Causes and Risk Factors for Neonatal Mortality-A Community based case Control Study from Kollam, Kerala

Rakesh PS[a], Sheeja AL[b], Faizal Subair[c], Renjini BA[d], Subhagan S[e], Salila K[f]

a. District Epidemiologist, District Medical Office, Kollam; b. District Reproductive and Child Health Officer, Kollam;
c. School Health Co-ordinator, National Health Mission, Kollam; d. SSS Hospital, Kottarakkara;
e. District Programme Manager NRHM, Kollam; f. District Medical Officer, Kollam*

ABSTRACT

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Research Question: What are the causes and risk factors for neonatal deaths Kollam district, Kerala?

Settings: Kollam district, Kerala with total population of 2.6 million, birth rate of 15/1000 population and a female literacy rate of 92%.

Study design: A community based case control study

Participants: A case was defined as a neonatal death among the permanent residents of the district during January 1st to March 31st 2013. Controls were chosen by simple random sampling from a sampling frame of all children who were born alive in the study population, +/- 7 days from the day of birth of the case and the baby being alive and well on the 28th day of life.

Methodology: Causes of neonatal deaths were ascertained based on information from death audits, hospital records and verbal autopsy. Mother's of cases and control were interviewed at their home using a structured questionnaire.

Results: A total of 40 neonatal deaths and 80 controls were studied. Prematurity (35%) and congenital anomalies (27.5%) were the major causes of neonatal deaths. History of previous infant death [OR 13.02 (95% CI 1.24-131.2)], premature rupture of membranes [OR 3.46 (95% CI 1.28-10.36)], Low birth weight [OR 3.12 (95% CI 1.42-8.48)], Prematurity [OR 2.78 (95% CI 1.09-7.12)] and domestic violence during pregnancy [OR 11.37 (95% CI 1.32-137.11)] were identified as significant risk factors for neonatal mortality in the current study.

Keywords: Con genital anomalies, Domestic violence, Low birth weight, Neonatal mortality, Prematurity, Verbal autopsy

*See End Note for complete author details

INTRODUCTION

Neonatal deaths account for 40% of deaths under the age of five years worldwide.[1] The United Nations Millennium Development Goal 4 of reducing childhood mortality by two-thirds by 2015 will not be possible without substantial reduction in neonatal deaths.[2]

In India, around one million babies die each year before they complete their first month of life, contributing to one-fourth of the global burden.[3] While India has made significant gains in child survival in the age-group 1-4 years since 1990 (56 per cent decline over 30 years) the overall decline in child mortality was largely hindered by subdued progress in the area of neonatal deaths, especially within the first week of birth.[4,5]

Kerala state has made remarkable progress in reducing infant mortality rates as compared to other states in the country.[4] The infant and neonatal mortality rates of Kerala are 12 and 7 as compared to the country's average of 46 and 35 per 1000 live births.[6] The strategies and factors that contributed to Kerala's achievement have been well researched and documented.[7] But infant and neonatal mortality rates have been almost stagnant in the state over the last decade.[5]

For further reduction in neonatal deaths Kerala, strategies have to be framed to address specific risk factors that influences on neonatal deaths in state. The current study was done with an objective to identify the causes and risk factors for neonatal deaths Kollam district, Kerala. Identifying the causes and risk factors for neonatal mortality will help policy makers and health care providers to plan and implement targeted programs to further reduce the number of neonatal deaths.

Corresponding Author:
Dr. Rakesh PS, District Epidemiologist, District Medical Office, Kollam.
Phone: 9495537333. E-mail: rakeshrenjini@gmail.com

Table 1. Details of neonatal deaths (N=40)		
Characteristics	Categories	No. (%)
Time of neonatal death	<24hrs	12 (30%)
	24-48 hours	08 (20%)
	2-7 days	11 (27.5%)
	7-28 days	9 (22.5%)
Place of neonatal death	Govt. Secondary care center	02 (5%)
	Private secondary care center	04 (10%)
	Govt. Tertiary care center	27 (67.5%)
	Private tertiary care center	01 (2.5%)
	Home	02 (5%)
	In between referral	04 (10%)
Underlying cause of death	Prematurity	14 (35%)
	Congenital anomalies	11 (27.5%)
	Birth asphyxia	03 (7.5%)
	Infection/sepsis	03 (7.5%)
	Maternal causes	03 (5%)
	IUGR/Low birth weight	02 (5%)
	Others	04 (10%)

MATERIALS AND METHODS

Kollam, a district located in the south west cost of Kerala, Southern India has a population of around 2.6 million. Decadal growth rate of Kollam is 1.73 against 4.86 in the State. Sex ratio is 1113 females for 1000 males. Literacy rate for females is 91.95%. Rural population in the district is about 54.95% and 0.2% belonged to scheduled tribes. Health care is provided by 54 primary health centers (PHC), 17 community health centers and four certified first referral units in the Government sector and numerous private clinics and hospitals. There is no tertiary care center in the Government sector in the district.

