Title**: The effect of mother's age on neonatal survival associated with first and second birth in rural, Tanzania.**

Authors: Majige Selemani[1,2], Alexander Mathew[1], Sigilbert Mrema [1], Dan Kajungu[1,2], Abdallah Mkopi[1] , Eveline Geubbels[1] and Rose Nathan[1]

[1] Ifakara Health Institute, (IHI), Plot 463, Kiko Avenue, off Old Bagamoyo Road, Mikocheni P.O Box 78373, Fax: +255 222 771 714, Dar es Salaam, Tanzania

[2]INDEPTH Network Effectiveness and Safety Studies of Antimalarials in Africa (INESS), Secretariat, Tanzania, Plot 463, Kiko Avenue, off Old Bagamoyo Road, Mikocheni P.O Box 78373, Fax: +255 222 771 714, Dar es Salaam, Tanzania

Corresponding author:

MS mselemani@ihi.or.tz **or** majiges@yahoo.com

AM malexander@ihi.or.tz

SM smrema@ihi.or.tz

DK dan.kajungu@indepth-network.org

AM amkopi@ihi.or.tz

EG egeubbels@ihi.or.tz

RN rnathan@ihi.or.tz

Abstract

BACKGROUND: With a view to improve neonatal survival, data on birth outcomes are very important to plan maternal and child health care services. We present information on neonatal survival from Ifakara Health and Demographic Surveillance System(HDSS) in Tanzania, regarding the influence of neonatal survival.

METHODS: We conducted analysis using data collected from Ifakara HDSS which collect routinely data from Kilombero and Ulanga districts in Morogoro region. The data collection involves continues recording of vital events within households and among members over time. The analysis includes all births occurred between 2004 to 2009 and unit of observation was live birth. We used survival analysis to compare the survival of neonatal between different factors.

RESULTS: In this analysis, we included 12, 721 newborn reported in the HDSS between 2004 and 2009. The neonatal mortality rate were 33 per 1000 live births(95%CI: 30/1000-36/1000) for the period. Using Cox proportional hazard model, we found strong significant association between neonatal survival and mothers' age less than 20 year at delivery(p=0.00,HR=1.28,95%CI=1.11-1.47), first birth order (p=0.00, HR=0.66: 95%CI=0.57-0.75) and co-residence of husband (p==0.00,HR=0.76: 95%CI 0.66-0.88). While Sex of new born, Social economic status, place of delivery, season and maternal education were not significant association with neonatal survival.

CONCLUSION: Improvement of neonatal survival in developing countries should be to increase knowledge on teenagers to delay giving birth and improve care service to pregnancy women, with great potential for impact of neonatal survival.

Background to research problem

Each year worldwide 3.8 million new babies die in the first month of life that is the neonatal period [1]. Most of these deaths (98 percent) occur in low- and middle-income countries [2]. This is equivalent to more than 10,000 new babies dying per day or more than 430 die per hour during neonatal period. Neonatal mortality (0–28 days) now accounts for about two-thirds of global infant (0–1year) mortality and about 40 percent of overall under-five deaths. A common factor in these deaths is the health of the mother – each year more than 500,000 women die due to childbirth or from complications during pregnancy, and babies whose mothers have died during childbirth have a much greater chance of dying in their first year than those whose mothers remain alive [3]. However, child mortality also is still high in low and middle –income countries despite of different interventions taking place for reducing this mortality.

Population- and community-based studies of under-one-year mortality in most of developing countries are either few or lacking because of unavailability of vital registration or due to some limitations in resources. Available studies are either too small to make inference for the whole country or based on hospital data that tend to under-estimate the magnitude of the problem. Yet, such studies maybe considered tracers of what might be happening in other areas of the country.

Several risk factors have been suggested to influence neonatal mortality. They include parity, maternal age, race, marital status, smoking, birth weight and gestation age, labour complications, frequency of antenatal visits, previous unfavourable outcomes like stillbirth and neonatal deaths and various socio-economic factors [4]. However, the challenge today is to reduce the global rate of under-five mortality to two third between 1990 and 2015. Therefore, this can be achieved if the effort should be directed towards the neonatal period [2].

Although the data on birth outcomes are very important to plan maternal and child health care services accurate indicators especially from Tanzania are quite difficult to obtain. For example, there are big variations in estimates of neonatal mortality in Tanzania ranging from a minimum estimate of 27 to as high as 125 per 1000 births across different regions in the country [4-5]. A hospital based study in Kilimanjaro found neonatal mortality accounting for two thirds of infant mortality [6]. While some studies about neonatal mortality in the country have shown the rates ranging from 19 per 1000 births to 69 per 1000 live births [7]. Moreover, a recent community based study in northern rural area of Tanzania reported early neonatal mortality rate of 12 per 1000 live births.

