RURAL - URBAN DIFFERENTIALS IN INFANT MORTALITY IN KAKAMEGA CENTRAL SUB - COUNTY, KAKAMEGA COUNTY, KENYA

BY

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DECLARATION

I wrote this Thesis myself and in my own words, save for quotations from both published and unpublished sources all of which are well indicated and acknowledged as such. Thus, this Thesis is my original work and has not been submitted before, either in part or in full, for any degree programme at this or any other University.

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DEDICATION

To my late parents: dad Japheth Maube Ananda and mum Jenipher Nyarotso Maube.

ABSTRACT

Despite the tremendous strides made in reducing childhood mortality, global infant mortality rate remains high, at 28 deaths per 1,000 live births. About 53 percent of the global infant deaths occur in Sub-Saharan Africa. Majority of these deaths are as a result of improper access to prenatal care, childbirth delivery care and postnatal care services. These are correlated to geographical, socioeconomic, demographic and distance factors and yet it is not clearly documented. Infant mortality rate still remains high at 36 deaths per 1,000 live births in Kenya. Notably, in Kakamega County, the rate is at 37 deaths per 1,000 live births. This study aimed at examining rural-urban differentials in infant mortality in Kakamega Central Sub-County, Kakamega County, Kenya. The specific objectives of the study were to: establish the influence of geographical area of residence on the death of infants in rural and urban areas of Kakamega Central Sub-County; examine the influence of socioeconomic factors on the death of infants in rural and urban areas of Kakamega Central Sub-County; examine the influence of demographic factors on the death of infants in rural and urban areas of Kakamega Central Sub-County; and to assess the influence of the distance covered to the nearby medical facility on the death of infants in rural and urban areas of Kakamega Central Sub-County. 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 was collected by administering structured questionnaires, interviewing key informants and observation and photography. Secondary data was obtained from the 2019 Kenya Population and Housing Census. Content validity ratio was computed to test data validity while data reliability was tested by computing Cronbach's alpha coefficient of internal consistency. Qualitative data on nature of roads, level of education of the mother and maternal occupation were analysed by coding, creating categories, themes and patterns. Quantitative data on population density, number of health facilities, age of the mother and distance were analysed by descriptive statistics and multinomial logistic regression analyses. The study revealed that the main contributors to rural-urban differentials in infant mortality in Kakamega Central Sub-County were nature of roads (aOR = 3.867; 95% CI = 1.079 – 3.857), first births (aOR = 3.492; 95% CI = 0.992 – 2.291) and high order births (aOR = 1.881; 95% CI = 0.584 – 6.063) in rural areas. Nature of roads and order of the index birth were insignificant in explaining urban infant mortality. In urban areas, a ≤ 24 months wait period prior to the index birth was significantly associated with post-neonatal (aOR = 3.294; 95% CI = 1.224 – 8.863) and infant (aOR = 3.616; 95% CI = 1.342 – 9.740) mortalities in comparison with a > 24 months wait period. A distance of 1.1 to 3.9 kilometres from one's residence to the nearby medical facility had a higher likelihood of neonatal mortality (aOR = 2.127; 95% CI = 1.197 – 3.781) compared to an at most 1 kilometre distance. Wait period prior to the index birth and distance were not significant in rural mortalities. The study concluded that nature of roads, order of the index birth, wait period prior to the index birth, and distance were the main contributors to rural-urban differentials in infant mortality in Kakamega Central Sub-County. The study recommends concerted efforts towards road maintenance in rural areas; encouraging beyond-primary level female education; advocating for childbearing during the middle reproductive ages; and research on the influence of culture on infant mortality.

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LIST OF ABBREVIATIONS AND ACRONYMNS

aHR	–	Adjusted Hazards Ratio
aOR	–	Adjusted Odds Ratio
CI	–	Confidence Interval
CGoK	-	County Government of Kakamega
cOR	–	Crude Odds Ratio
CVR	–	Content Validity Ratio
HHs	-	Households
HR	–	Hazards Ratio
ICF	–	International Classification of Functioning, Disability and Health
IND	-	Infant Death
INM	-	Infant Mortality
KDHS	–	Kenya Demographic and Health Survey
KNBS	–	Kenya National Bureau of Statistics
KPHC	–	Kenya Population and Housing Census
MoALF	-	Ministry of Agriculture, Livestock and Fisheries
NACOSTI	-	National Commission for Science, Technology and Innovation
NCPD	–	National Council for Population and Development
NND	-	Neonate Death
NNM	-	Neonatal Mortality
PNND	-	Postneonate Death
PNNM	-	Postneonatal Mortality
SME	–	Subject Matter Experts
SPSS	–	Statistical Package for Social Sciences
UN	–	United Nations

UNDP	–	United Nations Development Programme
UNICEF	–	United Nations Children's Fund
WHO	–	World Health Organisation

WORKING DEFINITION OF TERMS

Age of the mother at the birth of her child

This is the age that the mother was when she delivered her baby who died during infancy. It was considered in the following categories: <20 years; 20 – 34 years; and 35 – 49 years.

Antenatal care

This is the ordered health and treatment attention suggested for women during prenatal period. This study measured the uptake of antenatal care visits as follows: none; 1 – 3 visits; and 4+ visits.

Birth

This is a child brought forth from the body of its parent while alive.

Demographic factors

These are the particular characteristics of a research participant, including the age of the mother at the birth of her child, the order of a birth, and the wait period prior to the birth of a newborn who died during infancy.

Distance covered to the nearby medical facility

This is the distance a mother who lost her baby at infancy could cover to arrive at the nearest health facility. According to this study, distance covered to the nearby health facility was estimated in terms of approximate distance and travel-time. Approximate distance was estimated in kilometres and categorised as: at most 1 km; 1.1 - 3.9 km; and at least 4 km. Travel-time was categorised as: ≤30 minutes; 31 – 60 minutes; and >60 minutes.

Geographical factors

These are the characteristic features of the place where the mother who had an experience of an infant death was residing when the infant died. In this study, it was measured by population density, nature of roads, number of health facilities, and type of housing.

Infant mortality

This is the death of babies between zero days of life and the eleventh month of life. It is thus the sum of neonatal and post-neonatal mortality.

Level of education qualification of the mother

This is the highest formal educational qualification of a mother at the time of giving birth to the infant who died. This study measured it as follows: none, primary education, and secondary and above education.

Maternal occupation

This is the measure of the kind of job the mother was doing when she lost her baby during infancy. This study categorised maternal occupation as follows: not employed, agriculture employment, professional/technical/managerial/clerical employment and other (manual/domestic workers/sales/marketing/grocers) employment.

Nature of roads

This is the measure of the state of a route and a linear way used to convey traffic. This study categorized it as: mud roads, well-maintained murram roads, and tarmacked roads.

Number of health facilities

This is the measure of the count of places that provide human health care. It was categorized as: at most 2 health facilities, 3 to 4 health facilities, at least 5 health facilities.

Neonatal mortality

This is the death of a baby between birth and exactly 28 life days.

Order of a birth

This is the order in which a baby is born. This study categorised order of a birth as follows: first births, births of orders two to three, and births of orders four and above.

Place of childbirth delivery

This is the place where a childbirth occurred; either in a government medical facility or private medical facility or outside a medical facility/at home.

Population density

This is the number of people living on a unit area of land. It was calculated using the 2019 Kenya Population and Housing Census data. It was categorized as less densely populated (at most 599 people per square km), densely populated (600 to 999 people per square km) and more densely populated (at least 1,000 people per square km).

Post-neonatal mortality

This is the death of babies between exactly age 29 days of life and the eleventh month of life.

Religion

This is a particular system of faith and worship being embraced by the mother. This was measured as: Catholic, Anglican Church of Kenya/Protestant/Seventh Day Adventist, Islam, and Others.

Rural residence

A rural residence is where the primary economic activities are agriculture, forestry, sand harvesting and mining activities. The rural areas in the study area are Shirakalu, Murumba, Indangalasia, Shibuli, Shiyunzu, Emukaya, Matioli, Eshisiru and Eshibeye.

Rural-urban differentials in infant mortality

This is the geographical variation in the death of infants. It was measured by geographical factors, socioeconomic factors, demographic factors and distance covered to reach the nearby medical facility factor.

Socioeconomic factors

These are the constituents and dimensions of financial viability and social standing of life that have a direct effect on societal freedom and intensities of monetary objectivity of a household. They herein include: level of education qualification of the mother and maternal occupation.

Type of housing

This was constructed from information on the material used for the floor, wall and roof construction of the house. It was categorised as non-durable, good, durable. A non-durable housing is one with poorly-maintained earth floor, wooden, iron sheet, tin and poorly-maintained mud walls, and grass and perforated roofing materials. A good housing is one with

well-maintained earth floor, well-maintained mud walls, and corrugated iron sheet roofing materials. A durable housing is one with cemented and tiled floors, stone/brick/block walls, and corrugated iron sheet roofing materials.

Urban residence

An urban residence is where the secondary economic activities are manufacturing and service industries and commercial activities. The urban areas are Mahiakalo, Shirere, Sichilayi and Bukhungu Township.

Wait period prior to a birth

This is the measure of the duration of time interval from the previous birth to the index birth in months. It was measured as either less than or equal to 24 months' preceding interval or greater than 24 months' preceding interval.

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CHAPTER ONE

INTRODUCTION

1.1 Background to the Study

Infant mortality is the death of a new-born baby before reaching age one. Being a measure of child survival, it remains to be an excellent pointer to the health of children and the socioeconomic development of the society. The United Nations, in 2000, came up with a goal that aimed at reducing under age five mortality by about 67 percent in a span of 25 years (UNDP, 2000). National governments intensified efforts to lower under-five mortality and enhance child survival. This bore some fruit as there were observed advances in under-five mortality rates. The Millennium Development Goals Report (UN, 2014) noted that the world-wide rate of under-five mortality dropped from 90 (in 1990) through to 43 (in 2015) deaths for every 1,000 live births. However, these improvements did not enable many countries to meet the target by the United Nations.

At the elapse of the 25-year period, the pressing requisite to end avertable death of children was still in existence. Thus, in 2015, the United Nations came up with the third Sustainable Development Goal (SDG) that 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 states 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.

Generally, the number of children dying at tender ages is still high. The world has however advanced incredible developments in decreasing childhood mortality over decades. A report by UNICEF et al. (2020) noted that the world-wide rate of under-five mortality dropped from

93 (in 1990) through to 38 (in 2019) deaths for every 1,000 live births. Among the under-five deaths, 47 percent took place in the first month of life (neonate deaths), 28 percent at ages 1 to 11 months (post-neonate deaths), and 25 percent at ages 1 to 4 years (child deaths). The rates were 17, 11 and 10 deaths for every 1,000 live births for neonatal, post-neonatal and child mortality, in that order, with 53 percent of the infant deaths occurring in sub-Saharan Africa. The foremost roots of these deaths were pneumonia and complications occurring preterm and intrapartum such as birth asphyxia (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 global 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 examine whether infant mortality differed based on the geographical area of residence. The studies neither assessed whether there existed any relationship concerning geographical, socioeconomic, demographic and distance factors and the death of babies between birth and the eleventh month of life in rural and urban areas of residence.

Studies have found that geographical factors of population density, nature of roads, number of health facilities, and type of housing influence infant mortality (Root, 1997; Black et al., 2003; Magadi et al., 2003; Agarwal & Taneja, 2005; Leon, 2008; Masuma & Bangser, 2009; Matthews et al, 2010; Macassa et al., 2012; Mehan et al., 2014; Ghosh, 2015; Gruebner et al., 2015; Hathi et al., 2017). Contradicting findings have been reported on how population density influence infant mortality. In Zimbabwe, a study by Root (1997) accepted the hypothesis that low population densities in the Ndebele provinces had significantly contributed to their lower child mortality. A study by Hathi et al. (2017) found high population density to be more detrimental to infant health in the presence of poor sanitation. Contrarily, other studies have indicated that densely populated areas are more likely to be

characterised by access to child healthcare services that substantially reduces infant mortality (Magadi et al., 2003; Matthews et al., 2010). From these studies, we find no clear pathway through which population density influences infant mortality.

A study by Masuma and Bangser (2009) found road transport to be problematic in rural areas of Tanzania leading to difficulties in accessing health facilities and thus aggravating infant deaths. The study however failed to consider population density and type of housing as factors that could be contributing to infant death. In the analysis of the 2009 Kenya population and housing census, Gruebner et al. (2015) found residence in durable housing to reduce infant mortality in rural areas while it increased it in urban areas. The mix-up in these findings was a call for this study.

The number of health facilities in a place gives a measure of the health facility density. A study done in India by Ghosh (2005) attributed pronounced differences in the prevalence of infectious diseases among children to be as a result of differences in healthcare development and population density. In their study, Sanou and colleagues (2009) found out that having a health facility within a village significantly increased chances of being fully vaccinated: vaccination is correlated with infant mortality. The current study considered the number of health facilities present in an area to influence infant mortality in terms of availability, geographical accessibility, accommodation space, and stocking of the necessary drugs and equipment needed for infant health.

In Jordan, infant mortality varied with wait period prior to a birth (DoS & ICF Macro, 2010). The survey reported that the death of infants dropped from 35 deaths per 1,000 livebirths for under-2 years' wait period prior to a birth to 11 deaths for every 1,000 live births for 3 years' wait period prior to a birth. In Africa south of Sahara, van Malderen et al. (2019) found out that under-five mortality was lesser in urban regions of Comoros, Lesotho, Namibia, Niger

and Senegal while it was higher in urban regions of Kenya, Congo and Tanzania. The study attributed the observed urban-rural mortality differentials to varied ecological settings, political economy and health systems (Mosley and Chen, 1984; Kanmiki et al., 2014). The urban advantage in terms of mortality was due to family access to health services and better economic opportunities (Gunther & Harttgen, 2012; Bocquier et al., 2011).

The study by van Malderen et al. (2019) further established that births to mothers with secondary and above education qualifications had lesser mortality rates than those births to mothers with below secondary education qualifications in Burundi, Cameroon, Comoros, Gambia, Ghana, Lesotho, Liberia, Mozambique, Nigeria, Rwanda, Uganda and Zambia. The study explained that mother's education operated through empowerment, health and reproductive behaviour and health service utilisation to influence rural-urban inequalities in mortality (Mosley & Chen, 1984; Kanmiki et al., 2014). Educated mothers are more likely to receive antenatal care (Tayie & Lartey, 2008), delay motherhood and decrease the total number of children they bear (Gyimah, 2003). These studies show the influence of geographical area of residence, level of education qualification of the mother, and wait period prior to a birth on infant mortality differentials. The current study, in addition, considered maternal occupation, order of a birth, age of the mother at the birth of her child, and distance covered to the nearby medical facility as variables that could be influencing infant mortality differentials as well.

Different authors have done research on social factors influencing infant mortality globally. In rural Iran, the risk of infant mortality was 3.3 times greater among infants whose fathers had no any education qualification compared to those infants whose dads had at least high school education qualifications (Sharifzadeh et al., 2008). 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 the whole urban state of 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 yields 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 accords them healthier behaviours and attitudes that are passed onto their offsprings. These global studies pointed out that infant mortality varied with the social disparities of rural geographical area of residence and level of education qualification of the parent. However, the studies did not clearly explain how the rural and urban geographical areas of residence influence infant mortality. They neither told us whether level of education qualification of the mother could be significantly linked to the death of new-borns between birth and age eleven months of life in rural areas.

Studies in the African region found occupation of the mother as a significant source of inequalities in early childhood mortalities (Ester et al., 2011; 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 by Omedi and Wanjiru (2014) explained that working mothers practice either incomplete or unexclusive breastfeeding due to limited maternity leaves, thus

increasing the likelihood of experiencing infant death. There was however no clear contribution of maternal occupation on infant mortality in East Africa, West Africa and Southern Africa. The current study considered maternal occupation as a tenet which could be significantly contributing to rural-urban differentials in infant mortality in Kakamega Central Sub-County, a region in East Africa.

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). Omariba, Beaujot and Rajulton (2007) did a study in Kenya and 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 by Mustafa and Odimegwu (2008) found out that the maternal age was significantly linked to the death of infants in rural areas of Kenya 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. The study recognised that infants born to mothers younger than 19 years were 42 percent and 47 percent respectively, more likely to die. This is attributed to the protective effect on mortality that comes with higher maternal ages (Kadobera et al., 2012). The disagreement between results of the studies by Omariba et al. (2007) and Liu (2014) and those of the study by Ikamari (2013) on the clear pattern of the influence of age of the mother at the birth of her child on the death of infants was a reason for the current study.

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 a birth. A study 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 regions of Kenya. Urban births that occurred at a wait period of at least 2 years had a 0.726 lesser risk of post-neoante mortality with reference to urban births that occurred at a wait period of less than 2 years. The study explained that delayed conception enables mothers to regain their strength and prepare them to accord sufficient care to the newborn.

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 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. As much as these studies give us a glimpse on how the order of a birth and wait period prior to the birth relates with infant mortality in Kenya, they mainly relied on KDHS secondary data sources for analyses. The current study used primary data to establish the influence of order of a birth and the wait period prior to its birth on the

death of babies between birth and the eleventh month of life in rural and urban areas of Kakamega Central Sub-County.

A number of studies have identified the distance covered to reach the nearby medical facility as a factor related to childhood mortality (Kembo & van Ginneken, 2009; Ettarh & Kimani, 2012; Kanmiki, et at., 2014). A study done in rural areas of Tanzania found the rate of mortality for infants who lived within 5 kilometres to the nearby medical facility to be 72.4 for every 1,000 person years while that of those living greater than 5 kilometres from the health facility was 82.3 for every 1,000 person years (Kadobera et al., 2012). In selected districts of Kenya, Noor and colleagues (2006) projected that roughly 63 percent of the people were able to reach a government medical centre within an hour. A different study by Quattrochi et al. (2020) found greater distance to be associated with higher mortality, lower healthcare utilisation, increased home deliveries, reduced number of antenatal care visits, and a reduction in skilled aid in the course of childbirth delivery. The current study postulated that the distance covered to reach the nearby medical facility might be influencing infant mortality either through travel time or distance, or through other pathways.

According to Kenya demographic and health surveys, 1989 through to 2014, Kenya's infant mortality has shown an erratic pattern over time as follows: 60 (1989), 62 (1992), 74 (1998), 77 (2003), 52 (2008/09) and 39 (2014). It was not until 2008 that there was a reversal in infant mortality based on the geographical area of residence. Before, the rate had been higher in rural compared to urban areas of Kenya. In 2008/09, infant mortality rate was 58 and 63 in rural and urban areas, respectively. The rate declined to 40 and 43 deaths for every 1,000 live births in rural and urban areas, respectively, in 2014. Rural-urban mortality differentials have previously been documented (Gruebner et al., 2015; van De Poel et al., 2009; Yaya et al., 2017). Studies have attributed the reversal in infant mortality based on the type of place of

residence to the more rapid mortality decline in rural areas than in urban areas and the deplorable living conditions in urban slums (Kimani-Murage et al., 2014). Other studies have explained it in terms of family poverty and consequently inaccessibility of paediatric healthcare services (Ekholuenetale et al., 2020). According to the analytical report on mortality based on the 2019 Kenya population and housing census, rural and urban areas of Kenya have a similar infant mortality rate of 36 deaths for every 1,000 live births in 2019 (KNBS, 2022). The analysis in this report was however based on the entire birth and death histories of mothers unlike the current study that has a well-defined time-frame.

Regional disparities exist in the death of infants in Kenya due to variations in social, economic 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 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 is 36 while that of Kakamega County is 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. As explained in the report, the proportion of dead children born to women is a reflection of the level of early childhood mortality (KNBS, 2022). 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.

In 2015, nations pledged to terminate avertable deaths of children under the age of 60 months of life. They also pledged to lower the death of neonates to at least 12 for every 1,000 live births and that of children under the age of 60 months to at least 25 for every 1,000 live births

come the year 2030 (UNDP, 2015). To achieve this goal, each country is expected to understand the local factors influencing infant mortality and implement appropriate interventions to address the elevated risk of mortality and the existing differentials. The reviewed literature has indicated that, as much as geographical, socioeconomic, demographic and distance factors are fundamental predictors of infant deaths, there exist regional and temporal variations in the level, direction and significance of their influence on infant mortality. A study conducted in West Africa pointed out that diverse geographical environments have distinctive contextual features (Sombie et al., 2017) that can bring about disparities in factors influencing infant mortality. Thus, the reason for conducting this study to examine the rural-urban differentials in infant mortality in Kakamega Central Sub-County, Kakamega County, Kenya.

1.2 Statement of the Problem

As much as the global infant mortality rate is 28 infant deaths per 1,000 live births, 53 percent of infant deaths occur in Sub-Saharan Africa. In Kenya, infant mortality has shown an erratic pattern over time, ranging from 60 through to 36 deaths per 1,000 live births in 1989 and 2019, respectively. There exist regional variations in infant mortality in Kenya, an occurrence that could be attributed to varied geographical, social, economic and demographic characteristics depicted by the population. Kenya's 2014 demographic and health survey reported a national infant mortality rate of 39 while that of Kakamega County was 40. The 2019 Kenya population and housing census reported that infant mortality rate was 36 and 37 deaths for every 1,000 live births for Kenya and Kakamega, respectively. It is possible that this greater-than-national infant mortality rate in Kakamega County could be due to geographical, social, economic, demographic and distance factors, an area that is yet to be fully explored. The 2019 Kenya population and housing census 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 0.02 in Uasin Gishu. Being neighbouring counties, it would be expected that their populations depict similar characteristics. Yet Kakamega stood out with its proportion reflecting a comparatively higher level of infant mortality.

An observation worth noting is the reversal in infant mortality based on the geographical area of residence. The 2008/09 and 2014 KDHS reports indicated that, unlike what preceding surveys reported, infant mortality was higher in urban than in rural areas of Kenya. For instance, in 2003, infant mortality rate was 79 and 61 deaths per 1,000 live births in rural and urban areas, respectively. This reversed to 40 and 43 deaths per 1,000 live births in rural and urban areas, respectively, in the year 2014. Using multinomial logistic regression analysis, this study sought to examine rural-urban differentials in infant mortality in Kakamega Central Sub-County, Kakamega County, Kenya.

