**Determinants of Infant Mortality** **in Kenya based on Kenya Demographic and Health Survey 2022: Applying Cox proportional hazards model**

**Abstract:** Although the country has made great strides in lowering infant mortality, it is still lagging behind the Sustainable Development Goal target 3.2 adopted by the United Nations meeting in 2015, which targets neonatal mortality, a sub-component of infant mortality, of 12 deaths per 1,000 live births by 2030 for preventable deaths. Five years before the Kenya demographic and health survey was conducted in 2022, the infant mortality rate was 32 deaths per 1,000 live births. The information was collected as part of a retrospective pregnancy history, in which female respondents between 15-49 listed all the children to whom they had given birth, along with each child’s date of birth, survivorship status, and current age or age at death. The study only considered infant deaths and live births between 2017-2022. The objective of the study was to identify the demographic, socio-economic and environmental factors that affect infant mortality in Kenya and their relative risks in order to achieve the Sustainable Development Goal target 3.2. The study employed the Cox proportional hazards model to determine the relative risk of the factors. The result of the study showed that maternal age, multiple births, highest maternal education level, birth intervals, place of delivery, frequency of antenatal during pregnancy, and region have significant effects on infant mortality in Kenya.The study recommends policymakers and programme managers in the health sector formulate appropriate strategies to reduce infant mortality by creating awareness of these factors and improving them. They should also enhance their monitoring, evaluation, and reporting procedures to take appropriate remedial action.

**Keywords:** Infant Mortality, Relative risk, Cox-Proportional Hazard Model, Kenya Demographic and Health Survey

**1.0 Background**

The infant mortality rate is defined as the number of children who die before reaching their first birthday in a given year, expressed per 1,000 live births or the probability of dying between birth and the first birthday.The rate reflects the effect of demographic, economic, social and environmental conditions on the health of mothers and infants and the effectiveness of health systems.Globally, the infant mortality rate has decreased from an estimated rate of 65 deaths per 1000 live births in 1990 to 29 deaths per 1000 live births in 2018 according to the World Health Organization [1]. In 2020, the mortality rate among children under the age of one in Africa was around 43 deaths per thousand live births. Infant mortality on the continent decreased significantly compared to 2000 when approximately 86 newborn infants out of a thousand died before one year of age [2]. The infant mortality rate was 32 deaths per 1,000 live births according to [3] in 2022.According to [4], Sustainable Development Goal target 3.2 adopted by the United Nations meeting in 2015, targets neonatal mortality, a sub-component of infant mortality, of 12 deaths per 1,000 live births and child mortality of 25 deaths per 1,000 live births by 2030 for preventable deaths. In 2020, 125 countries had already met the SDG target for under-5 mortality and a further 16 countries are expected to meet the target by 2030 if current trends continue [23,24]. However, accelerated progress will be needed in 54 countries, which will not achieve the target by 2030 on current trends. Thirty-five of these countries will need to double their current rates of reduction without considering the additional challenges brought about by the COVID-19 pandemic [5]. Kenya’s infant mortality rate is higher than the targeted rate by 2030. This requires strategic intervention by the National and county governments to lower the rates.

**2.** **Literature review**

The infant mortality rate is a key indicator of infant health care as well as the socio-economic and environmental status of any region such as the county, country, continent or the world. According to UNICEF [6], 85 per cent of child deaths occur during the first five years of life. The indicator is included in the Sustainable Development Goals set a target of 3.2 to be achieved by 2030.

[7] studied factors affecting infant and child mortality in Kenya based on the 2014 Kenya Demographic and Health Surveys. They used logistic regression and survival analysis methods to evaluate factors affecting infant and child mortalities. The results of the study showed that the HIV status of the mother and lengths of the preceding birth interval were significantly associated with both Infant and Child Mortality. Other significant covariates include birth order, age of the mother at birth of the child, sex of the child, education of the mother and father and wealth index.

[8] they studied the infant mortality risk factors using a logistic regression model and spatial analysis in Kenya based on the 2014 Kenya Demographic Health Survey. The study found that counties from the northern parts of Kenya, Rift Valley, Central, Eastern, Nyanza, Coastal and Western parts of Kenya had a higher level of infant mortality. Infant mortality is high in arid and semi-arid areas and coastal areas due to the high prevalence of infectious diseases and inadequate water supply, health facilities and low education levels. Infant mortality varies significantly across regions in Kenya due to cultural activities, and weather patterns hence exists spatial autocorrelation among neighbouring regions.

