

Determinants of Early Childhood Mortality in Kenya – Evidence from 2022 KDHS

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Abstract

Child mortality rates in Kenya have declined significantly, but progress has slowed down in the recent past, and the country is likely to miss the Sustainable Development Goal (SDG) targets for newborn and under-five mortality. The objective of this study is to explore factors that are currently influencing early childhood mortality in Kenya, to inform the design and targeting of effective intervention strategies to accelerate mortality decline. The study is guided by the Mosley and Chen (1984) framework for child survival. It employs chi-square tests to assess associations and logistic regression analysis to identify the determinants of child mortality. From the analysis, the key determinants of early childhood mortality in Kenya are maternal education, timing of antenatal care (ANC) visits, breastfeeding, weight of child at birth, attitudes and use of family planning, age of mother at birth, and multiple births (p-value<0.05). The factors contributing to elevated early childhood mortality are uptake of ANC of fewer than four ANC visits, which affects 37.6% of children, not using family planning (38%), extreme maternal age at 15%, low birth weight, which affects 13% of children. Other factors are delivering at home, 19%, and having a birth interval of less than 24 months, which affects 34% of children. To accelerate the decline in early childhood mortality, Kenya should improve prenatal services, intensify family planning and expand maternal education.

Key words: Determinants, Mortality, Early Child, Kenya

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Introduction

Early childhood mortality is an important indicator of child health and socio-economic development of a country (McGuire 2006). The standard breakdown for early childhood mortality are neonatal mortality (probability that a newborn baby will die within 28 days of life), infant mortality (probability that a newborn baby will die before celebrating their first birthday), child mortality

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(includes all deaths of babies between exact age 1 and exact age 5 years) and Under-five mortality (probability that a baby will die before reaching 5 years of age) (UNICEF 2018).

The global risk of death at birth is still high but declining, and is highest among children born in sub-Saharan Africa. In 2021, for example, 5 million children under the age of 5 years died globally. Eighty percent of these deaths occurred in Sub-Saharan Africa and Southern Asia. The global under-five mortality rate was 38 in comparison to 74 deaths per 1,000 live births in sub-Saharan Africa, and this rate was 15 times higher than in Europe and Northern America (UN IGME 2023). In 2022, the under-five mortality rate in Kenya was 41 deaths per 1,000 live births, and the neonatal mortality rate was 21 deaths per 1,000 live births (KNBS and ICF 2023). The rate of decline has, however, slowed down globally. The global rate of decline for under-five mortality, for example, decreased by 30 per cent over 10 years' period (2000-2009) to 24 per cent from 2010-2021 (UN IGME 2023). Kenya has also experienced a similar trend. According to the 2022KDHS, the under-five mortality rate declined by 30% for the under-five in 4 years (2009-2014) compared with 21% in 8 years (2015-2022) (KNBS and ICF 2023).

The risk of death in childhood is highest in the first month of life. As the level of under-five mortality rate (U5MR) declines, the share of neonatal deaths among under-five increases (UN IGME 2023). The World average of neonatal mortality was 18 deaths per 1,000 live births in 2021, about 47% of under-five mortality, while in sub-Saharan Africa, it was 27 deaths per 1,000 live births, a 38% share of under-five mortality (UN IGME, 2023). In Kenya, 51% of under-5 deaths reported in 2022KDHS were neonatal deaths (KNBS and ICF 2023). It is also worth noting that the neonatal mortality rate in Kenya hardly declined from 22 in 2014 to 21 deaths per 1000 live births in 2022; the risk of death at birth has not improved in the last 8 years. At this rate, therefore, unless drastic measures are taken to accelerate progress, Kenya is at risk of missing the SDG targets on child survival, to reduce neonatal and under-five mortality rates to at least as low as 12 and 25 deaths per 1,000 live births, respectively, by 2030.

The rate of progress of mortality decline has slowed down despite various national policies and interventions, such as the Newborn, Child, and Adolescent Health (NCAH) Policy; Integrated Management of Childhood Illnesses (IMCI), Newborn and Child Health Strategic Plan; Expanded Programme on Immunization; and *Okoa Mama na Mtoto* (Maternal and Newborn Survival) Initiative

(OMMI). The research question is therefore; *which factors are responsible for the slowing decline of early childhood mortality?* This calls for revisiting risk factors (Ahsan *et al.* 2024) to provide the vital information required to identify and implement targeted high-impact public health interventions.

The objective of this study is to determine prevailing predictors of early childhood mortality in Kenya using 2022KDHS data. The knowledge generated can be used to inform, formulate, design, and implement policies and programmes to improve child survival and accelerate Kenya towards achieving SDG targets for childhood mortality. This study is guided by the analytical framework developed by Mosely and Chen (1984) and empirical studies on child survival. The framework combines social and medical science methodologies for a better understanding of child survival, and advances research on social policy and medical interventions to improve child survival in developing countries (Mosley and Chen 1984). According to Mosley and Chen (1984), all economic and social determinants of mortality act through biological mechanisms and processes to affect child health and survival. The five intermediate variables through which all socioeconomic factors affect child survival are: biological factors, environmental and health conditions, nutritional factors, injury, and health behaviour.