There exists no clear pattern in which various factors influence infant mortality. Some literature indicates that level of education of the mother negatively influence infant mortality, others indicate that it positively influences infant mortality while others indicate no significant relationship between level of education of the mother and infant mortality. On maternal occupation, some studies have reported that the risk of infant mortality is lower among working mothers while others have reported that it is higher among working than non-working mothers. Pertaining maternal age, some studies have found an increased risk of infant mortality among younger and older mothers than middle-aged mothers while others have found maternal age as an insignificant predictor of infant mortality. The current study therefore further examined the association of geographical, socioeconomic, demographic and

distance factors with infant mortality in rural and urban areas of Kakamega Central Sub-County, Kakamega County, Kenya.

1.3 Objective of the Study

This study aimed at examining rural-urban differentials in infant mortality in Kakamega Central Sub-County, Kakamega County, Kenya.

The specific objectives were to:

i. Establish the influence of geographical area of residence on the death of infants in rural and urban areas of Kakamega Central Sub-County.

ii. Examine the influence of socioeconomic factors on the death of infants in rural and urban areas of Kakamega Central Sub-County.

iii. Examine the influence of demographic factors on the death of infants in rural and urban areas of Kakamega Central Sub-County.

iv. Assess the effect of distance covered to the nearby medical facility on the death of infants in rural and urban areas of Kakamega Central Sub-County.

1.4 Research Hypotheses

This study tested the following research hypotheses:

i. H_0: Geographical area of residence has no significant influence on the death of infants in rural and urban areas of Kakamega Central Sub-County.

   H_1: Geographical area of residence has a significant influence on the death of infants in rural and urban areas of Kakamega Central Sub-County.

ii. H_0: Socioeconomic factors have no significant influence on the death of infants in rural and urban areas of Kakamega Central Sub-County.

H_1: Socioeconomic factors have a significant influence on the death of infants in rural and urban areas of Kakamega Central Sub-County.

iii. H_0: Demographic factors have no significant influence on the death of infants in rural and urban areas of Kakamega Central Sub-County.

H_1: Demographic factors have a significant influence on the death of infants in rural and urban areas of Kakamega Central Sub-County.

iv. H_0: Distance covered to the nearby medical facility does not positively contribute to the likelihood of infant death in rural and urban areas of Kakamega Central Sub-County.

H_1: Distance covered to the nearby medical facility positively contributes to the likelihood of infant death in rural and urban areas of Kakamega Central Sub-County.

1.5 Justification of the Study

The rate of death of babies between birth and the eleventh month of life is an excellent pointer to the health standing of children and the life expectancy at birth of a given society. High infant mortality is undesirable and a reflection of poor health status of a society. This is because infant mortality robs a country of the much needed human capital besides increasing maternal mortality as women try to get pregnant to replace dead infants before their bodies fully recover from the lost births. It also increases fertility as women tend to have more children as a result of the fear of losing some along the way. Infant mortality thus retards development.

The Millennium Development Goal number four purposed to reduce infant mortality rate by about 67 percent by the year 2015. However, Kenya's infant mortality rate was 39 and Kakamega County's infant mortality rate was 40 in 2015, as opposed to the Millennium Development Goal target of 20. The rate dropped to 36 and 37 in Kenya and Kakamega County, respectively, in 2019. This observed pace of reduction is somehow slow and might jeopardise the achievement of the third Sustainable Development Goal whose formulation targets to terminate avertable childhood deaths and reduce the death of neonates to 12 for every 1,000 live births and that of children under the age of five years to 25 for every 1,000 live births come the year 2030.

Since there exist regional and geo-spatial variations in infant mortality in Kenya, it was vital to examine the rural-urban differentials in infant mortality and how population density, nature of roads, number of health facilities, type of housing, level of education qualification of the mother, maternal occupation, age of the mother at the birth of her child, order of a birth, wait period prior to the birth, distance and travel-time taken to reach the nearby medical facility influence infant mortality in rural and urban areas of Kakamega Central Sub-County, and in Kenya by extension. This examination helps in addressing the geo-spatial disparities in rural-urban infant mortality and in fast-tracking the United Nation's Sustainable Development Goals. Reducing infant mortality allows new-borns to live out their social and economic potential in their families and societies at large. It also provides knowledge necessary for improving child survival and creates awareness on geographical, socioeconomic, demographic and distance factors which are associated with infant mortality in Kakamega Central Sub-County, and in Kenya, by extension. The created awareness is useful to child health policy and program makers and implementers, and also aid in the confirmation of the

demographic theories related to infant mortality and in the build-up of literature related to population geography.

1.6 Scope and Limitations of the Study

The current study was conducted in Kakamega Central Sub-County, Kakamega County, Kenya. The Sub-County is made up of six wards, namely Butsotso East Ward, Butsotso South Ward, Butsotso Central Ward, Shieywe Ward, Mahiakalo Ward and Shirere Ward. The rural areas in the study area are Shirakalu, Murumba, Indangalasia, Shibuli, Shiyunzu, Mukaya, Matioli, Eshisiru and Eshibeye. The urban areas are Mahiakalo, Shirere, Sichilayi and Bukhungu Township.

The inclusion criteria of the study participants was mothers within the childbearing ages of 15 to 49 years who were residents of Kakamega Central Sub-County and had experienced a childbirth in the study period of 2013 through to 2022. All other people with contrary descriptions were excluded from the study.

Several factors influence differentials in infant mortality, such as geographical, social, economic, demographic, distance, political and cultural factors. However, the current study focussed on geographical, socioeconomic, demographic and distance factors. Confirmatory factor analysis was done and population density, nature of roads, number of health facilities, type of housing, level of education qualification of the mother, maternal occupation, age of the mother at the birth of her child, order of a birth, wait period prior to the birth, approximate distance and travel-time taken to reach the nearby medical facility were selected for this study. The choice of these factors was further backed-up by the existing literature that points to their contribution in explaining disparities in infant mortalities. The study excluded

political and cultural factors since they influence not only infant mortality but also child and adult mortalities.

The data might have suffered from errors of under-reporting and over-reporting as a result of estimating mortality from backdated birth accounts. This is especially on the number of babies dead as well as the ages at birth and death of the baby through recall bias. The current study mitigated this by engaging recent mothers in the study period of 2013 to 2022 as respondents. Since the study engaged a sample population, biases were likely to occur leading to either over-estimation or under-estimation of the actual mortality situation within Kakamega Central Sub-County. The effect of in-and-out migration of mothers could also create a bias in the study findings. Also, the interview of alive women within the reproductive ages during data collection left the researcher with little to do in order to minimize the possibility of missing out on the births to dead, younger (<15 years) and older women (>49 years). These live births might have had worse survival prospects. This study assumed that female adult mortality was not high and that there was negligible correlation between mother and infant mortality risks in cases of high female adult mortality. However, as acknowledged by Garenne (2003), sample survey data have the advantages of being absent of major biases and involving widespread range of population that make it of an acceptable quality.

1.7 Conceptual Framework

The conceptual framework that was employed in this study is illustrated in Figure 1. The framework demonstrates how the independent variable acts to influence the dependent variable. The independent variable is segmented into: geographical factors, socioeconomic factors, demographic factors and distance factors. The geographical factors are population density, nature of roads, number of health facilities and type of housing. The social factor is

level of education qualification of the mother. The economic factor is maternal occupation. The demographic factors are age of the mother at the birth of her child, order of a birth and wait period prior to the birth. The distance factors are distance and travel-time taken to reach

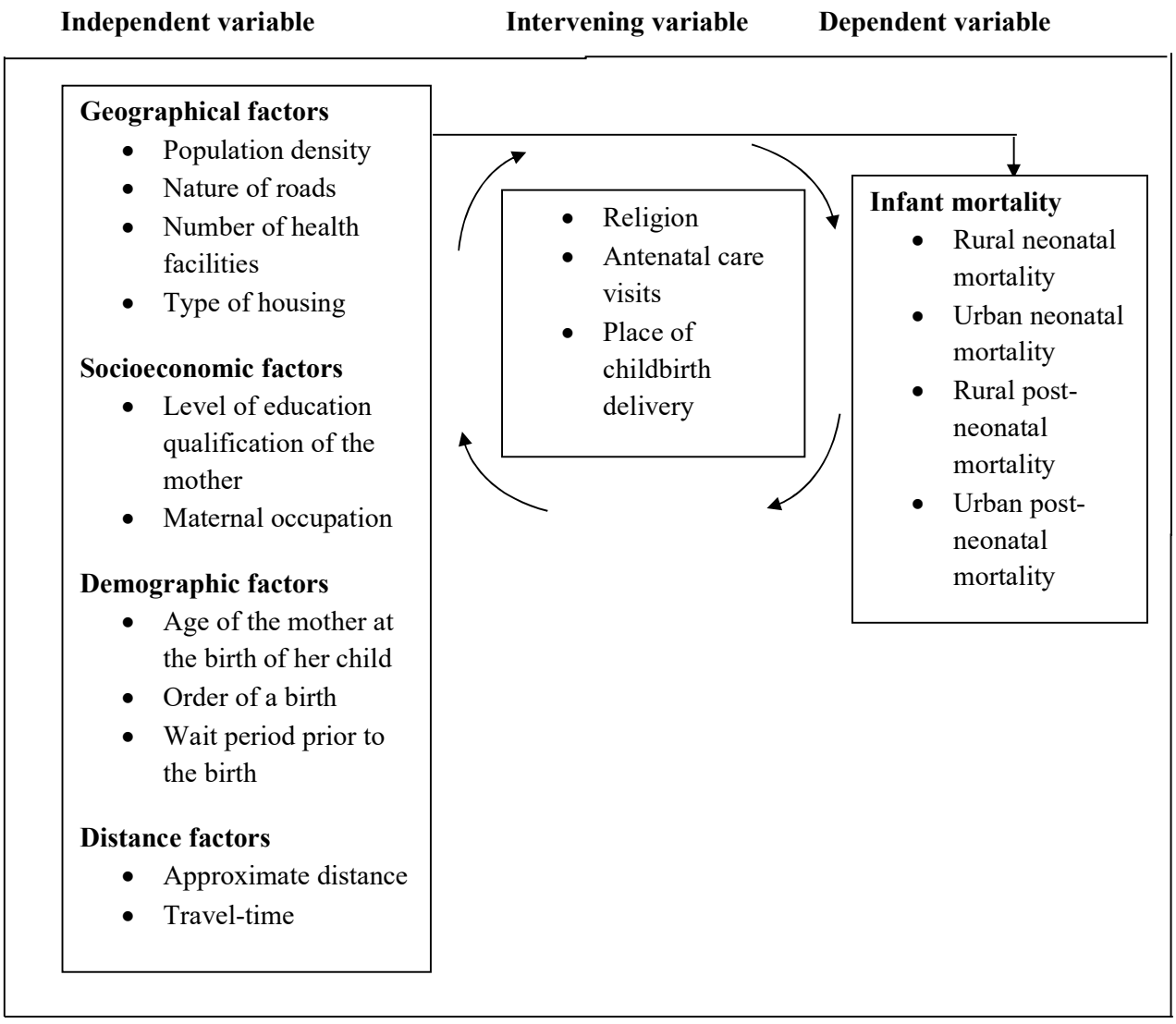

Figure 1: A Conceptual Framework Showing the Relationship Between Geographical, Socioeconomic, Demographic and Distance Factors, and Infant Mortality

Source: Author (2023)

to the nearby medical facility. The intervening variables are religion, number of antenatal care visits, and place of childbirth delivery. The outcome variable is infant mortality: neonatal mortality and post-neonatal mortality at the time of survey, according to the geographical area of residence.

Geographical, socioeconomic, demographic and distance factors may act independently or jointly to influence infant mortality. Further, they may also work through intervening variables to influence infant mortality. The intervening variables mediates the relationship between the exposure variables and the outcome variable and assist to explain the net effect of each of the exposure variables on infant mortality. As acknowledged by Mosley and Chen (1984), such variables should be measurable, either directly or indirectly, in population-based research.

Studies have indicated that social and economic development has a strong effect on the health outcome of an infant and its nutritional status (Parashar, 2005; Boyle et al., 2006). Other studies have indicated that infant mortality, compared to other mortalities, is commonly an outcome of the social and economic situations of a society (Madise et al., 2003; Fantini et al., 2006; Rosicova et al., 2011). A study by Liu (2014) postulated that socioeconomic and demographic factors influence the death of infants either directly or through changes in environmental factors and changing maternal factors.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

Every human birth is a unique event and the cost of death of an infant to the family and friends in psychological terms is inestimable. This brings out the need of improving our understanding of the factors that contribute to rural-urban differentials in infant mortality thus the review of selected geographical, socioeconomic, demographic and distance factors in the next respective sections.

2.2 Influence of Geographical Area of Residence on the Death of Infants

Geographical factors of population density, nature of roads, number of health facilities and type of housing may influence infant mortality in one way or the other. This is because not all geographical areas have equitable distribution of and access to socioeconomic infrastructure neither do they depict similarities in population densities and housing types and patterns. This results in differences in the development of regional welfare. A study done in Mozambique that investigated the relationship between the province of residence of the mother and under-five mortality concluded that population density and distribution of basic infrastructure, including healthcare services, may have confounding effects on geographical differentials in under-five mortality (Macassa et al., 2012). Different studies noted that housing and health were essential for human wellness and quality of life (Curtis et al., 2010) and that poor housing conditions represented stern environmental health threats (WHO, 2011).

Population density may explain differentials in geospatial infant mortality by affecting the transmission of such diseases as diarrhoea, measles, acute respiratory tract infections and

malaria that contribute to infant deaths. It also influences economic growth which indirectly affects the well-being of children (Ghosh, 2005). Further, population density may also influence variations in sanitation and the disease environment. Studies in developing countries have reported that people in densely populated areas are more likely to have access to health services that matter for child survival and development, such as trained doctors, maternal care, and medicines (Magadi et al., 2003; Matthews et al., 2010). High population density without poor sanitation is substantially less dangerous in that the advantages of access to health care and other resources might dominate the disadvantages of disease externalities, yielding a net health benefit of living in dense urban centres (Leon, 2008). Again, urban areas characterised with low population density may not be disadvantaged relative to rural areas characterised with high population density (Hathi, et al., 2017).

Other researches have suggested that open defecation is an important cause of infant mortality in both rural and urban areas of developing countries (Cameron et al., 2013; Spears, 2013; Fink et al., 2011; Humphrey, 2009). Yet open defecation can be a result of overcrowding due to high population density that causes strain on the available toilet facilities. A study by Hathi, et al. (2017) found high population density characterised by poor sanitation to be more detrimental for early-life health.

A study done in Zimbabwe by Root (1997) argued that regional differences observed in childhood mortality were as a result of variations in population densities. Using Cox regression analysis, the study found that children aged between 1 to 4 years residing in the Ndebele provinces experienced a 45 percent lower mortality than their counterparts living in the Shona provinces. The study accepted the hypothesis that low population densities in the Ndebele provinces had contributed to their lower child mortality.

Health facilities are the primary distribution channels for many cost-effective interventions, including immunizations, safe child delivery and insecticide-treated bed nets (Simmons et al., 2021). Physical distribution of health services is an important determinant of child survival (Karra et al., 2017). In Sub-Saharan Africa, a higher proportion of avertable deaths is associated with poor access to healthcare services than the quality of healthcare services (Kruk et al., 2018). The association between poor access and mortality reflects limited physical access in terms of distance, travel time and poor distribution of facilities resulting in crowding and unmanageable volumes of patients. It is estimated that 15 to 29 percent of people in Sub-Saharan Africa live beyond 2 hours travel time from the nearby public hospital (Falchetta et al., 2020; Ouma et al., 2018), something that highlights the geographical distribution of healthcare services (Simmons et al., 2021). However, having a large number of health facilities, each with a low caseload, may increase costs and could lower the quality of service provision (Karra et al., 2017).

The number of health facilities in a geographical area can be used to compute the density of health facilities. When we consider the population density and health facility density, then we are able to tell whether or not there is strain on the usage of the available health facilities. Considering the population present in an area, having a health facility within the village of residence significantly increases chances of being fully vaccinated (Sanou, et al., 2009) yet vaccination is correlated with infant death. In India, Ghosh (2005) attributed pronounced differences in the prevalence of infectious diseases among under-five children to be as a result of differences in the development of basic amenities, infrastructure, healthcare and such macro-economic indicators as trade, income distribution between and within different provinces and population density. The current study postulates that the number of health facilities in a region influence the death of infants either directly in terms of availability or

indirectly in terms of geographical accessibility, accommodation space, and proper stocking of the necessary drugs and equipment needed for infant survival.

Type of housing is postulated to influence the death of infants. A study by Macassa et al. (2012) found that, with reference to finished houses, those houses with natural clay floor material had a 0.02 lower risk, while those houses with rudimentary wood and adobe floor materials had a 0.61 higher risk of reporting under-five deaths. While analysing the 2009 Kenya Population and Housing Census, Gruebner et al. (2015) found the quality of housing to be a risk factor of infant deaths in urban areas as compared to rural areas. The study found 23.34 percent of infant deaths to be reported by urban mothers who lived in non-durable houses. Living in slums was a proactive factor for mothers with previous child death. Slums are defined by poor structural quality of housing and high population densities (UN-Habitat, 2003) that increases exposure to disease pathogens that aggravates infant mortality (Black, et al., 2003; Agarwal & Taneja, 2005). Unable to afford clean fuel, the non-durable housing-dwellers rely on biomass fuels for cooking and heating. Air pollution is higher inside such smoky dwellings leading to ill health and undermined quality of life and hope for the future (Mutunga, 2007).

Pertaining the risk of infant deaths based on type and quality of housing, Gruebner et al. (2015) found good and durable housing to reduce the risk of infant death by 31 percent and 18 percent, respectively, compared to non-durable housing in rural areas of Kenya. In urban areas of Kenya, the study found that, compared to non-durable housing, good housing reduced the risk of infant death by 32.33 percent. However, durable housing quality in urban areas was a risk factor for infant death as compared to rural areas. Residing in durable housing increased the risk of infant death by 2 percent in urban areas. The study attributed this finding to be related to better socioeconomic status that is characterised by changing

lifestyle patterns and maternal obesity which is a risk factor for infant death (Meehan, et al., 2014). A different study by Adebowale et al. (2017) found the probability of dying at exact age one year to be highest among women who lived in houses that were built with inadequate hosuing materials and least among their counterparts whose houses were built with adequate materials. The study attributed this finding to ill health that is associated with poor hosuing conditions.

A study by Izugbara (2014) reported a higher likelihood of neonatal, post-neoantal and child mortality in households whose floors were made of mud and sand than in households with cemented floors. Epidemiological studies relate chronic diseases to households built with inferior materials (Peat et al., 1998; Strachan, 1993). Households built with mud and cement are prone to dump conditions which encourage the growth of moulds in an indoor environment (Yakubu et al., 2014), leading to chronic respiratory infections in infants. These findings show a mix-up on the effect of type of housing on infant mortality: durable housing reduces the risk of infant deaths in rural areas while it increases the risk of death in urban areas. The current study anticipated durable housing to reduce the risk of infant deaths by reducing contamination and transmission of disease-causing micro-organisms to infants residing in a household.

Roads are used to convey traffic between one's residence and such amenities as health and trading centres that are necessary in infant care and raising. The nature of roads demonstrates the actual routes that an ill infant would probably follow to reach to the nearest health facility for medication. It also demonstrates the routes a parent would take to reach a trading centre to acquire basic needs for proper infant care. Muddy and dilapidated roads can be impassable and hence curtail access to health and trading centres. A study done in Tanzania by Masuma and Bangser (2009) reported that transport in rural Tanzania was problematic and often

patients had to walk long distances to the nearest health facilities, sometimes in difficult terrains. Well-maintained murram and tarmac roads improves the traffic flow between residential areas and health and trading centres, and in the long run, reduces infant mortality when other factors are held constant.

2.3 Influence of Socioeconomic Factors on the Death of Infants

Maternal education accounts for differentials in childhood mortality (Caldwell & McDonald, 1982; Pena et al., 2000; Gruebner et al., 2015; Dendup et al., 2021). As much as there was a 17.77 percent reduction in the general prevalence of infant deaths in Kenya based on mother's education, majority of this reduction was witnessed in urban areas (27.14%) than in rural areas (15.96%) (Gruebner et al., 2015). A study by Dendup et al. (2021) 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.

Studies have documented a decrease in infant mortality with a rise in the education qualification of the mother (Mondal et al., 2009; Kabir et al., 2011; Ikamari, 2013; Weldearegawi et al., 2015; Ekholuenetale et al., 2020; Rahman et al., 2020; Liu, 2014). A study done in Kenya by Ikamari (2013) found a considerably lesser risk of post-neonatal mortality among children born to mothers with above primary education qualifications. According to Rahman et al. (2020), the level of infant mortality reduced by 0.053 percent for every one percent upsurge in the level of schooling of mothers. Births to mothers with above primary education qualifications had a considerably lesser risk of infant mortality (aOR = 0.88) relative to those of mothers who had at most primary education (Liu, 2014). According to Buor (2003), improved socioeconomic status of a mother through education modifies her role in the family and equips her in taking measures to improve infant's health by adequately using modern and innovative health services.

A study by Imbo et al. (2021) employed logistic regression to examine the determinants of neonatal mortality in Kenya using data from the 2014 Kenya demographic and health survey. The analysis showed that infants whose mothers had no any education qualifications were 43.7 percent more likely to die as neonates compared to mothers who had higher levels of education (cOR = 1.437; $p<0.05$; CI = 1.01 – 2.08). After adjusting for confounders, mothers with no education were 120.2 percent more likely to experience neonatal mortality compared to their counterparts with higher education qualifications (aOR = 2.202; $p<0.05$; CI = 1.43 – 4.15). According to Ansem et al. (2014), the benefits arising from the education of a mother includes its influence on reproductive health choices and such fertility preferences as uptake of contraception, better health-seeking behaviours, better knowledge on nutrition and other practices that increase the chances of a neonate surviving.