[9] they studied the infant mortality risk factors using a Cox-Proportional Hazard Model in Kenya based on the 2014 Kenya Demographic Health Survey. The study revealed the socioeconomic and demographic factors affecting infant mortality. They found that the maternal education level, occupation, wealth index, place of residence, maternal age, sex of the infant, place of delivery, birth order, sources of drinking water, and type of toilet were significantly affecting infant mortality.

[10] conducted a retrospective analysis of infant mortality based on the Nigeria Demographic

and Health Surveys (NDHS) 2013. They used the proportional hazard Model to determine the relative risk of some covariates responsible for infant mortality. They found that the region, sex of the infant, religion, gender, maternal education level, wealth index and age at birth were significantly affecting infant mortality.

[11] investigated household factors associated with infant mortality in thirty-five sub‑Saharan African countries for the survey conducted between 2012-2017. They used Cox proportional hazard regression to determine the relative risk of the household factors. They found that polygamy, large family size or increased number of children ever born, history of mothers’ involvement in multiple unions and rural residence were associated with a higher risk of infant mortality. Conversely, female household headship, long duration in union, maternal education, and improved household wealth status were associated with a reduction in the risk of infant mortality.

[12] investigated infant mortality in Sierra Leone by applying the Cox proportional hazards model to determine the relative risk of each variable. He found that birth spacing of three years and above associated with a reduced risk of infant mortality contrasted with short birth intervals, Children born to nonanemic mothers have a lower hazard of infant mortality compared to those born to anemic mothers, at least one antenatal care visit by mothers lowers infant mortality rate by 41% compared to no antenatal visits at all, infants whose mothers have received postnatal care are at lower risk of dying than those whose mothers have not received.

In this study, our focus was to examine the impact of the demographic, socio-economic and environmental factors that affect infant mortality in Kenya and their relative risks based on Kenya's demographic and health survey conducted in 2022. Identifying these factors will help researchers, policymakers, and the government in formulating policies to address infant deaths.

**3. Methodology**

**3.1Model Specification**

The data obtained from the Kenya Demographic and Health Survey **2022**(KDHS) was analyzed using the COXREG Survival analysis command, in the Statistical Package for Social Science (SPSS 21.0) program. The program was used to compute the Cox proportional hazard ratios for the determinants of infant mortality. The proportional hazard model, which stems from the work of [13], assumes that for an individual with a vector of Covariates in, the hazard rate (death rate) at a time is given by:

 

 is the hazard function for the comparison group at a time with.

is the baseline hazard function for an individual with a time.

 is a known vector of explanatory variables associated with the individual.

 is a vector of unknown coefficients of explanatory variables.

The relative risk is given by:

 

If the risk of dying is less in the comparison group.

If the risk of dying is greater in the comparison group.

If the risk of dying is equal in the two groups.

**Assumptions of the model**

Assumption 1: Independent observations. This assumption means that there is no relationship between the subjects in your data set and that information about one subject’s survival does not in any way inform the estimated survival of any other subject.

Assumption 2: Non-informative or Independent censoring. This assumption is satisfied when there is no relationship between the probability of censoring and the event of interest.

Assumption 3: The survival curves for two different strata of a risk factor must have hazard functions that are proportional over time. This assumption is satisfied when the change in hazard from one category to the next does not depend on time.

**3.2 Data source**

Kenya is located in the East Africa region. The country borders Tanzania and Uganda to the west, South Sudan and Ethiopia to the north, Somalia to the east and the Indian Ocean to the south. Kenya covers a total area of 580,876.3 Km2 with a population density of 82 persons per Km2. According to the 2019 Population and Housing Census, Kenya’s population is approximately 47.6 million with a sex ratio of 98 (more females than males). The intercensal population growth rate was reported at 2.2 percent and the average household size was reported at 3.9 persons.

The sample for the 2022 KDHS was drawn from the Kenya Household Master Sample Frame (K-HMSF). The frame is based on the 2019 Kenya Population and Housing Census (KPHC) data, in which a total of 129,067 enumeration areas were developed. Of these enumeration areas, 10,000 were selected with probability proportional to size to create the Kenya Household Master Sample Frame. The 10,000 enumeration areas were randomized into four equal subsamples. The 2022 KDHS sample was drawn from subsample one of the K-HMSF. The EAs were developed into clusters through a process of household listing and geo-referencing.

