GSC Advanced Research and Reviews

eISSN: 2582-4597 CODEN (USA): GARRC2

Cross Ref DOI: 10.30574/gscarr

Journal homepage: https://gsconlinepress.com/journals/gscarr/

(RESEARCH ARTICLE)

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The influence of socioeconomic and demographic factors on rural-urban disparities in infant mortality in Kakamega Central Sub-County, Kakamega County, Kenya

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GSC Advanced Research and Reviews, 2024, 18(02), 022–039

Publication history: Received on 28 December 2023; revised on 31 January 2024; accepted on 02 February 2024

Article DOI: https://doi.org/10.30574/gscarr.2024.18.2.0033

Abstract

Background: Infant mortality, measured as the summation of neonatal and post-neonatal mortalities, remain unacceptably high in Kakamega Central Sub-County, Kakamega County, Kenya. Reducing infant mortality is paramount not only in assessing the progress made towards the third sustainable development goal but also in creating a conducive environment for fertility reduction and in giving a chance to new-born babies to live out their social and economic potential in their families and societies at large.

Objective: This study sought to establish the influence of socioeconomic and demographic factors on rural – urban disparities in infant mortality in Kakamega Central Sub - County, Kakamega County, Kenya.

Methods: A cross-sectional research design was used. Systematic random sampling was employed to obtain a sample of 422 mothers within the reproductive age range of 15 to 49 years. Purposive sampling was used to arrive at key informants that were engaged in the study. Primary data were collected from December 2022 to January 2023 by administering pretested and validated questionnaires and interviewing key informants. Descriptive statistics and multinomial logistic regression analyses were conducted on the Statistical Package for Social Sciences computer software to estimate the prevalence of infant mortality and the odds ratio used as a measure of association at $\rho<0.05$.

Results: Results of multivariate analysis indicated that there were higher likelihoods of rural neonatal (aOR = 1.913) and urban post-neonatal (aOR = 3.823) mortalities amongst mothers with no education qualifications. There were reduced likelihoods of rural post-neonatal (aOR = 0.105) and urban neonatal (aOR = 0.108) mortalities amongst mothers working in the professional, technical, managerial and clerical sectors. Both young (aOR = 1.579 for neonatal mortality) and old (aOR = 2.742 for infant mortality) ages at motherhood, and first births (aOR = 3.492 for infant mortality) and births of high orders (1.881 for neonatal mortality) were associated with increased likelihoods of mortalities in urban and rural areas, respectively. Urban mothers who observed a ≤ 24 months wait period prior to an index birth were more likely to report both post-neonatal (aOR = 3.294) and infant (aOR = 3.616) mortalities.

Conclusions: The major contributors to the rural - urban disparities in infant mortality in Kakamega Central Sub-County were order of the index birth, which was significant only in rural areas, and wait period prior to the index birth, which was significant only in urban areas, after controlling for the confounding variables. It is important to advocate for childbearing during the middle reproductive ages and widen the wait period between successive births so as to improve the maturity of the mother and reduce parity, both of which correlate with low infant mortality. Future studies should be done on the relationship between marital status of the mother and infant mortality.

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Keywords: Level of education qualification of the mother; Maternal occupation; Age of the mother at the birth of her child; Order of the index birth; Wait period prior to the index birth; Neonatal mortality; Post-neonatal mortality; Infant mortality

1. Introduction

Nine years have elapsed since the formulation of the Sustainable Development Goals by the United Nations. We are left with six years to reach 2030, the year in which nations are expected to have attained their respective targets as stipulated in the Sustainable Development Goals. Kenya, a country with 47 administrative counties, is among these nations. As a country, Kenya did not manage to attain the United Nation's Millennium Development Goal number 4 which aimed at reducing under-five mortality by about 67 percent in a span of 25 years (UNDP, 2000). As per the goal, Kenya's infant mortality rate was supposed to be at about 20 deaths for every 1,000 live births in the year 2015. Instead, the country recorded an infant mortality rate of 39 (KNBS & ICF Macro, 2015). About that time, a report by World Health Organization and UNICEF (2014) indicated that new-born health and stillbirths were part of the unfinished agenda of the Millennium Development Goals for maternal and child health.

Post-formulation of the Sustainable Development Goals, Kenya's infant mortality has maintained the declining trend that began over the last two decades: 77 (2003), 52 (2008/09), 39 (2014) and 32 (2022) (KNBS & ICF Macro, 2023). Under-five mortality has declined respectively as follows: 115 (2003), 74 (2008/09), 52 (2014) and 41 (2022). This is a good observation yet not better enough considering the target set by the United Nations. The third Sustainable Development Goal calls for a termination of avertable deaths of all children below 60 months of age come the year 2030 (UNDP, 2015). Target 3.2 of the Sustainable Development Goals calls for all nations to lessen the death of new-borns between birth and exactly 28 life days to at least 12 deaths per 1,000 live births and that of new-borns between birth and sixty months of life to at least 25 deaths per 1,000 live births.

The observed under-five mortality is majorly contributed to by infant mortality whose decline is snail-paced compared to that of child mortality. As documented in the 2022 Kenya demographic and health survey report, under-five, child, infant, post-neonatal and neonatal mortality rates were 41, 9, 32, 11 and 21 in the five-year period that preceded the survey (KNBS & ICF Macro, 2023). The rates show that it is an uphill task to attain Sustainable Development Goal number 3 in the remaining six years. A study done in Ghana when infant deaths accounted for about 68 percent of under-five deaths with neonatal and post-neonatal mortality rates at 25 and 12 deaths per 1,000 livebirths, respectively, indicated that the statistics were disturbing and posed a significant challenge to the country's socioeconomic development and life quality (Takramah & Aheto, 2023). Their observation was in support of that by Omedi (2018) who pointed out that high early childhood mortalities remained a threat to the socioeconomic advancement of nations. If the infant mortality statistics disturbed in Ghana, then they are also disturbing in Kenya, both countries falling in the Africa south of Sahara region.

There exist regional disparities in infant deaths in Kenya due to variations in socioeconomic and demographic characteristics of people in different regions of the country. In 2009, Kenya's infant mortality rate was 54 while that of Kakamega County was 65 (KNBS, 2012). This improved to 39 and 40 infant deaths for every 1,000 live births for Kenya and Kakamega County, respectively (KNBS & ICF Macro, 2015). According to the 2019 Kenya Population and Housing Census report, Kenya's infant mortality rate was 36 while that of Kakamega County was 37 (KNBS, 2022). The report by Kenya National Bureau of Statistics (2022) further noted that the proportion of dead children to women was 0.053 in Kakamega, 0.049 in Vihiga, 0.036 in Bungoma, 0.029 in Trans-Nzoia, 0.024 in Nandi, and 0.020 in Uasin Gishu counties. As explained in the report, the proportion of dead children born to women reflected the level of early childhood mortality (KNBS, 2022). Evidently, Kakamega County stood out with a higher level of early childhood mortality when compared to her neighbours. In their study in Kenya, UNICEF (2018) established that Kakamega County ranked fifth among fifteen counties with the poorest maternal, new-born, child and adolescent health indicators.