It is therefore extremely important to make available epidemiological information regarding the place and influences of neonatal deaths which will enable greater attention to policies and interventions aimed at

reducing levels of under-five mortality. The objective of this study was to investigate the relationship between neonatal survival and women age at delivery in rural Tanzania. The specific objectives were: 1.to measure and compare the neonatal survival among neonates born with teenage mother and non teenage, 2. to compare the neonatal survival and birth order, and 3.to measure the association between place of delivery and neonatal survival.

Methodology of Study

The Study area

The analysis used data from Ifakara Demographic Surveillance System (DSS) which collect routinely data from 1996 to date. Ifakara DSS is one of the three demographic surveillances system managed by Ifakara Health Institute in Tanzania. The Ifakara DSS is situated in Kilombero and Ulanga District in Morogoro region.

The DSS started in 1996, with a population of 52, 000 and at the end of 2010 it had a population of about 120 000. Each household is visited every 4 months, to collect information on pregnancies, births, deaths, and migrations by using the household-registration system (HRS). The data collection involves the continuous recording of vital events within households and among members over time. These events, recorded by enumerators using specific event forms, include births, deaths, pregnancies, pregnancy outcomes, marital status changes, as well as migrations (in and out of the survey area). In addition, lay key informants assist the enumerators by independently recording births and deaths that happen in their respective hamlets.

Data Processing

A longitudinal data analysis conducted using data collected from 2004 to 2009. The analysis involved merging files of HDSS member, pregnancy outcome and Social Economic Status files. The pregnancy outcome, membership, and social economic status datasets were all transferred from Microsoft visual FoxPro format with STATA transfer to STATA version 11. Data extraction, cleaning and merging for this study were done both in STATA version 11. The criteria for inclusion in the analysis were all births that occurred between 2004 and 2009 and unit observation of live birth. In this analysis determinant variables/explanatory variables include age of mother, sex, birth order, place of delivery, SES, education, co-residence of husband, time of the year and the outcome variable was neonatal survival.

The place of delivery was classified into two groups: health facility and outside health facility. All deliveries that occurred in the homes and deliveries that occurred on the way to a health facility were all classified as outside health facility deliveries. Time of delivery was classified into two groups: dry and wet season

according to the dates of birth. The response variable was the neonatal survival in the month of life (0-28 days), often death. Data on socio-economic status of the study mothers using household assets as an index, sex of neonate, maternal age at delivery, maternal educational level and marital status were also extracted from the socio-economic status (SES) database, pregnancy outcome database and membership database.

We used survival analysis to compare the survival of neonatal between different factors. Kaplan-Meier survival functions were used to estimate the distribution of survival times from new born children. Cox proportional hazard regression models were used in the analysis to assess the relative effect of the variables hypothesized to influence neonatal survival. The censored point were 28 days of the new born, some of the selected factors and covariates as predictors of neonatal survival include age of mother, birth order, co-residence of husband, sex of the infant, season during delivery, SES and place of delivery were used. At first age of the mother at delivery were treated as continuous variables in order to detect a linear trend by neonatal mortality risk. Then, age were categorized into two groups teenage (less than 20 years) and non teenage (Above 20 years) in order to minimize dangers of confounding. Although data were entered into the computer using HRS database, statistical analyses were performed using STATA version 11.0. Hazard ratios (HR) with 95 percent confidence intervals (CI) were used as measures of strength of association.

Results

From January 2004 to December, 2009, there were a total of 12,721 live births in the Ifakara Demographic Surveillance Area. Out of 12,721 of the newborn, 6,540 (51%) were males and 6,181(49%) were females (See Table 1). A total of 416 neonatal death occurred during the period of 2004 to 2009, this makes a total neonatal mortality rate of 33 per 1000 live births (95% CI: 30/1000-36/1000).

Table 1: Demographic characteristics of newborn from 2004-2009

Demographic			
New born(2004-2009)	N=12, 721		
Sex	**Number**	**Percentage**	**95%CI**
Male	6,540	51.4	50.5-52.3
Female	6,181	48.6	47.7-49.5

The risk for neonatal mortality among singleton were high in 2007 about 36 per 1000 live births and lowest mortality level of 30 per 1000 live births in the year 2008. It then increased significantly to mortality level of

34 per 1000 live births in 2009. It slightly decreased in 2004, 2005 and 2006 for the neonatal mortality rate of 33 per 1000 to 31 per 1000 live births (See Table 2).

Table 2: Estimates of neonatal mortality for the year of 2004-2009

Year	Number	Percentage	95%CI	Log-rank test (P-value)
2004	88	3.3	2.6-4.0	
2005	74	3.3	2.5-4.0	
2006	68	3.1	2.4-3.9	0.0013
2007	68	3.6	2.8-4.5	
2008	58	3.0	2.2-3.7	
2009	60	3.4	2.5-4.2	

Table 3 shows the risk of neonatal mortality were high about 33 per 1000 live births to children born at home compared to 30 per 1000 live births who were born in health facilities. There were more neonatal deaths rate for boys about 37 per 1000 than girls 28 per 1000 during the study period. Also the univariate analysis showed the selected factors on the risk of neonatal mortality among women delivery in Ifakara DSS. It is found that there was strong association between neonatal mortality and maternal age at delivery, birth order, and year of delivery (See Table 3).