 To design the frame, each of the 47 counties in Kenya was stratified into rural and urban strata, which resulted in 92 strata since Nairobi City and Mombasa counties are purely urban. The sample size was computed at 42,300 households, with 25 households selected per cluster, which resulted in 1,692 clusters spread across the country, 1,026 clusters in rural areas, and 666 in urban areas. The sample was allocated to the different sampling strata using power allocation to enable comparability of county estimates. The 2022 KDHS employed a two-stage stratified sample design, where in the first stage 1,692 clusters were selected from the K-HMSF using the Equal Probability Selection Method (EPSEM). The clusters were selected independently in each sampling stratum. Household listing was carried out in all the selected clusters, and the resulting list of households served as a sampling frame for the second stage of selection, where 25 households were selected from each cluster. However, after the household listing procedure, it was found that some clusters had fewer than 25 households; therefore, all households from these clusters were selected for the sample. This resulted in 42,022 households being sampled for the 2022 KDHS. Interviews were conducted only in the pre-selected households and clusters; no replacement of the preselected units was allowed during the survey data collection stages. Household listing was done with computer-assisted personal interviews (CAPI) with the data transmitted to a central server for processing. During the listing exercise, geo-data were collected to assist in identifying the selected households.

The quality of mortality estimates calculated from retrospective birth histories depends upon the completeness with which births and deaths are reported and recorded. Potentially the most serious data quality problem is the selective omission from the birth histories of births who did not survive, which can lead to underestimation of mortality rates. Other potential problems include displacement of birth dates, which may distort mortality trends, and misreporting of the age at death, which may distort the age pattern of mortality. Underreporting of early infant deaths is most commonly observed for births that occurred long before the survey; hence it is useful to examine the ratios over time.

[14] have offered a conceptual framework to explore the main thrust of infant mortality at length. It uses three factors: proximal, intermediate and distal. Proximal includes birth size and sex of the newborn child. Intermediate factors are the age of the mother’s age at first birth, maternal health care and education and socioeconomic status of the mother. Distal elements infer district, place of residence and community characteristics. Many studies have followed the aforementioned conceptual groundwork to analyze newborn child death. The purpose of this article is to explore how these factors influence infant and under-five mortality rates.

**4.0 Results and Discussions**

The study sought to establish the effect of demographic, socioeconomic variables and environmental factors influencing infant mortality results are provided in Table 1.