Studies have linked infant deaths to prematurity, pneumonia, neonatal tetanus, sepsis and other complications occurring intrapartum such as birth asphyxia (Deribew et al., 2007; Liu et al., 2014; WHO, 2014). A study carried out by Liu et al. (2014) on the causes of child mortality established that the observed reductions in child mortality were mainly a result of reductions in such communicable diseases as pneumonia, diarrhoea and measles. These studies and reports addressed the causes of death but did not establish whether there existed any relationship concerning socioeconomic and demographic factors and infant mortality in rural and urban areas of residence. The current study sought to establish the influence of socioeconomic and demographic factors on rural – urban disparities in infant mortality in Kakamega Central Sub - County, Kakamega County, Kenya. Understanding the contribution of these factors to infant mortality in Kakamega and Kenya, by extension, will direct the development and implementation of initiatives geared towards improved child survival and population standards. A reduction in infant mortality will give a chance to new-

born babies to live out their social and economic potential in their families and societies at large (Omedi et al., 2023). It will also create a conducive environment for fertility reduction as the need to insure against potential deaths of children or replacing dead infants will be reduced (Omedi, 2015). The study findings will further contribute to the existing knowledge in geography.

2. Review of related literature

The mechanisms through which different factors operate to influence infant health and eventually death are complex because of the synergism of social, economic and demographic processes. The linking of background factors to infant health and mortality through proximate determinants has been illustrated in the conceptual framework by Mosley and Chen (1984). The framework was proposed to analyse the effect of socioeconomic and bio-demographic factors on infant and child mortality in developing countries. The current study adopted the framework and operationalised that socioeconomic and demographic factors influenced infant mortality either directly or through proxies of geographical and distance factors.

Various studies have found infant mortality to be strongly and negatively correlated with maternal level of education qualification (Mondal et al., 2009; Kabir et al., 2011; Dallolio et al., 2012; Ratnasiri et al., 2020). Ratnasiri and colleagues (2020) carried out a study in California and found out that infants whose mothers had at least a first degree were 0.89 times less likely to die than infants whose mothers had education less than high-school. The study attributed this observation to the long stay in school that yielded to biological maturity and improved employment opportunities. In support of this, a study by Finlay et al. (2011) showed that women participation in higher education accorded them healthier behaviours and attitudes that were passed onto their offsprings. Educated mothers were more likely to receive antenatal care (Tayie & Lartey, 2008), delay motherhood and decrease the total number of children they bore (Gyimah, 2003).

Studies in the African region found occupation of the mother as a significant source of inequalities in early childhood mortalities (Akinyemi et al., 2016; Adebowale et al., 2017; van Malderen et al., 2019; Ekholuenetale et al., 2020). In their study in rural areas south of Sahara, Akinyemi et al. (2016) found high hazards ratio for infant mortality among working mothers than the non-working mothers in Central Africa. In Cameroon, mothers who were working in the agricultural sector had a 1.52 greater likelihood of reporting infant deaths as compared to those mothers who were not working. In Gabon, mothers who were working in professional/ managerial and sales/clerical sectors were 3.19 and 2.40 times, respectively, more probable of reporting infant deaths than the non-working mothers. A study done by Omedi and Wanjiru (2014) explained that working mothers practiced either incomplete or unexclusive breastfeeding due to limited maternity leaves, thus increasing the likelihood of experiencing infant death. A different study by Omedi (2015) indicated that working mothers left their babies under the care of nannies who sometimes exposed the babies to cold and other environmental risks that ruined their lives. There was however no clear contribution of maternal occupation on infant mortality in East Africa, West Africa and Southern Africa (Akinyemi et al., 2016).

Studies done on infant mortality in Kenya have suggested that infant mortality may be explained by demographic factors (Omariba et al., 2007; Liu, 2014; Miringu, 2016; Omedi, 2018; Wabwile, 2019). In their study, Omariba, Beaujot and Rajulton (2007) established that infants whose mothers were aged below 20 years and at least 35 years had significantly greater likelihoods of dying than those born to mothers aged between 20 and 24 years. A study conducted by Mustafa and Odimegwu (2008) found out that maternal age was significantly linked to the death of infants in rural areas but not in urban areas of Kenya. A study done by Ikamari (2013) found maternal ages of 20-34 years and at least 35 years to have 1.33 and 1.58 relative risks of post-neonatal death, respectively, with reference to maternal ages of less than 20 years. Conversely, Liu (2014) analysed Kenya demographic and health survey datasets for 2003 and 2008/09 and recognised that infants born to mothers younger than 19 years were 42 percent and 47 percent, respectively, more likely to die when compared to their colleagues born to mothers aged above 19 years. This could be attributed to the protective effect on mortality that comes with higher maternal ages (Kadobera et al., 2012).

Considering wait period between births, Omariba et al. (2007) found out that short wait periods were linked to higher risks of infant death. The study found infants characterised by a less than 19 months' wait period prior to their birth to have a 0.48 higher likelihood of dying compared to their colleagues in the 19-35 months' wait period prior to their birth. A study carried out by Miringu (2016) found out that the order of a birth and wait period prior to its birth were meaningfully related to the death of infants in Kenya. The study found infants of at least forth order of birth and less than 2 years' wait period prior to the birth to have a higher likelihood of dying than those infants of at least forth order of birth and greater than 2 years' wait period prior to the birth.

A study done on reversal in infant mortality in Kenya based on type of place of residence by Omedi (2018) established that the preceding interval of a birth was an important predictor of infant mortality in urban but not in rural regions of Kenya. Urban births that occurred at a wait period of at least 2 years had a 0.726 lesser risk of post-neonatal mortality with reference to urban births that occurred at a wait period of less than 2 years. The study explained that delayed conception enabled mothers to regain their strength and prepared them to accord sufficient care to their new-borns. In her study on the effects of maternal education on infant mortality in Kenya, Wabwile (2019) found infants born in Nyanza region at a wait period of more than 2 years prior to their birth to be 0.611 times less likely to die than their counterparts born at a wait period of less than 2 years. A study done in Kenya by Mustafa and Odimegwu (2008) found short wait periods to be associated with higher infant mortality risks in rural but not urban areas. The researchers associated this observation to fertility factors that comes along with siblings' competition and maternal depletion.

3. Data and methods

3.1. Location of the study area

The area of this study was Kakamega Central Sub-County, Kakamega County, Kenya. Its longitudinal extent is from $34^{0}37'21''$ E to $34^{0}48'21''$ E while its latitudinal extend is from $0^{0}10'49''$ N to $0^{0}22'13''$ N. It borders Navakholo and Malava Northwards, Shinyalu Eastwards, Ikolomani and Khwisero Southwards, and Butere and Mumias East Westwards. The sub-county is approximately 155.2 square kilometres, with six administrative wards: Butsotso East Ward, Butsotso South Ward, Butsotso Central Ward, Shieywe Ward, Mahiakalo Ward and Shirere Ward (KNBS, 2019, 2022).