A community based case control study was conducted to identify the factors associated with the neonatal deaths in the district. A case was defined as a neonatal death (< 28 completed days since birth) following a live birth among the permanent residents of the district during January 1st to March 31st 2013. Controls were chosen by simple random sampling from a sampling frame of all children who were born alive in the study population, +/-7 days from the day of birth of the case and the baby being alive and well on the 28th day of life.

Sample size was calculated with an alpha error of 5% and a beta error of 20% and an anticipated odds ratio of four. With an assumption of proportion of controls with 'preterm birth' as 10% and for two controls per case, number of cases needed was calculated to be 40 and controls to be 80.

All infant deaths have been reported over phone by Junior Public Health Nurses (JPHNs- female health workers). The Medical Officer of the concerned PHC has done a preliminary death audit to identify the cause of death. Information including certified cause of death has been collected from the hospitals regarding the same and the information was triangulated. The International standard verbal autopsy questionnaire developed by the World Health Organization was used to identify probable cause of deaths, in doubtful cases.[8] The purpose of verbal autopsy questionnaire was to distinguish among stillbirths and early neonatal deaths and to determine causes of neonatal deaths.

A questionnaire was framed based on literature review, expert opinion and group consensus. It included socio demographic characteristics, antenatal, obstetric, details of delivery, quality of antenatal services, personal and environmental history, domestic violence and services by health system. Domestic violence was assessed using the translated version of HITS domestic violence screening tool for use in the community.[9] Thirty JPHNs have been trained over two days regarding data collection. The questionnaire was translated to Malayalam, the regional language and back translated to test for consistency. It was pilot tested before initiating the study.

Data entry was done using the software Epi- Info2002 version 3.5.1. Statistical analysis software SPSS for windows 12.0 was used for the analysis. Descriptive statistics for cause of death was done. Univariate analysis for factors associated with neonatal deaths was done, generating odds ratio and 95% confidence intervals. Logistic regression has been performed with variables of groups 1, 2 and 4 (socio demographic, maternal factors, and domestic violence); all maternal and antenatal variables considered to be associated with the outcomes at p< 0.2 were included. Selected variables from the other group (neonatal factors) were then added in a backward conditional logistic regression model along with the variables selected in the former stage in each group so that the variables remained in the model, was p<0.05.

OBSERVATIONS

There were 43 neonatal deaths reported during the study period (NMR=5.51/1000 live births). It constituted of 75% all infant deaths reported during the period (IMR=7.17/1000 live births).

Two of the mothers were not available for interview as they temporarily moved out of the district. One family

Table 2. Socio demographic characteristics of the study subjects			
Characteristics	Categories	Cases (N=40)	Controls (N=80)
Age of mother	<19 years	3 (7.5%)	5 (6.3%)
	20-24 years	12 (30%)	27 (33.8%)
	25-29 years	13 (32.5%)	25 (31.3%)
	30-34 years	12 (30%)	21 (26.3%)
	> 35 years	0	2 (2.5%)
Educational Status of Mother	< 8th standard	01 (2.5%)	01 (1.3%)
	8-10th standard	16 (40%)	29 (36.3%)
	11-12th standard	15 (37.5%)	28 (47.6%)
	Graduate	08 (20%)	12 (15%)
Mother employed	YES	09 (22.5%)	11 (13.8%)
	NO	31 (77.5%)	69 (86.3%)
Educational Status of Father	< 8th Standard	03 (7.5%)	02 (2.5%)
	8-10th standard	23 (57.5%)	37 (46.3%)
	11-12th standard	06 (15%)	15 (18.8%)
	Graduate	08 (20%)	26 (32.5%)
Socio economic Status	APL Card holders	25 (62.5%)	59 (73.8%)
	BPL Card holders	15 (37.5%)	21 (26.3%)
Religion	Hindu	25 (62.5%)	55 (68.8%)
	Christian	10 (25%)	16 (20%)
	Muslim	05 (12.5%)	09 (11.3%)
Caste	Scheduled Caste	07 (17.5%)	07 (8.8%)
	Other Backward	17 (42.5%)	36 (45%)
	Others	16 (40%)	37 (46.3%)
Type of family	Nuclear	22 (55%)	38 (47.5%)
	Joint/Extended	18 (45%)	42 (52.5%)

did not give consent for the study. A total of 40 cases and 80 controls were included in the analysis.

