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CAUSES OF NEONATAL MORTALITY TWO YEARS BEFORE AND AFTER THE IMPLEMENTATION OF A FREE MATERNAL HEALTH CARE POLICY IN KENYAN PUBLIC HEALTH FACILITIES
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ABSTRACT

Background: **Neonatal mortality remains unacceptably high more so in the developing countries such as Kenya. The government of Kenya waived delivery fees charges in public health facilities through a free maternal health care policy on 1st June 2013 with an aim of reducing pregnancy related mortalities.**

Objective: **To determine the changes in causes of neonatal mortality following the implementation of a free maternal health care policy in Kenyan public health facilities.**

Design: **This study was of a quasi-experimental design to compare the causes of neonatal deaths two years before and after the exposure of new-borns to the free maternal health care services in Kenyan public health facilities.**

Setting: **This study was carried out in 77 public health facilities in Kenya.**

Subjects: The study subjects for this study were 9,591deceased neonates.

Results: **The highest proportion of neonatal deaths pre and post policy implementation were preterm delivery and low birth weight complications, birth asphyxia and trauma, neonatal infections and congenital anomalies.**

Conclusion: **There are no significant changes in the avoidable causes of neonatal deaths in Kenyan Public health facilities. With the policy addressing maternal health care financing, there is need to investigate the role of other health system blocks on neonatal deaths and address them to avert preventable causes of neonatal deaths.**

INTRODUCTION

Neonatal mortality is the death of a new-born within the first 28 days of life which is the most vulnerable time for a child's survival (1). It is estimated that in the year 2015 there were 2.7 million neonatal deaths accounting for 45% of all under-five deaths; of these, approximately 1 million deaths occurred within 24 hours of birth while approximately 2 million of the deaths occurred in the course of the first week of life (2).

Neonatal mortality remains unacceptably high more so in the developing countries with a baby born in a least developed country bearing a 14 times higher risk of death within first 28 days of life as

compared to a baby born in the developed country (1). Global statistics indicate that the highest proportion of neonatal deaths in the world occur in the Sub-Saharan Africa, with Kenya being listed as 1 of the 10 Sub-Saharan Africa countries with the highest neonatal mortality rate (3). The major causes of neonatal deaths worldwide are infections; sepsis, pneumonia, diarrhoea and tetanus (36%), preterm birth complications (28%) and birth asphyxia (23%) with minimal regional variations (6). It has been further shown that 75% of these neonatal deaths occur during the first week of life with 25% to 45% of the deaths occurring within 24 hours of birth (7). Most of these neonatal mortality cases have been linked to home delivery, consequently skilled delivery care has been shown to be crucial in improving new-borns' survival (7, 8). Over the last 13 years, Kenya has reduced neonatal mortality by one third from 33/1,000 to 22/1,000 but this figure still remains high (4). Neonatal deaths in Kenyan public health facilities are attributed to a high disease burden arising from birth asphyxia, neonatal sepsis, prematurity and low birth weight (5).

The role of free delivery services on neonatal mortality has not been demonstrated and there is scanty evidence of the same (9). However, it is well documented that close to half of neonatal deaths occur within 24 hours of birth and they are associated with care during and after delivery (10, 11). Having skilled attendants during birth can avert a significant proportion of deaths from preventable causes such as birth asphyxia, birth trauma and neonatal infections (12, 13). Skilled care during delivery has been shown to have a direct effect in preventing infection, birth trauma, and asphyxia among neonates (14-16) and further reducing the risk of neonatal mortality by 29% (15). Given that 45% of the neonatal deaths occur within 48 hours of birth during which neonates are still within health facilities, neonatal mortalities in Kenyan public health facilities can be addressed by uptake of facility based deliveries (17-19).

The Kenyan government implemented a free maternal health care policy on June 1st 2013 to encourage skilled delivery and subsequently reduce maternal and neonatal mortality (20). The costs reimbursed to health facilities for every delivery are based on the facility level and capacity to provide either basic or comprehensive obstetric health care service. However, the implementation of the free maternal health policy in Kenyan public health facilities is faced with numerous challenges among them shortage of supplies, insufficient funding, shortage of skilled health care workers, heavy workloads and demotivation of health workers (21). Similarly, previous attempts to abolish of user fees in Kenyan public health facilities have been shown to have a limited impact on the outcomes due to lack of supplies, drug shortages, delay in funds reimbursements, shortage of health care workers and low adherence to the policy (22).With the availability of free skilled delivery services in Kenyan public health facilities, this study therefore sought to determine whether the free maternal health care policy had significant role in reducing the preventable causes of neonatal mortality.

