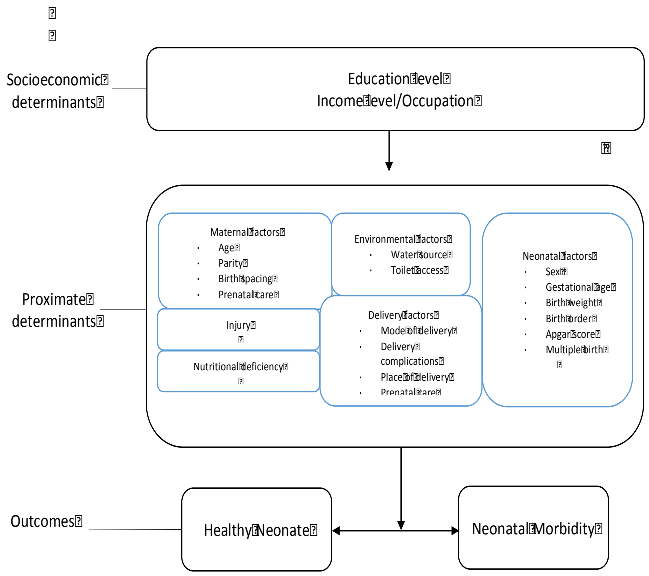

Figure 1: Adopted Mosley and Chen Analytical Framework (1984) [21]

Tools were pre-tested before onset of the study. Data was collected by two research assistants in each hospital from mothers and infants who met the eligibility criteria. The research assistants were trained on questionnaire administration and their roles were to distribute, administer, collect the questionnaires and clarify instructions if necessary. An entry questionnaire was adminstered within 72 hours post delivery through face to face interviews in the postnatal ward, at a time that was convenient to the mother. An exit questionnaire was administered at the last follow up (at 28 days of age) asking details about incidence of injury, nutritional factors and environmental factors. Data was also abstracted from the patient files.

C. Variables

The dependent variable was incidence of neonatal morbidity which was coded as: No incidence of morbidity=0 and incidence of morbidity=1. Independent variables were socioeconomic variables (education level of husband/spouse and mother, income level, and occupation) and proximate variables like maternal factors (age, parity, birth spacing and prenatal care), delivery factors (mode of delivery, delivery complications and place of delivery), injury, nutritional deficiency, environmental factors (water supply and presence of toilets) and neonatal factors (sex, gestational age at birth, birth weight, birth order, Apgar score and multiple birth).

D. Data Management and Analysis

Microsoft Excel was used for data entry and storage. Data analysis was done using Stata Statistical Software: Release 14 [28]. An alpha of 0.05 was used for statistical significance. Initially, basic descriptive statistics were used to describe the respondents' socioeconomic characteristics. Cross tabulations were done to determine the relationships between independent and dependent variables (neonatal morbidity). Multiple logistic regression analysis was conducted to determine the predictors of neonatal morbidity. The variables included in the regression model were based on their clinical significance. A backward stepwise method was used in coming up with a minimum set of determinants that resulted in the optimal predictive model of the final outcomes. Subgroup analysis was also done for neonatal sepsis and incidence of hospital readmission.

E. Ethical Considerations

Ethical clearance for the study was given by the Kenyatta National Hospital Ethics Review Committee after reviewing the study protocol. Institutional permission was sought from the respective County authorities and Medical Superintendents of the study hospitals. Permit to conduct the study was given by National Comission for Science, Technology and Innovation (NACOSTI). An informed consent was obtained and confidentiality was ensured by coding the questionnaires.

III. RESULTS AND DISCUSSION

A. Results

i. Socioeconomic characteristics,

A total of 343 LBW infants were recruited in the study between July 2016 to June 2017. The mean age of the mothers was 25.4 (SD=5.3), range 15-45 years. Majority of the mothers, 79.9% (N=343) were married/cohabiting, with half of them (50.2%, N=343) having secondary education. More than half of their spouses (59.4%, n=283) had secondary education. A third of the mothers had household income of below 6,000 Kenya shillings per month (about 60 USD), with majority 78.1% (N=343) renting the house they were living in. Two in every ten (22.2%, n=338) of the mothers were living in a temporary house with a similar number (23.9%, N=343) having no access to a toilet. A third of the mothers used kerosene as the main fuel for cooking. A small fraction of mothers, 5.5% (N=343) used river/pond as the source of water for drinking. A few of the respondents, 10.9% (n=339) had an incidence of diarrhea in the last three months before delivery. The distribution socioeconomic characteristics was as shown in Table 1.