Out of the neonatal deaths, 77.5% (31/40) deaths were Early Neonatal Deaths, and 50% happened within first two days. Prematurity was identified as the underlying cause of 35% of the neonatal deaths. Congenital anomalies contributed to 27.5% of neonatal deaths.

In the study, 7.5% (3/40) and 6.3% (5/80) of the mothers were less than 19 years, among the cases and controls respectively. There was no statistically significant difference in the Socio economic status, age of mother, age of father, educational status of parents, caste, mother's employment status or type of family among the cases and controls. The details of socio demographic characteristics of cases and controls are shown in Table 2.

The relationship of the neonatal deaths to mother's height, weight, order of birth has shown no significant difference between cases and controls. In the study, 22.5% (9/40) of the cases and 16.3% (13/80) of the controls had their antenatal registration beyond first

trimester (p 0.27). Among them, 95% of the cases and 97.5% of the controls had more than five antenatal visits to a gynecologist. The details of antenatal care and high risk factors have been shown in Table 3.

Of the neonatal deaths, 55% happened among females. 50% of the babies died during neonatal period had a low birth weight (<2.5kg), while the figure was 17.5% among the controls (p <0.001). 45% of the neonatal deaths happened in babies born pre-term (<37 weeks). The proportion of babies born preterm among controls was 17.5% (p<0.05). 22.5% of the babies

Table 3. Obstetric characteristics and antenatal care received				
Characteristics	Categories	Cases (N=40)	Controls (N=80)	P value
Order of birth	First	20 (50%)	48 (60%)	0.19
	Second	15 (37.5%)	26 (32.5%)	
	Third	05 (12.5%)	06 (8.5%)	
Maternal Height	<150 cm	09 (22.5%)	08 (10%)	0.06*
Mother's weight (at the time of	<47 kg	09 (22.5%)	15 (18.8%)	0.39
Antenatal Registration	Late registration (>12 weeks)	9 (22.5%)	13 (16.3%)	0.27
Total number of antenatal visits to a doctor	<5 visits	2 (5%)	2 (2.5%)	0.51
Total number of visits by or to a health worker	< 3 visits	12 (30%)	27 (33.8%)	0.42
No of USS Scans	< 3 Scans	10 (25%)	18 (22.5%)	0.46
IFA tablets consumed	<90 tablets	09 (22.5%)	12 (15%)	0.22
High risk factors during the pregnancy	RTI/UTI	9 (22.5%)	19 (23.8%)	0.53
	Twins	3 (7.5%)	2 (2.5%)	0.21
	GDM	6 (15%)	7 (8.8%)	0.23
	PIH	12 (30%)	11 (13.8%)	0.03*
	Antenatal high grade fever	10 (25%)	11 (13.8%)	0.10
	Previous Infant Death	04 (10%)	01 (1.3%)	0.04*
	Treatment for infertility	02 (5%)	06 (7.5%)	0.22
	Previous preterm	02 (5%)	03 (3.8%)	0.54
	Consanguineous marriage	03 (7.5%)	05 (6.3%)	0.53
	Previous LBW baby	01 (2.5%)	03 (3.8%)	0.59
	Maternal anemia (Hb <11g/dl)	14 (35%)	20 (25%)	0.17

*p<0.05 GDM- Gestational Diabetes Mellitus, PIH- Pregnancy Induced Hypertension, RTI- Reproductive Tract Infection

died at neonatal period were born before 32 weeks of gestation, while only 1.3% of the controls were born extremely preterm. 30% of the cases had premature rupture of membrane while the figure was 11.3 % among the controls (p0.012). 57.5% of the cases and 60% of the controls had caesarian section (p 0.116). Fourteen babies were referred to a higher center after birth. Ambulance with basic facilities was available for one baby. In the study, 17.5% of mothers with a neonatal death and 1.3% of mothers without neonatal deaths experienced domestic violence during the current pregnancy period (p<0.01).