METHODOLOGY

Study design: This study used a quasi-experimental design to compare the causes of neonatal deaths before and after the exposure of new-borns to the free maternal health care services in Kenyan public health facilities.

Study setting: Public health facilities across 14 counties where the free maternal health care policy was being implemented.

These were 17 urban based and 60 rural based health facilities.

Study population: The study population was deceased neonates whose records were retrieved from the health facilities. At the time of data collection, Kenya's public health care facilities was organized in a hierarchical-pyramidal outfit comprising six levels with the lowest being the level 1-community health centres, Level 2 - dispensaries , level 3-health centres, level 4-sub district hospitals and district hospitals, level 5-provincial hospitals and level 6-national referral hospitals (23). This hierarchical-pyramidal outfit in Kenya has since changed from six to four tiers (39). namely: tier 1- community centres, tier 2-primary care level facilities (previous levels 2 and 3 facilities), tier 3- county facilities (previous level 4 facilities), tier 4-Referrral facilities (previous levels 5 and 6 health facilities)

Sample Size: In every comparative study, an adequate sample size is required to give a statistical test enough power (sensitivity) to detect the smallest measured difference between comparison groups. In this study, a 90% confidence interval and a 10% margin error were used to compute the minimum required sample size as 2,592 neonatal deaths before after the policy intervention (24). Upon review of neonatal records in the 77 health facilities, a total of 9,591 records of neonatal mortality were identified (2,846 pre policy and 6,745 post policy implementation). While a minimum of 2,592 neonatal deaths before and after the policy were sufficient to detect a change in causes of neonatal mortality following the intervention (4,24), all records on neonatal mortality were included in the study since no heterogeneity of variance was expected in the study (25,26). Data analysis for this study was carried out using SPSS version 23.

Sampling: Multistage cluster sampling was used in this study. The first stage involved selection of 14 counties out of the 47 counties based on maternal mortality risk over the previous years (5 high risk maternal mortality counties, 5 medium risk maternal mortality risk counties and 4 low risk maternal mortality risk counties were selected through simple clusters based on the previous provincial administration system in Kenya. The second stage involved selection of the number of facilities from every county to be included in the study which was done proportionately based on the total number of health facilities in each county. The third stage involved selection of individual health facilities in every county which was based on location (whether urban or rural) and facility level clusters (level 4, 5 and 4 health facilities were selected proportionately based on their numbers in each county). Seventy seven health facilities were selected amongst them a maternity nursing home, a national referral hospital, 58 Level 4 health facilities and 17 level 5 health facilities. Subsequently, records on all neonatal deaths in these facilities during the period of interest were retrieved from the ward registers. The focus was on neonates specifically delivered in the health facilities, managed by health care workers and followed up daily till death (from birth to day 28 of life).

Data management and Statistical analysis: Four research assistants were trained on data collection and research ethics. Pre testing of the data collection tool was done at a level 4 health facility in Kiambu County. Themes of interest from every neonatal death were extracted from facility records and recorded into prepared data capture form. This data was thereafter keyed into a Microsoft Excel (2013) spread sheet. Descriptive and inferential analysis (test of proportions) was performed using SPSS (version 23). Epi Info version 7.2.0.1 was used to analyse the odd ratio for survival following the policy intervention.

Ethical Clearance: Ethical approval was obtained from Kenyatta National Hospital

and University of Nairobi Ethical Committee while administrative approval was obtained from the ministry of health headquarters, County health officials and the health facility administrators.

RESULTS

Social Demographics

There were a total of 12,423 neonatal deaths in the 77 health facilities during the period of interest (5,442 before the policy implementation and 6,981 after the implementation); of these there were 9,591 complete case records which were reviewed (2,846 before the policy and 6,745 after the policy intervention). This shows that there were more complete records on neonatal deaths after the policy intervention when compared to the pre-policy duration, however, this does not imply more deaths but rather more mothers delivering in health facilities due to free delivery health services as well as possibilities of improved record keeping since reimbursements for costs of free delivery services are based on the health facility records. The largest proportion of neonatal deaths was in the level 4 health facilities (37.1%) and urban based health facilities (71%) while majority (72.4%) of the deceased new-borns were delivered through spontaneous vaginal deliveries (Table 1).