ii. Proximate characteristics,

The average birth weight was 1492.6 grams (SD=275.3), range 700-2000 grams. The average gestational age among the mothers was 30.3 weeks (3.8), 20-40 weeks. More than half (59.8%, n=343) of the infants were female, and majority (78.4%, N=343) were born in the study hospital. Most of the infants (83.3%, n=342) were born through spontaneous vagina delivery and only a third (29%, n=341) were multiple births. Delivery complications were recorded in 26.6% (n=342) of the births. About two thirds (63.9%, n=144) of the infants had a birth interval of more than 36 months. A few of the mothers (4.4%, n=342) reported taking only one meal on average during their most recent pregnancy. Most (93.2%, n=339) of the mothers attended antenatal clinic while pregnant. About half (51.4%, n=329) of the mothers reported having no pregnancy loss and having 1 or more live births prior to their most recent pregnancy. Nearly a third (30%, N=343) of the mothers had not used micronutrient supplementation during their most recent pregnancy. HIV prevalence was 8.5% (n=329) among the mothers while prevalence of non communicable diseases was 13.1% (N=343) among the mothers. A few (2.9%, N=343) of the mothers reported use of alcohol during pregnancy while 0.9% (n=342) smoked cigarette during pregnancy. Some 7.7% (n=274) of the mothers reported that their spouses smoked cigarettes during the pregnancy period. Majority (81.4%, n=301) of the infants had an Apgar score at 1 minute of more than 5.

iii. Incidence of neonatal morbidity,

TABLE 1. ASSOCIATION BETWEEN SELECTED SOCIOECONOMIC CHARACTERISTICS AND NEONATAL MORBIDITY

Variable		**Infant complication (Yes)**	**P Value**
		n (%)	
Marital status	Married	170 (62%)	0.689
	Single	41 (59.4%)	
Maternal level of education	Primary & below	79 (67%)	0.27
	Secondary	99 (57.6%)	
	Tertiary	33 (62.5%)	
Spouses level of education	Primary & below	27 (53%)	0.481
	Secondary	104 (61.9%)	
	Tertiary	40 (62.5%)	
Household income per month	<6000	76 (69.1%)	0.053
	6000 to 15000	58 (53.2%)	
	>15000	63 (62.4%)	
Type of house ownership	Own	51 (68%)	0.192
	Rented	160 (59.7%)	
Access to toilet	No	61 (74.4%)	0.006*
	Yes	150 (57.5%)	
Source of fuel for cooking	Electricity/Gas	99 (60.7%)	0.0064*
	Charcoal	55 (72.4%)	
	Kerosene	57 (55.3%)	
Source of drinking water	Piped	163 (57.4%)	0.003*
	River/pond	16 (84.2%)	
	Well/borehole	32 (80%)	
Incidence of diarrhea in last 3 months	No	184 (60.9%)	0.269
	Yes	26 (70.3%)	

*. The Chi-square statistic is significant at the 0.05 level

Almost two thirds (61.5%, N=343) of the LBW infants had an incidence of neonatal morbidity and more than half (53.9%, N=343) of the LBW infants had an incidence of neonatal sepsis. Neonatal sepsis was the most common form of neonatal morbidity, accounting for 87.7% (n=211) of the neonatal morbidity. A total of 14 (4.5%, n=314) neonates were readmitted to hospital after discharge.

iv. Association between selected socioeconomic characteristics and neonatal morbidity,

The relation between access to toilet, source of fuel for cooking and source of drinking water were significantly associated with incidence of neonatal morbidity ($p<0.05$). There was no significant relationship between the other socioeconomic characteristics and incidence of neonatal morbidity ($p>0.05$).

v. *Association between selected proximate characteristics and neonatal morbidity,*

Among the proximate characteristics, delivery complications, pregnancy history and use of micronutrients were significantly associated with neonatal morbidity ($p<0.05$). The other proximate characteristics including infant sex, place of delivery, mode of delivery, multiple births, birth interval, average number of meals per day during pregnancy, ANC attendance, HIV status, NCDs and Apgar score at one minute were not significantly associated with infant complications ($p>0.05$).