**Table 1: Demographic, Socioeconomic variables and Environmental factors related to Infant mortality.**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  | B | SE | Wald | df | Sig. | Exp(B) | 95.0% CI for Exp(B) |
| Lower | Upper |
| **Maternal age** |  |  |  |  |  |  |  |  |
| 15-19 |  |  | 12.488 | 6 | .052 | 1.000 |  |  |
| 20-24 | -.247 | .180 | 1.874 | 1 | .171 | .781 | .549 | 1.112 |
| 25-29 | -.431 | .179 | 5.794 | 1 | .016 | .650 | .457 | .923 |
| 30-34 | -.425 | .185 | 5.298 | 1 | .021 | .654 | .455 | .939 |
| 35-39 | -.275 | .189 | 2.123 | 1 | .145 | .759 | .525 | 1.100 |
| 40-44 | -.050 | .217 | .053 | 1 | .818 | .951 | .622 | 1.455 |
| 45-49 | -.004 | .330 | .000 | 1 | .989 | .996 | .521 | 1.901 |
| **Marital status** |  |  |  |  |  |  |  |  |
| Never in union |  |  | 8.954 | 5 | .111 | 1.000 |  |  |
| Married | -.159 | .144 | 1.219 | 1 | .270 | .853 | .643 | 1.131 |
| Living with partner | .016 | .195 | .007 | 1 | .935 | 1.016 | .693 | 1.490 |
| Widowed | .188 | .285 | .436 | 1 | .509 | 1.207 | .691 | 2.108 |
| Divorced | .337 | .309 | 1.190 | 1 | .275 | 1.401 | .765 | 2.567 |
| No longer living together/separated | .124 | .197 | .398 | 1 | .528 | 1.133 | .769 | 1.667 |
| **Multiple Births** |  |  |  |  |  |  |  |  |
| Single birth |  |  | 190.756 | 3 | .000 | 1.000 |  |  |
| 1st of multiple | 1.603 | .160 | 99.953 | 1 | .000 | 4.966 | 3.627 | 6.798 |
| 2nd of multiple | 1.624 | .159 | 104.925 | 1 | .000 | 5.074 | 3.719 | 6.923 |
| 3rd of multiple | -6.473 | 74.435 | .008 | 1 | .931 | .002 | .000 | 3.535E+060 |
| **Sex of the infant** |  |  |  |  |  |  |  |  |
| Male |  |  |  |  |  | 1.000 |  |  |
| Female | -.123 | .081 | 2.323 | 1 | .127 | .884 | .755 | 1.036 |
| **Sex of the head of the household** |  |  |  |  |  |  |  |  |
| Male |  |  |  |  |  | 1.000 |  |  |
| Female | -.046 | .089 | .274 | 1 | .601 | .955 | .803 | 1.136 |
| **Birth order** |  |  |  |  |  |  |  |  |
| 1 |  |  | 2.613 | 2 | .271 | 1.000 |  |  |
| 2-4 | -.138 | .096 | 2.070 | 1 | .150 | .871 | .722 | 1.051 |
| 5 and above | -.017 | .110 | .024 | 1 | .876 | .983 | .792 | 1.221 |
| **Age of the first birth** |  |  |  |  |  |  |  |  |
| Less than 18 |  |  | 2.398 | 2 | .301 | 1.000 |  |  |
| 19-35 | -.135 | .088 | 2.362 | 1 | .124 | .874 | .736 | 1.038 |
| 36 and above | -.283 | 1.003 | .080 | 1 | .778 | .754 | .106 | 5.378 |
| **Highest education level** |  |  |  |  |  |  |  |  |
| No education |  |  | 12.774 | 3 | .005 | 1.000 |  |  |
| Primary | .284 | .110 | 6.707 | 1 | .010 | 1.328 | 1.071 | 1.646 |
| Secondary | .143 | .117 | 1.477 | 1 | .224 | 1.153 | .916 | 1.451 |
| Higher | -.145 | .155 | .873 | 1 | .350 | .865 | .639 | 1.172 |
| **Religion** |  |  |  |  |  |  |  |  |
| Catholics |  |  | 4.460 | 3 | .216 | 1.000 |  |  |
| Protestants | .235 | .120 | 3.843 | 1 | .050 | 1.265 | 1.000 | 1.600 |
| Muslim | .113 | .141 | .644 | 1 | .422 | 1.120 | .850 | 1.476 |
| Others | .182 | .224 | .660 | 1 | .417 | 1.200 | .773 | 1.861 |
| **Wealth status** |  |  |  |  |  |  |  |  |
| Poorest |  |  | 3.637 | 4 | .457 | 1.000 |  |  |
| Poorer | -.011 | .114 | .009 | 1 | .924 | .989 | .791 | 1.237 |