The selection of potential covariates for this study was guided by existing literature on child health and survival, where studies have found a relationship between the identified variables and early childhood mortality (Under-five, Infant, and Neonatal mortality) in the developing world (Mosley and Chen 1984; Abir *et al.* 2015). Socioeconomic (Maternal education, father occupation/family income, place of residence), biodemographic (age of mother at birth, birth order and interval, multiple delivery, sex and size of child at birth), environmental (drinking water and sanitation), health behaviour (ANC uptake, breastfeeding, place of delivery, and contraceptive use and intention, health insurance) are among the factors associated with under-five mortality in developing countries (Aheto 2019; Ezeh *et al.* 2015; Getachew and Bekele 2016).

The favourable relationship between maternal education and child mortality may be attributed to fertility behaviour, better health knowledge, and use of healthcare facilities, and better labour market outcomes (Le and Nguyen 2020). For family size and parity, the relationship with child mortality may be attributed to decreased attention in care giving, resource constraints and increased risk of infectious diseases within crowded households (Reidpath and Allotey 2003). Exclusive breastfeeding is regarded as a source of food and nutrition that provides health protection for the first six months of life (James

and Lessen 2009) and hence better health; while for place of residence, it could be due to better health facilities and living conditions (Omedi 2018). Economic conditions may influence child mortality by impacting the household's ability to provide healthcare, nutrition and living conditions for the children.

Neonatal mortality is mainly attributed to preterm birth, intrapartum-related complications (including birth asphyxia, respiratory infections, and congenital malformation) (Garcia *et al.* 2019; Lawn *et al.* 2014; Nair *et al.* 2011; Perin *et al.* 2022; WHO and UNICEF 2014), and foetal malnutrition and maternal health (Andrea *et al.* 2022). De Brouwere and Van Lerberghe (2001) argue that access to proper medical attention and hygienic conditions during delivery can reduce the risk of complications and infections to the mother and the baby (Brouwere and Lerberghe 2001). According to WHO and UNICEF (2014), 80% of all newborn deaths result from complications due to birth asphyxia, respiratory infections and congenital malformation (Griffin *et al.* 2017), and recommend the following indicators to monitor progress: four or more antenatal care contacts, births attended by skilled health personnel, postnatal care within 2 days (WHO and UNICEF 2014).

Many studies have analysed child mortality and identified risk factors for Kenya. Wanjohi and Muriithi (2020) modelled covariates of infant and child mortality in Kenya and found maternal health status, preceding birth interval, birth order, maternal age at birth, sex of the child, maternal education, and wealth index influenced childhood mortality. However, other studies have not found the sex of the child to influence mortality in early childhood (Manda 1999). Ettarh and Kimani (2012), in a study that compared child survival in urban and rural areas in Kenya, found that breastfeeding and a mother's level of education determined childhood mortality in rural and urban areas. According to UNICEF (2018), some of the most effective low-cost interventions to reduce preventable early childhood deaths include antenatal care, skilled birth attendance, immunization, exclusive breastfeeding and improved sanitation. Dlamini *et al.* (2023) in a child mortality study focusing on East African countries, observed that Rwanda, Tanzania and Ethiopia have significantly reduced child mortality rates by improving access to healthcare, immunization programs, nutrition interventions and community-based initiatives. Iddi *et al.* (2024), in a study of childhood mortality in urban informal settlements in Nairobi, reported a reduced risk of early childhood mortality among children who had BCG vaccination. Children born to mothers who are married or not engaging in any income-generating activity, children from singleton pregnancy, and the ethnicity of the child had a lower risk of death.

Kenya has continued to implement relevant programmes on maternal and newborn care (Ministry of Health 2022a), which have resulted in improvement on these indicators, though not fast enough, and with regional disparities. The proportion of pregnant women reporting four or more antenatal care visits has increased from 58% in 2014 to 66% in 2022 (KNBS and ICF 2023). However, less than 80% of countries have more than 70% coverage, recommended by WHO in the global Every Newborn Action Plan (ENAP) – an action plan to end preventable newborn deaths and stillbirths by 2035. During the same period, facility delivery increased from 65% to 88%, postnatal care within two days of delivery rose from 55% to 78%, while the proportion that received sufficient tetanus toxoid injections increased marginally from 74% to 75% (KNBS & ICF, 2023). However, regional disparities remain below the ENAP-recommended levels of 80% of counties with over 80% facility deliveries and 80% of counties with more than 60% coverage of postnatal care (WHO 2018). The level of coverage for immunization has also increased to 80%, exclusive breastfeeding is at 60% and access to improved drinking water is 68% and sanitation at 41% (KNBS and ICF 2022).

Methods

Study site and population

This study used data from the Kenya Demographic and Health Survey, 2022 (henceforth referred to as 2022 KDHS); this is the most recent demographic survey that is nationally representative and has quality data for the relevant indicators for childhood mortality. KDHS is a series of repeated cross-sectional studies based on a multistage cluster sampling design to acquire nationally representative data. It targets women of reproductive age (15-49 years) and men (15-54 years) and collects data for a range of indicators, including maternal and child health, fertility, mortality, family planning, breastfeeding practices, nutrition status, immunization status, awareness and behaviour regarding HIV. In 2022 KDHS, 42,022 households were selected, but only 38,731 (92%) were occupied. Among the occupied households, 98% (37,911) were successfully interviewed. In the interviewed households, 33,879 women aged 15–49 were recruited for individual interviews, but only 95% (32,156) were interviewed successfully.