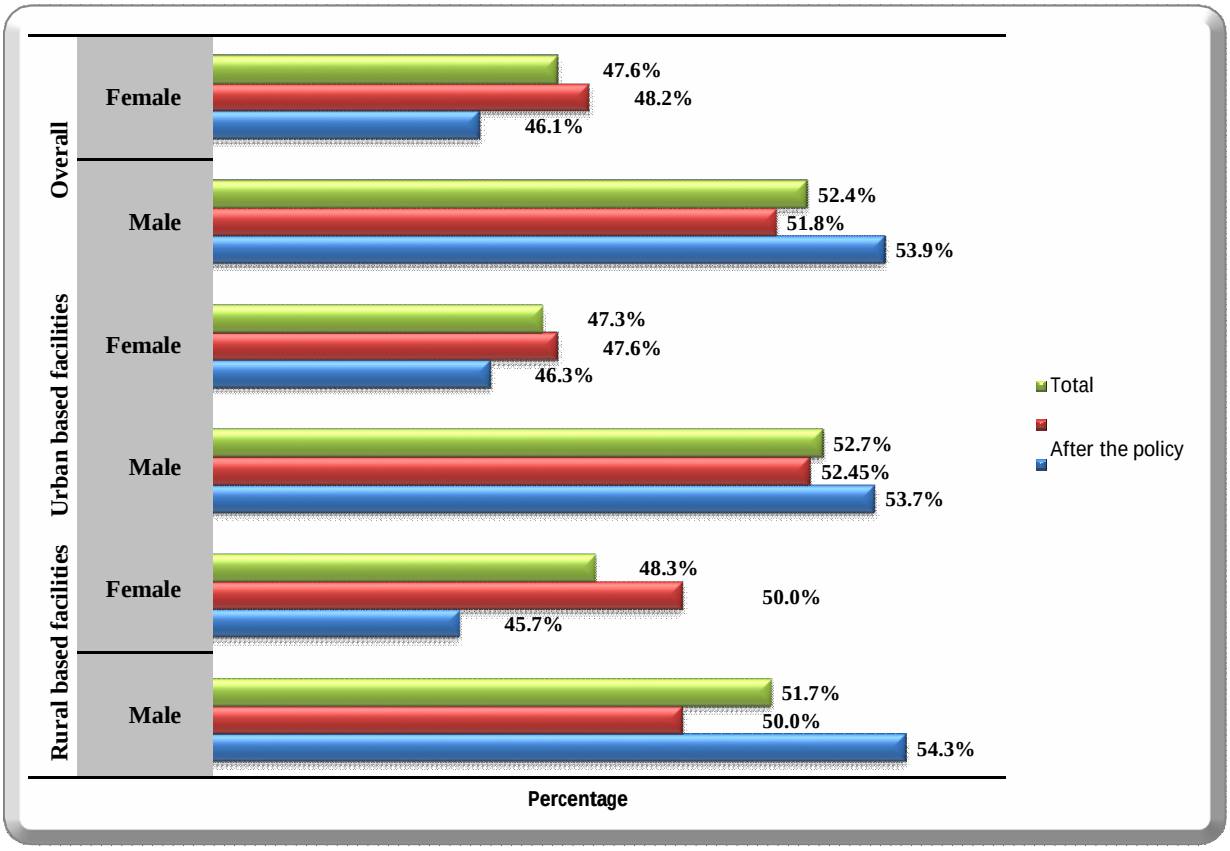
Table 1
Number of neo-natal mortalities and mode of delivery

		Before the policy	After the policy	Total
Facility Level	Maternity nursing home	15.1%(429)	19.3%(1,674)	21.9%(2,103)
	Level 4	44.2%(1,259)	34.1%(2,303)	37.1%(3,562)
	Level 5	16.3%(464)	21.8%(1,468)	20.1%(1,932)
	Level 6	24.4%(694)	21.8%(1,300)	20.8%(1,994)
Location	Rural	38.6%(1,098)	24.9%(1,681)	29.0%(2,779)
	Urban	61.4%(1,748)	75.1%(5,064)	71%(6,812)
Mode of delivery	Spontaneous vaginal delivery	75.5%(2,150)	71.0%(4,790)	72.4%(6,940)
	Caesarean section	24.5%(696)	29.0%(1,955)	27.6%(2,651)
Total		29.7%(2,846)	70.3%(6,745)	100.0%(9,591)

**Level 1, 2 and 3 health facilities were excluded in the study due to their inability to offer services such as caesarean sections offered under the free maternal health care policy

Overall, there were more neonatal mortalities amongst the male new-borns (52.4%) as compared to the females (47.6%). This was a feature replicated across all locations and health facilities prior to the policy intervention and after the policy intervention (Figure 1).