| Middle | -.106 | .124 | .723 | 1 | .395 | .900 | .705 | 1.148 |
| Richer | .134 | .117 | 1.307 | 1 | .253 | 1.143 | .909 | 1.437 |
| Richest | -.100 | .134 | .558 | 1 | .455 | .905 | .695 | 1.177 |
| **Mosquito net** |  |  |  |  |  |  |  |  |
| No |  |  |  |  |  | 1.000 |  |  |
| Yes | -.053 | .090 | .344 | 1 | .558 | .949 | .795 | 1.132 |
| **Source of drinking water** |  |  |  |  |  |  |  |  |
| Piped |  |  | 3.321 | 6 | .768 | 1.000 |  |  |
| Well/boreholes | .063 | .091 | .472 | 1 | .492 | 1.065 | .891 | 1.272 |
| Rain water | -.056 | .183 | .094 | 1 | .759 | .945 | .660 | 1.354 |
| Tnker and carts | .045 | .209 | .046 | 1 | .830 | 1.046 | .695 | 1.574 |
| Bottled water | .127 | .235 | .291 | 1 | .589 | 1.135 | .717 | 1.797 |
| Others | .458 | .324 | 1.995 | 1 | .158 | 1.580 | .837 | 2.983 |
| **Birth interval** |  |  |  |  |  |  |  |  |
| 0-12 |  |  | 26.182 | 3 | .000 | 1.000 |  |  |
| 13-24 | -.775 | .208 | 13.836 | 1 | .000 | .461 | .306 | .693 |
| 25-48 | -1.011 | .199 | 25.685 | 1 | .000 | .364 | .246 | .538 |
| 49 and above | -.863 | .200 | 18.603 | 1 | .000 | .422 | .285 | .624 |
| **Place of delivery** |  |  |  |  |  |  |  |  |
| Home |  |  | 10.040 | 3 | .018 | 1.000 |  |  |
| Public facility | -.033 | .131 | .062 | 1 | .803 | .968 | .749 | 1.251 |
| Private facility | -.666 | .234 | 8.110 | 1 | .004 | .514 | .325 | .813 |
| NGO and others | -.299 | .275 | 1.185 | 1 | .276 | .741 | .433 | 1.270 |
| **Main floor Materials** |  |  |  |  |  |  |  |  |
| Natural |  |  | .683 | 2 | .711 | 1.000 |  |  |
| Improved | -.016 | .082 | .038 | 1 | .846 | .984 | .838 | 1.156 |
| others | .174 | .231 | .568 | 1 | .451 | 1.190 | .756 | 1.873 |
| **Occupations**  |  |  |  |  |  |  |  |  |
| Not working |  |  | 6.890 | 10 | .736 | 1.000 |  |  |
| Professional/technical/managerial | .057 | .125 | .211 | 1 | .646 | 1.059 | .829 | 1.352 |
| Clerical | .352 | .383 | .848 | 1 | .357 | 1.422 | .672 | 3.010 |
| Sales | -.075 | .184 | .166 | 1 | .684 | .928 | .647 | 1.330 |
| Agricultural - self employed | .336 | .503 | .446 | 1 | .504 | 1.400 | .522 | 3.755 |
| Agricultural - employee | -.001 | .126 | .000 | 1 | .995 | .999 | .780 | 1.280 |
| Household and domestic | .311 | .177 | 3.101 | 1 | .078 | 1.365 | .965 | 1.931 |
| Services | .178 | .186 | .915 | 1 | .339 | 1.195 | .829 | 1.722 |
| Skilled manual | .419 | .322 | 1.697 | 1 | .193 | 1.521 | .809 | 2.857 |
| Unskilled manual | .023 | .169 | .019 | 1 | .891 | 1.024 | .735 | 1.425 |
| Don't know | .184 | .413 | .199 | 1 | .655 | 1.202 | .536 | 2.699 |
| **Frequency of antenatal during pregnancy** |  |  |  |  |  |  |  |  |
| 0 |  |  | 24.316 | 3 | .000 | 1.000 |  |  |
| 1-6 | -1.046 | .225 | 21.609 | 1 | .000 | .351 | .226 | .546 |
| 7-12 | -1.004 | .313 | 10.276 | 1 | .001 | .366 | .198 | .677 |
| Above 12 | .683 | 1.022 | .446 | 1 | .504 | 1.979 | .267 | 14.681 |
| **Place or residence** |  |  |  |  |  |  |  |  |
| Urban |  |  |  |  |  | 1.000 |  |  |
| Rural | -.085 | .084 | 1.020 | 1 | .313 | .919 | .780 | 1.083 |
| **COUNTY** |  |  |  |  |  |  |  |  |
| Mombasa |  |  | 59.463 | 46 | .088 | 1.000 |  |  |