3.2. Climate of the study area

The area experiences warm climate with minimal excesses, cool nights and quite rainy. The annual rainfall amount ranges from 1280.1mm to 2214.1 mm per annum. Heavy rains are received in March and July while December and February receives light rains. The temperatures range from 18 ^{0}C to 29 ^{0}C. January, February and March are the hottest months with other months having relatively similar temperatures except for July and August which have relatively cold spells. These temperatures are however increasing with time. The region has an average humidity of about 67 percent (CGoK, 2018).

Climate change and variability in the region is as a result of uncontrolled deforestation, brick making and burning, charcoal burning and factory emissions (CGoK, 2018) to meet the demands of the surging population. Increasing average temperatures and changes in seasonal rainfall magnitude, duration and timing are being felt across key economic sectors, including agricultural production, health status, water availability, energy use, infrastructure, biodiversity and ecosystem services that touches on forestry and tourism (CGoK, 2018). A study by the Ministry of Agriculture, Livestock and Fisheries (MoALF, 2017) reported that the observed increase in rainfall variability had resulted to increased risks and uncertainty of floods and drought occurrence.

3.3. Population characteristics of the study area

Kakamega Central Sub-County has a population of 188,212 (92,774-male and 95,432-female and 6-intersex). The population density of the area is 1,212 persons per square kilometre. The sub-county has 52,015 households with an approximate household size of 3.6 persons (KNBS, 2019, 2022). The area has a total fertility rate of 4.4, maternal mortality rate of 316 maternal deaths per 100,000 livebirths, infant mortality rate of 37, under-five mortality rate of 60, male life expectancy of 63.4 years and female life expectancy of 66.1 years (KNBS & ICF Macro, 2015; KNBS, 2019). As pertains to population health, 38.6 percent of mothers attended at least four antenatal care clinics with 95.3 percent attending at least an antenatal care clinic. About 53.4 percent of mothers gave birth by the assistance of skilled birth attendants with 51.6 percent of deliveries being institutional (KNBS et al., 2016). It is the most densely populated sub-county in the entire county due to the observed rate of urbanisation and presence of several learning institutions (CGoK, 2018).

3.4. Socioeconomic activities of the study area

The key social activities in the area are education, religious, administration, security and health activities with the area housing all levels of learning institutions from kindergarten to university, cathedrals and mosques, Kakamega Prisons, the County Government, and both public and private health facilities, including the Kakamega County Referral Hospital. Overall, 44.4 percent of women aged at least 3 years were in school, 28.2 percent left school after completion, 19.2 percent left school before completion, and 7.6 percent had never been to school (KNBS, 2019).

Economically, subsistence agriculture is common where land is available. The leading crops being grown are sugarcane, maize, beans, cassava, finger millet and sorghum. Urban areas are characterised by secondary economic activities such as commercial activities, service and manufacturing industries. Rural areas are characterised by primary economic activities of agriculture, forestry, sand harvesting, quarrying and mining. Of women above 5 years, 45.99 percent were working, 4.02 percent were seeking for employment, and 49.96 percent were not working (KNBS, 2019). Some part of the study area is under government-owned forest cover (CGoK, 2018).

3.5. Research design

This study employed a cross-sectional research design where the outcome variable and the exposure variable(s) in the participants of the study were measured at the same point in time. This design was useful in the study because it provided information about the prevalence of exposures and outcomes, and allowed estimation of odds ratios to study associations between exposure and outcome variables. The study data were gathered from 422 mothers within the childbearing ages of 15 to 49 years who had an experience of a childbirth between 2013 and 2022. The unit of analysis was households with an experience of a childbirth.

3.6. Study variables

The study considered socioeconomic and demographic factors as the exposure variable. The social factor was level of education qualification of the mother. The economic factor was maternal occupation. The demographic factors were age of the mother at the birth of her child, order of a birth and wait period prior to the birth. The confounding variable was geographical and distance to the nearby medical facility factors. The outcome variable was infant mortality, measured as neonatal mortality and post-neonatal mortality at the time of survey, according to the geographical area of residence.

3.7. Sampling

Systematic random sampling technique was used to arrive at households which were involved in the study. Community Health Volunteers and village elders helped in reaching households and respondents to whom questionnaires were administered. Only one respondent, the most recent mother, was presented with a questionnaire in households with multiple cases of childbirths from multiple respondents. Purposive sampling technique was used to arrive at key informants that were interviewed in the study.

3.8. Data analyses

Data analyses were conducted at descriptive and inferential analyses levels on the Statistical Package for Social Sciences (SPSS) version 25 computer software program. Descriptive statistics involved cross-tabulation analysis that was done to obtain the prevalence of childbirths and infant mortality in rural and urban areas by study variables of level of education qualification of the mother, maternal occupation, age of the mother at the birth of her child, order of a birth, and wait period prior to the birth.

Inferential analysis engaged multinomial logistic regression modelling at univariate (Models 1 and 2) and multivariate (Model 3) analytical levels. Multinomial logistic regression has been used in other related studies (Omedi & Amwoliza, 2015; Ari, 2016; Al-Neyazy, 2021; Sakala & Kombe, 2022; Klu et al., 2023). In model 1, multinomial logistic regression analysis was conducted to analyse data on the influence of level of education qualification of the mother and maternal occupation on the death of infants in rural and urban areas. Model 2 engaged multinomial logistic regression to examine the influence of age of the mother at the birth of her child, order of a birth and the wait period prior to the birth on the death of infants in rural and urban areas. Further, in Model 3, all the exposure variables were fitted in the multinomial logistic regression model controlling for the confounding variables of geographical and distance to the nearby medical facility factors in order to study the independent effect of each one of them on neonatal, post-neonatal and infant deaths in terms of adjusted odds ratios. This was aimed at examining the major socioeconomic and demographic influential factors of early childhood mortalities in rural and urban areas of Kakamega Central Sub-County.

3.9. Ethical considerations

This study was ethically endorsement by Maseno University Scientific and Ethics Review Committee, reference number MSU/DRPI/MUSERC/01119/22 on 29th November 2022. A research licence was obtained from the National Commission for Science, Technology and Innovation (NACOSTI), license number NACOSTI/P/22/22577 on 08th December 2022. Authority to conduct the study, reference number CGK/OCS/GEN.CRR. /04/ (621), was gotten from the Office of Kakamega County Secretary on 19th December 2022.

On the field, the researchers briefed the study participants about the nature of the research, its aim and implications to academic researchers, geographical literature and child-health policy and program makers and implementers. The study participants were further informed that all the information generated in this study was to be treated with all due confidentiality by ensuring that their identities were not revealed to anyone else. An informed consent was sought from all the targeted respondents whereby each willing participant was asked to append a signature on the participant's agreement form at the verge of the interview. The willing participants voluntarily participated in the study without coercion or inducement.