Figure 1
Gender of the deceased neonates



Age, Weight and Apgar Scores

The mean age at death for the new-borns was 3.7 days before the policy implementation and 3.7 days after the policy intervention. The longest duration for survival of neonates was 28 days both before and after the policy intervention. The highest birth weight recorded was 5.2 kilograms with the minimum being 0.2 kilograms and the median weight being 1.9 kilograms. The mean Apgar scores for the deceased neonates at 1 minute after birth were 5.1 before the policy intervention and 5 after the policy intervention; the scores at 5 minutes after birth were 5.7 before the policy and 5.5 after the policy intervention (Table 2).

Table 2
Age at Death, Birth Weight, Weight at Death and Apgar Scores

Variable	Timing	Mean	Minimum	Maximum	Std. Deviation
Age at Death	Before the policy intervention	3.7	0.0	28.0	5.2
	After the policy intervention	3.4	0.0	28.0	4.5
	Total	3.5	0.0	28.0	4.7
Birth weight	Before the policy intervention	2.1	0.2	5.2	1.0
	After the policy intervention	2.0	0.2	4.7	0.9
	Total	2.0	0.2	5.2	0.9
Weight at birth	Before the policy intervention	2.0	0.2	5.2	1.0
	After the policy intervention	2.0	0.2	31.0	1.2
	Total	2.0	0.2	31.0	1.2

Apgar score 1 minute after birth	Before the policy intervention	5.1	1.0	10.0	2.1
	After the policy intervention	5.0	1.0	10.0	2.3
	Total	5.0	1.0	10.0	2.3
Apgar score 5 minutes after birth	Before the policy intervention	5.7	1.0	10.0	2.1
	After the policy intervention	5.5	1.0	10.0	2.3
	Total	5.5	1.0	10.0	2.3

** The minimum weight shows a case of a live abortion/miscarriage

Timing of the Neonatal Deaths

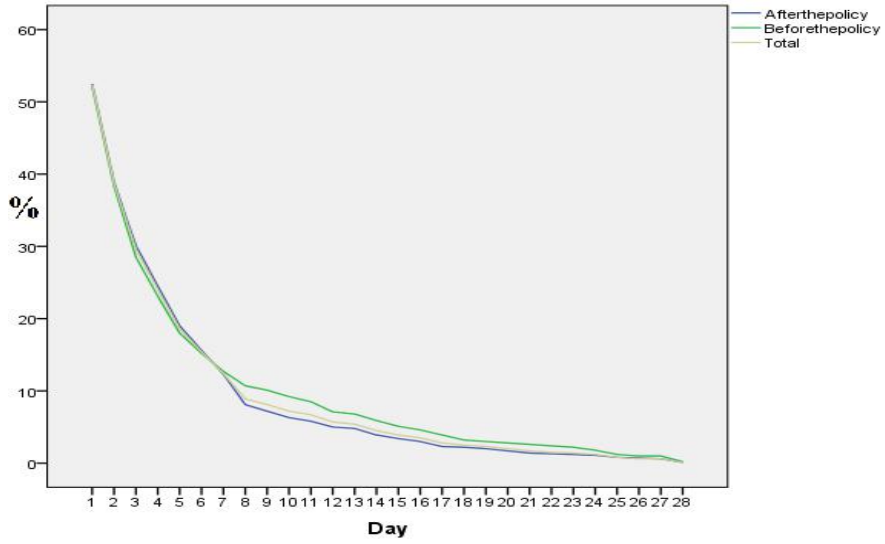
Of all the neonatal deaths before the policy intervention, 61.3% were within 48 hours of delivery. Following the policy intervention, 61.2% of all the deaths were within 48 hours of birth. In addition, 87.8% and 87.8% of all neonatal deaths were within 7 days of birth pre and post policy intervention. There were no significant differences in survival rates before and after the policy intervention (P>0.05). Survival outcomes within 48 hours and 7 days were better in urban based facilities when compared to rural based facilities. The level 6 health facility had better outcomes at 24 hours after birth, 48 hours after birth and 7 days after birth when compared to level 4 health facilities, level 5 health facilities and the maternity nursing home (Table 3).