Table 3: Univariate analysis of factors identified for neonatal death

Factors	Number	Percentage	95%CI	Log-rank test (P-value)
Neonatal death				
Sex				
Male	241	3.7	3.2-4.1	0.174
Female	175	2.8	2.4-3.2	
Mothers' age group				
Teenage(13-19)	159	4.9	4.1-5.6	
Non Teenage(20-49)	257	2.7	2.4-3.0	0.000
Birth order				
First order	293	3.0	2.7-3.4	
Second order	123	4.1	3.4-4.8	0.000
SES at birth				

Poorest	88	3.4	2.7-4.1	
Poorer	79	3.0	2.4-3.7	
Poor	80	3.0	2.3-3.6	
Less Poor	86	3.2	2.6-3.9	0.000
Least Poor	83	3.9	3.1-4.7	
Factors	**Number**	**Percentage**	**95%CI**	**Log-rank test (P-value)**
Place of delivery				
Home	392	3.3	3.0-3.6	
Health Facility	24	3.0	1.8-4.2	0.396
Education of mothers'				
Educated	3	1.4	0.2-2.6	0.338
Non Educated	399	3.2	2.9-3.5	
Co-residence of husband				
Husband available	294	3.0	2.7-3.4	
Husband not available	122	4.1	3.4-4.8	0.000

The analysis further showed that neonatal mortality of newborn of teenage mothers' were 49 (95% CI: 41-56) per 1000 live birth while for non teenagers mothers' it were 27 (95%CI 24-30) per 1000 live birth. The neonatal death were high by 45% of newborn of teenager mothers compared to non teenage mothers'. This can raise more attention to teenage mothers to reduce under five mortality. The birth order were statistically associated with the neonatal survival, the neonatal death were high to second birth 41(95%CI: 34-48) per 1000 live birth and were low in first- birth 30(95%CI:24-30) per live births. This mean the neonatal survival were higher to first birth than second birth. The neonatal death for children born with mothers' who are educated were 14 (95%CI: 2-26) per 1000 live birth while for non educated mothers were 32(95%CI: 29-37) per 1000 live birth. This indicates that the neonatal survival were higher to newborn with literacy mothers compare to illiteracy mothers'. The place of delivery were not associated with neonatal death, the neonatal death for newborn delivered at home were 33(95%CI: 30-36) per 1000 live birth and 30 (95%CI: 18-42).

Kaplan-Meier survival curves estimates were constructed by following the survival of newborn from birth to 28 days of birth and log-rank test to investigate difference between factors. The probabilities of surviving within 28 days of birth were investigated with respect to the factors identified for neonatal survival. In Figure1 the analysis shows that there was slight difference in neonatal survival between years. In 2007 the neonatal survival were lowest compared to other years but the mean neonatal mortality rate was higher than

other years. The Log-rank test indicates that the survival of neonate was statistically different between years of birth (Pr>chi2 = 0.0013).