| Kwale | -1.086 | .418 | 6.740 | 1 | .009 | .338 | .149 | .766 |
| Kilifi | -.591 | .365 | 2.618 | 1 | .106 | .554 | .271 | 1.133 |
| Tana River | -.715 | .330 | 4.693 | 1 | .030 | .489 | .256 | .934 |
| Lamu | -.186 | .316 | .346 | 1 | .557 | .830 | .447 | 1.543 |
| Taita Taveta | -.708 | .439 | 2.602 | 1 | .107 | .492 | .208 | 1.164 |
| Garissa | -.225 | .297 | .574 | 1 | .449 | .798 | .446 | 1.430 |
| Wajir | -.430 | .300 | 2.055 | 1 | .152 | .650 | .361 | 1.171 |
| Mandera | -1.137 | .335 | 11.483 | 1 | .001 | .321 | .166 | .619 |
| Marsabit | -1.588 | .465 | 11.643 | 1 | .001 | .204 | .082 | .509 |
| Isiolo | -.713 | .356 | 4.002 | 1 | .045 | .490 | .244 | .986 |
| Meru | -.980 | .465 | 4.437 | 1 | .035 | .375 | .151 | .934 |
| Tharaka-Nithi | -1.575 | .619 | 6.470 | 1 | .011 | .207 | .062 | .697 |
| Embu | -.396 | .387 | 1.047 | 1 | .306 | .673 | .315 | 1.437 |
| Kitui | -1.281 | .500 | 6.563 | 1 | .010 | .278 | .104 | .740 |
| Machakos | -.785 | .439 | 3.193 | 1 | .074 | .456 | .193 | 1.079 |
| Makueni | -.704 | .401 | 3.077 | 1 | .079 | .495 | .225 | 1.086 |
| Nyandarua | -.629 | .401 | 2.456 | 1 | .117 | .533 | .243 | 1.171 |
| Nyeri | -.396 | .401 | .975 | 1 | .324 | .673 | .306 | 1.478 |
| Kirinyaga | -.316 | .375 | .707 | 1 | .400 | .729 | .349 | 1.522 |
| Murang'a | -.491 | .401 | 1.494 | 1 | .222 | .612 | .279 | 1.345 |
| Kiambu | -.680 | .387 | 3.079 | 1 | .079 | .507 | .237 | 1.083 |
| Turkana | -.426 | .309 | 1.906 | 1 | .167 | .653 | .356 | 1.196 |
| West Pokot | -.685 | .309 | 4.910 | 1 | .027 | .504 | .275 | .924 |
| Samburu | -.584 | .325 | 3.228 | 1 | .072 | .558 | .295 | 1.055 |
| Trans Nzoia | -.578 | .365 | 2.505 | 1 | .113 | .561 | .274 | 1.148 |
| Uasin Gishu | -.601 | .365 | 2.705 | 1 | .100 | .548 | .268 | 1.122 |
| Elgeyo-Marakwet | -.911 | .401 | 5.153 | 1 | .023 | .402 | .183 | .883 |
| Nandi | -.442 | .356 | 1.539 | 1 | .215 | .643 | .320 | 1.292 |
| Baringo | -.099 | .306 | .106 | 1 | .745 | .905 | .497 | 1.648 |
| Laikipia | -.147 | .348 | .177 | 1 | .674 | .864 | .436 | 1.710 |
| Nakuru | -.604 | .356 | 2.872 | 1 | .090 | .547 | .272 | 1.099 |
| Narok | -1.043 | .375 | 7.727 | 1 | .005 | .352 | .169 | .735 |
| Kajiado | -.698 | .365 | 3.650 | 1 | .056 | .498 | .243 | 1.018 |
| Kericho | -.919 | .401 | 5.241 | 1 | .022 | .399 | .182 | .876 |
| Bomet | -.719 | .375 | 3.666 | 1 | .056 | .487 | .234 | 1.017 |
| Kakamega | -.904 | .401 | 5.068 | 1 | .024 | .405 | .184 | .890 |
| Vihiga | -.507 | .375 | 1.821 | 1 | .177 | .603 | .289 | 1.258 |
| Bungoma | -.269 | .320 | .705 | 1 | .401 | .764 | .408 | 1.432 |
| Busia | -.122 | .312 | .153 | 1 | .696 | .885 | .480 | 1.633 |
| Siaya | -.530 | .356 | 2.215 | 1 | .137 | .588 | .293 | 1.183 |
| Kisumu | -.339 | .330 | 1.058 | 1 | .304 | .712 | .373 | 1.360 |
| Homa Bay | -.230 | .325 | .500 | 1 | .479 | .795 | .420 | 1.502 |
| Migori | -.340 | .316 | 1.154 | 1 | .283 | .712 | .383 | 1.323 |
| Kisii | -.681 | .401 | 2.880 | 1 | .090 | .506 | .230 | 1.111 |
| Nyamira | -.717 | .439 | 2.667 | 1 | .102 | .488 | .206 | 1.154 |
| Nairobi | -.620 | .348 | 3.165 | 1 | .075 | .538 | .272 | 1.065 |