4. Results

4.1. Descriptive statistics

Descriptive analysis was carried out to bring out the percentage distribution of births and infant deaths according to socioeconomic and demographic factors in rural and urban areas of Kakamega Central Sub-County. The results are presented in Table 1.

Table 1 Distribution of births and deaths according to socioeconomic and demographic factors in Kakamega Central Sub-County, Kakamega County, Kenya

	OVERALL		**RURAL**		**URBAN**	
Exposure variable	Births	Deaths	Births	Deaths	Births	Deaths
Level of education qualification of the mother						
None	11.61	11.85	8.97	5.13	13.16	15.79
Primary	45.02	46.92	57.05	62.82	37.97	37.59
Secondary+	43.36	41.23	33.97	32.05	48.87	46.62
Maternal occupation						
Not employed	40.76	40.28	25.64	25.64	49.62	48.87
Agriculture	14.93	14.69	33.97	32.05	3.76	4.51
Pro./Tech./Man./Cler.	9.72	9.48	8.33	8.97	10.53	9.77
Other	34.60	35.55	32.05	33.33	36.09	36.84
Age of the mother at the birth of her child (in years)						
x<20	21.56	19.43	19.23	21.79	22.93	18.05
20≤x≤34	67.06	66.35	64.74	58.97	68.42	70.68
35≤x≤49	11.37	14.22	16.03	19.23	8.65	11.28
Order of the index birth						
First birth	37.68	36.02	31.41	29.49	41.35	39.85
2 - 3 birth	37.44	37.91	39.10	44.87	36.47	33.83
4+ birth	24.88	26.07	29.49	25.64	22.18	26.32
Wait period prior to the index birth						
≤ 24 months	33.21	35.82	29.91	28.85	35.44	40.24
> 24 months	66.79	64.18	70.09	71.15	64.56	59.76

Source: Field Data (2023)

Results in Table 1 showed that most births occurred to rural mothers with primary education (57.05%) and urban mothers with above primary education (48.87%). As pertains to maternal occupation, there were more births amongst rural mothers working in agriculture and the unemployed urban mothers. There were many infants dying to mothers with primary education qualifications (62.82%) and those working in other occupations such as sales, marketing,

grocers, manual and domestic managers/nannies (33.33%) in rural areas. In urban areas, many infant deaths were to mothers with some secondary education qualifications (46.62%) and those who were not working (48.87%). Overall, majority of infant deaths occurred to mothers with primary education qualifications with modest differentials amongst the non-working mothers and those working in other sectors.

Demographically, the findings in Table 1 showed that majority of births (rural – 64.74%; urban – 68.42%) were to mothers in the 20 to 34 age range. Further, 39.10 percent and 70.09 percent of rural births were of the 2 to 3 birth order and greater than 24 months wait period prior to their birth. Many urban births were of the first order (41.35%) and a greater than 24 months wait period prior to their birth (64.56%). There were many infant deaths to mothers aged 20 to 34 years (rural-58.97%; urban-70.68%), of birth order 2-3 in rural areas (44.87%) and first birth order (39.85%) in urban areas and of a greater than 24 months wait period prior to the index birth (rural-71.15%; urban-59.76%). Modest differentials existed in the prevalence of infant deaths in the at least 4 order of the index birth category.

The prevalence of infant mortality was higher among rural mothers with primary education qualifications (62.82%) and urban mothers with some secondary education qualifications (46.62%). This could be because urban residents have more opportunities to pursue education beyond the primary level, and higher education institutions are primarily located in urban areas. Therefore, more infant deaths occurred among urban mothers with secondary or higher education qualifications than those with less education.

Mothers with no education qualifications had a lower prevalence of infant mortality both in rural and urban areas of Kakamega Central Sub-County (rural - 5.13%; urban - 15.79%) compared to those with some education qualifications (rural - 94.87%; urban - 84.21%). The government's free primary and day secondary education initiatives have helped to provide basic education to most women. The government has also encouraged school attendance through various campaigns. The introduction and recognition of Community Health Volunteers has contributed to the prevalence of infant deaths according to the level of education of the mother. Such volunteers offer informal education on maternal, new-born and child healthcare at grassroots level.

Rural mothers working in other sectors such as manual, sales and grocers and domestic managers/nannies had a higher prevalence of infant mortality (33.33%) than their counterparts working in the agricultural sector (32.05%). The reducing sizes of agricultural land due to land fragmentation to meet the needs of the ever-increasing population has made many mothers opt for jobs alternative to farm-related jobs. Even so, the current reduced farm sizes have undergone continuous farming making them to lose fertility and productivity over time.

The study further observed that the prevalence of infant mortality was higher among the non-working urban mothers and least among those urban mothers working in the agricultural sector. Some of the unemployed urban mothers are economically disadvantaged residents of informal areas with lower accommodation charges. Such residential areas have poor housing, sanitation and living conditions that puts children at increased risks of communicable diseases, measles and cholera. Basically, there are reduced agricultural activities in urban areas as compared to rural areas. Such agricultural activities generally include market gardening, poultry farming and dairy farming since they require less areal space and the livestock rely on commercial feeds. Even so, urban farming is characterized by intensive use of agro-chemicals that degrades the environment through pollution. As a result, infants suffer acute respiratory ailments that poses a threat to their lives.

The demographic statistics showed a higher prevalence of infant deaths amongst mothers aged $20 \leq x \leq 34$ years both in rural and urban areas (rural - 58.97%; urban - 70.68%). This prevalence was distantly followed by those mothers aged under-20 years. Mothers aged at least 35 years reported the least prevalence of infant mortality both in rural and urban areas. The median age of reproduction falls in the $20 \leq x \leq 34$ years' maternal age category. This explains why majority of the deaths were to mothers in that age range. Old mothers had the least prevalence of infant deaths because minimal childbearing generally occurs to mothers in their sunset ages of reproduction.

First order births had a higher prevalence of infant mortality in urban areas (39.85%) unlike births of orders 2 to 3 in rural areas (44.87%). The higher prevalence of infant mortality amongst first order births in urban areas was partly as a result of biologically immature conceptions that are rampant more so amongst the urban poor. Such mothers participate in sex-for-cash in strive to meet their basic needs. The generally reducing desired family sizes contributes to the lower prevalence of infant mortality amongst high order births. The challenging economic times and the parental desire to accord children the best living standards makes them to prefer fewer children. There was a generally higher prevalence of infant mortality amongst infants whose wait period prior to their birth was above 24 months (rural - 71.15%; urban - 59.76%). This implies that beyond half of the mothers observed an at least 24 months wait period between successive births.

4.2. Inferential analyses

4.2.1. Univariate analysis

Socioeconomic and demographic factors were included in the multinomial logistic regression model in order to examine their influence on the death of infants in rural and urban areas of Kakamega Central Sub-County. The results in terms of crude odds ratios were as presented in Table 2.