Children's data for this study were extracted from the full birth history (FBH) of the 32,156 women surveyed. Potential data quality problems include selective omission of non-surviving births,

displacement of birth dates, and misreporting of age at death. However, estimation of childhood mortality that relies on the mothers' reports assumes that there is little or no correlation between the mortality risks of the mothers and those of their children. The children analysed were born in the last five years of the survey (n=19,530). Neonatal, infant, and under-5 deaths occurred among these children within 28 days of birth, less than twelve months, and less than five years, respectively.

Study model and Variables for analysis

The study adapted the hierarchical model on child survival developed by Mosely and Chen (1984). The main outcome measures are neonatal and under-five mortality (death from birth to 28 days of life and less than five years). The potential predictor variables are organized into groups and in a hierarchy as follows:

Group1 represents socioeconomic risk factors which include: maternal education (categories: no education, primary level, secondary level, higher); mother employment status (employed, not employed); household wealth (poor, medium, rich); place of residence (urban, rural); marital status (never married, currently married/living together, formerly married/lived together); source of drinking water (improved, unimproved).

Group 2 consists of the behavioural factors and use of health services, which include: number of ANC visits (<4 visits, ≥ 4 visits); timing of first ANC uptake (within 13 weeks, 14-27 weeks, ≥ 28 weeks); place of delivery (home, public facility, private facility, NGOs); breastfeeding status (ever breastfed, never breastfed); contraceptive use or intention (yes, no to FP); timing of the index child's birth (Want then, later, no more).

Group3 represents biological risk factors which are: sex of child (male, female); gestation age (preterm, full term); age of mother at birth (15-19, ..., 44-49); type of pregnancy (singleton, multiple), birth order (1st, 2nd and 3rd, 4th- and 5th, 6th plus); preceding birth interval (< 24 months, 24-35, ≥ 36 months); size at birth (small, average, large), birth weight (1.5, 1.5-2.5, 2.5-3, 3-4, >4kg); current Health status of mother (self-report) (good, moderate, poor).

Data analysis

For purposes of data analysis, the outcome and predictor variables were coded as presented in Table 1. New variables were derived by either computing or recording the variables provided in the KDHS data file. The syntax for recording and computing variables is presented in Table 2. Statistical data analyses performed were descriptive and multivariate. Univariate analysis was done on all variables in the study and summarized into frequencies and statistics for ease of management and presentation. Chi-square test (Bivariate statistical analysis) was then conducted to establish the relationship between each of the selected covariates and the outcome variables (Table 3). A relationship where the p-value was 0.25 or less was regarded as fair enough, and the independent variable was considered for logistic analysis (Hosmer and Lemeshow 2000).

Table 1: Coding scheme of the outcome and predictor variables

Outcome Var	Survival status	0 - Dead; 1 –Alive
Group1: Socioeconomic	Maternal education	0 - No Education; 1 - Primary Level; 2 - Secondary level; 3 – Higher
	Mother employment status	0 - Not employed; 1 - Employed
	Household wealth	0 – Poor; 1 – Medium; 2 – Rich
	Place of residence	1 – Urban; 2 – Rural
	Marital status	0-Never married; 1-Currently married/living together; 2-Divorced/separated
	Source of drinking water	0 - Unimproved; 1 – Improved
Group2: behavioural factors and use of health services	Number of ANC visits	0 - <4 visits; 1 - ≥4 visits
	Timing of 1 st ANC uptake	1 - Within 13 weeks; 2- 14-27 weeks; 3 - ≥28 weeks
	Place of delivery	1 – Home; 2 - Public facility; 3 - Private facility; 4 – NGOs
	Breast feeding	0 - Never breastfed; 1 - Child ever breastfed
	Contraceptive use or intend to	0 - No to FP ; 1 - Yes to FP
	Timing of index child	1 - No more; 2 – Later; 3 - Want then
	Immunization	1- fully immunized; 0-not fully immunized)
Group3: biological risk factors	Sex of child	1 – Male; 2 – Female
	Gestation age	0 – Preterm; 1 - Full term
	Age group of mother at birth	0 -(<15); 1-(15-19); 2-(20-24); 3-(25-29); 4-(30-34); 5-(35-39); 6-(40-49)
	Type of birth	0 – Multiple; 1 - Singletone
	Birth order	0 - 1 st ; 1 – (2 nd and 3 rd order); 2 – (4 th and 5 th order); 3 – (6+ order)
	Preceding Birth interval	0 - < 24 months; 1 - 24-35 months; 2 - ≥36 months
	Size at birth	0 – Small; 1 – Average; 2 - Large
	Birth weight	1 - <1.5 Kg; 2 - 1.5-2.5Kg; 3 - 2.5-3Kg; 4 - 3-4Kg; 5 - >4kg
	Current Health status of mother	1 – Poor; 2 – Moderate; 3 – Good

Finally, logistic regression analysis was undertaken to identify determinants of early childhood mortality — neonatal and under-5 mortalities. The analysis took a hierarchical approach, whereby the selected socioeconomic (group 1) variables from bivariate analysis were analyzed separately as a block (stage 1) to generate model 1. Behavioural factors (group 2) were then introduced (stage 2) from bivariate analysis to generate model 2. In the third stage, biologic factors from bivariate analysis were

analyzed together with variables in the second model to generate model 3. All factors in the logistic analysis with a p-value<0.05 are classified as determinants of childhood mortality in Kenya, and low-cost effective interventions are recommended for those amenable.