Figure 1: Probability of neonatal survival by year

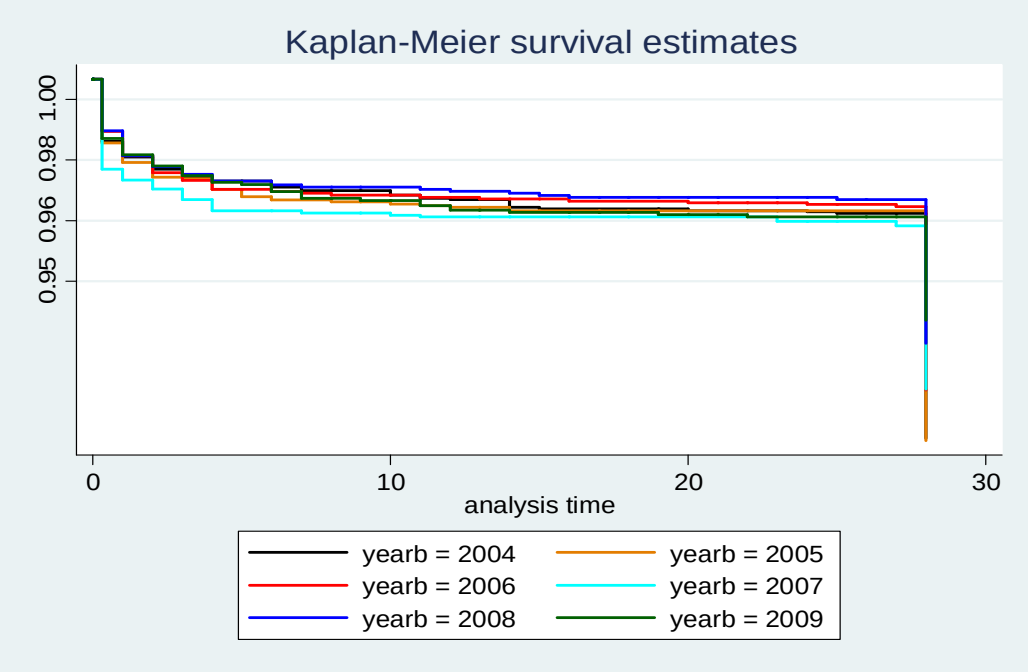
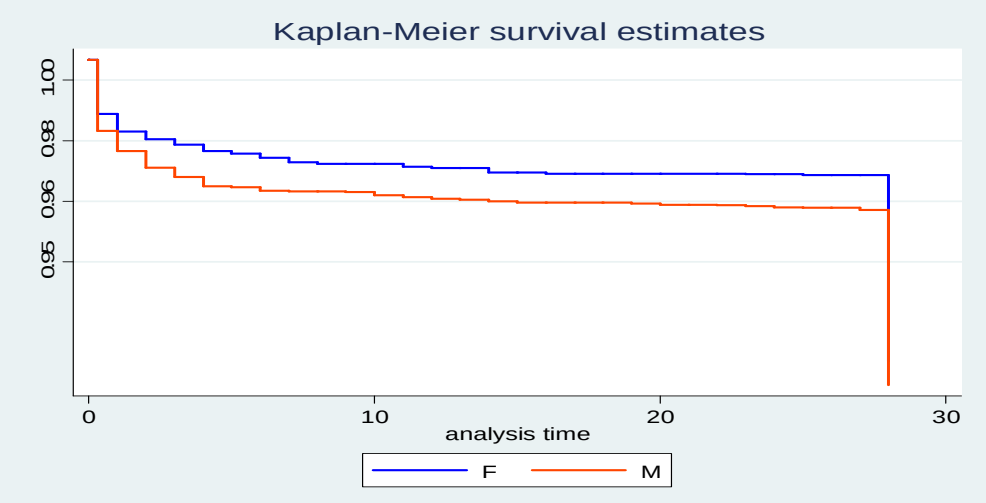


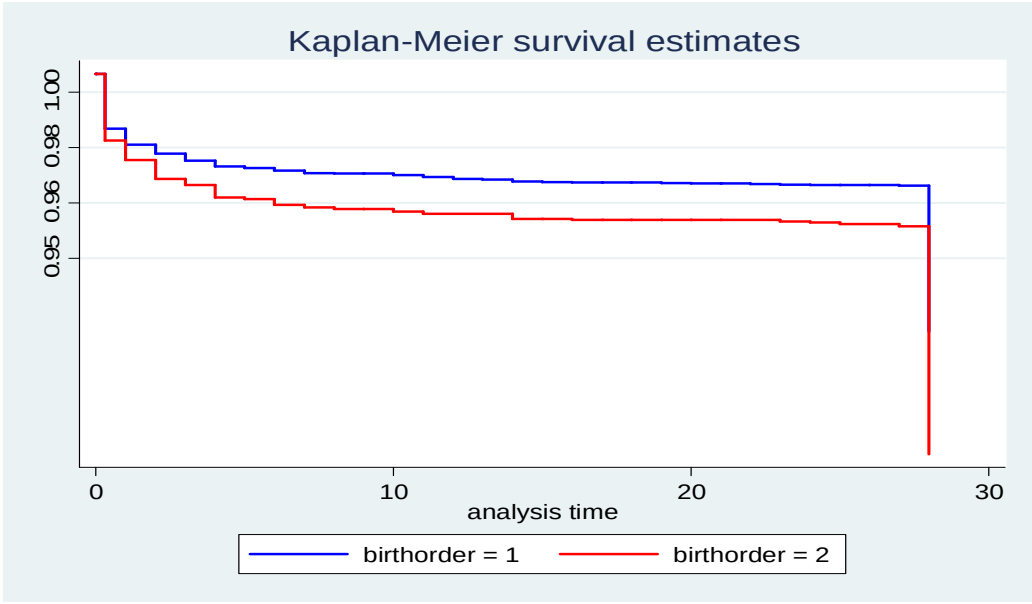
Figure 2, shows that the probability of surviving for newborn boys were low compared to girls. The neonatal mortality for new born boys were higher than girls, this mean newborn boys die more than newborn girls within 28 days. The log-rank test show that the survival of newborn was not statistically difference between sex of newborn(Pr>chi2 = 0.1744).