Table 2 Crude odds ratios on the influence of socioeconomic and demographic factors on neonatal, post-neonatal and infant mortality in Kakamega Central Sub-County, Kakamega County, Kenya

	RURAL			**URBAN**		
Exposure variable	Neonatal	Post-neonatal	Infant	Neonatal	Post-neonatal	Infant
Level of education qualification of the mother						
Secondary+	1.000	1.000	1.000	1.000	1.000	1.000
None	1.303	1.318	1.484	0.881	1.168**	1.059
Primary	3.787	1.874	3.196**	0.477	1.103	0.634
Maternal occupation						
Agriculture	1.000	1.000	1.000	1.000	1.000	1.000
Not employed	1.078	1.184	1.213	1.668	0.553	0.698
Pro./Tech./Man./Cler.	1.149	0.978	1.066	0.645	1.583	1.127
Other	0.470**	1.317	0.727	0.838	1.273	1.119
Age of the mother at the birth of her child (in years)						
20≤x≤34	1.000	1.000	1.000	1.000	1.000	1.000
x<20	1.092	1.774	1.793	2.408*	0.868	1.755
35≤x≤49	0.286**	3.929**	1.147	2.424	1.615	2.891**
Order of the index birth						
2 - 3 birth	1.000	1.000	1.000	1.000	1.000	1.000
First birth	1.405*	1.517	1.750	1.481	1.393	1.685
4+ birth	0.674	1.623	1.150	0.671	2.331**	1.568
Wait period prior to the index birth						
> 24 months	1.000	1.000	1.000	1.000	1.000	1.000
≤ 24 months	0.622	1.184	0.906	0.560	2.132**	1.552**

[a] Reference category; *ρ<0.01; **ρ<0.05; Source: Field Data (2023)

The results in Table 2 showed that the level of education qualification of the mother was a significant predictor of infant (in rural areas) and post-neonatal (in urban areas) mortalities. In rural areas, the odds ratios of infant mortality were higher among infants whose mothers had primary education qualifications compared to infants whose mothers had secondary and higher education qualifications (cOR = 3.196; ρ<0.05; CI = 0.922 – 11.07), though at a lesser measure of precision as indicated by the wide confidence interval. Post-neonates born to mothers with no any education qualifications were 0.168 times more likely to experience post-neonatal mortality than their counterparts born to mothers with some secondary education qualifications in urban areas (cOR= 1.168; ρ<0.05; CI = 0.640 – 2.130). As pertains to the occupation of the mother, rural mothers working in other sectors such as manual, domestic managers/nannies, sales and grocers were significantly less likely to report neonatal mortality than their counterparts working in the agricultural sector (cOR = 0.470; ρ<0.05; CI = 0.103 – 2.152). Maternal occupation was an insignificant predictor of infant mortality in urban areas at this analytical level.

Demographically, as displayed in Table 2, maternal age of below 20 years was significantly associated with neonatal mortality (cOR = 2.408; ρ<0.05; CI = 0.943 – 6.148) with reference to motherhood in the age range 20≤x≤34 years in

urban areas. Old aged mothers significantly contributed to infant mortality both in rural and urban areas. In rural areas, mothers aged 35 to 49 years were 0.714 times less likely and 2.929 times more likely to experience neonatal and post-neonatal mortalities, respectively, relative to mothers aged 20 to 34 years. Maternal age did not have a significant contribution to infant mortality as a whole in rural areas. There were higher odds ratios of infant mortality among mothers aged 35 to 49 years than those aged 20 to 34 years in urban areas (cOR = 2.891; ρ<0.05; CI = 1.063 – 7.858).

As pertains to the order of the index birth, first order births were more likely to die as neonates in comparison to 2 to 3 order births in rural areas (cOR = 1.405; ρ<0.01; CI = 0.509 – 3.880). In urban areas, high order births of at least 4 were 1.331 times more likely to experience post-neonatal mortality in comparison to 2 to 3 order births (cOR = 2.331; ρ<0.05; CI = 1.176 – 4.623). Wait period prior to the index birth was found to be significantly associated with urban infant mortality but not rural infant mortality. Infants born at a less than or equal to 24 months wait period were 1.132 times and 0.552 times more likely to experience post-neonatal and infant mortalities, respectively, with reference to infants born at a greater than 24 months wait period in urban areas. The odds ratios were 2.132 (ρ<0.05; CI = 1.088 – 4.179) for post-neonatal mortality and 1.552 (ρ<0.05; CI = 0.803 – 3.000) for infant mortality.

4.2.2. Multivariate analysis

Table 3 Adjusted odds ratios on the influence of socioeconomic and demographic factors on neonatal, post-neonatal and infant mortality controlling for geographical and distance factors in Kakamega Central Sub-County, Kakamega County, Kenya

	RURAL			**URBAN**		
Exposure variable	Neonatal	Post-neonatal	Infant	Neonatal	Post-neonatal	Infant
Level of education qualification of the mother						
Secondary+	-	-	-	-	-	-
None	1.913*	0.452	1.923	0.495	3.823*	2.515
Primary	2.832	1.071	3.094	2.656	6.304*	4.448*
Maternal occupation						
Agriculture	-	-	-	-	-	-
Not employed	0.724	0.567	0.745	1.556	1.676	1.240
Pro./Tech./Man./Cler.	6.995	0.105*	0.530	0.108*	1.569	0.741
Other	0.033	2.373	0.859	1.025	0.434	0.724
Age of the mother at the birth of her child						
20 - 34 years	-	-	-	-	-	-
< 20 years	0.471	3.203	1.952	1.579*	0.621	2.390
35 - 49 years	0.005*	1.361*	0.330	2.123	4.093	2.742*
Order of the index birth						
2 - 3 birth	-	-	-	-	-	-
First birth	5.522	1.968	3.492*	0.434	1.608	1.067
4+ birth	1.881*	2.324	1.563	2.130	2.674	1.200
Wait period prior to the index birth						
> 24 months	-	-	-	-	-	-
≤ 24 months	0.522	1.992	1.241	1.545	3.294*	3.616*

[a] Reference category; *ρ<0.01; **ρ<0.05; Source: Field Data (2023)

Multivariate multinomial logistic regression was carried out to examine the independent effect of socioeconomic and demographic factors on infant mortality while controlling for geographical and distance factors in Kakamega Central Sub-County. The results are presented in Table 3.

The results in Table 3 showed that neonates born to rural mothers with no any education qualifications were significantly more likely to die than their counterparts born to mothers with at least secondary education qualifications (aOR = 1.913; ρ<0.05; CI = 1.169 – 3.131). The significant association of infant mortality with level of education qualification of rural mothers that was observed at univariate analysis disappeared at multivariate analysis level. There was increased likelihood of post-neonatal mortality of 2.655 from 1.168 (at univariate regression level) to 3.823 (at multivariate regression level) amongst infants who were born to urban mothers with no any education qualifications with reference to those infants born to urban mothers with some secondary education qualifications. Again, there was an introduced significant relationship between level of education qualification of the mother and infant mortality in urban areas. The study found urban mothers with primary education qualifications to be significantly more likely to experience infant deaths relative to their colleagues with some secondary education qualifications (aOR = 4.448; ρ<0.01; CI = 0.796 – 2.866).