Table 2: SPSS syntax for computing and recoding of new variables

Socioeconomic factors	Behaviour and health services	Biological factors
RECODE V106 (0=0) (1=1) (2=2) (3=3) INTO Education. VARIABLE LABELS Education 'Woman Education'. RECODE V716 (110 THRU 934=1) (0=0) INTO Employed. VARIABLE LABELS Employed 'Mother is employed'. RECODE V190 (1=0) (2=0) (3=1) (4=2) (5=2) INTO Wealth. VARIABLE LABELS Wealth 'Household wealth'. RECODE V025 (1=1) (2=2) INTO Residence. VARIABLE LABELS Residence 'Place of residence'. RECODE V501 (0=0) (1=1) (2=1) (3=2) (4=2) (5=2) INTO MaritalS. VARIABLE LABELS MaritalS 'Marital status'. RECODE V113 (10 thru 31=1) (41=1) (51=1) (32=0) (42 thru 43=0) (61 thru 62=0) (71=1) INTO water_source. VARIABLE LABELS water_source 'Source of drinking water'. EXECUTE.	RECODE M14 (Lowest thru 3=0) (4 thru 20=1) INTO ANC4. VARIABLE LABELS ANC4 '4+ ANC visits'. RECODE M13 (0=0) (1 thru 3=1) (4 thru 6=2) (7 thru 11=3) INTO ANC_timing. VARIABLE LABELS ANC_timing 'Trimester of 1st ANC'. RECODE M15 (11 thru 12=1) (21 thru 26=2) (31 thru 36 =3) (41 thru 47 =4) INTO P_delivery. VARIABLE LABELS P_delivery 'Place of delivery'. RECODE M4 (93=1) (95 thru 96=1) (94=0) INTO Bfeed. VARIABLE LABELS Bfeed 'Breastfeeding'. RECODE V481 (0=0) (1=1) INTO H_insurance. VARIABLE LABELS H_insurance 'Health insurance'. RECODE V364 (4=0) (1 thru 3=1) INTO FP_UseInt. VARIABLE LABELS FP_UseInt 'Contraceptive use or intend to'. RECODE V367 (1=3) (2=2) (3=1) INTO Want_child. VARIABLE LABELS Want_child 'Timing of last child'. EXECUTE.	RECODE AgeAtBirth (8 thru 14 =0) (15 thru 19=1) (20 thru 24 =2) (25 thru 29=3) (30 thru 34 =4) (35 thru 39=5) (40 thru 49=6) INTO Age_at_birth. VARIABLE LABELS Age_at_birth 'Age of mother at birth'. RECODE B0 (0=1) (1 THRU 5=0) INTO Multiple_birth. VARIABLE LABELS Multiple_birth 'Multiple birth or single'. RECODE B4 (1=1) (2=2) INTO Child_sex. VARIABLE LABELS Child_sex 'Sex of the child'. RECODE BORD (1=0) (2 THRU 3=1) (4 THRU 5=2) (6 THRU 20=3) INTO B_ord. VARIABLE LABELS B_ord 'Birth order'. RECODE B11 (8 THRU 23=0) (24 THRU 35=1) (36 THRU 45=2) INTO B_interval. VARIABLE LABELS B_interval 'Preceding Birth interval'. If (B_ord=0) Order_inter=0. If (B_ord=1 AND B_interval=1) Order_inter=1. If (B_ord=2 AND B_interval=1) Order_inter=2. If (B_ord=3 AND B_interval=1) Order_inter=3. If (B_ord=1 AND B_interval=0) Order_inter=4. If (B_ord=2 AND B_interval=0) Order_inter=5. If (B_ord=3 AND B_interval=0) Order_inter=6. VARIABLE LABELS Order_inter 'Birth order and Preceding Birth interval'. RECODE M18 (4 THRU 5=0) (3=1) (1 THRU 2=2) INTO B_size. VARIABLE LABELS B_size 'Baby size at birth'. RECODE M19 (600 THRU 1499=1) (1500 thru 2499=2) (2500 THRU 2999=3) (3000 thru 3999=4) (4000 THRU 6000=5) INTO B_weight. VARIABLE LABELS B_weight 'Baby weight at birth'. RECODE V176 (1 THRU 2=3) (3=2) (4 THRU 5=1) INTO M_health. VARIABLE LABELS M_health 'Health status of mother'. RECODE B20 (5 THRU 8=0) (9 THRU 10=1) INTO Gest_age. VARIABLE LABELS Gest_age 'Gestation age (preterm?)'. EXECUTE.

Findings

In this study, 19530 children: 9950 males and 9580 females born in the last five years to the 2024 according to the Kenya Demographic and Health survey were analysed for their survival status and

factors associated with it. Most of the births (66%) were from rural areas, most (35%) were born to mothers with a primary level of education, and 20% were home deliveries. From Table 3a, 437 of the children (54.2% male and 45.8% female) died within 28 days after birth, 617 (54% male and 46% female) before celebrating their first birthday, and 694 (53% male and 47% female) before age 5 years.