TABLE 2. ASSOCIATION BETWEEN SELECTED PROXIMATE CHARACTERISTICS AND NEONATAL MORBIDITY

Variable		Neonatal morbidity (Yes)	P Value
		n (%)	
Infant Sex	Female	124 (60.5%)	0.633
	Male	87 (63%)	
Place of delivery	This hospital	163 (60.6%)	0.065
	Another hospital	35 (74.5%)	
	Home	13 (48.2%)	
Mode of delivery	CS	31 (54.4%)	0.233
	Normal	179 (62.8%)	
Multiple births	No	145 (59.9%)	0.244
	Yes	66 (66.7%)	
Delivery complications	No	144 (57.4%)	0.011*
	Yes	66 (72.5%)	
Birth interval	<18 months	19 (79.2%)	0.094
	18-36 months	14 (50%)	
	>36 months	58 (63%)	
Average number of meals per day when pregnant	One	10 (66.7%)	0.484
	Two	29 (70.7%)	
	Three	114 (58.5%)	
	More than three	57 (62.6%)	
ANC attendance	No	10 (43.5%)	0.068
	Yes	198 (62.7%)	
Pregnancy history	Never pregnant	56 (50%)	0.007*
	No pregnancy loss with 1 or more live births	110 (65.1%)	
	1 or more pregnancy loss with 1 or more live births	30 (79%)	
	1 or more pregnancy loss with no live birth	6 (60%)	
Use of micronutrient supplementation	No	48 (46.6%)	0.000*
	Yes	163 (67.9%)	
HIV status	Negative	184 (61.1%)	0.283
	Positive	20 (71.4%)	
Chronic conditions (NCDs)	No	181 (60.7%)	0.446
	Yes	30 (66.7%)	
Apgar score at 1 minute	Apgar score 1-5	37 (66.1%)	0.536
	Apgar Score 6-10	151 (61.6%)	

*. The Chi-square statistic is significant at the 0.05 level

The gestational age, birth weight, age of the mother and birth order were not statistically associated with the incidence of neonatal morbidity ($p>0.05$).

vi. *Multiple analysis of association of selected determinants with neonatal morbidity,*

A multiple logistic regression analysis was performed to ascertain the effects of socioeconomic characteristics and proximate characteristics on the likelihood of developing neonatal morbidity. Eight successive iterations were performed using backward and forward stepwise method retaining only ten determinants in the final model. The logistic regression model as a whole was statistically significant [likelihood ratio $\chi 2$ (13) = 86.33, $p < 0.000$].

Use of micronutrients was significantly associated with incidence of neonatal morbidity. LBW infants whose mothers used micronutrients were 4.3 times [95% CI, 2.1-8.7, p=0.000] more likely to develop neonatal morbidity than infants whose mothers did not use micronutrients during pregnancy.

The infants birth weight (grams) was significantly associated with incidence of neonatal morbidity. Every unit increase in birth weight (1 gram) was associated with a 1% reduction of incidence of neonatal morbidity [OR=0.99, 95% CI, 0.995-0.997, p=0.000].

Infant sex was significantly associated with incidence of neonatal morbidity. LBW male infants were 2.5 times more likely to develop neonatal morbidity compared to LBW female infants [OR=2.5, 95% CI, 1.3-4.8, p=0.005]. Complications during delivery were significantly associated with incidence of neonatal morbidity. Those with birth complications were 2.9 times [95% CI, 1.4-5.9, p=0.004] more likely to develop neonatal morbidity compared to LBW infants whose mothers did not experience delivery complications.

There was a significant association between water source and and incidence of neonatal morbidity. The incidence of morbidity was 11.5 times higher among those who used water from rivers/ponds compared to those who used piped water [OR=11.5, 95% CI, 1.8-73.8, p=0.01]. The incidence of morbidity was 4.4 times higher among those who used water from a well or borehole [OR=4.4, 95% CI, 1.3-14.5, p=0.014].

The other socioeconomic and proximate characteristics were not statistically significant predictors of incidence of neonatal morbidity (p>0.05).