Contrarily, by means of Cox regression model to analyse the direct, indirect and total percentage change of childhood mortality with respect to maternal education, Abou-Ali (n.d.) found a low educated mother to contribute more to the reduction in neonatal mortality than a medium and high educated mother. Yet still other studies have not found any substantial relationship between level of education qualification of the mother and infant mortality (Baraki et al., 2020; Conombo & Sawadogo, 2017; Liu, 2014). The pattern in which the level of education qualification of the mother affects infant mortality is therefore unclear: whether it is positive or negative or fading out with time, and thus the need for this study in Kakamega Central Sub-County.

Maternal occupation can be a measure of the economic status of a family and the time a mother will have to care for her infant. Historical literature indicated that the first among reasons for high infant mortality was female employment in the mills (Roberts, 1982). Reid (1906) noted that the marked disparities in infant death rates were a result of differentials in

the levels of female employment: zones characterised by greater ranks of female employment had greater rates of the death of infants. A different study conducted in India discovered that working mothers had a 10 percent greater rate of infant mortality than mothers who were not working (Kishor & Parasuraman, 1998).

Studies on the Asian continent have reported mixed results on the influence of occupation of the mother on the death of infants. In Rajshahi District of Bangladesh, Mondal et al. (2009) found the threat of death at neonatal stage to be 37.9 percent lesser among mothers who were working than those mothers who were not working. The authors attributed this observation to the fact that working mothers were likely to be well aware of immunisation programs and care during pregnancy. Counter-intuitively, a study in Bangladesh and South Asian countries by Rahman and colleagues (2020) reported higher rates of under-five mortality for the working/employed mothers as compared to the non-employed mothers in India. A study done on rural-urban differentials in early childhood mortality in Bhuttan found that children of non-working urban mothers had a 66.6 percent prevalence of deaths in comparison to those of the working mothers (Dendup et al., 2021). The study attributed this observation to the poor socioeconomic status of the unemployed urban mothers. The rapid rural-urban migration led to significant growth of the urban population in Bhuttan that left a socioeconomically disadvantaged migrant population.

On the African continent, a study by Mustafa and Odimegwu (2008) found the risk of post-neonatal mortality to be 3.09 times significantly higher for women working in agricultural sector than non-working women in urban Kenya due to the limited maternity leaves for the working mothers. As much as there were modest differentials in the spread of infant deaths according to the maternal occupation in rural areas of Kenya, Omedi and Wanjiru (2014) found mothers working in the agricultural sector to depict higher odds of experiencing the

death of infants than the non-working mothers. Akinyemi et al. (2016) found higher hazard ratio of infant mortality in the group of mothers who were working than those mothers who were not working in Cameroon and Gabon countries of Central Africa. Maternal occupation was insignificant to the risk of death of infants in East Africa, West Africa and Southern Africa. In Nigeria, Akinyemi et al. (2018) established an infant mortality rate of 65 and 70 deaths for each a thousand live births among the working and the non-working mothers, respectively. Further, the hazards of infant death were lowest among children of unemployed women compared to children of employed women. Such an unclear relationship between occupation of the mother and infant mortality was a call for this study.

2.4 Influence of Demographic Factors on the Death of Infants

Young and very old ages at motherhood are risk factors of infant mortality (Khalique et al., 1993; Yassin, 2000; Suwal, 2001; Mustafa & Odimegwu, 2008; Weldearegawi et al., 2015; Akinyemi et al., 2016; Ekholuenetale et al., 2020; Kim et al., 2021). A study by Khalique et al. (1993) found extremes of maternal age (<20 years and >35 years) to be threats related to the death of infants. Using Korean data from 2011 to 2015, Kim et al. (2021) found mothers younger than 29 years of age and greater than 40 years of age to relate significantly to relatively greater risks of early neonatal deaths as compared to the ages 30 to 34 years, independent of maternal socioeconomic factors. On their side, Akinyemi and colleagues (2016) found maternal age not to be an important forecaster of mortality of infants in East Africa while it was an important forecaster of mortality of infants in parts of Central, West and Southern Africa.

In Kenya, Mustafa and Odimegwu (2008) found age of the mother at the birth of her child to be considerably associated with the death of infants in rural Kenya but not urban Kenya. The inclusion of prenatal care and place of childbirth delivery in the regression model increased

the influence of maternal age at the neonatal and post-neonatal levels of infant mortality in Kenya (Ikamari, 2013). Specifically, the study noted that maternal ages of 20-34 and 35+ years had 1.33 and 1.58 relative risks of post-neonate deaths, respectively, with reference to maternal ages of less than 20 years. A study by Liu (2014) found infants born to mothers younger than 19 years at the first birth experience to depict a 42 percent and 27 percent increased risk of dying in 2003 and 2008/09 in Kenya. However, a study by Baraki et al. (2020) established no considerable relationship between the age of the mother at the birth of her child and infant deaths. From these literatures, the pathway through which the age of the mother at the birth of her child relates with the death of infants is yet to be fully elucidated.

Studies have documented the risk of infant mortality to generally decrease with increase in birth interval (Sharifzadeh et al., 2008; Kabir et al., 2011; Akinyemi et al., 2016; Adebowale et al., 2017; Conombo & Sawadogo, 2017). A study by Kabir and colleagues (2011) noted that the wait period of a birth of at least 2 years had 40 percent to 60 percent less likelihood of early childhood mortality as compared to the wait period of less than 2 years prior to a birth. A study by Akinyemi et al. (2016) found the interval between births to be considerably related to infant mortality in rural areas of East Africa, West Africa and Central Africa but not Southern Africa. Another study by Adebowale et al. (2017) noted that, with reference to the 7-23 months' birth interval, hazards ratios of childhood mortality were 0.81, 0.64 and 0.69 for the less than 36 months, less than 60 months and above 60 months wait period prior to a birth, respectively. On their side, Conombo and Sawadogo (2017) found a <18 months' birth interval to be associated with a probability of infant death of 24 percent, and that this probability decreased as and when the birth interval became large. However, using 2003 and 2008/09 KDHS data, Liu (2014) found birth interval not to considerably relate with the death of infants in Kenya.

Pertaining birth order, Chandrasekhar (1972) argued that a reduction in the size of families and therefore in the proportion of births of higher orders had some effect upon infant mortality. Firstborns and births of very high orders had noticeable mortality rates as compared to births of middle orders (Gyimah, 2002; Kabir et al., 2011). Example, a study by Kabir and colleagues (2011) found infant mortality rates of 79, 51, 66 and 97 for 1, 2-3, 4-6, and 7+ birth orders, respectively, an observation similar to neonatal mortality rates. The study further found statistically significant results in birth order numbers using logistic regression analysis. First births had a greater likelihood of early childhood mortality as compared to two to three birth orders. High birth orders points to large family sizes. A study by Ekholuenetale et al. (2020) explained that large family sizes reduced the emotional attachment between parents and their children making the affected children to be less-caterde for, more vulnerable and more exposed to higher death risks.

Other studies have considered the order of a birth and its preceding interval as a single factor affecting infant mortality (Mustafa & Odimegwu, 2008; Kembo & van Ginneken, 2009; Miringu, 2016). According to a study by Mustafa and Odimegwu (2008), births of orders greater than 4 and of less than 2 years preceding interval had infant mortality ratios of 3.71 and 2.32 in urban and rural areas, respectively, with reference to first order births. Using Cox's proportional hazards model, Kembo and van Ginneken (2009) found that births characterised by orders greater than five and short preceding intervals had the greatest mortality risks. Such infants had odds ratios of death of 2.8 as compared to their colleagues of order two to five with long preceding intervals.

On mortality differentials, a recent study by Dendup et al. (2021) found the prevalence of early childhood mortality to be highest among mothers aged 29 to 34 years in urban areas of Bhutan. The highest proportion of infant deaths was among above-two birth orders in rural

areas and first births in urban areas of Bhutan and amongst births of an interval of less than 33 months both in rural and urban areas of Bhutan. The study indicated that high birth orders and short birth inetrvals pointed to higher parity, declined health status of the mother, and competition for attention and restricted resources amongst siblings. With this background information, this study postulated that the influence of wait period between successive birth on the death of infants varies from a succeeding birth interval to preceding birth interval and considers a preceding birth interval herein referred to as the wait period prior to a birth.

2.5 Influence of Distance Covered to the Nearby Medical Facility on the Death of Infants

The distance covered to reach the nearby medical facility relates to infant mortality either directly or through various pathways: uptake of family planning services; uptake of antenatal care visits; place of childbirth delivery; help in the course of childbirth delivery; uptake of immunisation programs; and access of treatment when sick. A number of studies have identified the distance covered to reach the nearby medical facility as a factor related to childhood mortality. Poor geographical access to a health facility affects maternal service usage and increases the risk of new-born mortality (Kibret et al., 2023). Distance negatively affects antenatal care, facility delivery and postnatal counselling services due to the distance-decay effect (Schoeps et al., 2011). When compared with women who lived less than a kilometre from a facility, the odds of receiving at least 4 antenatal care visits for women living more than 10 kilometres from a facility were 38.8 percent lower (OR = 0.612; 95% CI = 0.559 – 0.671). The odds of in-facility delivery were lower at greater distances with the odds ratio for delivery for women living more than 10 kilometres being 55.3 percent lower (OR = 0.447; 95% CI = 0.394 – 0.508) relative to women living less than a kilometre away (Karra et al., 2017). A different study by Quattrochi et al. (2020) found greater distance to be

associated with higher mortality, lower healthcare utilisation, increased home deliveries, reduced number of antenatal care visits, and a reduction in skilled aid in the course of childbirth delivery.

Some studies found out that relative distance from medical facilities accounted for high childhood mortality (Kembo & van Ginneken, 2009; Ettarh & Kimani, 2012; Kanmiki, et at., 2014; Kibret et al., 2023). Kembo and van Ginneken (2009) explained that the distinct childhood mortality differentials in Zimbabwe were due to differences in regional health arrangement, an observation that points to the distribution of medical facilities. A study done in rural areas of Tanzania found the rate of mortality for infants who lived within 5 kilometres to the nearby medical facility to be 72.4 for every 1,000 person years while that of those living greater than 5 kilometres from the health facility was 82.3 for every 1,000 person years (Kadobera et al., 2012). In Ethiopia, Kiross et al. (2021) reported that there were insignificantly higher odds ratios for the distance to the medical facility not being problematic with reference to it being problematic.

In low- and middle- income countries, Karra et al. (2017) used multivariable logistic models and meta-analysis regressions to estimate the association between facility distance, child mortality, and health care utilisation. The study found children born in households that were located within 2 kilometres, 3 kilometres and 5 kilometres from a health facility to have 7.7 percent, 16.3 percent and 25 percent higher odds ratio of dying in the neonatal period, respectively, when compared with children born in households that were within a kilometre from a health facility. Further, being more than 10 kilometres from a health facility increased the odds of neonatal mortality in five surveys, decreased the odds of neonatal mortality in one survey, and there was no effect in the remaining 23 of the 29 demographic and health surveys.

Other studies have reported contradicting results (Lohela et al., 2012; Rammohan et al., 2013). Lohela, Campbell and Gabrysch (2012) did a study on distance to care, facility delivery and early neonatal mortality in Malawi and Zambia. The study found no association between distance and neonatal mortality in Malawi, while in Zambia, a ten kilometre further distance was associated with lower neonatal mortality. A study done in India by Rammohan, Igbal and Awofeso (2013) found neonatal mortality to decrease with increase in distance from home to the primary healthcare services.

Children born and raised in communities with reduced access to health facilities more likely suffer social and economic deficiency that affects their health outcomes (Robert, 1999; Ellen, et al, 2001). In rural areas of Burkina Faso, Schoeps et al. (2011) established that the death of children under the age of five years was greater when a time duration of 4 hours was needed to reach to the nearby medical facility as likened to when the nearby medical facility was village-based. A study by Okwaraji et al. (2012) established that people living in remote areas had greater risks of childhood deaths. According to the study findings, living at least 90 minutes from the nearby medical facility was associated with a double larger risk of the death of children than living within 90 minutes from the nearby medical facility. A different study by Karra et al. (2017) found children born to households that were located more than 60 minutes from a health facility to have a 25.6 percent (OR: 1.256; $p < 0.05$; CI: 1.105 – 1.429) higher odds ratio of dying in the neonatal period than children who were born to households that were within 10 minutes from a health facility. Kiross et al. (2021) explained that those people who live in the inaccessible mountainous and remote areas end up spending many hours trekking in search of maternal and infant health services. This might discourage some mothers from visiting health facilities and delay access of treatment in case of infant sickness.

Having insufficient resources at disposal limits the reach to and uptake of current health care more so given the pay-and-take system operating in several sub-Saharan countries (Ekholuenetale et al., 2020). In selected districts of Kenya, Noor and colleagues (2006) projected that roughly 63 percent of the people were able to reach a government medical centre within in an hour. Yet still, accessing a health facility does not necessarily guarantee access to proper infant care services. In Kenya at large, Toda and colleagues (2012) noted that only 75 percent of the assessed medical centres were well-stocked with family planning and vaccine commodities. The study further established that childbirth delivery services were available in below 50 percent of the assessed medical centres.

A study done on the effect of health systems context on infant and child mortality in Sub-Saharan Africa from 1995 to 2015 found infant and child survival to be related to the cost of care (Simmons et al., 2021). Moving from the first to the third quartile of prevalence of delivery fee was associated with an 11 percent increase in the risk of infant death. A similar scaled increase in the proportion of facilities charging immunization fee was associated with a 20 percent increase in the risk of child mortality. Therefore, the current study postulated that the distance covered to reach the nearby medical facility might be influencing infant mortality in Kakamega Central Sub-County either through travel time or distance, or through other pathways.

CHAPTER THREE

METHODOLOGY

3.1 Introduction

In this chapter, an overview of the area of study, the research design of the study, the study population and sampling, sources of data, methods of data collection, reliability and validity of the study, data analyses and results presentation, and research ethics that were observed in this study are presented.

3.2 Study Area

3.2.1 Location

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).

3.2.2 Climate

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 year. Heavy rains are received in March and July while December and February receives light rains. The

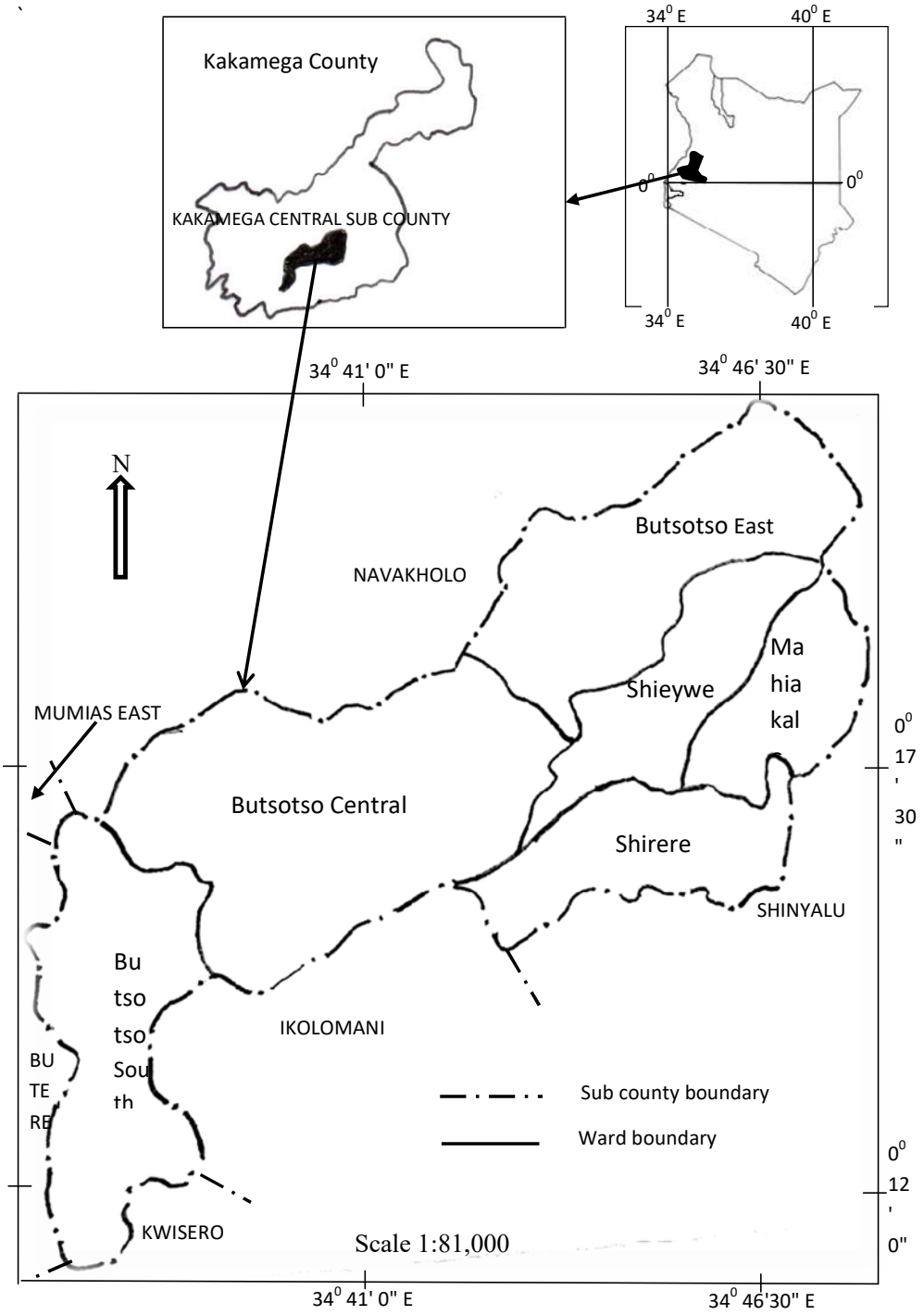

Figure 2: Map of the Study Area

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 uncertainity of floods and drought occurrence.

3.2.3 Population Characteristics

Kakamega Central Sub-County has a population of 188,212 (92,774-male and 95,432-female and 6-intersex). The ward population is as follows: Butsotso East Ward (population – 29,798), Butsotso South Ward (population – 19,442), Butsotso Central Ward (population – 32,690), Shieywe Ward (population – 59,267), Mahiakalo Ward (population – 13,197) and Shirere Ward (population – 33,818). 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).

Demographically, 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).

3.2.4 Socioeconomic Activities

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).

3.3 Research Design

This study employed a cross-sectional research design. The study data was gathered from mothers within the childbearing ages of 15 to 49 years who had an experience of a childbirth between 2013 and 2022. The cross-sectional research design involves the researcher measuring the outcome variable and the exposure variable(s) in the participants of the study 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 unit of analysis was households with an experience of a childbirth.

3.4 Study Population and Sampling

3.4.1 Study Population

Kakamega Central Sub-County had 14,007 households that had an experience of a childbirth in the study period of 2013 to 2022. A sample size of 384 respondents was drawn from these households. The study used a sample of women population of reproductive ages of 15 to 49 years. The sample population was arrived at through a formula developed by Fisher et al. (1983) as illustrated below:

$$n = \frac{z^2 pq}{d^2},$$ where:

n = Sample size given a greater than 10,000 target population

z = Normal deviation at the desired confidence interval. This study employed the 1.96 Z-score value at 95% confidence interval.

p = Proportion of the population with an experience of a childbirth. Since this proportion is unknown, then 0.5 was used.

q = Proportion of the population without an experience of a childbirth.

d = Measure of precision / level of significance.

Given that the target respondents, that is, women aged 15-49 years, were 50,426, the minimum sample size was arrived at as follows:

$n = (1.96^2 \times 0.5 \times 0.5) \div (0.05)^2 = 384.16 = 384$ (to the nearest whole number)

Thus, the questionnaire was presented to a total of 384 households with an experience of a childbirth. Kakamega Central Sub-County had a population of 188,212 with 52,015 households, giving an average household size of 3.6. The proportional sample size (the proportion number of households that were interviewed) in a geographical area was found by:

Number of households = Female population aged 15 to 49 ÷ Average household size.

Proportional sample size = (Number of households ÷ Total number of households) × 384.

Example, for Mahiakalo, the proportional sample size = (962 ÷ 14007) × 384 = 26.

To cater for non-response and missing data, questionnaires were administered to an extra ten percent respondents in each of the thirteen geographical areas.

Table 1: Sample Size Determination for Each Geographical Area

NO.	**Geographical area name**	**Type of area**	**Female population aged 15-49**	**No. of HHs with childbirths, 2013-2022**	**Proportional sample size**	**Final sample size**
1.	Shibuli	Rural	3885	1079	30	33
2.	Shiyunzu	Rural	3462	962	26	29
3.	Indangalasia	Rural	2471	686	19	21
4.	Murumba	Rural	3708	1030	28	31
5.	Shirakalu	Rural	1861	517	14	16

6.	Emukaya	Rural	1615	449	12	14
7.	Matiolo	Rural	2013	559	15	17
8.	Eshisiru	Rural	1565	435	12	13
9.	Eshibeye	Rural	1735	482	13	15
10.	Mahiakalo	Urban	3462	962	26	29
11.	Shirere	Urban	8901	2472	68	75
12.	Shichilayi	Urban	13272	3687	101	111
13.	Bukhungu Township	Urban	2477	688	19	21
	TOTAL		**50426**	**14007**	**384**	**422**

Source: Modified from KNBS (2019)

3.4.2 Sampling

Systematic random sampling technique was used to arrive at households which were involved in the study. The sampling interval was arrived at by dividing the sum of family units in a given geographical area by the respective proportionate size of sample of the area. Example, for Shiyunzu area, the sampling interval = (962 ÷ 29) = 33. The start point of sampling was randomly determined from which every 33rd household was presented with a questionnaire until a total of 29 households were obtained. Community Health Volunteers and village elders helped in reaching households and respondents to whom questionnaires were administered. This was because they had data on mothers within the study period of 2013 to 2022. Only one respondent, the most recent mother, was presented with a questionnaire in households with multiple cases of childbirths from multiple respondents. This was done in all the thirteen geographical areas until a total of 422 households were interviewed. Purposive sampling technique was used to arrive at key informants that were interviewed in the study.