Table 3a: Distribution of early child death by background characteristics

Characteristics		Categories		Neonatal Deaths		Under Five Deaths			
			N	No (%)	P-Value	No(%)	P-Value		
Biological factors									
Sex of the child	Male		9950	237(2.4)	0.165	368(3.7)	0.265		
	Female		9580	200(2.1)		326(3.4)			
Gestation age	Preterm		1360	122(9.0)	0.000	144(10.6)	0.000		
	full preterm		18170	315(1.7)		550(3.0)		**	
Mother age at birth	< 15 years		19	2(10.5)	0.013	2(10.5)	0.009		
	15-19		1716	48(2.8)		*		75(4.4)	*
	20-24		4618	92(2.0)				147(3.2)	
	25-29		4180	91(2.2)				150(3.6)	
	30-34		3262	61(1.9)				93(2.9)	
	35-39		1644	34(2.1)				64(3.9)	
	40-49		686	23(3.4)				34(5.0)	
	Type of birth	Singleton		18906		367(1.9)		0.000	605(3.2)
Multiple births			624	70(11.2)	**	89(14.3)	**		
Birth order and Interval	1st Birth		5161	2.4%	0.002	3.7%	0.001		
	Order2&3 interval>24		2729	1.7%		**		2.9%	**
	Order4&5 interval>24		1620	1.4%				2.5%	
	Order6+ interval>24		1490	1.8%				3.4%	
	Order2&3 interval<24		1381	3.0%				5.0%	
	Order4&5 interval<24		735	3.1%				4.5%	
	Order6+ interval<24		883	3.1%				4.8%	
Size of child at birth	Small		766	38(5.0)	0.000	56(7.3)	0.000		
	Average		4105	55(1.3)		**		105(2.6)	**
	Large		891	14(1.6)				25(2.8)	
Weight of child at birth	<1.5 kg		35	6(17.1)	0.000	7(20)	0.000		
	1.5kg to <2.5		394	14(3.6)		**		23(5.8)	**
	2.5kg to <3		998	16(1.6)				26(2.6)	
	3kg to 4		2906	26(0.9)				62(2.1)	
	>4(macrosomia)		422	10(2.4)				18(4.3)	
Current Health status of mother (self report)	Good		15946	331(2.1)	0.000	516(3.2)	0.000		
	Moderate		3176	81(2.6)		**		146(4.6)	**
	Poor		408	25(6.1)				32(7.8)	
Total			19530	437		694			

*significant (0.000<p-value<0.05); ** highly significant (p-value<0.000)

Bivariate analysis

Amongst the 21 factors subjected to bivariate analyses, 19 had a p-value<0.25 and were included in the hierarchical logistic regression analysis as recommended by Hosmer and Lemeshow (2000).

Table 3b: Distribution of early child death by background characteristics

Characteristics		Categories			Neonatal Deaths		Under Five Deaths	
				N	No (%)	P-Value	No(%)	P-Value
Socioeconomic factors								
Mother level of Education	No education	4464	90 (2.0)	0.024	141(3.2)	0.000		
	Primary	6896	179(2.6%)	*	290(4.2)	**		
	Secondary	5542	125(2.3)		195(3.5)			
	Higher	2628	43(1.6)		68(2.6)			
Mother is employed	Not employed	9493	212(2.2)	0.956	312(3.3)	0.052		
	Employed	9858	219(2.2)		375(3.8)			
Household level of Wealth	Poor	9762	209(2.1)	0.565	343(3.5)	0.787		
	Moderate	3379	75(2.2)		116(3.4)			
	Rich	6389	153(2.4)		235(3.7)			
Residence Place of residence	Urban	6686	161(2.4)	0.245	250(3.7)	0.312		
	Rural	12844	276(2.1)		444(3.5)			
Marital status	Never Married	1573	40(2.5)	0.017	56(3.6)	0.013		
	Married/Living together	16083	339(2.1)	*	549(3.4)	*		
	Formerly married	1874	58(3.1)		89(4.7)			
Source of drinking water	Unimproved	5881	139(2.4)	0.332	221(3.8)	0.253		
	Improved	12901	276(2.1)		442(4.3)			
Behaviour and use of health services								
ANC visits	< 4 ANC visits	3913	69(1.8)	0.094	113(2.9)	0.020		
	4 or More visits	6488	81(1.2)		139(2.1)	*		
	98.00	11	0(0.0)		1			
Timing of 1st ANC	within 13 weeks	2782	40(1.4)	0.035	72(2.6)	0.030		
	14-27 weeks	6271	86(1.4)	*	146(2.3)	*		
	28-40 weeks	974	4(0.4)		11(1.1)			
Place of delivery	Home	2277	49 (2.2)	0.009	86(3.8)	0.002		
	Public facility	7426	174(2.3)	*	258(3.5)	*		
	Private Facility	1381	14(1.0)		24(1.7)			
	NGO and FBO facility	580	8(1.4)		14(2.4)			
Breastfeeding	Never breastfed	332	155(46.7)	0.000	156(47)	0.000		
	Ever breastfed	11396	94(0.8)	**	230(2.0)	**		
Contraceptive use or intend to	No to FP	7366	207(2.8)	0.000	307(4.2)	0.000		
	Yes to FP	12164	230(1.9)	**	387(3.2)	**		
Timing of index child	Wanted then	9975	255(2.6)	0.053	399(4.0)	0.012		
	Wanted later	4095	79(2.4)		123(3.0)	*		
	Want no more	1228	24(2.0)		40(3.3)			

*significant (0.000<p-value<0.05); ** highly significant (p-value<0.000)

The bivariate analysis (chi-square test) established that child's death within 28 days of life is associated (p-value<=0.05) with mothers' level of education, marital status, timing of first ANC visit,

place of delivery, breastfeeding, contraceptive use or intention to (having a strong value of family planning), gestation age, age of mother at birth, type of birth (multiple/singleton birth), preceding birth interval, size of child at birth, weight of child at birth, and current health status of mother (self-report), and were therefore picked for logistic regression analysis. In addition, the place of residence, number of ANC visits, timing of last child and sex of child were also selected for multivariate analysis because of their $p\text{-value} < 0.25$ (Hosmer and Lemeshow 2000).