Moreover, maternal occupation was a significant contributor to rural-urban disparities in infant mortality in Kakamega Central Sub-County. Infants born to mothers working in professional/technical/managerial/clerical sectors were 0.895 times less likely to die as post-neonates in rural areas relative to their counterparts born to mothers working in the agricultural sector (aOR = 0.105; ρ<0.05; CI = 0.017 – 0.666). In urban areas, there was a lower likelihood of neonatal mortality amongst infants born to mothers working in professional/technical/managerial/clerical sectors when compared to their colleagues born to mothers working in agriculture (aOR = 0.108; ρ<0.05; CI = 0.015 – 0.791).

The results in Table 3 indicated that motherhood at the sunrise ages of reproduction (<20 years) was significantly associated with neonatal mortality in urban areas relative to motherhood in the ages 20 to 34 years (aOR = 1.579; ρ<0.05; CI = 0.117 – 2.307). Mothers aged 35 to 49 years were significantly less likely to experience neonatal mortality (aOR = 0.005; ρ<0.05; CI = 0.001 – 0.430) and significantly more likely to experience post-neonatal mortality (aOR = 1.361; ρ<0.05; CI = 0.695 – 2.665) compared to mothers aged 20 to 34 years in rural areas. In urban areas, old aged motherhood of 35+ years was significantly associated with higher adjusted odds ratio of infant mortality (aOR = 2.742; ρ<0.05; CI = 1.383 – 5.435).

The results further indicate that the significant influence of order of the index birth on infant mortality that was observed at univariate regression analysis level disappeared at multivariate regression analysis level in urban areas. This means that the order of an index birth influenced urban mortality through geographical, socioeconomic and distance pathways. Controlling for these factors vanished its influence on infant mortality. In rural areas, the above 3 birth orders had higher likelihood of neonatal mortality (aOR = 1.881; ρ<0.01; CI = 0.584 – 6.063) whereas first births had higher likelihood of infant mortality (aOR = 3.492; ρ<0.05; CI = 0.992 – 2.291). A shorter wait period prior to the index birth depicted higher adjusted odds ratios of post-neonatal and infant mortalities in comparison to the crude odds ratios in Table 2. Infants born at a wait period ≤ 24 months were 2.294 times and 2.616 times more likely to experience post-neonatal and infant mortalities, respectively, than infants born at a wait period > 24 months in urban areas.

5. Discussion

The results of descriptive analysis indicated that there was a lesser prevalence of infant mortality amongst mothers with no any education qualifications as compared to mothers with some education qualifications, both in rural and urban areas. Previously, there were higher proportions of infant deaths amongst mothers with no education than those with some education qualifications (KNBS & ICF Macro, 2010; Gruebner et al., 2015; Dendup et al., 2021). There was a 17.77 percent reduction in the general prevalence of infant mortality based on the education qualification of the mother (Gruebner et al., 2015). A study done in Bhutan found 64.6 percent and 40.9 percent of early childhood deaths to occur among mothers with no education in rural and urban areas, respectively (Dendup et al., 2021). In this study, these proportions have reduced.

A majority of infants however died to mothers with at most primary education qualifications (rural – 67.95%; urban – 53.38%). An interview with a key informant supported this finding when it revealed the following as pertains to the status of women education in Kakamega Central Sub-County and how it influences infant mortality:

"Majority of women in this area are either primary school drop-outs or never completed secondary schooling. Education of the mother helps her to make responsible choices in life and on maternal, new-born and child health", (Community Health Volunteer – Mahiakalo).

Further, many infant deaths occurred to rural mothers working in such sectors as manual, sales and grocers and domestic managers/nannies than to mothers working in agriculture. There was however a higher prevalence of infant mortality among the unemployed urban mothers. Some of the unemployed urban mothers are socioeconomically

disadvantaged residents of informal areas with lower accommodation charges. Such residential areas have deplorable conditions that put children at increased risks of communicable diseases, measles and cholera (Ikamari, 2004; Magadi, 2004; Kimani-Murage & Ngindu, 2007). A study by Dendup et al. (2021) in which children of non-working urban mothers had a 66.6 percent prevalence of deaths in comparison to those of the working mothers supports this observation. However, there was a generally lower prevalence of infant mortality amongst non-working mothers (rural - 25.64%; urban - 48.87%) than mothers working in any given sector. This observation is supported by a study by Kishor & Parasuraman (1998) that found working mothers to have a 10 percent greater rate of infant mortality than non-working mothers.

Demographically, there was a common trend in the prevalence of infant mortality according to the age of the mother at childbirth both in rural and urban areas of Kakamega Central Sub-County. In rural areas, the proportion of infant deaths increased from 21.79 percent to 58.97 percent before reducing to 19.23 percent in the maternal ages of <20 years, 20 to 34 years and above 34 years, respectively. In urban areas, this proportion increased from 18.05 percent to 70.68 percent before reducing to 11.28 percent in the maternal ages of <20 years, 20 to 34 years and above 34 years respectively. Therefore, majority of infant deaths were generally to mothers in their median ages of reproduction. This observation is supported by findings of a study that indicated that the prevalence of early childhood mortality was highest among mothers aged 29 to 34 years (Dendup et al., 2021). Minimal childbearing generally occurs to mothers in their sunset ages of reproduction. With this in mind, then there is equally a lesser proportion of infants dying to mothers in such ages.

There were visible inequalities in the prevalence of infant mortality in rural and urban areas of Kakamega Central Sub-County based on the order of the index birth. There was a higher proportion of infant deaths amongst births of orders 2 to 3 in rural areas (44.87%) and amongst first order births in urban areas (39.85%). This is in line with a study by Dendup et al. (2021) that found the highest proportion of infant deaths among above-two birth orders in rural areas and first births in urban areas of Bhutan. The study also found higher proportions of infant deaths among births with a wait period of above 24 months both in rural and urban areas of Kakamega Central Sub-County. This is consistent with the findings of Dendup et al. (2021) that infants with an interval of less than 33 months between births had a higher proportion of deaths in rural and urban areas.

The multivariate analytical results showed that having no any education qualifications increased the likelihood of a mother experiencing neonatal mortality by 91.3 percent compared to having some secondary education qualifications in rural areas. There were higher adjusted odds ratios of post-neonatal mortality amongst urban mothers with at most primary education qualifications relative to their counterparts with at least secondary education qualifications. Furthermore, urban mothers with primary education qualifications were 3.448 times more likely to experience infant mortality in comparison to their counterparts with secondary and higher education qualifications. These results are consistent with those of other studies (Ikamari, 2013; Liu, 2014; Imbo et al. 2021; Kuse et al. 2022; Yemane, 2022). Imbo, Mbuthia and Ngotho (2021) found mothers with no education to have had higher odds of experiencing neonatal mortality (aOR = 2.201; ρ <0.05; CI = 1.43 – 4.15) compared to mothers with higher education. Neonatal mortalities for mothers with secondary and higher educational levels were about 22 percent and 46 percent less likely compared to those of mothers with no education, respectively (Kuse et al., 2022). The odds of infant mortality decreased by 64 percent, 88 percent and 82 percent respectively, for mothers with primary, secondary, and higher educational levels with reference to their colleagues with no any education qualifications.