The relative risks and their significance for maternal age are shown in Table 1 above. The relative risk for infants was highest within the 15-19 and 40-49 maternal age groups. These results show that the risk for infant mortality tends to decrease as maternal age increases which was consistent with the findings by [15] and [16] who argued that teenage mothers lack both physical and psychological maturity which poses a high challenge during pregnancy, delivery and post-delivery periods. Consequently, infants born by ageing mothers experience similar problems to those of teenage mothers due to repeated births which lead to depletion associated with it and other birth complications[17]. The risk for the 25-34 age groups was significant due to the challenges of seeking employment and settling into new careers and families.

The relative risks and their significance for marital status are shown in Table 1 above. The marital status of the mother was also fitted to determine its significance in this study and was categorized as either Never in the union, Married, Living with a partner, Widowed, Divorced and No longer living together/separated. The infant born to those living with a partner, windowed, divorced and separated have a higher risk than those who were never in union. Infants born among married couples have a lower risk than those never in a union. This was consistent with the study by [18] that infants born to unmarried mothers had higher mortality rates than those born to married mothers. The widowed, divorced and separated mothers suffer from loss of emotional and financial support from their partners resulting in higher infant risk. The infant born among married couple have a lower risk due to physical, emotional and financial support from both parents.

The relative risks and their significance for multiple births are shown in Table 1 above. Multiple births were classified into four categories as single birth, 1st of multiple, 2nd of multiple and 3rd of multiples. Multiple births have a significantly higher risk compared to single births due to lack of enough nutrition such as milk, the transmission of infections from one infant to another and physical support among others.

The relative risks and their significance for sex are shown in Table 1 above. Female infants have a lower risk compared to male infants. This is consistent with [19] who claim that preconception environment and infant biology increase the mortality of male infants.

The relative risks and their significance for the sex of the head of the household are shown in Table 1 above. The infant has a lower risk in those households headed by females. This is consistent with [20] who found that amongst many other factors, household headship was a strong determinant of under-five mortality. This shows that women’s autonomy and empowerment through improved maternal literacy, and ability to decide independently on the use of maternal healthcare services including pediatric care, could help to reduce under-five mortality.

The relative risks and their significance for birth order are shown in Table 1 above. The infant whose birth order is above one has a lower risk compared to the firstborn. Their mother has accumulated experience such as nutrition requirements, vaccinations etc. from taking care of the firstborn and the infant has siblings also taking care of them. The risk is slightly higher for five and above compared to 2-4 due to limited resources to cater for the infants.

The relative risks and their significance for the age of the first birth are shown in Table 1 above. The infant born to girls below the age of 18 has a higher risk compared to an infant born to older women. The girls below age 18 may not be physically mature enough to carry pregnancy and give birth. They are not financially well off to take care of the infant and the majority still depend on their parent for maintenance. Teen mothers are stigmatized by stereotypes that they are irresponsible and incompetent mothers [21]. The teen mothers may therefore not attend all prenatal and antenatal care due to the stigma associated with teenage pregnancy.

The relative risks and their significance for the highest education level are shown in Table 1 above. Infants born to women with no education have less risk compared to women with primary and secondary education but higher than women with post-secondary education. Women with no education are likely at home taking care of the infant while women with post-secondary education may have enough income to hire house help to take care of the infant. Women with primary and secondary education may have less interaction with the infant as they engage in informal jobs that require them to report very early in the day and finish very late in the evening resulting to less breastfeeding and other maternal care.

The relative risks and their significance for religion are shown in Table 1 above. Infants born from parents who profess the catholic faith have a lower risk compared to other religious faith. Some protestant church discourages their followers from taking their infants to hospitals resulting in higher risk. Some traditionalists and Muslims encourage polygamy and might not be able to support all their infants due to limited resources.

The relative risks and their significance for wealth status are shown in Table 1 above. Infant born in a family whose wealth status is poorest have higher risk compared to family whose wealth status are poorer and middle status. The poorest family may not have enough resources to take care of the infant such as medical care or insurance cover. The richer family may not always be available to take care of the infant and also have less support from extended family. The richest have the lowest risk compared with the poorest as they can afford the best medical services for their infant and hire trained house help to take care of the infant

The relative risks and their significance for the usage of mosquito nets are shown in Table 1 above. Infant sleeping under mosquito net have a lower risk compared to infant without mosquito net. The mosquito nets protect the infant from mosquito that spreads malaria and other insects. This lowers their risk.

The relative risks and their significance for the source of drinking water are shown in Table 1 above. Infant in household consuming rain water have a lower risk compared to those consuming piped water. Infant in household consuming water from wells, tanker/carts and bottled water have a higher risk compared to those consuming piped water. The rainwater may not be contaminated while water from other sources may be contaminated through leakage from sewer systems or the container ferrying the water may be contaminated with waterborne diseases.