From Table 3b, deaths of children under five years are associated ($p < 0.05$) with mothers' level of education, mother employment status, marital status, number of ANC visits, timing of first ANC visit, place of delivery, breastfeeding, contraceptive use or intention to (having a strong value of family planning), timing of the last child (if wanted), gestation age, age of mother at birth, multiple birth or single, preceding birth interval, size of child at birth, weight of child at birth, current Health status of mother (self-report) were entered in the logistic regression. In addition, mother's employment status and birth order ($p < 0.25$) were also included in the multivariate analysis.

Multivariate logistic analysis

From Table 4, level of education, ANC timing, breastfeeding, attitude and use of family planning, wanted child then, age of mother at birth, multiple births, gestation age and weight of child at birth are the determinants of early childhood mortality in Kenya; they are statistically significant ($p\text{-value} < 0.05$) in predicting early childhood mortality. Specifically, timing of the first ANC visit, breastfeeding, attitude and use of family planning, if the birth was wanted then, whether singleton or multiple births, and gestation age were found to influence both neonatal and under-five mortality. While education and age at birth statistically significantly (< 0.05) predict under-five mortality, and marginally affected education and age at birth (Table 4).

Other important predictors based on odds of survival are place of delivery, timing of the pregnancy/birth and birth order, where odds of survival for a category are more than twice that of the reference group. At any stage in early childhood, odds of survival for a birth born in a health facility are more than twice that of a child born at home, and odds of survival for a birth/pregnancy that was wanted at all are also more than two-fold that of a child/pregnancy that is not wanted at conception/birth.

Table 4: Regression models for early childhood mortality

	Neonatal				Under five mortality			
	Sig.	Exp(B)	95% C.I.for EXP(B)		Sig.	Exp(B)	95% C.I.for EXP(B)	
			Lower	Upper			Lower	Upper
Residence(1)	.761	1.108	.572	2.146	.791	1.063	.675	1.674
Education	.081				.000	**		
Education(1)	.010	.302	.121	.755	.000	.271	.148	.496
Education(2)	.036	.321	.111	.931	.001	.289	.142	.590
Education(3)	.119	.376	.110	1.288	.041	.411	.175	.966
Employed(1)	.425	.793	.448	1.403	.131	.747	.512	1.091
Wealth	.787				.587			
Wealth(1)	.724	.873	.412	1.853	.675	.895	.534	1.502
Wealth(2)	.489	.742	.319	1.727	.305	.742	.419	1.312
water_source(1)	.366	1.320	.723	2.410	.357	1.207	.809	1.800
MaritalS	.761				.543			
MaritalS(1)	.469	1.447	.533	3.933	.343	.695	.327	1.474
MaritalS(2)	.671	1.304	.382	4.448	.274	.610	.252	1.477
ANC4	.550				.184			
ANC4(1)	.275	1.399	.766	2.557	.066	1.462	.976	2.190
ANC_timing	.034	*			.023	*		
ANC_timing(1)	.343	1.327	.739	2.383	.114	1.380	.926	2.058
ANC_timing(2)	.010	10.951	1.787	67.129	.007	3.369	1.393	8.148
P_delivery	.401				.121			
P_delivery(1)	.293	.624	.259	1.502	.033	1.729	1.046	2.855
P_delivery(2)	.941	1.048	.303	3.617	.037	2.221	1.049	4.706
P_delivery(3)	.758	1.287	.258	6.411	.125	2.074	.816	5.271
Bfeed(1)	.000	131.050	76.287	225.123	.000	37.103	24.340	56.558
FP_UseInt(1)	.001	2.671	1.517	4.705	.000	2.106	1.446	3.066
Want_child	.043	*			.025	*		
Want_child(1)	.013	2.758	1.237	6.149	.026	1.743	1.070	2.840
Want_child(2)	.445	1.481	.541	4.055	.062	2.003	.965	4.156
Age_at_birth	.064				.010	*		
Age_at_birth(1)	.015	31.261	1.961	498.235	.070	10.400	.829	130.404
Age_at_birth(2)	.008	44.474	2.727	725.277	.032	16.206	1.275	206.032
Age_at_birth(3)	.050	17.361	1.006	299.682	.083	9.790	.743	128.971
Age_at_birth(4)	.037	22.434	1.211	415.687	.055	12.970	.943	178.381
Age_at_birth(5)	.061	16.868	.876	324.847	.168	6.366	.457	88.622
Age_at_birth(6)	.078	16.404	.732	367.531	.246	4.909	.334	72.166
Multiple_birth(1)	.000	.111	.037	.331	.000	.216	.093	.499
B_weight	.039	*			.433			
B_weight(1)	.324	3.400	.299	38.671	.567	1.654	.295	9.287
B_weight(2)	.222	4.568	.398	52.405	.428	2.030	.353	11.677
B_weight(3)	.019	21.657	1.653	283.715	.196	3.309	.540	20.270
B_weight(4)	.184	7.078	.393	127.332	.572	1.792	.237	13.568
Child_sex(1)	.832	.946	.565	1.583	.566	.905	.644	1.272
Order_inter	.713				.658			
Order_inter(1)	.416	1.432	.602	3.403	.308	1.345	.761	2.379
Order_inter(2)	.714	1.233	.402	3.779	.165	1.728	.798	3.744
Order_inter(3)	.861	1.132	.282	4.546	.758	1.154	.464	2.867
Order_inter(4)	.325	.572	.188	1.740	.598	.816	.382	1.741
Order_inter(5)	.393	2.247	.351	14.383	.729	1.209	.413	3.546
Order_inter(6)	.825	.836	.171	4.083	.622	1.342	.417	4.319
M_health	.748				.443			
M_health(1)	.765	.897	.442	1.822	.271	.777	.496	1.217
M_health(2)	.465	.604	.156	2.334	.444	.685	.259	1.807
Gest_age(1)	.003	2.814	1.434	5.521	.015	1.874	1.132	3.102
Constant	.012	.021			.065	.082		