In the final logistic regression model, history of previous infant death [OR 13.02 (95% CI 1.24-131.2)], premature rupture of membranes [OR 3.46 (95% CI 1.28-10.36)], Low birth weight [OR 3.12 (95% CI 1.42-8.48)], Prematurity [OR 2.78 (95% CI 1.09-7.12)] and domestic violence during pregnancy [OR 11.37 (95% CI 1.32-137.11)] were identified as significant risk factors for neonatal mortality in the current study (Table 6).

Table 4. Details of delivery and characteristics of newborn				
Character-istics	Categories	Cases (N=40)	Controls (N=80)	Odds Ratio (95% Confidence Interval)
Gender	Female	22 (55%)	42 (52.5%)	1.11 (0.52-2.37)
	Male	18 (45%)	38 (47.5%)	
Gestational Age	< 32 weeks	09 (22.5%)	01 (1.3%)	28.27 (2.38-235.39)*
	32-34 weeks	03 (7.5%)	02 (2.5%)	4.71 (0.79-29.99)
	34-37 weeks	06 (15%)	08 (10%)	2.35 (0.73-7.52)
	>=37 weeks	22 (55%)	69 (86.3%)	Reference Category
Birth weight	< 1kg	06 (15%)	0	-
	1-1.49 kg	04 (10%)	01 (1.3%)	13.20 (1.39-124.9)*
	1.5-1.99 Kg	03 (7.5%)	03 (3.8%)	3.30 (0.62-17.54)
	2-2.49 Kg	07 (17.5%)	10 (12.5%)	2.31 (0.78-6.85)
	>=2.5 Kg	20 (50%)	66 (82.5%)	Reference Category
PROM	YES	12 (30%)	09 (11.3%)	3.38 (1.28-8.91)*
	NO	28 (70%)	71 (88.2%)	
Type of Delivery	LSCS	23 (57.5%)	48 (60%)	0.90 (0.41-1.95)
	Vaginal	17 (42.5%)	32 (40%)	800

*p<0.05 LSCS- Lower Segment Caesarian Section

DISCUSSION

The success of Kerala state in reducing infant mortality has been attributed to its overall development characterized by high female literacy, higher status of women in the society, good accessibility of health services even in rural areas and equitable distribution of wealth resulting from land reforms.[7] Kerala outperform other states in terms of delivery care, with nearly all deliveries taking place in medical institutions. However the fall in mortality has more or less reached a plateau; and achieving a further decline in infant mortality from the current levels of 10-15/1000 live births, will not be an easy task.

Prematurity (35%) and congenital anomalies (27.5%) were leading causes of neonatal deaths identified in this study. Neonatal infections, birth asphyxia and prematurity were identified as the major causes of neonatal mortality in India.[10,11] In Kerala, as other causes of death like infections and birth asphyxias are decreased due to a high hospital delivery rate, proportion of deaths because of prematurity and congenital anomalies are likely to increase.

Preterm birth is the leading cause of new born deaths and the second leading cause of death after pneumonia in children under five years.[12] Common causes of preterm birth include multiple pregnancies, infections and chronic conditions, such as diabetes, high blood pressure and obesity; however, often no cause is identified.[13-15] The alarmingly increasing trends of obesity and diabetes in Kerala have to be viewed seriously in this context also.

Despite the burden of preterm birth, few effective prevention strategies are available for clinicians, policy-makers and program managers.

Multiple studies in high-income contexts have attempted to prevent preterm birth, yet have failed to identify high-impact interventions in the preconception and antenatal periods.[16] Pre- eclampsia and eclampsia prevention, detection and treatment of asymptomatic bacteriuria, corticosteroids for preterm labour, antibiotics for preterm premature rupture of labour, skilled maternal and immediate neonatal care are some of the interventions with proven effect on reduction in death due to prematurity.[17]

There is a dramatic difference in survival of premature babies depending on where they are born. For example, over 90% of extremely preterm babies (<28 weeks) born in low-income countries die within the first few days of life; yet less than 10% of babies of this

Table 5. Environmental factors and details of domestic violence

Characteristics	Cate-gories	Cases (N=40)	Controls (N=80)	p value
Sanitary latrine at home	NO	02 (5%)	06 (7.5%)	0.46
Problems due to indoor smoke	YES	13 (32.5%)	25 (31.3%)	0.52
Somebody smokes cigarettes inside home	YES	08 (20%)	16 (20%)	0.58
Drinking water available within 10 m	NO	13 (32.5%)	29 (36.3%)	0.42
Husband problem alcoholic	YES	07 (17.5%)	09 (11.3%)	0.25
Experienced Physical violence during pregnancy	YES	07 (17.5%)	01 (1.3%)	0.002
Insulted by a family member*	YES	06 (15%)	02 (2.5%)	0.016
Family member threatened with harm*	YES	06 (15%)	01 (1.3%)	0.005
Screamed or cursed by a family member*	YES	09 (22.5%)	01 (1.3%)	<0.001