Figure 2: Probability of neonatal survival by Sex



In figure 3, the analysis compared the neonatal survival between birth order and indicates that the survival of newborn were statistically difference between birth order (Pr>chi2 = 0.000). The probability of surviving was high in first birth compared to the second birth. This indicates that the probability of dying for neonatal is high in second birth than in the first birth.

Figure3: Probability of neonatal survival by birth order



In Figure 4 it is observed that the probability of neonatal survival was high to babies born by non teenage mother than teenage mothers. The babies who mother are teenage were more likely to die than children who mothers' were non teenage. The log-rank test indicates that the survival of newborn was statistically significantly difference between age of mothers' (Pr>chi2 = 0.0000).

Figure 4: Probability of neonatal survival by Mothers' age

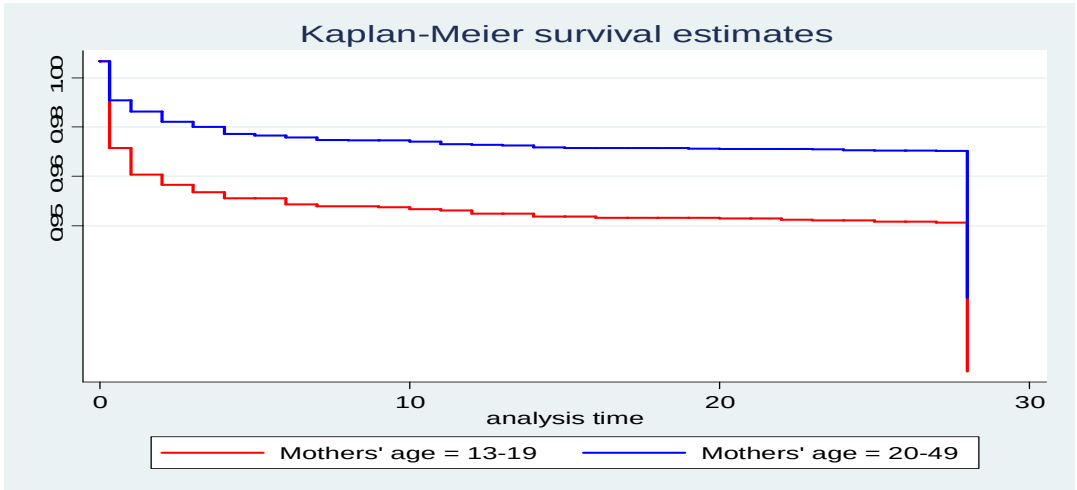


Figure 5,shows that the probability of surviving the neonatal in 0 to 5 days were high for babies who were born at home compared to children delivered at health facility. After five days the probability of neonatal survival become higher for children who mothers delivery at health facility compared to mothers delivery at home. The analysis indicates that the survival of newborn were not statistically difference between the place of delivery (Pr>chi2 = 0.3993).

Figure 5: Probability of neonatal survival by place of delivery

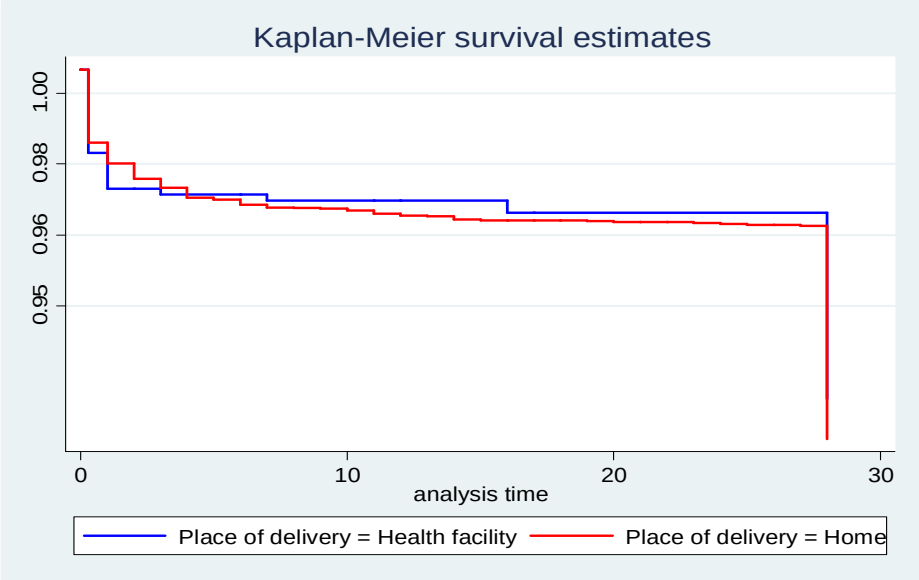


Figure 6, indicate that the survival of newborn were not statistically significance difference between social economic status of the household (Pr>chi2 = 0.8009). The analysis indicates that child who born in least poorer households are more likely to die than babies born in other wealth quintiles.