Table 3
Deaths Within 24 Hours, 48 Hours, 4 Days And 7 Days

		Before the policy	**After the policy**	**Total**
Neonatal deaths in 24 hours	Maternity nursing home	49.5%(211)	48.7%(812)	48.9%(1,093)
	Level 4 facilities	48.8%(610)	52.9%(1,206)	51.4%(1,816)
	Level 5 facilities	49.6%(229)	47.6%(695)	48.1%(924)
	Level 6 facility	44.1%(305)	36.5%(474)	39.1%(779)
	Rural based facilities	46.4%(504)	49.8%(1,664)	48.5% (1,336)
	Urban based facilities	49.0%(851)	46.8%(2,355)	47.3%(3,206)
	Total	47.9%%(1,355)	47.5%(3,187)	47.6%(4,542)
Neonatal deaths in 48 hours	Maternity nursing home	63.1%(269)	63.2%(1,053)	63.2%(1,322)
	Level 4 facilities	62.3%(778)	64.9%(1,479)	63.9%(2,257)
	Level 5 facilities	63.2%(292)	67.7%(930)	64.6%(1,222)
	Level 6 facility	58.7%(406)	49.3%(640)	52.5%(1,046)
	Rural based facilities	60.0%(652)	63.0%(1,053)	61.9%(1,705)
	Urban based facilities	63.0%(1,093)	60.6%(3,049)	61.1%(4,142)
	Total	61.7%(1,745)	61.2%(4,102)	61.3%(5,847)
Neonatal deaths in 7 days	Maternity nursing home	87.65(373)	88.9%(1,482)	88.7%(1,855)
	Level 4 facilities	87.5%(1,094)	88.6%(2,018)	88.2%(3,112)
	Level 5 facilities	88.6%(409)	89.1%(1302)	89.0%(1,711)
	Level 6 facility	86.0%(594)	83.6%(1,086)	84.4%(1,680)
	Rural based facilities	87.3%(949)	86.1%(1,439)	86.7%(2,388)
	Urban based facilities	87.6%(1,521)	88.4%(4,449)	88.0%(5,970)
	Total	85.1%(2,470)	87.8%(5,888)	87.7%(8,358)

Prior to the policy, only 52.5% of the deceased neonates survived the first 24 hours while 52.1% of the neonates survived the first 24 hours following the policy implementation. A 48 hours survival rate was recorded among 38.9% and 38.3% of the neonates pre and post policy implementation. Similarly, survival for the first 7 days was recorded among 12.3% and 12.7% of the neonates before and after the policy intervention. There was a numerically high number of neonates surviving from days 7 to 25 before the policy intervention when compared to the post policy implementation phase (Figure 2).

Figure 2
Timing of neo-natal death



Causes of Neonatal Mortalities

Across the 77 health facilities, the major causes of neonatal mortalities pre and post policy intervention were preterm delivery and low birth weight complications, birth Asphyxia and birth trauma and neonatal infections as illustrated in Table 4.

Table 4
Causes of the Neonatal Mortalities

	Cause of neonatal death	Before the policy	After the policy	Total
Maternity Home	Birth Asphyxia and Trauma	27.3%(117)	33.3%(557)	32.0%(674)
	Congenital Anomalies	8.9%(38)	3.5%(59)	4.6%(97)
	Diarrhoea Diseases	0.5%(2)	1.7%(28)	1.4%(30)
	Neonatal Infections (Sepsis, Pneumonia, Tetanus)	14.2%(61)	10.9%(183)	11.6%(244)
	Preterm Delivery and Low Birth Weight Complications	45.9%(197)	47.5%(795)	47.2%(992)
	Other causes	3.3%(14)	3.1%(52)	3.1%(66)
Level 4 facilities	Birth Asphyxia and Trauma	28.5%(359)	32.9%(757)	31.3%(1,116)
	Congenital Anomalies	6.8%(85)	3.3%(75)	4.5%(160)
	Diarrhoea Diseases	1.1%(14)	1.6%(37)	1.4%(51)
	Neonatal Infections (Sepsis, Pneumonia, Tetanus)	12.9%(162)	12.7%(293)	12.8%(455)