3.5 Sources of Data

The study relied on both primary and secondary data. First-hand information was collected by observation and photography, and interviewing targeted household members and key informants. Observation and photography provided data on geographical area of residence. The data collected from targeted household members included level of education qualification of the mother, maternal occupation, age of the mother at the birth of her child, order of a birth, wait period prior to a birth, antenatal care visits, place of childbirth delivery, religion and distance covered to the nearby medical facility. The quantitative data was captured and stored on the Statistical Package for Social Sciences computer software. Data from the 2019 Kenya Population and Housing Census was used to compute population density per geographical area of study as indicated in Table 2. Population density is the ratio of the population against land size. Example, for Murumba, population density = (13878 ÷ 14.5) = 957.1 persons per square kilometre. Secondary data from population and housing censuses, demographic and health surveys and relevant journal publications were used to validate the analysed data in the discussion.

Table 2: Population Density for Each Geographical Area

NO.	Geographical area name	Type of area	Population	Land size in square km	Population density
1	Shibuli	Rural	14290	25.3	564.8
2	Shiyunzu	Rural	12679	14.5	874.4
3	Indangalasia	Rural	8965	11.1	807.7
4	Murumba	Rural	13878	14.5	957.1
5	Shirakalu	Rural	6955	8.0	869.4
6	Emukaya	Rural	5903	8.7	678.5
7	Matiolo	Rural	7201	9.7	742.4
8	Eshisiru	Rural	5721	8.7	657.6

9	Eshibeye	Rural	6338	13.4	473.0
10	Mahiakalo	Urban	13197	8.3	1590.0
11	Shirere	Urban	33818	15.4	2196.0
12	Shichilayi	Urban	49680	15.2	3268.4
13	Bukhungu Township	Urban	9587	2.5	3834.8
	TOTAL		**188212**	**155.3**	1211.9

Source: Modified from KNBS (2019)

3.6 Methods of Data Collection

The study collected both qualitative and quantitative data. The methods of data collection entailed questionnaires, key informant interviews, and observation and photography. Questionnaire and observation and photography data were collected by research assistants that were trained by the principal researcher while the key informant interviews were conducted by the principal researcher. The principal researcher trained bilingual research assistants on the use of the research instruments, on how to seek informed consent from the study participants, how to administer the structured questionnaire and how to ensure that the data collected were complete and reliable. The researchers explained to the study participants about the topic of study, the objectives of study and the significance of the study, and all other ethical issues surrounding the study.

3.6.1 Questionnaire

Structured questionnaires were directed to women within the reproductive ages of 15 – 49 years who had an experience of a child birth in the period 2013 through to 2022. The age range of 15-49 years has been widely used in researches (Kiruja, 2018; KNBS & ICF Macro, 2015; Selemani et al., 2014; Ikamari, 2013; KNBS & ICF Macro, 2010, 2015). Probing was

done to obtain information pertaining the social, economic, demographic, maternal and childcare characteristics of the respondents. The information that was captured on the questionnaires include: woman's background characteristics of religion, age of the mother at the birth of her child, level of education qualification of the mother, and maternal occupation; woman's birth history including number of births a woman has had, current age of each of the livebirth, and if dead, the age at which each of the livebirth died; maternal and childcare information entailing antenatal care visits; place of childbirth delivery; and distance covered to the nearby medical facility.

This information was used to establish the influence of geographical area of residence (population density, nature of roads, number of health facilities, type of housing) on the death of infants; examine the influence of socioeconomic factors (level of education qualification of the mother, maternal occupation) on the death of infants in rural and urban areas; examine the influence of demographic factors (age of the mother at the birth of her child, order of a birth, wait period prior to the birth) on the death of infants in rural and urban areas; and assess the effect of distance covered to the nearby medical facility (approximate distance, travel-time) on the death of infants in rural and urban areas of Kakamega Central Sub-County.

The questionnaires were pretested on a 10 percent sample size of the target population, that is, 38 respondents in Kakamega Central Sub-County, as recommended by Wuensch (2012). This aimed at defining the validity of the tool, readiness of the respondent to participate in the study, the approximate time a questionnaire was to be administered and if there was any need to revise the format of the questionnaire tool. Pretesting helped to minimise uncertainty, augment precision and establish replies to the questions contained in the questionnaire (Ary et al., 1996). The results of the pilot study were useful in assessing the validity and reliability of the data collection instrument and in refining the instrument to ensure that the results

collected in this study echoed the state of affairs in Kakamega Central Sub-County. The pilot study identified the need to recruit bilingual research assistants who assisted in the interpretation of English words to Kiswahili and Luhya. It also helped the researcher to eliminate ambiguous and repetitive questions from the questionnaire. The ultimate study sample excluded those respondents who were interviewed in the pilot study.

3.6.2 Key Informant Interview

Key Informants were interviewed so as to gather information from their informed perspectives on infant mortality. A Senior Population Programmes Officer at the National Council for Population and Development (NCPD) Office, a Public Health Officer at Kakamega, and a Community Health Volunteer at Kakamega Central Sub-County were interviewed. The NCPD develops, coordinates and implements population and its associated policies and programs to ensure enhanced quality of life. Public Health Officers identifies and investigates health issues and health hazards in the people; provides communities with required personal health services; develops plans and policies that help individual and community health initiatives; and search for new ideas and innovative solutions to health issues. Community Health Volunteers are significant in the provision of maternal, new-born and childcare health education at grass root levels. The information collected here was used to create themes and patterns that supported the questionnaire data in answering the objectives of the study accordingly.

3.6.3 Observation and Photography

Participant observation is important in gaining an understanding of the actors, interactions, scenes and events that take place at the site of research. The researchers used their eyes to observe the geographical area of residence of the respondents guided by the observation

checklists. Photography was used to enhance whatever was observed in order to help in answering the objectives of the study and in hypotheses testing. The key information captured here included presence of build-up areas, main economic activities, population and settlement of an area, nature of roads, number and type of health facilities, type of housing, and presence of a toilet facility used by a family unit.

3.7 Data Validity and Reliability

3.7.1 Data Validity

Construct, content and criterion validity were observed in this study. Construct validity is how far, deep and wide a measure adheres to the prevailing philosophy and understanding of the idea under measurement. Content validity is how far, deep and wide a measure covers all facets of the idea under measurement. Criterion validity is how far, deep and wide the results of a measure correspond to other binding measures of the concept in consideration.

Content Validity Ratio (CVR) that involves confirmation by subject matter expert raters (SMEs) was used to measure content validity in this study. The range of values in the ratio is from +1 to -1. According to Lawshe (1975), positive values show that no less than 50 percent of the subject matter expert raters rated the data collection tool as necessary. The procedure used to obtain the CVR was as follows:

$CVR = (ne - {}^{N}/_{2}) \div {}^{N}/_{2}$, where:

CVR – Content Validity Ratio

ne – number of subject matter expert panellists indicating essential

N – total number of subject matter expert panellists

Of the 13 SMEs at the School of Arts and Social Sciences, Maseno University, 11 indicated the questionnaire tool as essential. Thus,

$CVR = (11 - {}^{13}/_{2}) \div {}^{13}/_{2}$

$CVR = 0.7$

3.7.2 Data Reliability

Reliability is how dependable a data collection instrument measures the concept of concern (Scholtes et al., 2011). A reliable research instrument must depict the attributes of being dependable, consistent, accurate and comparable. It must enhance the power of the study to show the differences and relationships in the population under study. To increase reliability, a researcher has to include several comparable items on a measure, assess a varied sample of characters while applying unvarying testing techniques (Mugenda & Mugenda, 2003).

Reliability is expressed as a coefficient in the range between 0.0 and 1.0. In this case, r greater than 0.9 point to Excellent; r greater than 0.8 point to Good; r greater than 0.7 point to Acceptable; r greater than 0.6 point to Questionable; r greater than 0.5 point to Poor; and r less than 0.5 point to Unacceptable (George & Mallery, 2003). The alpha approach by Cronbach was employed to gauge internal consistency reliability of the research instrument. According to Gliem and Gliem (2003), the technique requires a sole administration of the test, and that the closer the Cronbach's alpha coefficient is to 1.0 the greater the internal consistency of the items in the scale.

Cronbach's alpha coefficient of internal consistency was arrived at by the formula:

$Alpha = rk / \{1 + r (k - 1)\}$ whereby:

r – mean of the inter-item correlations

k – number of items considered in the scale

The gauge was arrived at by means of the reliability analysis in the Statistical Package for Social Sciences (SPSS) computer program. The inter-item correlation matrix considered the following exposure variables of study: population density, nature of roads, number of health facilities, type of housing, level of education qualification of the mother, maternal occupation, age of the mother at the birth of her child, order of a birth, wait period prior the birth, distance covered to the nearby medical facility, and time taken to reach the nearby medical facility. The inter-item correlation is a descriptive information about the correlation of each of the eleven items with the sum of the remaining ten items. The sum of the inter-item correlation matrices was obtained and their average computed to obtain the mean of the inter-item correlations. The gauge yielded a Cronbach's alpha mean value of 0.8674 with a Cochran's Q value of 51.753 at $\rho < 0.000$. The Cronbach's alpha coefficient of internal consistency approach has been used in other related studies (Kiruja, 2018) and found to yield acceptable results.

3.8 Data Analyses and Results Presentation

3.8.1 Data Analyses

Data analyses were conducted using Statistical Package for Social Sciences (SPSS) version 25 computer software program at descriptive and inferential analyses levels. The SPSS tool has been widely used in geographical studies (Ikamari, 2004, 2013; Mustafa & Odimegwu, 2008; Liu, 2014; Miringu, 2016; Wabwile, 2019; Yemane, 2022). At descriptive level, data were analysed by frequencies to obtain the background information of the study population. Cross-tabulation analysis was done to obtain the prevalence of childbirths and infant mortality in rural and urban areas by study variables of population density, nature of roads, number of health facilities, type of housing, level of education qualification of the mother,

maternal occupation, age of the mother at the birth of her child, order of a birth, wait period prior to the birth, approximate distance and travel-time.

Inferential analysis engaged multinomial logistic regression modelling at univariate and multivariate 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 objective 1, data on population density, nature of roads, number of health facilities and type of housing were analysed by multinomial logistic regression in order to examine their influence on the death of infants in rural and urban areas of Kakamega Central Sub-County. In objective 2, 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. Objective 3 was analysed by 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. Objective 4 involved the assessment of the effect of distance covered to the nearby medical facility (approximate distance and travel-time) on the death of infants in rural and urban areas using multinomial logistic regression analysis.

In the multinomial logistic regression model, data were fitted in a logit function logistic curve in order to estimate the occurrence of an outcome as a result of the influence of several explanatory variables. The findings, in terms of crude odds ratios, were arrived at by considering the exponential function of the appraised coefficients of regression. The above-one crude odds ratios indicated a higher likelihood of dying while the below-one crude odds ratios indicated a lower likelihood of dying, for a specific group with respect to the reference group.

Further, all the exposure variables were fitted in the multinomial logistic regression model controlling for covariates 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 influential factors of early childhood mortalities in rural and urban areas of Kakamega Central Sub-County.

Qualitative data on nature of roads, type of housing, level of education qualification of the mother and maternal occupation were analysed by creating categories and coding before cross-tabulation and regression analyses. Quantitative data on neonatal deaths, post-neonatal deaths, infant deaths, population density, number of health facilities, age of the mother at the birth of her child, order of a birth, wait period prior to the birth, distance and travel-time taken to reach the nearby medical facility were analysed using cross-tabulation and multinomial logistic regression analyses. Data from key informants and observation and photography were analysed by uploading digital photographs on computer and creating relevant themes and patterns to support the questionnaire data.

The analyses were segmented at neonatal level, post-neonatal level, and the infant level both for rural and urban geographical areas. This was guided by literature that indicates that the influence of geographical, socioeconomic, demographic and distance factors on the death of infants varies with age (Kuse et al., 2022; van Malderen et al., 2019; Madise, et al. 2003; Da Vanzo et al., 1983). A study by van Malderen et al. (2019) showed that the main sources of inequalities in mortality varied according to the age group: neonatal, post-neonatal, infant and child age groups. Further, a study by Alkema et al. (2014) showed changes in sex ratios of mortality as children get older. Both the World Health Organisation and the United Nations Development Programme recognise segmented study of mortality into neonatal, post-

neonatal and infant ages for policy-oriented monitoring (UNDP, 2015, Braveman, 1998). The hypotheses were tested at 95 percent significance level.

3.8.2 Results Presentation

The study findings were offered in statistical tables, in plates and in text-form, accompanied by an interpretation and discussion of each of the same.

3.9 Minimising Potential Biases

Since the study was based on retrospective birth history, recall bias was minimised by engaging recent mothers as respondents. The focus on infant mortality put the mothers in a position to recall most of the issues under study unlike if the study focussed on child mortality. Adequate time was given to the respondents to reflect and think through the circumstances that related to the lives of their infant births. Probing was done in an effort to lessen recall bias.

The in-migration and inter-ethnic marriage factors might lead to the problem of language barrier between the researcher and the respondents. To mitigate this, the researcher engaged the services of bilingual research assistants who assisted in interpreting the English words on the research instrument to Kiswahili and Luhya when need arose. The principal researcher conducted the training of the research assistants prior to the pilot study. This was done to ensure there was precision with the questions asked so as to augment the accuracy of the responses given.

The filled data collection tools were kept in safe custody in the principal researcher's house and only presented to the examiners on need. The data were captured and stored on the

Statistical Package for Social Sciences (SPSS) version 25 computer software in the custody of the principal researcher and were not disclosed elsewhere save to the examiners.

3.10 Research Ethics

This being a research involving people, the study observed research ethics of minimising the risk of psychological and social harm especially on recall of events of death, confidentiality, anonymity, informed consent and honesty. This was done to minimise the risk of participant exposure as the principal researcher targeted to get optimum responses from the target population. The approval to conduct this study was obtained from the Maseno University School of Graduate Studies, reference number PHD/NS/00058/019 on 28th June 2022. Ethical endorsement for the research was gotten from Maseno University Scientific and Ethics Review Committee, reference number MSU/DRPI/MUSERC/01119/22 on 29th November 2022. A research licence was gotten from the National Commission for Science, Technology and Innovation (NACOSTI), license number NACOSTI/P/22/22577 on 08th December 2022. With the research approval, ethical endorsement and research licence, the principal researcher visited the Kakamega County Secretary's Office to ask for permission to conduct research in Kakamega Central Sub-County, and was granted a research authorization reference number CGK/OCS/GEN.CRR./04/(621) on 19th December 2022.

The researcher briefed the participants of the study about the nature of the research, its aim and implications to academic researchers, geographical literature and childhealth 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. The data obtained was solely used for the purpose of this study. An informed consent was sought from all the targeted respondents after describing to them what the study entailed at the point of gathering data. 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.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 Introduction

This chapter presents the findings, interpretation and discussion of the analyses carried out on rural-urban differentials in infant mortality in Kakamega Central Sub-County, Kakamega County, Kenya. Descriptive statistics and regression analyses were carried out on the survey data and the results were as presented.

4.2 Background Information of the Study Population

This section presents background information of the study population in terms of age-group of the mother, marital status of the mother, household size in which the infant belongs/ belonged and religious affiliation of the household members. Descriptive statistics were carried out on the background information of the study population and the results are presented in Tables 3 and 4.

Table 3: Frequency Distribution of the Study Population

	OVERALL		RURAL		URBAN	
Variable	Count	%	Count	%	Count	%
Age in 5-years age groups						
15-19	14	3.32	7	4.49	7	2.63
20-24	67	15.88	18	11.54	49	18.42
25-29	87	20.62	29	18.59	58	21.80
30-34	115	27.25	48	30.77	67	25.19
35-39	83	19.67	30	19.23	53	19.92
40-44	44	10.43	17	10.90	27	10.15
45-49	12	2.84	7	4.49	5	1.88
Marital status						
Single	70	16.71	14	9.15	56	21.05
Married	314	74.94	135	88.24	179	67.29
Wid./Div./Sep.	35	8.35	4	2.61	31	11.65

Household size						
1	23	5.45	-	-	23	8.65
2	34	8.06	11	7.05	23	8.65
3	83	19.67	23	14.74	60	22.56
4	110	26.07	46	29.49	64	24.06
5	90	21.33	33	21.15	57	21.43
6	46	10.90	22	14.10	24	9.02
7	17	4.03	9	5.77	8	3.01
8	11	2.61	8	5.13	3	1.13
9	3	0.71	3	1.92	-	-
10	3	0.71	1	0.64	2	0.75
11	-	-	-	-	-	-
12	2	0.47	-	-	2	0.75
Religion						
Catholic	123	29.22	34	21.79	89	33.58
ACK/SDA/Protestant	229	54.39	116	74.36	113	42.64
Islam	43	10.21	2	1.28	41	15.47
Other	26	6.18	4	2.56	22	8.30

Source: Field Data (2023)

As indicated in Table 3, age of the mother at the birth of her child formed a cone-shape whereby the proportions started low at the sunrise stages of reproduction, increased through the median ages before declining to the sunset ages of reproduction. About 3.32 percent (overall), 4.49 percent (rural) and 2.63 percent (urban) of responds were aged 15-19 years. These proportions increased to 27.25 percent (overall), 30.77 percent (rural) and 25.19 percent (urban) in the 30 to 34 years' age group before declining to 2.84 percent (overall), 4.49 percent (rural) and 1.88 percent (urban) in the 45 to 49 years' age group. In the entire sub-county, the minimum age of the respondents was 16 years with the maximum being 49 years, giving a mean age of 31.25 years, median age of 31 years and standard deviation of 6.877 (Table 4).

Table 4: Mean, Median and Standard Deviation of the Study Population

Variable	N	Minimum	Maximum	Mean	Median	Std. Dev.
Current age	422	16	49	31.25	31	6.877
Household size	422	1	12	4.25	4	1.766

Source: Field Data (2023)

According to the marital status of the respondents, the study found widowed/divorced/separated women to be the least (overall – 8.35 percent; rural – 2.61 percent; urban – 11.65 percent), followed by single women (overall – 16.71 percent; rural – 9.15 percent; urban – 21.05 percent). Married women formed the majority of the respondents (overall – 74.94 percent; rural – 88.24 percent; urban – 67.29 percent).

The proportional household size increased from a single occupant (overall – 5.45 percent; urban – 8.65 percent) to a high of 4 occupants (overall – 26.07 percent; rural – 29.49 percent; urban – 24.06 percent) before reducing to a low of 12 occupants (overall - 0.47 percent; urban – 0.75 percent). The proportion of rural residents in households of 4 outweighed that of urban residents in similar household sizes. Overall, the minimum household size was 1 occupant with the maximum being 12 occupants, giving a mean household size of 4.25 years, median household size of 4 and standard deviation of 1.766 (Table 4).

According to religion, a majority of the respondents were of the ACK/SDA/Protestant faith (overall – 54.39 percent; rural – 74.36 percent; urban - 42.64 percent), followed by those of the Catholic faith (overall – 29.22 percent; rural – 21.79 percent; urban – 33.58 percent). More urbanites subscribed to the catholic faith than the rural dwellers. On the flip side, more rural mothers subscribed to the ACK/SDA/Protestant faith than the urban mothers. Islam religion was least reported in rural areas (1.28 percent) than in urban areas (15.47 percent). Other religious practices such as African Divine Church and African Nineveh Church also

existed in Kakamega Central Sub-County (overall – 6.18 percent; rural – 2.56 percent; urban – 8.30 percent).

Findings of a study done in Kenya by Mutunga (2007) showed that the youngest mother was 15 years of age while the oldest mother was 49 years old, giving a mean age of 28.16 years and a standard deviation of 6.65. The disparity between the findings of the current study and those of the study by Mutunga (2007) could be explained by the scale of the survey whereby, unlike the current study which is based on Kakamega Central Sub-County, the study by Mutunga was based on the entire country of Kenya. The disparity can further be explained by difference in the study time frame in that the current study collected data in December 2022 through to January 2023 while that of Mutunga used the 2003 Kenya Demographic and Health Survey data.

Unsurprisingly, about 4 in every 25 respondents were single, as this trend is rising throughout Kenya. Despite this, many women still choose to conceive and raise children independently to demonstrate their fertility. As a result, some households have grown more prominent, with daughters remaining in their parent's homes and even giving birth there. This background explains why some households have become more extensive. In contrast to the 2019 Kenya Population and Housing Census, which reported an average household size of 3.6 in Kakamega Central Sub-County (KNBS, 2019), the current study found an average household size of 4.25. The discrepancy can be partly due to the universal census (involving men, women, and children of all ages and kinds). The current study engaged a sample population of women in their reproductive age range who had childbirth from 2013 to 2022. The 2014 Kenya demographic and health survey found majority of households to have 4 occupants (overall – 16.4 percent; rural – 17.0 percent; urban – 15.6 percent) with a mean average household size of 3.9 (KNBS & ICF Macro, 2015).

Religious beliefs and practices affect infant mortality in one way or the other. Some religions do not advocate for hospital visits when sick in belief that a sick person should be prayed for and not hospitalized. Other religions are anti-contraception, meaning that if unchecked, a mother ends up having many births. Yet literature shows a relationship between fertility and mortality (Ikamari, 1996; Gyimah, 2002; Hertel-Fernandez et al., 2007; Hossain et al., 2007; Weeks, 2008). In his study on the factors affecting child survival in Kenya, Ikamari (1996) pointed out that a fall in fertility can bring about a reduction in infant and child mortality by reducing high order births.

4.3 Influence of Geographical Area of Residence on the Death of Infants in Rural and Urban Areas of Kakamega Central Sub-County

This objective sought to establish the influence of geographical factors on the death of infants in rural and urban areas of Kakamega Central Sub-County. Descriptive analysis was carried out to bring out the percentage distribution of births and infant deaths according to geographical factors. The results are presented in Table 5.