*significant (0.000<p-value<0.05); ** highly significant (p-value<0.000)

The most significant factors hindering early childhood mortality decline, measured by the number of children affected and their odds of survival, include ANC visits of fewer than 4, impacting 37.6% of children; negative attitudes towards family planning, affecting 38%; small birth sizes, affecting 13%; and extreme maternal age, impacting 15%. Other factors are delivery at home or at government health facilities, which affect 19%, and a birth interval of less than 24 months, affecting 34% of children.

Models for Neonatal Mortality

The results show that the first model for predicting neonatal mortality from a socioeconomic angle was not statistically significant (chi-square (8.510), $p=0.579$) from the null model. The second model (chi-square (138.841), $p<.000$), which had socioeconomic and behavioural factors, showed significant improvement from the first model. The third model, comprising biologic factors, showed significant improvement from the null model ($\chi^2(35) = 166.479$, $p < 0.001$).

Overall, timing of ANC uptake ($p=0.034$), breastfeeding ($p<0.001$), attitude and use of family planning ($p=0.001$), if child was wanted at the time of conception ($p=0.043$), multiple births ($p<0.001$), gestation age ($p=0.003$) and weight of child at birth ($p=0.039$) were statistically significant. Maternal education (0.081) and age of mother at birth ($p=0.064$) were marginally statistically significant. Other important results are that, although ANC 4 uptake was not statistically significant, a birth where the mother had four or more visits had higher odds of survival (1.5 times) than that with less than 4 visits, and timing of the first visit is extremely important — ANC visits that started in the first trimester resulted in about 11 times odds of survival than those who started in the third trimester.

The importance of breastfeeding is clear from the results as children who were breastfed had more than 131 odds of survival than those who were not. Age of mother at birth was not statistically significant, but the odds of survival among births for women at the age of 24-29 years were about 44 times that of those borne of teenage (15-19) mothers. The odds of survival for a child whose mother *wanted to have it then* are a good predictor for survival; a child who was wanted at conception had about 3 times the odds of survival than one who was not wanted at all. This is reinforced by the fact that the attitude towards the use of family planning was also statistically significant. Birth order and birth interval were not statistically significant. However, their importance is depicted in the higher odds of

survival for children of birth order 2 and 3 in combination with a birth interval of at least 24 months, which is about one-and-half times that of first-order birth.

Models for Under-five mortality

The results show that the first model with socioeconomic variables to predict under-five mortality was not statistically significant (chi-square (12.619), $p=0.262$). The second model (chi-square (122.268), $p<.001$), which included behavioural factors, showed significant improvement from the first model. The third/final model, which included socioeconomic, behavioural and biological factors was also statistically significant ($\chi^2 (35) = 143.952$, $p<0.001$) from the null model.

Factors in the final models that significantly predicted under five mortality were maternal education ($p<0.001$), timing of the first ANC visit ($p=0.023$), breastfeeding ($p<0.001$), attitude and use of family planning methods ($p<0.001$), if wanted child at the time of conception ($p=0.025$), age at the time of this birth ($p=0.010$), type of birth(multiple/singleton) ($p<0.001$), and gestation age(full or preterm) ($p<0.001$).

Discussion

The objective of the study is to determine predictors of early childhood mortality in Kenya. Overall, early child death in Kenya is mainly driven by biological factors and is significantly associated with behavioural factors and use of health services. The most significant socioeconomic factor is the mother's education.

Determinants of early childhood mortality in Kenya identified in this study include breastfeeding, weight of child at birth, multiple births, timing of ANC uptake, age of mother at birth and contraceptive use or intentions. Breastfeeding and timing of ANC uptake, contraceptive use or intentions, birth/pregnancy type are determinants of survival in neonatal and under-five stages of the early childhood period, while birth weight predicts neonatal mortality only, and age of the mother at birth predicted under-five mortalities. The size of the child at birth, multiple births and birth order are natural factors (and not amenable to intervention directly) which are interrelated. Multiple births are more likely to be born premature and, therefore, small for gestational age (SGA) and low birth weight (Heino et al. 2016). Low birth weight has also been attributed to foetal malnutrition and maternal health (Verhulst et

al. 2022). Claudia Bohn et al (2020) in a longitudinal cohort study in the city of Leipzig, Germany, found that birth order also influences birth weight at delivery (Claudia *et al.* 2020).

Maternal Education

The relationship between maternal education and early childhood mortality is well documented. This study found that education can predict early child mortality. The finding is consistent with findings of many other studies (Le and Nguyen 2020; Wanjohi and Muriithi 2020; Ettarh and Kimani 2012). Educated women are empowered and better informed about nutrition, general hygiene and family planning methods, and can efficiently use the methods to prevent unwanted pregnancies.