	Preterm Delivery and Low Birth Weight	48.1%(605)	45.1%(1,038)	46.1%(1,643)
	Complications			
	Other causes	2.7%(34)	4.5%(103)	3.8%(137)
Level 5	Birth Asphyxia and Trauma	27.4%(127)	34.4%(505)	32.7%(632)
health	Congenital Anomalies	5.4%(25)	1.8%(27)	2.7%(52)
facilities				
	Diarrhoea Diseases	1.5%(7)	3.2%(47)	2.8%(54)
	Neonatal Infections (Sepsis, Pneumonia,	12.9%(60)	14.6%(215)	14.2%(275)
	Tetanus)			
	Preterm Delivery and Low Birth Weight	49.6%(230)	43.1%(633)	44.7%(863)
	Complications			
	Other causes	3.2%(15)	2.8%(41)	2.9%(56)
Level 6	Birth Asphyxia and Trauma	25.4%(176)	23.6%(307)	24.2%(483)
health				
	Congenital Anomalies	10.5%(73)	6.1%(79)	7.6%(152)
facility				
	Diarrhoea Diseases	0.3%(2)	1.0%(13)	0.8%(15)
	Neonatal Infections (Sepsis, Pneumonia,	13.5%(94)	12.1%(157)	12.6%(251)
	Tetanus)			
	Preterm Delivery and Low Birth Weight	46.5%(323)	53.0%(689)	50.8%(1,012)
	Complications			
	Other causes	3.7%(26)	4.2%(55)	4.1%(81)
Rural based	Birth Asphyxia and Trauma	28.1%(308)	33.1%(556)	31.1%(864)
facilities	Congenital Anomalies	7.4%(81)	3.6%(60)	5.1%(141)
	Diarrhoea Diseases	0.7%(8)	1.9%(32)	1.4%(40)
	Neonatal Infections (Sepsis, Pneumonia, Tetanus)	13.4%(147)	13.3%(224)	13.4%(371)
	Preterm Delivery and Low Birth Weight Complications	47.4%(521)	44.0%(740)	45.4%(1,261)
	Other causes	3.0%(33)	4.1%(69)	3.7%(102)
Urban	Birth Asphyxia and Trauma	26.9%(471)	31.0%(1,570)	30.0%(2,041)
based	Congenital Anomalies	8.0%(140)	3.6%(180)	4.7%(320)
facilities	Diarrhoea Diseases	1.0%(17)	1.8%(93)	1.6%(110)
	Neonatal Infections (Sepsis, Pneumonia, Tetanus)	13.2%(230)	12.3%(624)	12.5%(854)
	Preterm Delivery and Low Birth Weight Complications	47.7%(834)	47.7%(2,415)	47.7%(3,249)
	Other causes	3.2%(56)	3.6%(182)	3.5%(238)
All the 77	Birth Asphyxia and Birth Trauma	27.4%(779)	31.6%(2,131)	30.3%(2,910)
health	Congenital Anomalies	7.9%(224)	3.8%(257)	5.0%(481)
facilities	Diarrhoea Diseases	0.9%(25)	1.9%(125)	1.6%(150)
	Neonatal Infections (Sepsis, Pneumonia, Tetanus)	13.2%(377)	12.6%(848)	12.8%(1,225)
	Preterm Delivery and Low Birth Weight Complications	47.6%(1,355)	47.1%(3,175)	47.2%(4,530)
	Other causes	3.0%(86	3.1%(209)	3.1%(295)

A Chi square of trends was carried out on the causes of neonatal mortality before and after the implementation of the free maternal health care policy and it was significant meaning that the distribution of deaths had changed ($P<0.01$). A test of proportion shows no significant reductions in the number of neonatal deaths from preventable causes (Table 5).

Table 5
Test of Proportion on the Preventable Causes of Neonatal Deaths

Cause of mortality	P value	Conclusion
Birth asphyxia and trauma	0.001<	No Significant change
Neonatal infections	0.42	No significant change
Preterm delivery and low birth weight	0.65	No significant change

On calculation of odds ratio across all facility levels and locations, it was <1 suggesting that the odds of neonates' exposure to the free maternal health care policy are associated with the adverse outcomes compared to the odds of not being exposed. As such, the odds of neonates' survival before the policy intervention were higher when compared with the post policy intervention phase (Table 6).