The results in Table 5 indicated that majority of rural births were to mothers in areas with a population density of $600 \leq x \leq 999$, murram roads, at most 2 health facilities, and good housing. No rural area had a population density of 1,000 people per square kilometer. In urban areas, 63.53 percent, 86.84 percent, and 44.74 percent of births occurred to mothers residing in areas with tarmacked roads, above 4 health facilities, and in durable housing, respectively. All urban areas under study had a population density of above 1,000 persons per square kilometre and more than 2 health facilities.

Table 5: Distribution of Births and Deaths According to Geographical Factors

	RURAL				URBAN			
Exposure variable	Births	NND	PNND	IND	Births	NND	PNND	IND
Population density								
x≤599	24.36	19.35	25.53	23.08	-	-	-	-
600≤x≤999	75.64	80.65	74.47	76.92	-	-	-	-
x≥1000	-	-	-	-	100.00	100.00	100.00	100.00
Nature of roads								
Mud roads	28.21	6.45	31.91	21.79	3.01	1.92	4.94	3.76
Murram roads	52.56	70.97	51.06	58.97	33.46	30.77	34.57	33.08
Tarmacked roads	19.23	22.58	17.02	19.23	63.53	67.31	60.49	63.16
Number of health facilities								
x≤2	76.92	83.87	72.34	76.92	-	-	-	-
3≤x≤4	16.03	12.90	17.02	15.38	13.16	9.62	16.05	13.53
x≥5	7.05	3.23	10.64	7.69	86.84	90.38	83.95	86.47
Type of housing								
Non-durable housing	1.92	3.23	0.00	1.28	25.56	19.23	32.10	27.07
Good housing	82.05	80.65	85.11	83.33	29.70	28.85	29.63	29.32
Durable housing	16.03	16.13	14.89	15.38	44.74	51.92	38.27	43.61

NND – Neonate deaths; PNND – Postneonate deaths; IND – Infant deaths

Source: Field Data (2023)

About 76.92 percent of infant deaths occurred in rural areas with a population density of between 600 to 999 persons per square kilometre. Additionally, 58.97 percent, 76.92 percent and 83.33 percent occurred in areas with murram roads, at most 2 health facilities and in homes with good housing, respectively, in rural areas of Kakamega Central Sub-County. Further, 63.16 percent, 86.47 percent, and 43.61 percent of infant deaths occurred in urban areas characterised by tarmacked roads, at least 5 health facilities, and durable housing, respectively.

These findings can be interpreted that there was a higher prevalence of infant mortality in rural areas characterised by a population density of 600≤x≤999 than those with a population density of less than 600. Generally, Kenya's population is positively growing yet the land

size is static. Geographical areas with a population density of less than 600 are fading out with time. A higher population density points to crowding, competition for space and health infrastructure, all of which contribute to a higher prevalence of infant mortality. There was a higher prevalence of infant mortality in rural areas with murram roads and urban areas with tarmacked roads. Murram roads outweigh tarmacked roads in virtually all rural geographical areas. However, some murram roads are in a pathetic state as evidenced in Plate 1. Such dilapidated murram and mud roads undermine access to the nearest health facilities. On the contrary, tarmacked roads outweigh murram and mud roads in most of the urban settings.

Plate 1: Part of Shikoti - Emukaba Road (at Etamanoni) in Butsotso East Ward
Photograph taken by the principal researcher on January 04, 2023
Source: Author (2023)

There was a higher prevalence of infant mortality in rural areas with at most 2 health facilities and urban areas with at least 5 health facilities. The density of health facilities is generally in favor of urban settings in most regions in Kenya. This is due to urban bias policy in terms of development. Since health facilities are part of basic social infrastructure, then many of them

are constructed in urban areas than in rural areas. However, some dispensaries remained closed over weekends and on public holidays as can be seen in Plate 2.

Plate 2: A closed medical facility in Kakamega Central Sub-County

Photograph taken by the principal researcher on March 19, 2023
Source: Author (2023)

The closure of health facilities on some days and parts of the day implies that the differentials in the prevalence of infant mortality are fully explained by the physical number of health facilities present in a given geographical area but also by the ability of a sick infant to access the necessary health services and attention.

Considering the type of housing, the study found a higher prevalence of infant mortality in rural areas with good housing and in urban areas with durable housing. Generally, dilapidated grass-thatched houses and houses with perforated roofs are decreasing in rural areas of Kakamega Central Sub-County. With the ever-increasing population and its related demand of land for farming, grasslands have not been spared. Most of them have been cleared for crop farming and settlement clipping the supply of grass for thatching houses. The initially earth-floored and mud-walled houses are being improved by cementing to graduate them into

semi-permanent category. Because of differentials in economic levels of the urbanites, some are not able to afford durable housing and thus end up residing in good and non-durable housing. This partly explains the observed differentials in the prevalence of infant mortality based on the type of housing.

The descriptive analytical findings revealed that geographical factors contributed to rural-urban differentials in infant mortality in Kakamega Central Sub-County. The higher prevalence of infant mortality in rural areas with a population density of $600 \leq x \leq 999$ compared to their counterparts with a population density of $x \leq 599$ is in part due to the latter being less-crowded than the former. According to Ghosh (2005), population density explains differentials in geospatial infant mortality by affecting the transmission of such diseases as diarrhea, measles, acute respiratory tract infections and malaria that contribute to infant deaths. In contradiction to the current finding, studies by Magadi et al. (2003) and Matthews et al. (2010) reported that individuals in densely populated areas were more likely to have access to critical health services for child survival and development, leading to a lower prevalence of mortality.

Rural areas are mainly characterized by mud and murram roads compared to urban roads which are mainly tarmacked. This explains the 80.76 percent prevalence of infant deaths in rural areas with non-tarmacked roads vis-à-vis the 63.16 percent prevalence in infant deaths in urban areas with tarmacked roads. A study done in rural areas of Tanzania by Masuma and Bangser (2009) noted that transport was challenging and that patients walked long distances in complicated terrains to reach the nearest health facilities. Improving access to road transportation decreases the distance required to travel to a healthcare facility and minimizes travel time (Karra et al., 2017). Such a measure results in improved access to healthcare facilities and better infant health outcomes. As per Kruk et al.'s (2018) investigation, a

significant proportion of preventable deaths was connected to inadequate access to healthcare services rather than the quality of such services.

Additionally, univariate multinomial logistic regression analysis was done to establish the influence of geographical area of residence on the death of infants in rural and urban areas of Kakamega Central Sub-County. The results are presented in Table 6.

Table 6: Crude Odds Ratios on the Influence of Geographical Factors on Neonatal, Post-neonatal and Infant Mortality

	RURAL			**URBAN**		
Exposure variable	NNM	PNNM	INM	NNM	PNNM	INM
Population density						
x≤599[a]	1.000	1.000	1.000	1.000	1.000	1.000
600≤x≤999	1.441	0.921	1.154	-	-	-
x≥1000	-	-	-	1.533	0.706	0.936
Nature of roads						
Tarmacked roads[a]	1.000	1.000	1.000	1.000	1.000	1.000
Murram roads	1.178	1.138	1.247	0.930	1.015	0.970
Mud roads	9.116*	0.683	2.077**	1.369	0.521	0.613
Number of health facilities						
x≥5[a]	1.000	1.000	1.000	1.000	1.000	1.000
x≤2	2.798	0.615	1.050	-	-	-
3≤x≤4	0.583	1.445	0.904	0.608	1.574	1.109
Type of housing						
Durable housing[a]	1.000	1.000	1.000	1.000	1.000	1.000
Non-durable housing	1.005	1.074	1.061	0.852	1.173	1.019
Good housing	0.535	3.507	2.173	1.471	0.664	0.873

[a] Reference category; *ρ<0.01; **ρ<0.05

NNM – Neonatal mortality; PNNM – Postneonatal mortality; INM – Infant mortality

Source: Field Data (2023)

From Table 6, the study indicated that rural areas characterized by mud roads were significantly more likely to experience neonatal (cOR = 9.116; ρ<0.01; CI = 2.010 – 41.337) and infant mortality (cOR = 2.077; ρ<0.05; CI = 0.959 – 4.499) with reference to rural areas

characterized by tarmacked roads. There were insignificant lower crude odds ratios for mud roads being a contributor to post-neonatal mortality in rural areas. Population density, number of health facilities and type of housing were insignificant both in rural and urban areas of Kakamega Central Sub-County. Nature of roads was equally insignificantly related to infant mortality in urban areas of Kakamega Central Sub-County.

Further, multivariate multinomial logistic regression analysis incorporating all the variables of study so as to establish the net effect of each geographical factor on infant mortality was carried out. The results are presented in Table 7.

Table 7: Adjusted Odds Ratios on the Influence of Geographical Factors on Neonatal, Post-neonatal and Infant Mortality Controlling for Socioeconomic, Demographic and Distance Factors

	RURAL			**URBAN**		
Exposure variable	NNM	PNNM	INM	NNM	PNNM	INM
Population density						
x≤599[a]	1.000	1.000	1.000	1.000	1.000	1.000
600≤x≤999	5.524	0.402	0.651	-	-	-
x≥1000	-	-	-	0.694	0.269	0.274
Nature of roads						
Tarmacked roads[a]	1.000	1.000	1.000	1.000	1.000	1.000
Murram roads	0.409	1.818	1.210	0.802	0.958	0.982
Mud roads	2.067**	0.832	3.867**	1.641	0.041	0.069
Number of health facilities						
x≥5[a]	1.000	1.000	1.000	1.000	1.000	1.000
x≤2	1.039	8.225	2.962	-	-	-
3≤x≤4	0.202	9.248**	1.363	1.442	3.715	3.651**
Type of housing						
Durable housing[a]	1.000	1.000	1.000	1.000	1.000	1.000
Non-durable housing	2.827	0.561	1.543	0.373	0.949	0.618
Good housing	0.016**	3.575	2.885	0.813	0.265**	0.312**

[a] Reference category; *ρ<0.01; **ρ<0.05

NNM – Neonatal mortality; PNNM – Postneonatal mortality; INM – Infant mortality

Source: Field Data (2023)

The results in Table 7 showed that the adjusted odds ratios of the likelihood of neonatal mortality were 2.067 ($\rho<0.05$; CI = 1.065 – 4.012) while those of infant mortality were 3.867 ($\rho<0.05$; CI = 1.079 – 3.857) among babies born to rural mothers who resided in areas with mud roads when compared to their counterparts who resided in areas with tarmacked roads. Furthermore, there was a higher likelihood of post-neonatal mortality in rural geographical areas with 3 to 4 health facilities (aOR = 9.248; $\rho<0.05$; CI = 0.979 – 87.389) with reference to rural areas with at least 5 health facilities. Urban areas with 3 to 4 health facilities had higher adjusted odds ratios of infant mortality (aOR = 3.651; $\rho<0.05$; CI = 0.790 – 6.883) than urban areas with above-4 health facilities.

Type of housing was a significant contributor to neonatal mortality in rural areas and post-neonatal mortality and infant mortality in urban areas. In rural areas, neonates housed in good housing were 0.984 times less likely to experience neonatal mortality when compared to their counterparts in durable housing. In urban areas, there were lower likelihoods of post-neonatal mortality (aOR = 0.265; $\rho<0.05$; CI = 0.070 – 1.010) and infant mortality (aOR = 0.312; $\rho<0.05$; CI = 0.089 – 1.097) amongst children residing in good housing than those residing in durable housing.

Nature and availability of roads, geographical distribution of health facilities, and kind of housing vary across administrative regions and geographical areas. Mud roads delay the flow of traffic. They sometimes discourage patients from leaving their homes to seek medication especially late at night and in rainy seasons. That there were higher odds of infant mortality in rural areas with mud roads when compared to those with tarmacked roads is unsurprising. Unlike rural areas which are mainly characterized by mud and murram roads with few stretches of tarmacked roads, urban areas are characterized by tarmacked roads with few

stretches of murram and mud roads. This partly explains why nature of roads was an insignificant contributor to infant mortality in urban areas.

The central distribution channel for many cost-effective maternal, new-born and childcare interventions are health facilities. Areas with less than five health facilities were generally found to have higher likelihoods of experiencing infant mortality. The adjusted odds ratios were 8.248 and 2.651 times higher for post-neonatal and infant mortality in rural and urban areas, respectively, in areas that had 3 to 4 health facilities when compared to areas with at least 5 health facilities. A reduced health facility density points to increased distance to accessing healthcare services. It also points to congestion in the available health facilities, an observation that can contribute to infant mortality in the affected population. Thus, insufficient health systems hamper progress in infant survival.

There were generally significantly reduced likelihoods of neonatal (rural – aOR = 0.016), post-neonatal (urban – aOR = 0.265) and infant (urban – aOR = 0.312) mortalities amongst infants born in good housing than their counterparts born in durable housing. In most instances, durable housing points to improved socioeconomic lifestyle that brings in non-communicable diseases and challenges of maternal obesity which heightens the likelihood of mortality. Some durable houses are unhygienic with poor sewerage systems and blocked flush toilet facilities that speeds up the spread of diarrheal diseases. On the other hand, residents in some less-durable houses observe the expected hygiene and lifestyle practices.

The findings from the inferential analysis indicated that the nature of roads significantly contributed to infant mortality in rural areas but not in urban areas. Specifically, the multivariate model revealed that rural areas with mud roads had a higher likelihood of experiencing neonatal and infant mortality than rural areas with tarmacked roads. These

results are consistent with previous studies conducted in Ethiopia by Kibret et al. (2023) and Okwaraji et al. (2012), which found that individuals living in remote areas were at a higher risk of childhood mortality. Such areas typically have poorly-developed transport infrastructure, including the often impassable mud and dilapidated roads, that limits access to health facilities. Moreover, human trekking is the primary mode of transport along such roads. During rainy seasons, motorcycle operators often refuse to transport individuals along specific routes. An interview with a key informant supported this as expressed below:

> Access to the nearest health facility is undermined. When roads are poor, transport becomes a problem in terms of few public vehicles and the transport cost is likely to be prohibitive. The health facility may also be more interior from the available accessible road.
>
> (Senior Population Programme Officer – NCPD)

This is unlike tarmacked roads that depict improved traffic flow by motorcycles and motor-vehicles between residential areas and health centers all-year round. Human trekking is equally easier and faster along tarmacked roads than along mud and dilapidated roads.

The number of health facilities present in an area was significantly associated with disparities in post-neonatal mortality in rural areas and infant mortality in urban areas. In comparison to areas with at least 5 health facilities, areas with 3 to 4 health facilities had higher adjusted odds ratios of post-neonatal and infant mortality in rural and urban areas, respectively. Previous research by Karra et al. (2017) highlighted that the physical distribution of health services was a crucial determinant of child survival. In areas with fewer health facilities, expectant mothers are less likely to attend antenatal care visits, deliver in a health facility, and have their infants fully vaccinated. Furthermore, the inadequate number of health facilities to meet the increasing demands of the population for healthcare services leads to a stressed healthcare system, resulting in infant deaths. Such health facilities are overcrowded

with patients, have fewer health workers, and cannot handle emergencies. A cross-sectional study conducted in Burkina Faso indicated that the presence of a health facility within a village significantly positively affected the likelihood of children being fully vaccinated (Sanou et al., 2009). This is important because vaccination is strongly associated with reducing infant mortality rates.

Worth noting is that access to a health facility is not directly related to proper infant care services. A country-wide study done in Kenya by Toda et al. (2012) found a quarter of medical centers to be poorly stocked with family planning and vaccination commodities. An interview with a key informant provided the following information on the pathways throughwhich access to a health facility might influence infant mortality:

> Some health facilities have a likelihood of overcrowding of patients and fewer health workers. Such facilities are also likely to lack medical equipment or skilled human resource to operate them. Essential medicines easily get stocked out. Such facilities may be incapable of handling emergencies. They would also be spread over long distances making referral a nightmare.
>
> (Senior Population Programme Officer – NCPD)

Again, some health facilities remained closed over weekends and on public holidays in the study area as evidenced by Plate 2. Some infants getting sick on such a health facility closure day lose their lives that could otherwise be salvaged suppose the health facilities remained open all days. As appreciated by Armstrong (2008), peripheral health facilities have huge potential to improve the health and survival of families if distance and travel-time is reduced. The findings of this study are however inconsistent with the findings of a study by Simmons et al. (2021) that found a higher ratio of health facilities relative to the population to be associated with poor infant survival.

Furthermore, there were lower adjusted odds ratios of neonatal mortality in rural areas and post-neonatal mortality and infant mortality in urban areas amongst residents of good housing with reference to residents of durable housing. Residing in good housing reduced the likelihood of neonatal mortality by 98.4 percent compared to residence in durable housing in rural areas. In urban areas, residing in good housing reduced the likelihood of post-neonatal and infant mortality by 73.5 percent and 68.8 percent, respectively, compared to residing in durable housing. The generally warm conditions in good houses favors infant survival than the cold conditions in most durable houses.

The findings on the influence of type of housing on infant mortality in Kakamega Central Sub-County are in agreement with findings of other studies (Macassa et al., 2012; Meehan et al., 2014; Gruebner et al., 2015). A study on geographic differentials in mortality of children in Mozambique by Macassa et al. (2012) found houses with natural clay floor material to have a 0.02 lower risk of under-five mortality with reference to finished (durable) houses. On their side, Gruebner et al. (2015) found residence in durable housing to increase the risk of infant death by 2 percent in urban areas. A key informant revealed the following about the lower likelihood of infant mortality in households with good housing than those with durable housing:

> Maybe the issue would be exposure of the infant to cold. A good housing has the possibility of maintaining warm temperatures compared to bricked/stoned/tiled housing.
>
> (Senior Population Programme Officer – NCPD)

In search of an explanation, Meehan et al. (2014) indicated that durable housing was related to better socioeconomic status characterized by changing lifestyle patterns and maternal obesity, which are risk factors for infant mortality. It is plausible that some expectant mothers residing in durable housing and with better socioeconomic status opt for a planned cesarean

section before their expected due dates. Some wealthy women view vaginal delivery as painful, complicated, and embarrassing and, therefore, choose to undergo a planned cesarean section to protect their social status (Omedi et al., 2020). However, premature births and low birthweights resulting from such practices are often associated with a higher risk of early childhood mortality (Omedi & Amwoliza, 2015). A study done on regional variation in neonatal and post-neonatal mortality in Kenya by Ikamari (2013) found underweight births to have elevated risks of neonatal and post-neonatal mortality. An interview with a key informant gave more insight into this issue as indicted below:

> We anticipate higher infant mortality in areas characterized by: poor roads; poor health infrastructure; inadequate workforce at the health facilities; absence of emergency services during odd hours; ignorance; obsolete knowledge, attitudes and practices; and challenging socioeconomic status.
>
> (Community Health Volunteer - Mahiakalo)

The response from the key informant related high likelihood of early childhood mortality to underprivileged accessibility to heathcare services as a result of inaccessible roads, poor healthcare arrangement that is characterized by inadequate medical personnel, partial availability of emergency services and even drug stock-outs. In the economically disadvantaged homes, the menace of drug stock-outs in health facilities makes some patients to be subjected to affordable drugs alternative to the prescriptions of the physicians or partial doses.

4.4 Influence of Socioeconomic Factors on the Death of Infants in Rural and Urban Areas of Kakamega Central Sub-County

This objective examined the influence of socioeconomic factors on the death of infants in rural and urban areas of Kakamega Central Sub-County, Kakamega County, Kenya. Descriptive analysis was carried out to bring out the percentage distribution of births and

infant deaths according to socioeconomic factors in rural and urban areas of Kakamega Central Sub-County. The results are presented in Table 8.

Table 8: Distribution of Births and Deaths According to Socioeconomic Factors

	RURAL				URBAN			
Exposure variable	Births	NND	PNND	IND	Births	NND	PNND	IND
Level of education qualification of the mother								
None	8.97	3.23	6.38	5.13	13.16	21.15	12.35	15.79
Primary	57.05	61.29	63.83	62.82	37.97	32.69	40.74	37.59
Secondary+	33.97	35.48	29.79	32.05	48.87	46.15	46.91	46.62
Maternal occupation								
Not employed	25.64	22.58	27.66	25.64	49.62	59.62	41.98	48.87
Agriculture	33.97	32.26	31.91	32.05	3.76	1.92	6.17	4.51
Pro./Tech./Man./Cler.	8.33	12.90	6.38	8.97	10.53	9.62	9.88	9.77
Other	32.05	32.26	34.04	33.33	36.09	28.85	41.98	36.84

NND – Neonate deaths; PNND – Postneonate deaths; IND – Infant deaths

Source: Field Data (2023)

Results in Table 8 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.

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 in both 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, newborn and child healthcare at grassroot 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 results of descriptive analysis indicated that there was a lesser prevalence of infant mortality amongst mothers with no any education qualifications both in rural and urban areas as compared to mothers with some education qualifications. 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). The proportions are lower in this study.

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. A key informant 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.

Additionally, socioeconomic factors of level of education qualification of the mother and maternal occupation were included in the multinomial logistic regression model in order to examine the influence of socioeconomic factors on the death of infants in rural and urban areas of Kakamega Central Sub-County. The results were as presented in Table 9.

The results in Table 9 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

Table 9: Crude Odds Ratios on the Influence of Socioeconomic Factors on Neonatal, Post-neonatal and Infant Mortality

	RURAL			URBAN		
Exposure variable	NNM	PNNM	INM	NNM	PNNM	INM
Level of education qualification of the mother						
Secondary+[a]	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[a]	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

[a] Reference category; *ρ<0.01; **ρ<0.05

NNM – Neonatal mortality; PNNM – Postneonatal mortality; INM – Infant mortality

Source: Field Data (2023)

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). 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.

Furthermore, multivariate multinomial logistic regression was carried out to examine the independent effect of socioeconomic factors on infant mortality in Kakamega Central Sub-County. The results are presented in Table 10.

Table 10: Adjusted Odds Ratios on the Influence of Socioeconomic Factors on Neonatal, Post-neonatal and Infant Mortality Controlling for Geographical, Demographic and Distance Factors

	RURAL			URBAN		
Exposure variable	NNM	PNNM	INM	NNM	PNNM	INM
Level of education qualification of the mother						
Secondary+[a]	1.000	1.000	1.000	1.000	1.000	1.000
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[a]	1.000	1.000	1.000	1.000	1.000	1.000
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

[a] Reference category; *ρ<0.01; **ρ<0.05

NNM – Neonatal mortality; PNNM – Postneonatal mortality; INM – Infant mortality

Source: Field Data (2023)

The results in Table 10 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 differentials 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). Such mothers have some sort of economic muscles to acquire resources and information needed towards appropriate infant nutrition and care. This suggests that female economic empowerment through paid occupations can give them power and privilege in family decision-making process, including those touching on childcare.