Breastfeeding

As demonstrated by other studies, breast milk is the healthiest in early childhood; it provides more than half of nutritional needs in the first month of life, has antibodies that protect against many common childhood illnesses, including diarrhoea and pneumonia (Story and Parish 2008). In this study, breastfeeding is a key determinant of survival in early childhood and hence central to Kenya's achievement of SDG targets on early childhood mortality; it is therefore a priority for national child-survival efforts. This finding is consistent with many other studies (Cherop *et al.* 2009; Kimani-Murage *et al.* 2014; Rowe-Murray and Fisher 2002; Sachdev and Mehrotra 1995). According to KDHS (2022), exclusive breastfeeding until 6 months is low and even declined marginally from 61 percent in 2014 to 60 percent in 2022.

Known barriers to breastfeeding include lack of knowledge and experience/skills, societal barriers and negative attitudes, and lack of Support and services (U.S. Department of Health and Human Services 2011). Other barriers include delivery method (Rowe-Murray and Fisher 2002; Sachdev and Mehrotra 1995), where caesarean births were less likely to be breastfed due to delay in mother-child contact and alternative feeding at birth by facility staff as the mother recuperates, work situation - need to resume work and long working hours (Kimani-Murage *et al.* 2014). Cultural and mythical beliefs that breast milk is unsatisfying to the infant, insufficient breast milk production, need to improve the nutritional status of the infant and differentials in diagnosis for breastfeeding (Cherop *et al.* 2009).

To achieve breastfeeding goals of six months of exclusive breastfeeding, these barriers must be addressed. Mothers should be supported through education, skills building, and positive attitude change.

Place of delivery

According to Weil and Fernandez (1999), over 40 percent of pregnancies have potential for obstetric disorders, and the occurrence of obstetric/intrapartum complications during labour and home delivery is likely to result in adverse maternal and newborn outcomes. To minimize preventable adverse outcomes, ENAP recommends that at least 80% of deliveries in a country should happen in a health facility (WHO, 2018). In Kenya, facility delivery was 80% in 2022 (2022 KDHS) with regional disparities. This study, like others, found higher odds of survival for births occurring at health facilities. According to Moindi *et al.* (2016), the major causes of home deliveries are precipitate labour/sudden onset of labour and long distance from the nearest health facility.

ANC timing and age of the mother at birth

WHO recommends at least four ANC visits during pregnancy, starting in the first trimester, for better outcomes. The finding that the timing of ANC visits predicts early childhood survival, and higher survival odds among births to mothers who reported having at least the recommended 4 ANC visits, is consistent with findings by Oduse *et al.* (2021) in Ethiopia. ANC visits provide an opportunity to identify risks associated with pregnancy, intrauterine growth monitoring, disease prevention and management. According to Verhulst *et al.* (2022), ANC visit is linked to maternal health and consequently to foetal health and its weight at birth.

As relates to mothers' age at time of delivery, this study found that children born to women in extreme ages (<15 and >40years) had a higher probability of death than the rest. Other studies have reported similar findings that maternal age predicts birth outcomes (Fall *et al.* 2015). Births to young mothers have been reported to have a greater risk of pre-term delivery, low birth weight, small for gestational age and neonatal mortality (Kang *et al.* 2015). To remedy this situation, family planning programs should be improved to address unwanted pregnancies in teenagers and older adults.

Biodemographic/Birth characteristics: Size of child at birth, multiple births and birth order

This study found that births described as small by mothers or found to have low birth weights had lower odds of survival than average and large babies. Multiple births also had higher odds of death than singleton births (Fotso *et al.* 2013), and first and birth orders of above 5 had higher odds of death in

comparison to the birth orders in between. The finding that perinatal factors predict early childhood mortality is consistent with findings of many researchers, including Garcia *et al.* (2019) in Brazil.

The findings of higher odds of survival among children with long preceding birth intervals and birth orders 2 and 3 than children with short birth intervals and extreme birth orders are consistent with studies elsewhere (Fotso *et al.* 2013). However, the finding that the index of child's wantedness and attitude towards family planning use predicted early childhood mortality in this study was inconsistent with Fotso *et al* (2013)'s finding in a longitudinal study in urban Kenya. The want of a child and family planning are interlinked. Family planning is known to prevent unwanted pregnancy and consequently reduce neonatal and maternal mortality rates significantly (WHO 2018). Marital status, though not statistically significant, children born to mothers in marital union had higher odds of survival than those born to single mothers. This is corroborated by Festo *et al* (2013) in urban Kenya. Being in a union has been attributed to stability in family and, hence, better health for children's outcomes.

Conclusion

Breastfeeding is a key determinant of early childhood mortality, and further research on the reasons for not exclusively breastfeeding for six months is therefore recommended. However, causes alluded to in the paper revolve around livelihood and health (breast engorgement and mastitis) (Cherop *et al.* 2009; Kimani-Murage *et al.* 2014), and WHO and UNICEF recommend community and employer support to encourage breastfeeding (WHO and UNICEF 2014). The size of the child at birth, multiple births, and birth order are the other determinants in this study. These are biological factors that are not expressively amenable to interventions. WHO and UNICEF recommend survival measures such as Kangaroo mother care, exclusive breastfeeding support, and community support (WHO and UNICEF 2014).

This study recommends further studies to determine the cause of not fully implementing exclusive breastfeeding in Kenya. It also recommends educational training for couples to embrace Kangaroo mother care, breastfeeding support from employers, community support and strengthening FP programmes to communicate the importance of contraceptives in minimizing mistimed pregnancies.

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