The above observations on the likelihood of infant mortality based on level of education qualification of the mother are well supported by existing literature. As suggested by Griffiths et al. (2004), more educated mothers can better utilize their limited resources and have better health and parenting practices which lead to better child survival. On their side, Ansem et al. (2014) pointed out that education of a mother influences her reproductive health choices and fertility preferences that increases the likelihood of neonatal survival. Mothers with better education are more likely to have better socioeconomic positions enabling for better child nutrition, better housing environment and better access to social and health care (Greubner et al., 2015). A study by Yemane (2022) noted that mothers with more education were more likely to have higher incomes, a greater understanding of health issues, and ability to make wiser decisions regarding their own health and that of their children. A key informant explained that maternal education influenced infant mortality by empowering mothers with knowledge and resources necessary to provide appropriate care for their children.

"There is evidence that women with higher education levels are more likely to take care of their children, including taking them to health facilities for check-ups and medication, thus lowering the chances of infant deaths. Again, with education, women are more likely to get formal employment, and that increases their chances of being economically stable such that they can afford healthcare services for their children", (Public Health Officer – Kakamega).

As pertains to maternal occupation, mothers who were working in other sectors (manual/sales/grocers/domestic managers) were less likely to experience neonatal mortality than their counterparts working in the agricultural sector in rural areas at univariate regression analysis level. Such mothers are able to move with their infants to their places of work and accord them the optimal maternal care and attention. They are also able to afford childcare expenses from their earnings as they do sales and grocers, house-help work and manual work here and there. The adjusted odds ratios were 0.105 ($\rho<0.05$; CI = 0.017 – 0.666) and 0.108 ($\rho<0.05$; CI = 0.015 – 0.791) for rural post-neonatal mortality and urban neonatal mortality, respectively, amongst children born to mothers working in professional/technical/managerial/clerical sectors as compared to those born to agriculturalist mothers. On why infant mortality was less likely amongst mothers working in professional/technical/managerial/clerical sectors than those working in an agricultural sector, key informants revealed that:

"Rural mothers working in such gainful employment are more likely to afford good healthcare for themselves and their young-ones", (Public Health Officer – Kakamega) and that:

"Mothers in the professional sector are more likely to earn better than those in the agricultural sector. Therefore, they are better placed to ensure the infant feeds well, has a clean and safe environment. As well, those in the professional sector would have better knowledge on childcare because they are likely to be better educated. They can also afford a balanced diet and safe storage of breastmilk", (Senior Population Programmes Officer – National Council for Population and Development).

The above findings are supported by a study done in Tanzania that found infant mortality rate to be 62 deaths per 1,000 live births among the urban top-level white collar people while it was 155 per 1,000 live births among farmers (Monsted & Walji, 1978). Mothers with stable salaries have some sort of economic stability and are able to use their earnings to improve the welfare of their babies. Besides, women's employment gives them greater control over their finances, increased access to information regarding childbearing practices, and the ability to engage with the outside world to meet their babies' nutritional, medical, and survival needs (Omedi, 2011). Against this, a historical study by Reid (1906) observed that areas with greater ranks of female employment had higher infant mortality rates as such jobs denied mothers sufficient time needed for child-caring.

The likelihood of neonatal mortality reduced with increase in the age of the mother at the birth of her child in rural areas of Kakamega Central Sub-County. Such findings were reported in other studies by Kadobera et al. (2012) and Dendup et al. (2021) that found higher maternal age to have a protective effect on early childhood mortalities. A study carried out by Kadobera et al. (2012) found out that mothers aged at least 40 years were 0.68 times less likely to experience under-five mortality (HR = 0.32; 90% CI = 0.22 – 0.45). In rural Bhuttan, results of multivariate analysis indicated that infants of older mothers had reduced odds of dying with reference to infants of younger mothers (Dendup et al., 2021). The study explained that such mothers were likely to have better socioeconomic status and ability to cope with pregnancy and related situations that lowered the likelihood of infant mortality.

Additionally, the current study found a higher likelihood of post-neonatal mortality among older mothers as compared to mothers aged 20 to 34 years in rural areas. This is consistent with the findings of a study by Ikamari (2013) that found 18.80 percent greater risk of post-neonate deaths among mothers aged 35+ years in comparison to those aged 20 to 34 years. The study further found the odds of dying among post-neonates born to women aged at least 35 years to be 1.58 times higher than those of post-neonates born to women aged under 20 years. The study appreciated that these results did not depict the U-shaped pattern that often characterized the association between early childhood mortality and maternal age in much of the demographic literature.

In urban areas, there were higher likelihoods of neonatal mortality among mothers aged less than 20 years with reference to mothers aged 20 to 34 years. The findings in urban areas relate to findings of other studies (Akinyemi et al., 2015; Woodall & Driscoll, 2020; Arunda et al., 2022; Wardani et al., 2022). A nationwide study conducted in Nigeria by Akinyemi et al. (2015) found hazard ratios of 1.75 and 1.50 comparing neonatal deaths among adolescent mothers to mothers aged 20 to 35 years. The USA national report indicated that neonatal mortality rate was 121.67 percent higher among teenage mothers compared to mothers aged 20 to 29 years (26.6 versus 12.0 deaths per 1,000 live births) (Woodall & Driscoll, 2020). A study done in Kenya, Uganda and Tanzania by Arunda et al. (2022) found the adjusted hazards ratio of death among neonates born to mothers aged less than 20 years to be 0.86 times higher compared to those born to mothers aged 20 to 29 years (aHR = 1.86; 95% CI = 1.06 – 3.29). In support of these findings, a key informant said:

"The younger mothers may not be well experienced: it could be a case of unintended pregnancy or a case of sexual violence. Thus, the adolescent may not really be interested in safe-keeping the child. They may even fail to seek antenatal care services", (Senior Population Programmes Officer - National Council for Population and Development).

Adolescent pregnancy and the associated higher neonatal mortality are more prevalent in low and middle income countries as much as they are a global burden affecting even high-income countries (WHO, 2021). This can be explained by the social and health-related vulnerabilities among adolescents. Such vulnerabilities include increased poverty, maternal depression, malnutrition exacerbated by competition for scarce nutrients between the mother and the fetus, and biological vulnerability as a result of physical immaturity (Alam, 2000). A recent study in Indonesia found lack of active participation in antenatal care visits (OR = 2.276; 95% CI = 1.168 – 4.435) and delivery complications (OR = 2.103; 95% CI = 1.082 – 3.970) to be significantly associated with neonatal deaths (Sampurna et al., 2023). Young mothers are more prone to inactive participation in antenatal care visits and birth complications associated with physical immaturity and cephalo-pelvic disproportionality.