The results in the full model 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 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 influences 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 facility 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 youngones.
>
> (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 Programme Officer – NCPD)

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 childcaring.

4.5 Influence of Demographic Factors on the Death of Infants in Rural and Urban Areas of Kakamega Central Sub-County

This objective examined the influence of demographic factors on the death of infants in rural and urban areas of Kakamega Central Sub-County. Descriptive analysis was carried out to bring out the percentage distribution of births and infant deaths as per demographic factors in rural and urban areas of Kakamega Central Sub-County. The results are presented in Table 11.

The findings in Table 11 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.

Table 11: Distribution of Births and Deaths According to Demographic Factors

	RURAL				URBAN			
Exposure variable	Births	NND	PNND	IND	Births	NND	PNND	IND
Age of the mother at the birth of her child (in years)								
x<20	19.23	38.71	10.64	21.79	22.93	21.15	16.05	18.05
20≤x≤34	64.74	48.39	65.96	58.97	68.42	63.46	75.31	70.68
35≤x≤49	16.03	12.90	23.40	19.23	8.65	15.38	8.64	11.28
Order of the index birth								
First birth	31.41	41.94	27.66	29.49	41.35	53.85	30.86	39.85
2 - 3 birth	39.10	29.03	36.17	44.87	36.47	25.00	39.51	33.83
4+ birth	29.49	29.03	36.17	25.64	22.18	21.15	29.63	26.32
Wait period prior to the index birth								
≤ 24 months	29.91	22.22	32.35	28.85	35.44	25.00	46.55	40.24
> 24 months	70.09	77.78	67.65	71.15	64.56	75.00	53.45	59.76

NND – Neonate deaths; PNND – Postneonate deaths; IND – Infant deaths

Source: Field Data (2023)

These findings showed a higher prevalence of infant deaths amongst mothers aged 20≤x≤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≤x≤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.

Descriptively, 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 another study conducted by Dendup et al. (2021) in Bhutan, which found that infants with an interval of less than 33 months between births had a higher proportion of deaths in rural and urban areas.

Univariate analysis was further conducted to examine the influence of age of the mother at the birth of her child, order of the birth and wait period prior to the birth on the death of infants in rural and urban areas of Kakamega Central Sub-County. The results in terms of crude odds ratios are presented in Table 12.

Table 12: Crude Odds Ratios on the Influence of Demographic Factors on Neonatal, Post-neonatal and Infant Mortality

	RURAL			**URBAN**		
Exposure variable	NNM	PNNM	INM	NNM	PNNM	INM
Age of the mother at the birth of her child (in years)						
20≤x≤34[a]	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[a]	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[a]	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

NNM – Neonatal mortality; PNNM – Postneonatal mortality; INM – Infant mortality

Source: Field Data (2023)

As displayed in Table 12, 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 $20 \leq x \leq 34$ 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 mortality, 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; $\rho<0.05$; 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; $\rho<0.01$; 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; $\rho<0.05$; 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 mortality, respectively, with reference to infants born at a greater than 24 months wait period in urban areas. The odds ratios were 2.132 ($\rho<0.05$; CI = 1.088 – 4.179) for post-neonatal mortality and 1.552 ($\rho<0.05$; CI = 0.803 – 3.000) for infant mortality.

All the study variables were fitted in the multinomial logistic regression model at multivariate analysis level to study the independent effect of each of them on neonatal, post-neonatal and infant mortality. The results of the demographic factors, in terms of adjusted odds ratios, are presented in Table 13.

Table 13: Adjusted Odds Ratios on the Influence of Demographic Factors on Neonatal, Post-neonatal and Infant Mortality Controlling for Geographical, Socioeconomic and Distance Factors

	RURAL			URBAN		
Exposure variable	NNM	PNNM	INM	NNM	PNNM	INM
Age of the mother at the birth of her child						
20≤x≤34[a]	1.000	1.000	1.000	1.000	1.000	1.000
x<20	0.471	3.203	1.952	1.579**	0.621	2.390
35≤x≤49	0.005**	1.361**	0.330	2.123	4.093	2.742**
Order of the index birth						
2 - 3 birth[a]	1.000	1.000	1.000	1.000	1.000	1.000
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[a]	1.000	1.000	1.000	1.000	1.000	1.000
≤ 24 months	0.522	1.992	1.241	1.545	3.294**	3.616*

[a] Reference category; *ρ<0.01; **ρ<0.05

NNM – Neonatal mortality; PNNM – Postneonatal mortality; INM – Infant mortality

Source: Field Data (2023)

The results in Table 13 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 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; $\rho<0.01$; CI = 0.584 – 6.063) whereas first births had higher likelihood of infant mortality (aOR = 3.492; $\rho<0.05$; CI = 0.992 – 2.291). A shorter wait period prior to the index birth depicted higher adjusted odds ratios of post-neonatal and infant mortality in comparison to the crude odds ratios in Table 13. Infants born at a wait period ≤ 24 months were 2.294 times and 2.616 times more likely to experience post-neonatal and infant mortality, respectively, than infants born at a wait period > 24 months in urban areas.

Mothers in the advanced stages of reproduction have childbearing experience that contribute to the less likelihood of neonatal mortality amongst them. Such mothers could have reached their stage of self-actualization and leading a settled family life. However, such ages are generally characterized by higher likelihood of infant mortality as depicted in the urban findings. This is due to maternal depletion effect that arises as a result of multiple births. When the order of an index birth is high, the mother is likely to be in her advanced ages of reproduction and her body unlikely to have the critical nutrients to support a pregnancy. The wait period prior to an index birth had a negative relationship with infant mortality. When births are spaced at an interval of at least 24 months, infant survival is higher. Too closely spaced births are risky for infant survival. Bodies of mothers take time to fully recovered from previous births. The unrecovered bodies lack important nutrients to supply to the unborn baby thus compromising the immunity of the baby which leads to deficiencies and deformities.

The inferential analytical results found the likelihood of neonatal mortality to reduce 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 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 by Ikamari (2003) 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 - NCPD)

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 - NCPD)

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 - NCPD)

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. Poel et al. (2009) noted that a short birth interval and high birth order reflect 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. Leibenstein (1974) distinguished three types of utility children yield to their parents. First, for most parents, children are a source of pleasure; in this sense, children are regarded as consumption goods. Second, children have value as productive agents, especially in the more traditional setting. They can help on the family farm or work away from the home and contribute to the family income. Third, children can provide insurance for the old age and illness.

These findings are in agreement with findings of recent 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 increase 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.

4.6 Effect of Distance Covered to the Nearby Medical Facility on the Death of Infants in Rural and Urban Areas of Kakamega Central Sub-County

This objective sought to assess the effect of distance covered to the nearby medical facility on the death of infants in rural and urban areas of Kakamega Central Sub-County. Descriptive analysis was conducted to bring out the percentage distribution of births and infant deaths according to distance factors in rural and urban areas of Kakamega Central Sub-County. The results are presented in Table 14.

Table 14: Distribution of Births and Deaths According to Distance Factors

	RURAL				URBAN			
Exposure variable	Births	NND	PNND	IND	Births	NND	PNND	IND
Approximate distance (in km)								
x≤1	17.95	32.26	10.64	19.23	50.76	46.15	53.75	50.76
1.1≤x≤3.9	39.10	41.94	42.55	42.31	39.02	44.23	35.00	38.64
x≥4	42.95	25.81	46.81	38.46	10.23	9.62	11.25	10.61
Travel-time (in minutes)								
x≤ 30	49.36	61.29	44.68	51.28	82.26	88.24	81.48	84.09
31≤x≤60	32.05	25.81	31.91	29.49	15.85	9.80	14.81	12.88
x>60	18.59	12.90	23.40	19.23	1.89	1.96	3.70	3.03

NND – Neonate deaths; PNND – Postneonate deaths; IND – Infant deaths

Source: Field Data (2023)

The descriptive statistics in Table 14 showed that there was a higher prevalence of rural infant mortality amongst mothers who lived/stayed at a distance of between 1.1 and 3.9 kilometers to the nearby medical facility. The prevalence was lowest amongst mothers who lived/stayed at an at most a kilometer distance to the nearby medical facility in rural areas. Shorter distance to the nearby medical facility increases utilization of health services in terms of antenatal care visits, hospital delivery, post-natal care visits and in case of infant sickness. The uptake of such services contribute to reduced prevalence of infant mortality. This is unlike longer distances that call for means of transport other than human trekking, some of which are unaffordable to some households. The unaffordability of quicker means of transport coupled with the unaffordability of medication costs in the cash-and-carry healthcare system limits the utilization of modern healthcare services.

In urban areas, there was a higher prevalence of infant mortality amongst mothers who lived/stayed at a distance of at most a kilometer to the nearby medical facility. This prevalence was lowest amongst mothers who lived/stayed at a distance of at least 4

kilometers to the nearby medical facility. The higher prevalence of infant mortality amongst infants who resided at reduced distances to the nearby medical facilities in urban areas was partly as a result of the choice of public vis-à-vis private health facilities. Some private health facilities that are closer to clients are costly making the clients unable to afford the hospital charges. Of course there is a higher number of health facilities in urban areas than in rural areas. With the small land-size area of urban areas, then the physical distance from one health facility to the other is not that large. So is the general distance from one's area of residence to the nearby medical facility.

Mothers and their infants who took at most 30 minutes to reach the nearby medical facility had a higher prevalence of infant mortality (rural - 51.28%; urban – 84.09%) when compared to their counterparts who took beyond an hour to reach the nearby medical facility (rural - 19.23%; urban – 3.03%). Some people residing closer to medical facilities in terms of travel-time wait until their sick infants reach critical conditions before taking them for medication. People far away from medical facilities in terms of travel-time do not take risks: they avail their sick infants to hospitals once they notice some abnormal symptoms. Some near health facilities in terms of travel time are not well-equipped with the rightful medical infrastructure for maternal and infant care: frequent stock-outs of drugs, shortage and/or absence of qualified medical personnel to offer the required services and absence of equipment needed to diagnose the expectant mothers and sick infants. After disease diagnosis, a number of health facilities in the study area asked patients to go buy drugs in chemists.

The results of descriptive analysis indicated that there existed rural-urban differentials in the prevalence of infant death according to distance covered to reach the nearby medical facility. As explained by Kembo and van Ginneken (2009), distinct differentials in childhood mortality exist due to differences in regional health arrangement. The current study found

50.76 percent of infant deaths to occur to mothers who resided within a kilometer to the nearby medical facility in urban areas while 42.31 percent occurred to mothers who resided within a distance of 1.1 to 3.9 kilometers to the nearby medical facility in rural areas. Majority of deaths were to infants who lived relatively close to a medical facility. About 61.54 percent and 89.39 percent of infants died in households that lived within 3.9 kilometers from a medical facility in rural and urban areas, respectively. This is confirmed by the findings of a study by Karra et al. (2017) that found 52.2 percent of children to live within 3 kilometers from a health facility. The observed economic development as a result of devolution has contributed to the findings in the current study.

Pertaining travel-time taken to reach the nearby medical facility, this study found an inverse relationship between the prevalence of infant mortality and the travel-time taken to reach the nearby medical facility both in rural and urban areas. There were more infants dying to mothers who took a shorter travel time to reach the nearby medical facility than to mothers who took a longer travel-time to reach the nearby medical facility. Shorter travel-time to the nearby medical facility is sometimes characterised by unaffordable medication costs or hospitals suffering frequent stock-outs of medical equipment and drugs, absent and limited medical personnel. These findings are unlike the findings of a rural-based study done in Burkina Faso by Schoeps et al. (2011) that found lesser death of children when the nearby medical facility was village-based than when a time duration of 4 hours was needed to reach the nearby medical facility.

Further, the distance factors of distance and travel-time taken by a mother and her infant to reach the nearby medical facility were fitted in the multinomial logistic regression model to obtain the crude odds ratios on the effect of distance covered to the nearby medical facility on neonatal, post-neonatal and infant mortality. The results are presented in Table 15.

Table 15: Crude Odds Ratios on the Effect of Distance Factors on Neonatal, Post-neonatal and Infant Mortality

	RURAL			URBAN		
Exposure variable	NNM	PNNM	INM	NNM	PNNM	INM
Approximate distance (in km)						
x≤1[a]	1.000	1.000	1.000	1.000	1.000	1.000
1.1≤x≤3.9	0.284**	2.183	0.746	1.799	0.956	1.407
x≥4	0.495	0.953	0.653	1.220	1.248	1.359
Travel-time (in minutes)						
x≤ 30[a]	1.000	1.000	1.000	1.000	1.000	1.000
31≤x≤60	0.763	1.267	1.076	0.705	3.797	3.399
x>60	0.990	1.442	1.395	1.812	3.842	5.929

[a] Reference category; *ρ<0.01; **ρ<0.05

NNM – Neonatal mortality; PNNM – Postneonatal mortality; INM – Infant mortality

Source: Field Data (2023)

The results in Table 15 showed that distance between one's residence and nearby medical facility significantly contributed to rural-urban differentials in infant mortality in Kakamega Central Sub-County. In rural areas, mothers and their infants who travelled between 1.1 kilometres to 3.9 kilometres to reach the nearby medical facilities were less likely to experience neonatal mortality when compared to their counterparts who travelled at most a kilometre to reach the nearby medical facility (cOR = 0.284; ρ<0.05; CI = 0.086 – 0.939). There was a general insignificant increase in the likelihood of infant mortality with increase in distance covered to reach the nearby medical facility in urban areas. Travel-time taken to reach the nearby medical facility did not significantly influence infant mortality both in rural and urban areas.

The findings in Table 15 showed that the crude odds ratios of neonatal mortality decreased by 71.6 percent for a 1.1 to 3.9 kilometre distance to the nearby medical facility in comparison to an at most a kilometre distance to the nearby medical facility in rural areas. This observation is partly explained by differences in the quality health care services offered from

one health facility to the other in rural areas of Kakamega Central Sub-County. Some near-home health facilities offer low-quality healthcare services with distant ones offering better healthcare services. Further, some near-home health facilities do not stay open throughout the day and seasons making them occasionally inaccessible.

The results in the final model that incorporated all the study variables showed that both approximate distance and travel-time were significantly related to infant mortality in Kakamega Central Sub-County (Table 16).

Table 16: Adjusted Odds Ratios on the Effect of Distance Factors on Neonatal, Post-neonatal and Infant Mortality Controlling for Geographical, Socioeconomic and Demographic Factors

	RURAL			**URBAN**		
Exposure variable	NNM	PNNM	INM	NNM	PNNM	INM
Approximate distance (in km)						
x≤1[a]	1.000	1.000	1.000	1.000	1.000	1.000
1.1≤x≤3.9	0.499	0.912	0.495	2.127**	0.926	3.978
x≥4	1.122	0.416	0.592	3.588	1.499	2.852
Travel-time (in minutes)						
x≤ 30[a]	1.000	1.000	1.000	1.000	1.000	1.000
31≤x≤60	7.336	3.137	5.747	6.524	9.278	2.672**
x>60	14.957	2.581	7.436**	18.28	13.44	6.257

[a] Reference category; *ρ<0.01; **ρ<0.05

NNM – Neonatal mortality; PNNM – Postneonatal mortality; INM – Infant mortality

Source: Field Data (2023)

From Table 16, the study noted that the significance of distance on rural neonatal mortality observed at the univariate regression analysis level disappeared in the full model. On the flip-side, there were higher adjusted odds ratios of neonatal mortality for urban mothers and infants who travelled between 1.1 kilometers to 3.9 kilometers to reach the nearby medical facility with reference to their counterparts who travelled at most a kilometer to reach the nearby medical facility (aOR = 2.127; ρ<0.05; CI = 1.197 – 3.781). Travel-time taken to

reach the nearby medical facility significantly influenced both rural and urban infant mortality. There was a general increase in the likelihood of infant mortality with increase in travel-time. In rural areas, the adjusted odds ratios of infant mortality were higher among infants who took at least an hour to reach the nearby medical facility compared to infants who took at most half-an-hour to reach the nearby medical facility (aOR = 7.436; $\rho<0.05$; CI = 0.948 – 5.834). There were higher adjusted odds ratios of infant mortality for urban infants who took between 31 to 60 minutes to reach the nearby medical facility with reference to their counterparts who took at most 30 minutes to reach the nearby medical facility (aOR = 2.672; $\rho<0.05$; CI = 0.534 – 1.340).

Urbanites travelling 1.1 to 3.9 kilometers to reach a nearby medical facility experienced a 112.7 percent higher likelihood of neonatal mortality than those who travelled for a kilometer to reach a medical facility. This was in part as a result of unaffordability of transport expenses and low utilization of antenatal, perinatal, delivery and postnatal care services, yet the uptake of these services influence infant mortality. Distance influences accessibility to healthcare services, causes delays to healthcare, and influences the ability of a mother to use health services during pregnancy, at birth and during postnatal period. In low income areas and households, long distance to the nearby health facility is out of reach, especially in case of limited infrastructure.

An increase in travel time was associated with an increase in the likelihood of infant mortality. The odds of infant mortality increased by 167.2 percent and 643.6 percent for a 30 minutes' and 60 minutes' increase in travel time in urban and rural areas, respectively. Sick infants in critical conditions get worse with increase in travel time making them to die before getting medical attention. The effect of travel time on infant mortality is exacerbated by poor

road infrastructure, absence of quicker means of transport and fear of insecurity in some parts of the study area.

Results of inferential analysis indicated that distance to the nearby medical facility was a significant contributor to rural-urban differentials in infant mortality. The results in Tables 13 and 14 showed that a distance of between 1.1 kilometers to 3.9 kilometers was significantly associated with neonatal mortality in comparison to a distance of at most a kilometer. However, the association was divergent in that there was a lower likelihood of neonatal mortality in rural areas (cOR = 0.284) whereas there was a higher likelihood of neonatal mortality in urban areas (aOR = 2.127). The findings in rural areas are in agreement with other studies that found neonatal mortality to decrease with increase in distance from home to health facilities (Kashima et al., 2012). In line with the urban findings were the findings of other studies (Kadobera et al., 2012; Karra et al., 2017; Quattrochi et al., 2020; Kibret et al., 2023). Compared to children who lived within a kilometer to a facility, children who lived within 2 kilometers, 3 kilometers and 5 kilometers to a facility had a 7.7 percent ($\rho<0.05$; CI = 0.927 – 1.251), 16.3 percent ($\rho<0.05$; CI = 1.020 – 1.327), and 25 percent ($\rho<0.05$; CI = 1.087 – 1.439) higher odds of neonatal mortality, respectively (Karra et al., 2017).

A most recent study in Ethiopia by Kibret et al. (2023) found a ten kilometer increase in distance to a health facility to increase the odds ratios of neonatal mortality by 1.33 percent (95% CI = 1.06 – 1.67). In support of the findings of this study, a study by Karra et al. (2017) found distance covered to the nearby medical facility to have no significant effect on infant mortality after the neonatal period. These findings are however inconsistent with those of a study that showed no significant association between distance and neonatal mortality in Malawi and a greater distance to be associated with significantly lower neonatal mortality in

Zambia (Lohela et al., 2012). A key informant said the following on how distance influence infant mortality:

> Distance compromises accessibility for those who need healthcare services. If the health facility is far off, this is likely to lead to delays in deciding or availing of transport costs to access the healthcare services. Distance can also force a healthcare seeker to decide to seek services of a traditional birth attendant instead of a skilled birth attendant putting the life of a mother and her infant at risk should any complication arise.
>
> (Senior Population Programmes Officer - NCPD)

Results of inferential analysis showed a common pattern on the influence of travel-time on infant mortality in rural and urban areas. An increase in travel time was associated with an increase in the likelihood of infant mortality. In comparison to an at most 30 minutes' travel-time, a travel-time of 31 to 60 minutes was associated with higher adjusted odds ratios of infant mortality in urban areas. Furthermore, a travel-time of beyond an hour was associated with higher adjusted odds ratios of infant mortality in rural areas. These findings are consistent with other findings of related studies (Schoeps et al., 2011; Okwaraji et al., 2015; Karra et al., 2017) that found the threat of mortality to be directly proportional to distance.

A study done in rural areas of Burkina Faso found greater under-five mortality when a time duration of four hours was needed to reach the nearby medical facility in reference to a village-based medical facility (Schoeps et al., 2011). Another study by Okwaraji and colleagues (2015) found living at least 90 minutes from the nearby medical facility to be associated with a double larger risk of death of children than living within 90 minutes from the nearby medical facility. In a study done in low and middle income countries, Karra et al. (2017) found neonates born in households located at a travel time of beyond an hour from a health facility to have higher odds ratio of dying than neonates born in households that were

within a ten minutes' travel time from a health facility (OR – 1.256; $\rho<0.05$; CI = 1.105 – 1.429).

Distance and travel-time relate to each other. Some short distances are characterised by impassable roads that lengthen the travel-time taken to reach the nearby medical facility. Conversely, some long distances have passable roads making a patient to take a shorter time to reach the nearby medical facility. Noor et al. (2006) indicated that about 63 percent of people were able to reach a government medical centre within an hour in some districts in Kenya. On their side, Kiross and colleagues (2021) explained that residents of inaccessible mountainous and remote areas spent many hours trekking in search of maternal and infant health services, something that delays access to treatment in case of infant sickness. In the current study, a Public Health Officer at Kakamega reported that:

> The longer the distance the higher the chances of infant mortality. This is because of the travel time taken to access health services, and there is no guarantee that services are offered in all our health facilities 24 hours a day! A patient can also lack or fail to afford proper means of transport to reach the nearby medical facility.
>
> (Public Health Officer – Kakamega)

Some mothers in the least economically stable homes are discouraged from visiting distant medical facilities for childcare-related services because of unaffordability of travel expenses involved. A study by Ekholuenetale et al. (2020) noted that having insufficient resources at disposal limits the reach to and uptake of current healthcare exacerbated by the pay-and-take system operating in several sub-Saharan countries. In their study, Kibret et al. (2022) noted that people experienced difficulties in accessing emergency new-born care. The study indicated that 46.5 percent of births in Ethiopia had access to emergency neonatal care facilities within two hours of travel-time. A key informant noted that:

> A longer travel time may be related to a prohibitive cost of travel. The mother may choose not to seek medical care because it may mean a full day activity yet she may not have that time. Example, if employed and paid per actual work done, it may be difficult to forego the work in search of medical attention.
>
> (Senior Population Programmes Officer - NCPD)

This is an indication that some pregnant women experience long distances of travel and challenging transportation conditions to access childcare services, observations that contribute to higher likelihoods of infant mortality.