Figure 6: Probability of neonatal survival by social economic status quintiles

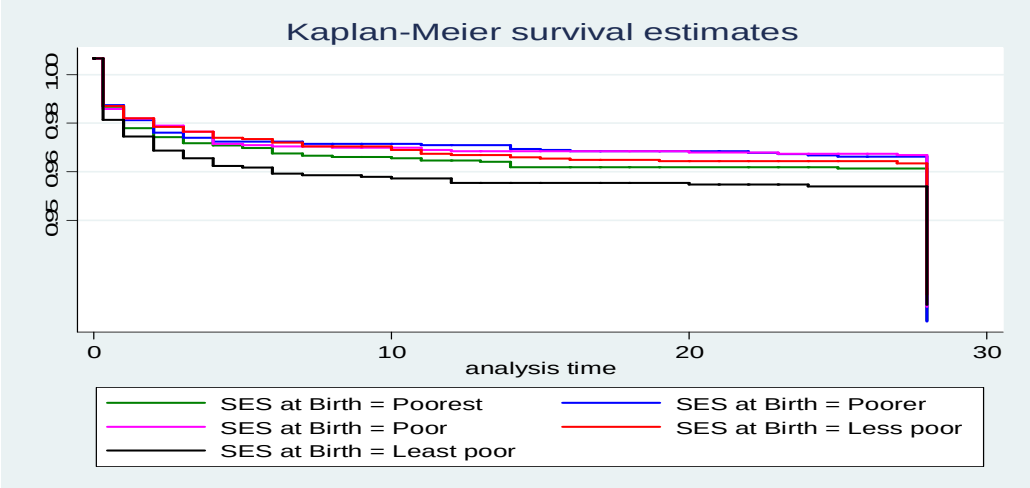


Figure 7: Probability of neonatal survival by co-residence of husband

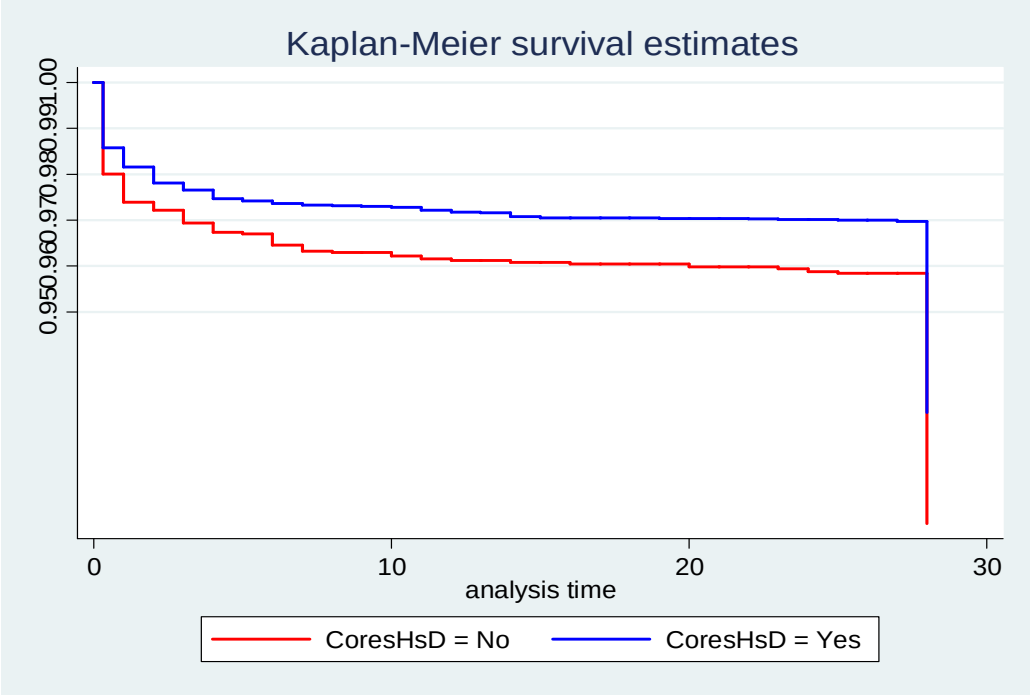


Figure 7 shows that the probability of neonatal survival was high to babies born by mothers' whose husbands were present. The babies whose fathers were not present were more likely to die than children who mothers' were residence with their husband. The log-rank test indicates that the survival of newborn was statistically significantly difference between co-residence of husband (Pr>chi2 = 0.0000).