Further in urban areas, there were higher likelihoods of infant mortality among mothers aged 35 to 49 years with reference to mothers aged 20 to 34 years. A study done in Indonesia on factors associated with infant deaths by Wardani et al. (2022) found older maternal ages to be risk factors for infant deaths compared to younger maternal ages (aOR = 3.61; CI = 1.42 – 9.23). As observed by Omedi (2011), (multiparous) women in their 40s suffer from anemia, malnutrition, damage to their reproductive systems from earlier births and sheer physical depletion associated with frequent childbearing. This increases their likelihood of experiencing infant mortality. An interview with a key informant supported this finding as articulated below:

"The most at risk maternal ages on infant mortality are the ≥40 years. There is enough evidence pointing to older women and risky childbirth as well as survival of infants of older women. As women age, their bodies shade a lot of blood coupled with a lot of vitamins and minerals. Thus, carrying a pregnancy at such older ages is risky. For working mothers, such ages are considered prime in terms of career advancement and caring for an infant may be second-place", (Senior Population Programmes Officer – National Council for Population and Development).

The findings on the influence of order of a birth on infant mortality in Kakamega Central Sub-County are consistent with findings of other studies (Gyimah, 2002; Kabir et al., 2011). These studies found first births and births of high orders to have significantly greater likelihoods of early childhood mortalities as compared to 2 to 3 birth orders. As explained by Kibet (2010), first-borns have higher risks of death because of the age of the mother (women who bear children in their early reproductive ages), pregnancy and birth complications and due to the inexperience of the mother in looking after the infant. On their side, Koenig and colleagues (1990) did observe that high order birth increased the risks of infant mortality for physiological and behavioural reasons. Women who have had multiple pregnancies are more likely to be physically depleted. Behavioural reasons arise due to constraints on household resources more so in cases of a lower birth spacing. The response from a key informant supported the findings as noted below:

"Research notes that first births are high risk for child survival may be due to less childcare knowledge or adolescent births. Some girls give birth when their reproductive organs are not fully developed", (Senior Population Programmes Officer – National Council for Population and Development).

Wait period prior to the index birth was found to be significantly associated with urban but not rural infant mortality. There were significantly higher likelihoods of infant mortality for a short wait period of at most 24 months than an above 24 months wait period. This reveals the dependency between fertility-related factors and early childhood mortalities. A short wait period prior to an index birth points to high fertility in response to a previous death or in pursuant of child utilities. A study conducted by Poel et al. (2009) noted that a short birth interval and high birth order reflected previous infant deaths. They thus have a direct effect on infant survival chances besides being correlated with unobserved mortality risks that threaten infants born within a household.

The findings on the association of wait period prior to the index birth and infant mortality are in agreement with findings of studies by Wardani et al. (2022) and Kuse et al. (2022). A study by Wardani et al. (2022) found the risk of infant mortality with a preceding birth interval of ≥ 24 months to be lower than that with a preceding birth interval of < 24 months (aOR = 0.48; CI = 0.26 – 0.90). Children born after a wait period greater than or equal to 24 months were 46 percent less likely to die at infancy compared to children born after a less than 24 months wait period (Kuse et al., 2022). Akinyemi et al. (2016) explained that short preceding birth intervals and high parity largely increased early childhood mortality risk after accounting for unobserved heterogeneity between them. This is related to maternal depletion syndrome, the mother not fully recovering from the previous pregnancy before supporting the next birth, sibling rivalry for attention and care, and resource competition between siblings experienced by high-order births (Saha & van Soest,

2013; van Malderen et al., 2019; Adedokun & Yaya, 2020; Ekholuenetale et al., 2020). In support of these findings, a key informant said the following regarding the relationship between wait period prior to a birth and infant mortality:

"In most cases, women who lose an infant try to replace immediately even though the body may not have fully recuperated to carry another pregnancy. When this happens, it is likely that the pregnancy may be complicated. This may also lead to low birthweights which further jeopardises child survival", (Community Health Volunteer - Mahiakalo).

Indeed, there are elevated risks of early childhood mortalities among low birthweight infants (Omedi & Amwoliza, 2015). A study by Guyatt and Snow (2001) found infant mortality to be three-times higher for low birthweights than for normal birthweights.

The findings of this cross-sectional study were however based on some assumptions. One was that the information on the mother and household characteristics at the time of the survey reflected the status at infant death. Two was that respondents had the will and ability to communicate the information that was asked for during the interviews. Three was that there were no major recall errors in the reporting of vital events of one's entry into life or exit from life. Four was that the information obtained from alive mothers in the ages 15 to 49 years at the time of survey reflected the information that would have been obtained from mothers who were dead, younger than 15 years and older than 49 years. A review of African population data done by Garenne (2003) concluded that sample survey data had the advantage of lacking major biases and that they involved widespread range of population that made them of acceptable quality.

6. Conclusions

This study sought to establish the influence of socioeconomic and demographic factors on rural – urban disparities in infant mortality in Kakamega Central Sub-County, Kakamega County, Kenya. The study established that mothers with below-secondary education qualifications were associated with higher chances of neonatal, post-neonatal and infant mortality as compared to their counterparts with some secondary education qualifications. Higher maternal education is associated with procrastinated childbearing, widened birth spacing and lower parity, all of which contributes to lower infant mortality. Mothers working in a professional/technical/managerial/clerical sector had lower chances of neonatal and post-neonatal mortalities. Such mothers are generally economically advantaged and participate in decision-making processes that touch on childcare.

Adolescent mothers had a higher likelihood of urban neonatal mortality because they were not well-experienced in childbearing and raring. Some of their births were as a result of unintended pregnancies. Old aged motherhood was associated with higher chances of post-neonatal and infant mortalities because of higher parities, physical depletion and damaged reproductive systems occasioned by frequent childbirths. First births and high order births were more likely to die as neonates and infants for physiological and behavioral reasons. Also, post-neonates and infants born within a two-year interval were more likely to die than their counterparts born beyond a two-year interval due to the mother not fully recovering from the previous pregnancy before supporting the next birth and sibling rivalry for attention and care.

Recommendations

The study recommends the following:

- Encouraging beyond-primary level female education as such is associated with better economic performance and reduced fertility, factors which contribute to increased infant survival.
- Advocating for childbearing during the middle reproductive ages and widening of the wait period between successive births. This will lead to improved maturity of the mother and reduced parity, both of which correlate with low infant mortality.

The study suggests that the following areas need investigations conducted on them:

- The influence of level of income of a household on infant mortality. The current study focused on maternal occupation yet paid occupations have varied rates of payment. Yet still, sources of income in a household could be from fathers and even working siblings.
- The relationship between marital status of the mother and infant mortality. The current study focused on mothers in general yet marital status of a mother: married, divorced/separated/widowed, or single, is thought to contribute to infant mortality through various pathways.

Compliance with ethical standards

Acknowledgement

The researchers acknowledge the Kakamega Central Sub-County community for receiving them and willingly participating in the data collection process that made this study a success.

Disclosure of conflict of interest

No conflict of interest to be disclosed.

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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