TABLE 3. ASSOCIATION OF SELECTED DETERMINANTS WITH NEONATAL MORBIDITY

Neonatal morbidity	Adjusted Odds Ratio	P value	[95% Conf. Interval]	
			Lower	Upper
Micronutrient use	4.309736	0.000	2.146884	8.651527
HIV status	2.304508	0.164	0.7110904	7.468468
Birth weight	0.9960246	0.000	0.9945579	0.9974936
Gestational age	1.038182	0.407	0.9502162	1.134291
Infant sex	2.525618	0.005	1.327304	4.805794
Maternal Education level				
Primary and below	Reference category			
Secondary	0.7624738	0.447	0.3787448	1.534981
Tertiary	0.6281353	0.414	0.2060756	1.914608
Birth complication	2.888588	0.004	1.391976	5.994313
Partner smoking status	2.937215	0.115	0.7693452	11.21374
Water source				
Piped	Reference category			
River/pond	11.45693	0.01	1.778629	73.79913
well/borehole	4.425524	0.014	1.34663	14.54391
Household income				
<6000 (about 60 USD)	Reference category			
6000 to 15000	0.751173	0.481	0.3391824	1.663591
>15000	1.071953	0.872	0.4606837	2.494299
_cons	6.244379	0.248	0.278662	139.9268

B. Discussion

This study found that neonatal morbidity was very high, with about two thirds of the LBW infants having an incidence of neonatal morbidity. There are other studies that have shown similar high incidences of morbidity, with a particular one in India reporting incidences of 72.2% [11].

Our study found that there was a significant relationship between source of drinking water with incidence of neonatal morbidity. This is in line with the analytical framework used in the study [21]. Socioeconomic determinants influence neonatal morbidity through proximate determinants. The model considers these socioeconomic determinants as household level factors that affect child health. Source of drinking water is influenced directly by household income, though as a variable was not significantly associated with incidence of morbidity in our study. Maternal and spouse's level of education would influence the household income as a higher level of education would be associated with getting a better job and that increase the household income, but these too were not statistically significant.

This study investigated other socioeconomic characteristics including marital status of the mother and incidence of diarrhea in the last three months before delivery. These characteristics did not have a significant relationship with neonatal morbidity. A study done in Nigeria found a significant relationship between level of education of mothers and neonatal morbidity [31]. They however did not investigate other socioeconomic characteristics.

The analytical framework (Fig. 1) identifies the proximate determinants that directly influence the risk of neonatal morbidity. Our study found that micronutrient use, birth weight, infant sex, delivery complications and water source were significantly associated with incidence of neonatal morbidity among LBW infants. The proportion of LBW infants with morbidity was higher among the mothers who used micronutrients supplements. This is contrary to existing literature where routine iron supplementation during pregnancy has a significant benefit in reducing incidence of anemia in mothers and improved perinatal outcomes including reduced low birth weight delivery [29]. Contrary to our findings, Olayinka, Abimbola and Adeleke (2012) [30] found place of delivery to be significantly associated with neonatal morbidity. Other studies have reported contrary findings. Njim et al. (2015) [31] found that NCDs (hypertensive diasorders) and HIV infection were significantly associated with neonatal morbidity. Njim et al. (2015) [31] also found maternal age >36 years contributing signifantly to neonatal morbidity. Our study found no significant relationship between neonatal morbidity with maternal age, though most of the mothers in our study were much younger.

A study in India on LBW ≤2000 grams [32] also found a correlation between birth weight and neonatal morbidity, just as we did in our study. Birth order however was not a significant factor in neonatal morbidity in our study as outlined in the Mosley and Chen (1984) [21] analytical framework. We found that LBW male infants had a significantly higher risk of developing neonatal sepsis and/or morbidity. In a similar weight category study of LBW infants, Janaswamy et al. (2016) [32] found that sex of the infant was not a significant predictor of neonatal morbidity.

IV.CONCLUSION

This study investigated the risk factors of neonatal morbidity in Kenya, which is applicable in other developing countries. We identified that neonatal morbidity was high among certain respondent characteristics like micronutrient use, lower birth weight, infant sex being male, birth complications, and source of water as rivers, well and ponds. This knowledge is useful in tailoring interventions to improve newborn health, and ultimately reduce neonatal mortality. There is need to investigate the relationship between micronutrient use and increased incidence of neonatal morbidity.

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