MULTIVARIATE STATISTICAL MODELING

The study used Cox (proportional hazards) model [8] which is the most commonly used multivariate approach for analysing survival time data in medical research. It is a survival analysis regression model, which describes the relation between the event incidence, as expressed by the hazard function and a set of covariates. In table 4, we present results from the Cox hazard regression analyses of effects of selected factors on the risk of neonatal survival among neonates. The result shows that there was strong association between neonatal survival and maternal age at delivery, birth order, and co-residence of a husband. From the model, age of the mother was identified as a significant predictor of neonatal survival with mother less than 20 years of age having a 28% higher risk of death for their children than a mother with above 20 years age (p=0.00,HR=1.28: 95%CI 1.11-1.47). Birth order decreases the risk of death in that the first birth has a

34% less hazard than the second birth (p=0.00,HR=0.66:95%CI 0.57-0.75). The analysis also shows that there was association between neonatal survival and co-residence of husband (p=0.00, HR=0.76: 95%CI 0.66-0.88), that the presence of husband a 24% less risk of death for their children than children without their fathers'. Sex of new born, social economic status, place of delivery, season and maternal education were found to have no association with neonatal survival.

Table 4: Multivariate analysis of factors influence neonatal death using Cox hazard regression

Factor	Hazard Ratio(HR)	P>|z|	95%CI
Sex of new born(Male vs Female)	1.10	0.14	0.97-1.25
Mothers' age (Teenage vs Non-Teenage)	1.28	0.00	1.12-1.47
Birth order(First birth vs Second)	0.66	0.00	0.57-0.75
Maternal Education(educated vs Non-Educated)	0.69	0.20	0.39-1.22
SES at birth(Poorest) reference			
Poorer	1.01	0.92	0.83-1.22
Poor	0.97	0.76	0.80-1.18
Less Poor	0.91	0.33	0.75-1.10
Least Poor	0.97	0.76	0.79-1.19
Place of delivery(Home vs HF)	1.15	0.32	0.87-1.51
Co-residence husband(presence of husband vs absence of husband)	0.76	0.00	0.66-0.88
Season(wet vs dry season)	1.02	0.80	0.89-1.15

Discussion

In Tanzania, the most recent demographic and health survey in 2005 indicated that neonatal mortality estimates decline from 36 deaths per 1000 in 5-9 year period preceding the survey (approximately 1995-1999) to 32 deaths per 1000 during the 2000-2004 period. This indicates 11% improvement in neonatal survival for the period from 1994 to 2004 [9]. However, available studies from many of which are hospital-based [2], largely concentrate on perinatal and neonatal mortality. Using two rural districts (Kilombero and Ulanga) in Tanzania, we estimated the early neonatal mortality rate of 33 per 1000 live birth for the period of 2004 to 2009. This estimate maybe the same estimates as compared from a recent demographic and health

survey 2004/05 in Tanzania and less than the estimates from community-based study in northern Tanzania[4]. Our data also indicates a significant decrease in early neonatal mortality rates especially between 2004 and 2006, and low neonatal mortality rate in 2008. The decline of neonatal mortality is statistically significant in Kilombero and Ulanga District due to the increase malaria control efforts which lead to the decline of malaria morbidity [10].

In most populations, male mortality is higher than female mortality at almost all ages [11]. This agrees with the results that male neonatal mortality rate is higher than female mortality. It is only in countries like India where female neonatal rate is higher than that of males a result of son preference, which leads to differential in treatment of sons and daughters in terms of food allocation, prevention of diseases and accidents and treatment of illness [12]. In India, many researchers have documented evidence of son preference and discrimination in caring for sons and daughters [13-15]. Biological differences between the sexes tend to result to higher male mortality than female mortality, while parental preference for male children tends to result in higher female mortality. Biological conditions affect mortality most strongly during the neonatal period, and parental care affects mortality most strongly during early childhood. The analysis results showed that there were hardly any differences in univariate analysis and adjusted sex differentials in mortality for Kilombero and Ulanga Districts. This is not surprising because child's sex is not correlated with any other factors used in multivariate analysis as predictor variables in this analysis.

There are studies suggesting a strong association between neonatal mortality and demographic characteristics, obstetric factors and maternal health factors [16]. If these pre-stated risk factors also would influence neonatal survival in the same direction, we only found strong association with maternal age, birth order, and child reported his/her father present(co-residence of husband).

The results showed that the survival of neonate was higher to mothers' who are non teenagers than teenage mother. These findings agreed with studies of [17-19]. Usually babies with mothers who are adolescent faced financial and social problem which lead to less provision of child care. Also, physiological immaturity of the teenager mothers such as small uterus or narrow bony pelvis and lack of social experience on caring newborn leads to more neonatal deaths.

Teenage pregnancies are mainly associated with social problems rather than physical or medical problems. A considerable proportion of teenage mothers originate from working-class families and ethnic minorities. Many are themselves the off springs of teenage or very young parents. In Western countries, the majority of teenage pregnancies are unplanned and unwanted. Consequently abortion rates among adolescent women are quite high, ranging from 30 to 60% of all confirmed pregnancies in that group age [17].