*husband/mother-in-law/sister-in-law

Table 6. Final logistic regression model for the risk factors of neonatal mortality

	p value	Adjusted OR (95% CI)
Previous Infant death	0.032	13.02 (1.24-131.2)
Premature Rupture of Membranes	0.027	3.46 (1.28-10.36)
Birth weight (<2.5 kg)	0.019	3.12 (1.42-8.48)
Preterm birth (<37 weeks)	0.048	2.14 (1.09 -7.12)
Experienced domestic violence during pregnancy	0.029	11.37 (1.32-137.11)

gestation die in high income settings. [18] In the current study 22.5% of the neonatal deaths happened in babies born less than 32 weeks of gestation. These facts along with the referral pattern, clearly points to the fact that the new born facilities in the district are not equipped enough to handle preterm babies. Facility up gradation at institutional level creating special care neonatal units at district and sub-district health facilities and improving linkages is the matter of the hour. The Government has started setting up special care newborn units (SCNUs) for managing sick newborns. Facility-based care of neonates (F-IMNCI) through strengthening of infrastructure, provision of extra nurses, and skills up gradation of physicians and nurses at district and sub-district hospitals is expected to reduce the neonatal mortality in the State. But this will involve heavy investment in hospital care for very small birth weight infants to ensure that they survive into adulthood.

Congenital anomalies are the second commonest cause of infant deaths. The availability of genetic services is essential for couples with a family history or past history of pregnancies affected. Secondary prevention of congenital anomalies is achieved through prenatal screening and diagnosis followed by the offer of termination of pregnancies affected by major anomalies. Majority of anomalies that caused neonatal deaths in this study were heart defects. The facilities to do the complex correction procedures are very limited in the government sector, limiting the chances of babies to survive.

The presence of domestic violence in the pathway of early neonatal mortality is similar to the results found by other studies relating domestic violence and preterm, low birth weight, PIH and neonatal mortality.[20-22] Previous studies from Uttar Pradesh and Tamilnadu has documented similar findings.[23,24] The National Family Health Survey-3, conducted in India during 2005–06, reported that 19% of women in the age group 15-49 experienced domestic violence in the 12 months preceding the survey.[25] Although additional research is clearly needed, these findings have potentially significant implications for current public health programs. Information on mothers with domestic violence should be sought to offer more suitable conditions to the follow-up of these pregnant women. The study results emphasize the need for public education and awareness programs that highlight the serious and negative consequences of domestic violence for the health and well-being of both mothers and their children.

This is a retrospective study and may present bias in mothers' memories and assessment bias during data collection. Some mothers whose birth led to death might have been touched in the interview and might have hidden information. The questions on emotional state and stress level could have been influenced by outcome of pregnancy. The questionnaire used for domestic violence was just a screening tool and it has not been validated in the local setting. The power of the study was not enough to assess some variables and the outcomes which reflect the complexity of the interrelations present among these variables. This also explains the wide confidence intervals of the odds ratios. The strength of the studies includes its design and the community based setting.

CONCLUSION

As deaths due to congenital malformations may be less amenable to policy intervention, without adequately

addressing the problem of preterm births, it would be difficult to reduce the infant mortality significantly in Kollam. Focus should be on prevention of premature deliveries and scaling up infrastructure for the care of preterm babies. There is an urgent need to set up intensive and special care units in government set up at district and sub district level with essential facilities and trained staffs to handle neonates with complications. Neonatal death audits should happen in all facilities where deliveries are happening to ensure quality of service.

END NOTE

Author Information

1. Dr. Rakesh PS,District Epidemiologist, District Medical Office, Kollam. Phone: 9495537333. E-mail: rakeshrenjini@gmail.com

2. Dr. Sheeja AL, District Reproductive and Child Health Officer, Kollam

3. Dr. Faizal Subair, School Health Co-ordinator, National Health Mission, Kollam,

4. Dr. Renjini BA, Consultant Paediatrician, SSS Hospital, Kottarakkara

5. Dr. Subhagan S, District Programme Manager NRHM, Kollam

6. Dr. Salila K, District Medical Officer, Kollam

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