Table 6
Odds Ratio Following the Policy Intervention

	Odds ratio	95 % Confidence Interval	Z statistic	Significance level
Maternity nursing home	0.2800	0.2516 to 0.3116	23.331	P < 0.0001
Level 4 health facilities	0.7674	0.7161 to 0.8223	7.508	P < 0.0001
Level 5 health facilities	0.3913	0.3523 to 0.4345	17.528	P < 0.0001
Level 6 health facility	0.6652	0.6055 to 0.7307	8.505	P < 0.0001
Rural based facilities	0.8323	0.7709 to 0.8985	4.700	P < 0.0001
Urban based facilities	0.4510	0.4269 to 0.4764	28.484	P < 0.0001
All the facilities	0.5462	0.5226 to 0.5709	26.852	P < 0.0001

DISCUSSION

The study shows that the first 7 days of birth are the most vulnerable period in a neonate's life; 6 out of 10 neonates died within 48 hours while 9 out of 10 neonates died within 7 days before and after the free maternal health care policy intervention in Kenya. This timing in neonatal deaths is similar to the global trends (2). Survival chances appear to be higher in the national referral hospital where health systems are well defined (32, 33). The Apgar score provides a pertinent, accepted and convenient method for evaluating the status new-borns after birth and the response to resuscitation when offered (28). The mean Apgar scores at 1 and 5 minutes after birth were persistently low at 5 predicting adverse outcomes and low survival prospects among the neonates (28).

Across the 77 health facilities, a high number of neonatal deaths were driven by prematurity and low birth weight, birth asphyxia and trauma and neonatal infections just like in other global set ups (13). Studies across the globe have reported that neonatal infections, prematurity and birth asphyxia can be avoided or reduced through skilled delivery (7, 8, 14-19).

However these trends have not been observed in this study implying that there are other health system gaps contributing to neonatal deaths in Kenyan public health facilities.

Previous studies illustrate that, management of very low birth weight complications (<1.5 kg) in Kenyan public health facilities is a challenge especially given the high number of low birth weight cases in settings designed to accommodate isolated cases, lack of basic supportive services and shortage of skilled workers (29, 32,33). Knowledge on neonatal resuscitation remains low among health care workers in Kenya thus contributing to the sequel of birth asphyxia (30).

There was an increase in the number of neonatal deaths, from 5,442 to 6,981 following the policy intervention; whereas no previous study has addressed the effects of maternal user fees abolishment on neonatal mortality (9), these increases in neonatal mortality may be attributed to increased facility based deliveries which have been demonstrated in countries where free maternal health care policies have been implemented (9, 35-37). Preliminary analysis of the DHIS in Kenya revealed an increase in facility based deliveries (38). The odds of neonates' exposure to the free maternal health care policy are associated with the adverse outcomes compared to the odds of not being exposed to the policy.

These observations may be due to the implementation of the free maternal health care policy in public health facilities without a commensurate effort to address the health systems gaps to cope with the high number of neonatal deaths and complications. Health systems challenges in the free maternal health care policy implementation have been documented in Malindi district hospital, Rift Valley Provincial General Hospital and Bondeni maternity nursing home (21, 34). These challenges include shortage of health care workers to handle the large number of mothers delivering in health facilities, heavy workloads among the few available health care workers resulting in burn out and demotivation, shortage of drugs and other medical supplies necessary to deliver maternal health care services, and delays in reimbursement of the costs incurred in providing free maternal health care services resulting in service delivery constraints for subsequent clients.

LIMITATIONS

This study was based on retrospective data, periodic comparisons of causes of neonatal death over time and space may be confounded by changing conceptions of neonatal diseases and case recording practices in different set ups. Secondary data on the mothers to these neonates and the presence of maternal complications which resulted in these deaths was not available. As such this study lacks information on the interplay between maternal and neonatal conditions which are essential in analysis of neonatal deaths.

CONCLUSION

The free maternal health care policy intervention has not had any significant effect on the causes of avoidable neonatal deaths. Birth Asphyxia, neonatal infections, and prematurity remain a key priority in reducing neonatal mortality rate in the country. There is need to address the health system gaps previously observed in the implementation of the free maternal health care policy to curb these preventable deaths.

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