It is interesting to note that the characteristics of babies' fathers whose mothers are adolescent are also unique. These men have a lower level of education, a greater age discrepancy between themselves and the mothers, a greater unemployment rate, less financial independence, less supportive attitude toward pregnancy, poorer attendance at childbirth, less provision of postpartum care for mothers and infants [18]. Female mortality associated with childbirth is high among humans [19]. Starting too early with reproduction may increase these risks. On one hand this may be due to the physiological immaturity of the still growing sub adult female, such as small uterus or narrow bony pelvis, on the other hand the lack of social experience, which may reduce the probability of infant survival. Therefore, in addition to biological maturity humans have evolved several social and behavioral traits to increase neonatal survival.

The neonatal survival was significantly associated with birth order for first born were less likely to survive than second birth. Usually the relationship between birth order and mortality at early ages takes a U-shaped form: Mortality is high for first-born children and births of very high orders and is low for births of order 2 or 3. First-order births are more likely to have a difficult birth process than later births, thus increasing the risk of neonatal mortality [20]. In addition, first-born children are likely to be raised by parents with limited skills and experience, possibly increasing the risk of infant and child mortality. Births of very high order may have mothers who are physically depleted at the time of conception and throughout pregnancy. The study results were contrary for it showed that the neonatal survival was high in first birth order compared to second birth. This may be because most children born to women under age 20 and over age 35 are known to have higher mortality than those born to mother's age 20–34. This is because it is most likely that a woman's physical condition is most favourable to childbearing during her twenties and early thirties. Also birth intervals increase mortality of children in two ways. Children born after a short interval are likely to have mothers in poor health, and such children tend to have low birth weight and increased chances of neonatal mortality. Short birth intervals also result in families with many children of similar ages. This increases competition for family resources and attention and also increases exposure to infectious childhood diseases. Children born to families in which a child has already died are more likely to die in childhood than are other children, probably because the conditions that caused the death of an older sibling affect the newborn child as well.

The presence of husband at the time of birth was more likely to influence the survival of neonatal children because of more decision for care was made by both parents. In addition, mothers' with presence of husband are more likely to provide their children with a healthy environment and nutritious food than are mothers without husband, even when other conditions are similar.

In developing countries, mother's educational level, as indicated here by education status, tends to have a strong effect on the mortality of young children [12,21]. These results agreed with the study results that neonatal survival were higher to newborn with educated mothers than illiterate mothers. These usually educated mothers give birth to healthier babies because they themselves tend to be healthier than mothers who are illiterate. In addition, literate mothers are more likely to provide their children with a healthy environment and nutritious food than are illiterate mothers, even when other conditions are similar. Also, literate mothers are likely to have more information about health-care facilities and to have more influence within the family in deciding to take sick children for treatment.

The results indicated that the neonatal survival were high to children delivered at health facility than newborn delivered at home. These means children delivered at health facility are likely to experience lower mortality than children delivered at home because such facilities usually provide a sanitary environment and medically correct birth assistance. This finding agreed with [20]. Moreover, children delivered at health facility, If complications develop during childbirth, medical professionals can attend to the problem immediately.

Contrary to some literature on neonatal mortality [22-23] we did not find significant association of socio economic status of the household. The findings are viewed as a surprise due to the lack of differentiation by socioeconomic status and the hazard ratio indicates that neonatal with least poor were less hazard than poorest. Increased rural development is viewed as potential explanation of access to health care [24]. Further declines are expected to be conditioned on improvements in quality of care and increase of malaria intervention in Kilombero and Ulanga district.

This analysis is based entirely on DSS dataset so one should be careful when generalizing and comparing of results from this study with other community-based studies because of the potential selection bias in other studies.

Conclusion

A reduction in under-five mortality is very important to meet the Millennium Development Goal (MDG 4) to reduce mortality in children younger than 5 years by two-thirds between 1990 and 2015. These can be achieved if more efforts should be directed toward the neonatal period [1-2]. It would be difficult to reduce neonatal mortality by changing socioeconomic characteristics such as mother's literacy or ownership of household goods in a short period of time. A priority for the improvement of neonatal survival in developing countries should be to increase knowledge on teenagers to delay giving birth. The study reviewed that the

neonatal death is higher to new born with teenage mothers than non teenagers. The quality of care should be improved to pregnancy women, with great potential for impact of neonatal survival.

Competing interests

The authors declare that they have no competing interests.

Authors' contributions

Alexander Mathew was overall in charge for Ifakara Demographic Surveillance system were the data were collected. Statistical analysis and interpretation was conducted by Majige Selemani, Alexannder Mathew, Sigilbert Mrema, Dan Kajungu, Abdallah Mkopi, Eveline Geubbles and Rose Nathan. Majige Selemani wrote the first draft, Alexander Mathew, Sigilbert Mrema, Dan Kajungu, Abdallah Mkopi, Eveline Geubbels and Rose Nathan revised the paper and contributed to discussion. All authors read and approved the final manuscript.

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