The relative risks and their significance for birth intervals are shown in Table 1 above. Infants born from mothers whose birth interval is less than one year have a higher risk compared to those mothers whose birth interval is more than one year. The birth interval has a significant effect on infant mortality. Short preceding intervals are associated with enhanced risk of prematurity and low birth weight for gestational age [22]

The relative risks and their significance for place of delivery are shown in Table 1 above. Infants born at home have a higher risk compared to those born in a health facility. The risk is significant in those born in a private facility. The infant born at home may die from complications due to a lack of professionals such as nurses or medical equipment to handle the situation. Home and private facilities have significant effects on infant mortality. Some private facilities may have inadequate facilities and unqualified personnel.

The relative risks and their significance for the main floor are shown in Table 1 above. The risk for the infant is higher for infants living in houses whose main floor is natural (earth, dung etc) compared to an improved main floor such as the cemented floor. The natural main floor is difficult to clean and provide hinder out for insects as mosquito, snakes that can harm the infant. The improved main floor is easier to clean thus reducing transmissions of infections such as cholera.

The relative risks and their significance for occupation are shown in Table 1 above. Some occupations such as technical, clerical, self-employed in agriculture, domestic services, and skilled and unskilled manual have a higher infant risk compared to those not working in sales and those working in agriculture as employees have a lower risk. The risk is higher since those careers offer little time for the mothers to interact with the infant and breastfeed them.

The relative risks and their significance for antenatal care during pregnancy are shown in Table 1 above. Infants born to mothers who were not attending antenatal care during pregnancy have a higher risk than those who were attending antenatal care. The mother whose attendance was more than twelve times had a higher risk probably to pregnancy-related illness. The antenatal care offers the mother advice on how to take care of the infant after birth and any threat to the infant is detected and handled in advance. Antenatal care during pregnancy has a significant effect on infant mortality.

The relative risks and their significance for place of residence are shown in Table 1 above. Infant born in rural areas have a lower risk compared to those born in urban areas. These due to the availability of fresh water and less pollution in rural areas. The county governments have also invested in and improved health facilities in rural areas that have reduced infant mortality in rural areas compared to urban areas.

The relative risks and their significance for place of residence are shown in Table 1 above. Infants born in Mombasa are at higher risk compared with other counties. The infant risk is significant in Kwale, Tana River, Mandera, Marsabit, Isiolo, Meru, Kitui, Elgeyo-Marakwet, Tharaka-Nithi, Narok and Kakamega.

**5.0 Conclusion and Recommendation**

Our learning institution should enhance guidance and counselling to reduce teenage pregnancies and encourage them to wait until they are married to start giving birth. Society should provide support such as finance, food, clothing etc. to mother having multiple births to enhance their survival. The government should continue providing free post-primary education. Educated mother can make informed decision about their infants such as vaccination, medical care, balance diet that can lower infant mortality risk. The ministry of health should continue encouraging household to use mosquito net to protect them self from mosquito that spread malaria. The Ministry of Health should continue encouraging mothers to have a wider birth interval since it greatly affect the infant born. They should continue providing family planning services that enable mothers to have better spacing of their pregnancies. The government should encourage and provide incentives to mother to give birth at health facilities where there are enough medical professional and equipment to handle any complications. The government should also empower citizen economically to enable them access better medical care, improved housing and other amenities. The government should also monitor private health facilities to ensure they have the right facilities and are only hiring qualified health professionals. They should also encourage mothers to visit health centers for antenatal care. The antenatal care ensures there is regular check, advice mothers on issues such as diets, access micronutrients supplements, treatments and immunization against tetanus. It also provides HIV testing and medications to prevent mother-to-child transmission of HIV. The county government should provide better sanitation such as fresh water, and better sewerage and reduce pollution in urban areas. The government should enforce labour laws that will ensure mothers working in informal sectors are offered maternity leave with pay to take care of the infants. The government should focus on Kwale, Tana River, Mandera, Marsabit, Isiolo, Meru, Kitui, Elgeyo-Marakwet, Tharaka-Nithi, Narok and Kakamega counties that have significant infant mortality risk. The government should monitor cultural influence, literacy levels, availability of family planning services, availability of healthcare facilities, sensitization on hygiene, utilization of antenatal care, immunization programs, weather patterns, improved diet and infectious disease control programs in these regions.

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