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.

CHAPTER FIVE

SUMMARY, CONCLUSION AND RECOMMENDATIONS

5.1 Introduction

This section presents a synopsis of the study findings, a conclusion of the same in terms of hypotheses testing, and suggested recommendations in reference to the analytical findings.

5.2 Summary

The primary objective of this study was to examine rural-urban differentials in infant mortality in Kakamega Central Sub-County, Kakamega County, Kenya. Geographically, results of univariate multinomial logistic regression analysis showed that nature of roads was a significant determinant of neonatal and infant mortalities in rural but not in urban areas. The same trend was observed at multivariate analysis level. Rural areas with mud roads had higher odds of neonatal (aOR – 2.067) and infant (aOR - 3.867) mortalities when compared to those with tarmacked roads. Additionally, the study found number of health facilities present in a given geographical area to significantly influence post-neonatal mortality in rural areas and infant mortality in urban areas. Areas with 3 to 4 health facilities had 8.248 and 2.651 higher adjusted odds ratios of post-neonatal and infant mortalities when compared to areas with at least 5 health facilities in rural and urban areas, respectively.

Further, geographically, type of housing in which an infant resided was significantly associated with rural neonatal mortality and urban post-neonatal and infant mortalities. Residing in good housing was associated with lower odds ratios of rural neonatal (aOR – 0.016), and urban post-neonatal (aOR – 0.265) and infant (aOR – 0.312) mortalities when compared to residing in durable housing. The introduced significant relationship between

geographical factors and infant mortality at multivariate analysis level means that the geographical factors of number of health facilities and type of housing influence infant mortality independent of socioeconomic, demographic and distance factors. For instance, type of housing can be correlated with maternal occupation to some extent.

Socioeconomically, the study found level of education qualification of the mother to significantly influence infant mortality (cOR – 3.196) in rural areas and post-neonatal mortality (cOR – 1.168) in urban areas at univariate analysis level. While maternal occupation was significantly related to rural neonatal mortality (cOR – 0.470), it was insignificant in urban areas at univariate analysis level. In the final model that controlled for confounding variables, the adjusted odds ratios showed that level of education qualification of the mother significantly influenced neonatal mortality in rural areas and both post-neonatal and infant mortalities in urban areas. There was a 64.9 percent increase in the likelihood of a post-neonate dying from mothers with no education (aOR – 3.823) to mothers with primary education (aOR – 6.304) in urban areas. Mothers working in the professional/technical/managerial/clerical sectors were less likely to experience post-neonatal (aOR – 0.105) and neonatal (aOR – 0.108) mortalities when compared to mothers who were working in agriculture in rural and urban areas, respectively. This means that socioeconomic factors influence infant mortality, to some extent, through geographical, demographic and distance factors. For instance, some mothers with some secondary education at the time of survey lost their infants when they had primary education qualifications.

Demographically, results of univariate analysis indicated that age of the mother at childbirth was an important explainer of neonatal (cOR – 0.286) and post-neonatal (cOR – 3.929) mortalities in rural areas, and neonatal (cOR – 2.408) and infant (cOR – 2.891) mortalities in urban areas. Order of the index birth was significantly related to neonatal mortality in rural

areas (cOR – 1.405) and post-neonatal mortality (cOR - 2.331) in urban areas. Wait period prior to the index birth negatively influenced post-neonatal (cOR – 2.132) and infant (cOR – 1.552) mortalities in urban areas while it was insignificant in rural areas. At multivariate analysis level, age of the mother at childbirth was found to be a significant contributor to rural neonatal and post-neonatal mortalities and urban neonatal and infant mortalities. Mothers aged under 20 years had a 57.9 percent increased likelihood of experiencing neonatal mortality in urban areas. Mothers in their old reproductive ages were less likely to experience neonatal mortality (aOR – 0.005) and more likely to experience post-neonatal mortality (aOR – 1.361) when compared to their counterparts aged 20 to 34 years in rural areas. In urban areas, old mothers were more likely to experience infant mortality (aOR – 2.742) when compared to mothers aged 20 to 34 years. Order of the index birth was significant in rural neonatal (aOR – 1.881) and infant (aOR – 3.492) mortalities for the high order births and first births, respectively, while it was insignificant in urban areas. The study further observed that the significance of wait period prior to the index birth on urban post-neonatal and infant mortalities remained consistent in the full model.

As pertains to the distance covered to the nearby medical facility especially in case of maternal and infant sickness or need for medical attention such as check-ups and vaccinations, the study found distance to be significantly associated with rural neonatal mortality at univariate analysis level and urban neonatal mortality at multivariate analysis level. The study found a straight line distance of 1.1 to 3.9 kilometres to a health facility to be less likely to experience neonatal mortality in rural areas (cOR – 0.284) and more likely to experience neonatal mortality in urban areas (aOR – 2.127) relative to an at most a kilometre straight line distance. Yet still, the influence of travel time on infant mortality was insignificant at univariate analysis level but significant at multivariate analysis level. A travel

time of 31 to 60 minutes significantly influenced infant mortality in urban areas (aOR – 2.672) while that of beyond an hour significantly influenced rural infant mortality (aOR – 7.436) when compared to a travel time of an at most 30 minutes. To some extent, travel-time influenced infant mortality through nature of roads, maternal occupation that reflected financial affordability, and age of the mother at childbirth.

The study therefore found nature of roads, number of health facilities, type of housing, 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, distance and travel-time taken to reach the nearby medical facility as the major factors influencing infant mortality in rural and urban areas of Kakamega Central Sub-County. However, the most significant independent contributors to rural-urban differentials in infant mortality in Kakamega Central Sub-County were nature of roads and order of the index birth which mainly influenced rural mortalities and wait period prior to the index birth and distance which mainly influenced urban mortalities.

5.3 Conclusion

The study established that the nature of roads influenced the death of infants in that parts of the study area with tarmacked roads, where infants could reach hospitals easily and faster, experienced lower likelihoods of neonatal and infant mortalities. The more the number of health facilities present in an area, the lower the chances of infant mortality. There were generally lower likelihoods of post-neonatal and infant mortalities amongst residents in good housing than their counterparts in non-durable and durable housing.

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 sector had lower chances of neonatal and post-neonatal mortalities. Such mothers are generally economically advantaged and participate in childcare decision-making processes.

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 behavioural 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.

Further, the study recognized that beyond a kilometer mileage from one's residence to the nearby medical facility was linked to higher urban neonatal mortality. This was as a result of compromised accessibility for those neonates in need of healthcare services. Again, an increase in travel time taken to reach the nearby medical facility led to an increase in the chances of experiencing infant mortality in the study area.

5.4 Recommendations

The study recommends the following:

1. Concerted efforts towards road maintenance in rural areas of Kakamega Central Sub-County. Roads are important traffic conveyors between places, and improved roads will reduce the time mothers and infants take to reach a medical facility when need arises.

2. Encouraging beyond-primary level female education as such is associated with better economic performance and reduced fertility, factors which contribute to increased infant survival.

3. 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.

4. Encouraging the opening up of health facilities on daily basis. The researcher observed that some health facilities stayed closed over weekends and on public holidays.. Sickness does not book an appointment with a patient. Further, the health facilities need to be well-stocked with the necessary drugs and equipment, and have medical personnel on duty.

5.5 Suggested Areas for Further Research

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

1. 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.

2. 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.

3. The influence of culture on infant mortality. The current study learnt of a respondent who murdered her twin (boy and girl) infants due to cultural believes that twin births were a bad omen. Other respondents believed that their infants died after being looked at by bad-eyed people.

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APPENDICES

Appendix 1: Measurement of study variables

Variable name	Measurement
Geographical area of residence	0 = Rural residence 1 = Urban residence
Population density	0 = x≤599 1 = 600≤x≤999 2 = x≥1000
Nature of roads	0 = Tarmacked road 1 = Murram road 2 = Mud road
Number of health facilities	0 = x≥5 1 = x≤2 2 = 3≤x≤4
Type of housing	0 = Durable 1 = Non-durable 2 = Good
Level of education qualification of the mother	0 = Secondary and above 1 = None 2 = Primary
Maternal occupation	0 = Agriculture 1 = Not employed 2 = Professional/ Technical/ Managerial/ Clerical 3 = Others (Sales/Grocers/Manual/Domestic Managers)
Age of the mother at the birth of her child	0 = 20≤x≤34 1 = x<20 2 = 35≤x≤49
Order of a birth	0 = 2-3 birth order

	1 = First birth 2 = 4+ birth order
Wait period prior to the birth	> 24 months ≤ 24 months
Approximate distance covered to the nearby medical facility (in km)	0 = x≤1 1 = 1.1≤x≤3.9 2 = x≥4
Travel-time taken to the nearby medical facility (in minutes)	0 = x≤ 30 1 = 31≤x≤60 2 = x>60

Appendix 2: Informed Consent Form of the Study Participants

Gilbert Omedi Maube
c/o Friends School Senende
P. O. Private Bag - 50309
Kaimosi.
November 2022

Dear respondent,

RE: PARTICIPANT'S CONSENT FORM

Greetings,

My name is Mr. Omedi Gilbert, a PhD in Geography student at Maseno University. I am conducting a survey on rural-urban differentials in infant mortality in Kakamega Central Sub-County, Kakamega County, Kenya. Your household has been selected for the survey. The information for the survey will be obtained through oral interviewing. The provided information is going to help in meeting the objectives of this research. All your responses will be held confidential, and strictly be used for the purpose of this research. I do trust that you agree to answer the questions because the research considers your views as very invaluable. If I ask you any question you feel uncomfortable to answer, kindly let me know and I will proceed to the next question.

Signature of the respondent: ..... Date: .....

Appendix 3: Questionnaire

Background Information

Sub-County: Kakamega Central Sub-County

Ward: .....

Sub-Location: .....

Marital status of the respondent:

Single [ ] Married [ ] Widowed/Separated/Divorced [ ]

Household size: .....

Religion of the respondent:

Catholic [ ] A.C.K./Protestant/S.D.A [ ] Islam [ ] Others [ ]

Main economic activity(ies):

.....

.....

……

……

Section I: Influence of geographical factors (population density, nature of roads, number of health facilities, type of housing) on infant mortality

101: How do you categorise this geographical area of residence?

(1) Rural residence [ ]

Explain your response:

……

……

……

(2) Urban residence [ ]

Explain your response:

……

……

……

102a: Is this your permanent residence?

Yes [ ] No [ ]

102b: If yes, how long have you lived/ stayed here?

……

102c: If no, how long have you stayed here?

……

103: Do you feel your area of residence is:

Under-crowded [ ]

Crowded [ ]

Over-crowded [ ]

104: How can you generally categorise the kind of roads in your area of residence?

Mud, impassable roads [ ]

Well-maintained murram roads [ ]

Tarmacked roads [ ]

105A: How many registered health facilities are there in your area of residence?

Type	Number
105A: Government health facilities	……..
105B: Private/mission health facilities	……..
TOTAL	……..

105B: Do you think that this number of health facilities is enough to serve the people of this area of residence?

Yes [ ] No [ ]

Give reason(s) for your answer

……

……

……

106: In which category does your type of housing fall?

106A: Non-durable [ ]

Give reasons

……

……

……

106B: Good [ ]

Give reasons

……

……

……

106C: Durable [ ]

Give reasons

……

……

……

107: Do you think that the geographical area of residence has an influence on infant death?

Yes [ ]

Explain your response:

……

……

……

No [ ]

Explain your response:

……

……

……

Section II: Influence of socioeconomic factors (level of education qualification of the mother, maternal occupation) on infant mortality

201: What is your highest level of education?

None [ ] Primary [ ] Secondary [ ] Tertiary/University [ ]

202: Does the level of education influence infant death in your area of residence?

Yes [ ] No [ ]

Explain your response:

……

……

……

203a: What is the number of live children you have ever given birth to?

……..

203b: How many of those children are alive today?

……..

204a: Were all your children a result of:

Wanted pregnancies [ ] Some unwanted pregnancies [ ]

204b: *(In case of unwanted pregnancy)* What were the reasons for you not wanting the pregnancy?

I wanted to delay the births ……...

I wanted to space the births ……..

I wanted to limit the births ……...

205: Does your level of education have any influence on infant death?

Yes [ ] No [ ]

Explain your response:

……

……

……

……

……

301a: Are you employed?

Yes [ ] No [ ]

301b: *(If yes)* What kind of employment?

Self-employed: .....

Not self-employed: .....

301c: What is your type of employment?

Employed in agricultural sector [ ]

Employed in a professional/technical/managerial sector [ ]

Employed as a clerical officer [ ]

Employed in a sales and marketing service sector [ ]

Employed in a manual sector [ ]

Employed as a domestic service provider [ ]

Any other [ ]

301d: How much do you earn per month from your occupation?

……

301e: Are you involved in making decisions on how to spend earnings from your occupation?

Involved [ ] Not involved [ ] Not working/ not earning from work [ ]

302a: Does the occupation of the mother have any influence on infant death?

Yes [ ] No [ ]

Give reasons for your response: ……

……

……

……...…

302b: Might you have ever lost your baby under 1 year of age to death as a result of your occupation?

Yes [ ] No [ ]

303: Did you have the opportunity for a maternity leave?

Yes [ ] No [ ]

304: Does your type of occupation have any influence on infant death?

Yes [ ] No [ ]

Give reasons for your response: ……

……

……

……...…

Section III: Influence of demographic factors (age of the mother at the birth of her child, order of a birth and the wait period prior to the birth) on infant mortality

401: When were you born?

Month: .....

Year: .....

402: In which year did you give birth to your:

402A: 1st born? .....

402B: 2nd born? .....

402C: 3rd born? .....

402D: 4th born? .....

402E: 5th born? .....

402F: 6th born? .....

402G: 7th born? .....

402H: 8th born? .....

403a: Have you lost to death any of your livebirths before they attained one year of age?

Yes [ ]; No [ ]

403b: *(In case of a mother whose child died at infancy)* What age were you at the time of birth of the baby who died?

……..

403c: What was the cause of death of your baby?

……

(Allow me to ask you some questions about each of your baby(ies) who was(were) born alive but later on died)

404a: Did you receive any healthcare services during the pregnancy?

Yes [ ]; No [ ]

404b (i): *(If yes)* Who provided the healthcare services to you?

Doctor/Nurse: .....

Midwife: .....

Community health volunteer: .....

Traditional birth attendant: .....

Other: .....

404b (ii): *(If no)* Why didn't you receive any healthcare services?

……

……

……

404c: In which month of pregnancy were you at the time you received the first antenatal care for this pregnancy?

Month: .....

Don't remember: .....

404d: What is the number of times you received antenatal care during this pregnancy?

Number of times: .....

Don't remember: .....

405a: From where did you give birth to the baby(ies) who was/were born alive only to die during infancy?

In a public medical facility: .....

In a private medical facility: .....

At home/Other: .....

405b: From whom did you receive assistance during that childbirth delivery?

From a doctor/ nurse: .....

From a midwife: .....

From a community health volunteer: .....

From a traditional birth attendant: .....

Other: .....

500: I wish to capture the details of all your births, both alive and dead, chronologically.

01: First born

501: Sex of the child

Male [ ] Female [ ]

502: Was it a singleton or twins/triplets?

Singleton [ ] Twins/Triplets [ ]

503a: Is s/he still alive?

Yes [ ] No [ ]

503b: *(If no)* How old was s/he at death?

Days: ..... Months: ..... Years: .....

02: Second born

501: Sex of the child

Male [ ] Female [ ]

502: Was it a singleton or twins/triplets?

Singleton [ ] Twins/Triplets [ ]

503a: Is s/he still alive?

Yes [ ] No [ ]

503b: *(If no)* How old was s/he at death?

Days: ..... Months: ..... Years: .....

03: Third born

501: Sex of the child

Male [ ] Female [ ]

502: Was it a singleton or twins/triplets?

Singleton [ ] Twins/Triplets [ ]

503a: Is s/he still alive?

Yes [ ] No [ ]

503b: *(If no)* How old was s/he at death?

Days: ..... Months: ..... Years: .....

04: Fourth born

501: Sex of the child

Male [ ] Female [ ]

502: Was it a singleton or twins/triplets?

Singleton [ ] Twins/Triplets [ ]

503a: Is s/he still alive?

Yes [ ] No [ ]

503b: *(If no)* How old was s/he at death?

Days: ..... Months: ..... Years: .....

05: Fifth born

501: Sex of the child

Male [ ] Female [ ]

502: Was it a singleton or twins/triplets?

Singleton [ ] Twins/Triplets [ ]

503a: Is s/he still alive?

Yes [ ] No [ ]

503b: *(If no)* How old was s/he at death?

Days: ..... Months: ..... Years: .....

06: Sixth born

501: Sex of the child

Male [ ] Female [ ]

502: Was it a singleton or twins/triplets?

Singleton [ ] Twins/Triplets [ ]

503a: Is s/he still alive?

Yes [ ] No [ ]

503b: *(If no)* How old was s/he at death?

Days: ..... Months: ..... Years: .....

07: Seventh born

501: Sex of the child

Male [ ] Female [ ]

502: Was it a singleton or twins/triplets?

Singleton [ ] Twins/Triplets [ ]

503a: Is s/he still alive?

Yes [ ] No [ ]

503b: *(If no)* How old was s/he at death?

Days: ..... Months: ..... Years: .....

08: Eighth born

501: Sex of the child

Male [ ] Female [ ]

502: Was it a singleton or twins/triplets?

Singleton [ ] Twins/Triplets [ ]

503a: Is s/he still alive?

Yes [ ] No [ ]

503b: *(If no)* How old was s/he at death?

Days: ..... Months: ..... Years: .....

(Use an additional questionnaire I case of beyond 8 births, clearly indicating the birth order)

504: Does the age of the mother have any influence on infant death in your area of residence?

Yes [ ] No [ ]

Give reasons for your response: ……

……

……

……..…

505: In your own perception, which of the following babies are not likely to die, less likely to die, likely to die, or more likely to die, during infancy:

505A: **First births:** Not likely [ ] Less likely [ ] Likely [ ] More likely [ ]

505B: **Births within 1 year:** Not likely [ ] Less likely [ ] Likely [ ] More likely [ ]

505C: **Births within 2 years:** Not likely [ ] Less likely [ ] Likely [ ] More likely [ ]

505D: **Births within 3 years:** Not likely [ ] Less likely [ ] Likely [ ] More likely [ ]

505E: **Births after 3 year interval:** Not likely [ ] Less likely [ ] Likely [ ] More likely [ ]

Section IV: Influence of distance covered to the nearby medical facility on infant mortality

601: What is the approximate distance in kilometres to the nearby medical facility from this home?

.....

602a: How long do you take to travel to the nearby medical facility from this home?

.....

602b: By which means of transport do you travel to the nearby medical facility from this home?

Trekking/walking: .....

Motorcycle: .....

Private vehicle transport: .....

Public vehicle transport: .....

602c: How can you categorise this distance covered to the nearby medical facility from this home?

Near: .....

Far: .....

Very far: .....

603: Does distance covered to the nearby medical facility influence infant death in any way?

Yes [ ] No [ ]

Explain your response:

……

……

……

604: In your opinion, is there any need for the government to build more healthcare facilities in this Sub-County?

Yes [ ] No [ ]

Explain your response:

……

……

……

605a: Are there any other ways of reducing infant deaths we might have left out?

Yes [ ] No [ ]

605b: *(If yes)* Kindly list them.

……

……

……

Appendix 4: Interview schedule for key informants

Rural-urban differentials in infant mortality in Kakamega Central Sub-County, Kakamega County, Kenya

Occupation of the key informant: …….
Work station: ……

1. (a) Briefly describe the geographical area of your residence.

(b) Explain the state of infant mortality in your residence.

2. (a) In which geographical area of residence do we anticipate infant mortality to be higher: rural area or urban area?

(b) What are some of the reasons for your response in 2 (a)?

3. Explain how infant mortality varies with:

(a) Population density in a geographical area.

(b) Nature of roads in a geographical area.

(c) Number of health facilities in a geographical area.

(d) Type of housing in which an infant lives/stays.

4. (a) What is the status of women education in your residence?

(b) Kindly explain how level of education qualification of the mother influences infant mortality.

5. (a) Explain the status of occupation/employment of mothers in your residence.

(b) (i) Does occupation of the mother relate with infant mortality in any way?

(ii) Give reasons for your response.

6. (a) What are the most at risk maternal ages on infant mortality?

(b) Kindly give reasons for your observation(s) in 4 (a)?

7. (a) Explain how infant mortality varies with birth order?

(b) Explain how infant mortality varies with wait period prior to a birth?

8. (a) Explain the general distance/mileage coverage to medical facilities in your area.

(b) Explain how distance covered to the nearby medical facility influences infant mortality in Kakamega Central Sub-County in terms of:

(i) Approximate distance between one's residence and the nearby medical facility.

(ii) Travel-time taken by a patient/client from their home residence to the nearby medical facility.

9. What are some of the measures being put in place to reduce infant mortality in Kakamega Central Sub-County?

Appendix 5: Observation checklist

Rural-urban differentials in infant mortality in Kakamega Central Sub-County, Kakamega County, Kenya

The following observations will be made at every targeted household of study:

1. Presence of build-up areas
2. Main economic activity(ies) in an area
3. Population and settlement
4. Number and type of health facilities present in an area
5. Nature of roads in an area
6. Means of transport used in an area
7. Type of housing in a homestead
8. General hygiene of the homestead

Appendix 6: ANOVA with Cochran's Reliability Test

		Sum of Squares	df	Mean Square	Cochran's Q	Sig.
Between People		15.996	23	0.695		
Within People	Between Items	44.068	10	4.407	51.753	0.000
	Residual	160.295	230	0.697		
	Total	204.364	240	0.852		
Total		220.360	263	0.838		
Grand Mean = .8674						

Appendix 7: Verbatim responses from key informant interviews

A: Interview schedule for a Senior Population Programs Officer at the National Council for Population and Development (NCPD)

1. (a) Briefly describe the geographical area of Kakamega Central Sub-County.

It is both rural and urban as evidenced by varied activities

(b) Explain the state of infant mortality in Kakamega Central Sub-County.

It is slightly higher than the national level

2. (a) In which geographical area of residence do we anticipate infant mortality to be higher: rural area or urban area?

Urban

(b) What are some of the reasons for your response in 2 (a)?

Because of high urban poor population. Urban poor settlements (slums) generally have poor health indicators and high fertility and mortality. Second, women in urban areas are mostly engaged in labour force thus most cannot afford the exclusive breastfeeding for the initial six months after birth while some abandon breastfeeding altogether thus exposing their infants to low immunities. Such women are more likely to leave their infants under the care of house-helps who might not take good care of the children. Fourth, working women are less likely to provide emotional care for their babies as most times they are away from home

3. Explain how infant mortality varies with population density, nature of roads, number of health facilities, and type of housing in which an infant lives.

Less-crowded areas have a lower mortality likelihood compared to crowded areas. Disease spread is quick and easy in crowded environments and this might jeopardise infant lives.

Poor roads make access to the nearest health facility to be undermined. When roads are poor (mud roads), transport becomes a problem in terms of few public vehicles and the transport cost is likely to be prohibitive. The health facility may also be more interior from the available access road.

Some health facilities have a likelihood of overcrowding of patients and fewer health workers. Such facilities are also likely to lack equipment or skilled human resource to operate them. Essential medicines easily get stocked out. Such facilities may be incapable of handling emergencies. They would also be spread over long distances making referral a nightmare

Durable housing may suffer the issue of exposure of the infant to cold. The good housing has the possibility of maintaining warm temperatures compared to bricked/stoned/tiled structure. Again, a durable housing is a sign of higher socio-economic household where the infant's mother could be working thus leaving the infant under the care of someone else while in the good housing structure, the mother could likely be a housewife therefore caring and nursing her baby ensuring proper feeding, a clean environment, frequent breastfeeding, clean feeding utensils, holding the infant for warmth, etc.

4. (a) What is the status of women education in your residence?

Moderate

(b) Kindly explain how level of education qualification of the mother influences infant mortality.

Educated women are more likely to participate in labourforce compared with those who are uneducated those less likely to fully care for their infants. They have less time with the infant and breastfeeding, an important component of a baby's growth and immunity as well as emotional connection, may be compromised

5. (a) Explain the status of occupation/employment of mothers in your residence.

Mostly engaged in some sort of labourforce

(b) (i) Does occupation of the mother relate with infant mortality in any way?

Yes.

(ii) Give reasons for your response.

Working mothers spend little time with their infants, thus less time for baby to build immunity through breastfeeding and quality care; babies are left in the care of a nanny who might have little or no clue on baby care or just mistreat the baby or expose the infant to health risks knowingly or unknowingly. Lack of emotional touch between mother and infant can lead to depression for both

On the flipside, mothers in the professional sector are more likely to earn better than those in the agricultural sector therefore better placed to ensure the infant feeds well, has a clean and safe environment, etc. 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 breast-milk.

6. (a) What are the most at risk maternal ages on infant mortality?

Before 20 years and after 40 years

(b) Kindly give reasons for your observation(s) in 5 (a)?

The younger ones 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 keeping the child - neglect. They may even fail to seek antenatal care services

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

7. (a) Explain how infant mortality varies with birth order?

Research notes that first births are high risk for child survival maybe due to less child care knowledge or adolescent births. Some girls give birth when their reproductive organs are not fully developed. Higher birth orders are also a risk

(b) Explain how infant mortality varies with wait period prior to a birth?

When births are spaced between 24 months and over, child survival is higher. Too closely spaced births are risky for child survival

8. (a) Explain the general distance/mileage coverage to medical facilities in Kakamega Central Sub-County.

It is varied with some people being closer to medical facilities while others are living far from medical facilities

(b) Explain how distance covered to the nearest medical facility influences infant mortality in Kakamega Central Sub-County in terms of approximate distance and travel time.

Distance compromises accessibility for those who need healthcare services. If the health facility is far off, this is likely to lead to delays in deciding or availing of transport costs to access services. Distance can also force a healthcare seeker to decide to seek services of a TBA instead of a skilled birth attendant putting the life of a mother and her infant at risk should any complication arise.

Also, a longer travel time may be related to a prohibitive cost of travel. The mother may choose not to seek care because it may mean a full day activity yet she may not have that time - e.g. if employed and paid per actual work done, it might be difficult to forego the work.

9. What are some of the measures being put in place to reduce infant mortality in Kakamega Central Sub-County?

Sensitization of communities on quality of care during pregnancy including importance of nutrition and ANC; sensitization on importance of skilled deliveries; family planning to support appropriate birth spacing; Breastfeeding; care of premature babies (Kangaroo care); counties encouraged to consider maternity sheds/homes where expectant women from far off villages or those carrying high risk pregnancies can be accommodated as their due dates approach. Health care facilities should have maternity wings for specialized care as well as be well equipped to handle emergency situations. TBA have been sensitized to refer clients for skilled health care services during pregnancy, delivery and after delivery

Thank you.

B: Interview schedule for a Public Health Officer at Kakamega

1. (a) Briefly describe the geographical area of your residence.

Response: I stay in Kakamega Municipality

(b) Explain the state of infant mortality in your residence.

Response: With high birth rates in Kakamega, it is obviously expected that child deaths must also be high as not all children born will survive in their first month. Moreover, common diseases that affect pregnant women and infants such as Malaria and diarrhoea are rampant in this region, with little solutions available yet. We know the County Government is doing their part in resolving this situation, but it is a continuous progress that is fairly slow.

2. (a) In which geographical area of residence do we anticipate infant mortality to be higher: rural area or urban area?

Response: Obviously in rural areas.

(b) What are some of the reasons for your response in 2 (a)?

Response: You know, in rural areas, access to quality healthcare is scarce. Additionally, levels of education among the women in rural areas in lower compared to their urban counterparts. Then there is the issue of household economics – ability to purchase health services: in rural areas, there is usually low purchasing power among many households, unlike in urban areas where people can afford to pay for good health services, including medication. I also mentioned about the common ailments – Malaria and diarrhoea, in urban areas, families are able to access bed nets and clean water for drinking, which is not the case in rural areas.

3. Explain how infant mortality varies with population density, nature of roads, number of health facilities, and type of housing in which an infant lives.

Response: There is generally high proportions of infant mortality is densely populated areas, areas with poor/mud roads that are impassable especially during rainy seasons, where health facilities are few and constrained, and in unhygienic houses.

4. (a) What is the status of women education in your residence?

Response: Education of women in urban sections of Kakamega is fairly high, as majority of those who live in the urban centres have completed secondary education. However, looking at the picture of rural areas, which form the greater part of the county, we note that women's education is still very low. You see, the population of this county is predominantly agricultural, meaning people tend to spend more of their time in the farms, such as sugarcane farmers, at the expense of going to school, thus education levels are still low

(b) Kindly explain how level of education qualification of the mother influences infant mortality.

Response: There is evidence that women with higher education levels are more likely to take care of their children, including taking them to the health facility for check-ups and medication, thus lower 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 will be able to afford healthcare services for their children.

5. (a) Explain the status of occupation/employment of mothers in your residence.

Response: As I had mentioned earlier on, women in this urban municipality are engaged in business or in formal employment. This is contrary to the situation in rural areas where women are mainly involved in agriculture and informal odd jobs.

(b) (i) Does occupation of the mother relate with infant mortality in any way?

Response: Yes.

(ii) Give reasons for your response.

Response: Mothers working in gainful employment are more likely to afford good healthcare for themselves and their young children

6. (a) What are the most at risk maternal ages on infant mortality?

Response: Young mothers aged below 20 years

(b) Kindly give reasons for your observation(s) in 4 (a).

Response: Young mothers are at greater risk as their reproductive systems are not fully developed. Our programs that target adolescents encourage them to live healthy lives and avoid pregnancies as it may lead to their death or death of their babies

7. (a) Explain how infant mortality varies with birth order?

Response: As a woman gives birth to many children, their reproductive system gets worn out. What I mean here is that a new pregnancy for a woman who already has seven children has higher chance of leading to the death of that infant, compared to the previous seven.

(b) Explain how infant mortality varies with wait period prior to a birth?

Response: We often encourage women to space their births appropriately so that there is no burden on their reproductive system. When there is high burden, there is increased possibility of death of the child born

8. (a) Explain the general distance/mileage coverage to medical facilities in your area.

Response: In the town, the distance to the health facilities is not a big issue. However, the issue comes in when someone has to travel to the health facility using public transport or boda boda, yet they are unable to afford the cost of transport. The people who live in rural areas still have the challenge of distance to the health facility, and we have had several cases of pregnant women dying on their way to the hospital. When we conduct verbal autopsy, we realize that such deaths would have been avoided if the health facilities were closer to our people

(b) Explain how distance covered to the nearest medical facility influences infant mortality in Kakamega Central Sub-County in terms of approximate distance and travel time.

Response: The longer the distance the higher the chances of infant mortality. This is because of the travel time taken to access health services, and there is no guarantee that services are offered in all our health facilities 24 hours a day! A patient can also lack or fail to afford proper means of transport to reach the nearby medical facility.

Construction of more medical facilities will help reduce on transport costs, travel time and congestion in the current medical facilities.

9. What are some of the measures being put in place to reduce infant mortality in Kakamega Central Sub-County?

Response: Engaged more Community Health Workers (CHVs) to enhance identification and referrals from the communities to the health facilities

Providing messages on common illnesses among infants, and also providing basic commodities that are essential for averting ailments to young children, such as bed nets and feeding equipment.

Encouraging mothers of young children to be coming to the health facility regularly.

Initiation of linda mama programs.

Encouraging pregnant women to seek a minimum of 8 ANC services, and also to deliver at the health facility.

C: Interview schedule for a Community Health Volunteer at Mahiakalo

1. (a) Briefly describe the geographical area of your residence.

Response: Part of Mahiakalo ward area is within the municipality and the Kakamega tropical forest therefore it means some part is sub urban and other parts are rural.
The population of the ward is about 12,000 people according to the KDHS data on population.
Most of the terrain is tarmac, and majority of the residents are either peasant farmers or unemployed

(b) Explain the state of infant mortality in your residence.

Response: Infant mortality is contributed by; Malnutrition, Home delivery, Cultural practices (abandonment of infant to die to cleanse self/community) in case of incest, Religious beliefs that brainwash mothers to attend antenatal and postnatal health services, Malaria, Pneumonia, and Teen pregnancies

2. (a) In which geographical area of residence do we anticipate infant mortality to be higher: rural area or urban area?

Response: Both rural and urban areas

(b) What are some of the reasons for your response in 2 (a)?

Response:
We anticipate higher infant mortality in any area characterised by: Poor roads, Poor health infrastructure, Inadequate workforce at the health facilities, No emergency service during odd hrs (at night), Ignorance on the part of the parents, Obsolete knowledge, attitude and practices, and Challenging socio economic status

3. Explain how infant mortality varies with population density, nature of roads, number of health facilities, and type of housing in which an infant lives.

Response: Majority of deaths occur in the very crowded and unhygienic environments, areas with poor, inaccessible roads, areas with out-of-reach medical centres, and extremes of housing, either slum-like housing or very high class housing sometimes).

4. (a) What is the status of women education in your residence?

Response: Majority of women in this area never went to secondary or higher learning institutions. Majority are either primary school drop outs or never completed secondary.

(b) Kindly explain how level of education qualification of the mother influences infant mortality.

Response: Education of the mother helps one make responsible choices in life and MNC health.

5. (a) Explain the status of occupation/employment of mothers in your residence.

Response: Majority of the women are homemakers, peasant farmers

(b) (i) Does occupation of the mother relate with infant mortality in any way?

Response: Yes,

(ii) Give reasons for your response.

Response: A good occupation will give a mother some income which can be used to acquire goods and services that can promote health hence reducing or preventing mortality and morbidity

6. (a) What are the most at risk maternal ages on infant mortality?

Response: Mothers under 20 years

(b) Kindly give reasons for your observation(s) in 4 (a).

Response: Most of their children are never exclusively breastfed, leading to malnutrition. Some of these mothers have undeveloped reproductive systems and some do not adhere to ANC visits

7. (a) Explain how infant mortality varies with birth order?

Response: Firstborns and births of high orders are more likely to die than 2nd and 3rd borns

(b) Explain how infant mortality varies with wait period prior to a birth?

Response: The longer the wait the lesser the chances of mortality, enough time to cater for the child at hand can reduce the risk of 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

8. (a) Explain the general distance/mileage coverage to medical facilities in your area.

Response: The distance is not too far, about 50m to 6km

(b) Explain how distance covered to the nearest medical facility influences infant mortality in Kakamega Central Sub-County in terms of approximate distance and travel time.

Response: Only at night can the distance influence infant mortality due to lack of quick means of transport. Some areas are very insecure and mothers may fear long trek to hospitals at night

9. What are some of the measures being put in place to reduce infant mortality in Kakamega Central Sub-County?

Response: Prompt referrals by CHVs'

Linda mama care that takes care of medical bills

Appendix 8: Multinomial logistic regression models of the association of neonatal mortality with geographical, socioeconomic, demographic and distance factors in rural areas of Kakamega Central Sub-County

Model 1: Geographical factor

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Population density					
x≤599	-	-	-	-	-
600≤x≤999	0.365	0.536	0.496	1.441	0.504 - 4.122
x≥1000	-	-	-	-	-
Nature of roads					
Tarmacked roads	-	-	-	-	-
Murram roads	0.164	0.582	0.779	1.178	0.376 - 3.689
Mud roads	2.210	0.771	0.004	9.116	2.010 - 41.337
Number of health facilities					
x≥5	-	-	-	-	-
x≤2	1.029	1.253	0.412	2.798	0.240 - 32.621
3≤x≤4	-0.539	0.646	0.404	0.583	0.165 - 2.068
Type of housing					
Durable housing	-	-	-	-	-
Non-durable housing	0.005	0.635	0.994	1.005	0.289 - 3.489
Good housing	-0.626	1.379	0.650	0.535	0.036 - 7.976

Model 2: Socioeconomic factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Level of education qualification of the mother					
Secondary+	-	-	-	-	-
None	0.264	0.491	0.590	1.303	0.498 - 2.882
Primary	1.332	1.078	0.217	3.787	0.458 - 31.312
Maternal occupation					
Agriculture	-	-	-	-	-
Not employed	0.075	0.502	0.882	1.078	0.403 - 2.882
Pro./Tech./Man./Clerical	0.139	0.555	0.802	1.149	0.388 - 3.408
Other	-0.754	0.776	0.031	0.470	0.103 - 2.152

Model 3: Demographic factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Age of the mother at the birth of her child					
20≤x≤34	-	-	-	-	-
x<20	0.088	0.613	0.886	1.092	0.328 - 3.632
35≤x≤49	-1.253	0.661	0.048	0.286	0.078 - 1.043
Order of the index birth					
2 - 3 birth	-	-	-	-	-
First birth	0.340	0.518	0.011	1.405	0.509 - 3.880
4+ birth	-0.395	0.493	0.423	0.674	0.256 - 1.770
Wait period prior to the index birth					
> 24 months	-	-	-	-	-
≤ 24 months	-0.474	0.611	0.438	0.622	0.188 - 2.062

Model 4: Distance factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Distance (in kilometers)					
x≤1	-	-	-	-	-
1.1≤x≤3.9	-1.259	0.610	0.039	0.284	0.086 - 0.939
x≥4	-0.704	0.498	0.158	0.495	0.186 - 1.313
Travel-time (in minutes)					
x≤ 30	-	-	-	-	-
31≤x≤60	-0.270	0.660	0.682	0.763	0.209 - 2.781
x>60	-0.010	0.677	0.988	0.990	0.263 - 3.733

Model 5: Full model

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Population density					
x≤599	-	-	-	-	-
600≤x≤999	1.709	1.769	0.334	5.524	0.173 - 176.883
x≥1000	-	-	-	-	-
Nature of roads					
Tarmacked roads	-	-	-	-	-
Murram roads	-0.893	1.332	0.503	0.409	0.030 - 5.572
Mud roads	3.029	1.513	0.045	2.067	1.065 - 4.012
Number of health facilities					
x≥5	-	-	-	-	-
x≤2	0.039	2.534	0.988	1.039	0.007 - 149.082

3≤x≤4	-1.601	1.620	0.323	0.202	0.008 - 4.826
Type of housing					
Durable housing	-	-	-	-	-
Non-durable housing	1.039	1.877	0.580	2.827	0.071 - 111.912
Good housing	-4.112	2.268	0.050	0.016	0.000 - 1.394
Level of education qualification of the mother					
Secondary+	-	-	-	-	-
None	2.951	1.426	0.039	1.913	1.169 - 3.131
Primary	4.481	2.406	0.063	2.832	0.791 - 9.616
Maternal occupation					
Agriculture	-	-	-	-	-
Not employed	-0.323	1.087	0.766	0.724	0.086 - 6.093
Pro./Tech./Man./Clerical	1.945	1.433	0.175	6.995	0.422 - 115.997
Other	-3.407	2.285	0.136	0.033	0.000 - 2.921
Age of the mother at the birth of her child					
20≤x≤34	-	-	-	-	-
x<20	-0.753	1.464	0.607	0.471	0.027 - 8.301
35≤x≤49	-5.240	2.243	0.019	0.005	0.0001 - 0.430
Order of the index birth					
2 - 3 birth	-	-	-	-	-
First birth	1.709	1.156	0.139	5.522	0.573 - 53.255
4+ birth	0.632	0.597	0.013	1.881	0.584 - 6.063
Wait period prior to the index birth					
> 24 months	-	-	-	-	-
≤ 24 months	-0.649	1.202	0.589	0.522	0.049 - 5.513
Distance (in kilometers)					
x≤1	-	-	-	-	-
1.1≤x≤3.9	-0.695	1.388	0.616	0.499	0.033 - 7.574
x≥4	0.115	1.064	0.914	1.122	0.139 - 9.033
Travel-time (in minutes)					
x≤ 30	-	-	-	-	-
31≤x≤60	1.993	1.960	0.309	7.336	0.157 - 342.043
x>60	2.705	1.787	0.130	14.957	0.451 - 496.11

Appendix 9: Multinomial logistic regression models of the association of post-neonatal mortality with geographical, socioeconomic, demographic and distance factors in rural areas of Kakamega Central Sub-County

Model 1: Geographical factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Population density					
x≤599	-	-	-	-	-
600≤x≤999	-0.082	0.420	0.845	0.921	0.404 - 2.099
x≥1000	-	-	-	-	-
Nature of roads					
Tarmacked roads	-	-	-	-	-
Murram roads	0.130	0.572	0.821	1.138	0.371 - 3.494
Mud roads	-0.382	0.423	0.367	0.683	0.298 - 1.564
Number of health facilities					
x≥5	-	-	-	-	-
x≤2	-0.487	0.829	0.557	0.615	0.121 - 3.119
3≤x≤4	0.368	0.535	0.492	1.445	0.506 - 4.125
Type of housing					
Durable housing	-	-	-	-	-
Non-durable housing	0.071	0.552	0.897	1.074	0.364 - 3.170
Good housing	1.967	0.570	0.237	3.507	0.936 - 4.596

Model 2: Socioeconomic factors

Exposure variable	β	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Level of education qualification of the mother					
Secondary+	-	-	-	-	-
None	0.276	0.421	0.511	1.318	0.578 - 3.005
Primary	0.628	0.693	0.365	1.874	0.482 - 7.292
Maternal occupation					
Agriculture	-	-	-	-	-
Not employed	0.169	0.432	0.696	1.184	0.507 - 2.764
Pro./Tech./Man./Clerical	-0.023	0.460	0.961	0.978	0.397 - 2.410
Other	0.275	0.776	0.723	1.317	0.288 - 6.023

Model 3: Demographic factors

Exposure variable	β	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Age of the mother at the birth of her child					
20≤x≤34	-	-	-	-	-
x<20	0.573	0.457	0.210	1.774	0.724 - 4.345
35≤x≤49	1.368	0.634	0.031	3.929	1.133 - 13.619
Order of the index birth					
2 - 3 birth	-	-	-	-	-
First birth	0.417	0.418	0.319	1.517	0.669 - 3.443
4+ birth	0.484	0.445	0.276	1.623	0.679 - 3.883
Wait period prior to the index birth					
> 24 months	-	-	-	-	-
≤ 24 months	0.169	0.449	0.706	1.184	0.492 - 2.853

Model 4: Distance factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Distance (in kilometers)					
x≤1	-	-	-	-	-
1.1≤x≤3.9	0.781	0.605	0.197	2.183	0.666 - 7.152
x≥4	-0.048	0.384	0.901	0.953	0.449 - 2.025
Travel-time (in minutes)					
x≤ 30	-	-	-	-	-
31≤x≤60	0.236	0.491	0.630	1.267	0.484 - 3.315
x>60	0.366	0.500	0.464	1.442	0.541 - 3.843

Model 5: Full model

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Population density					
x≤599	-	-	-	-	-
600≤x≤999	-0.913	0.925	0.324	0.402	0.066 - 2.458
x≥1000	-	-	-	-	-
Nature of roads					
Tarmacked roads	-	-	-	-	-
Murram roads	0.598	1.062	0.574	1.818	0.227 - 14.57
Mud roads	-0.184	0.675	0.785	0.832	0.221 - 3.124
Number of health facilities					
x≥5	-	-	-	-	-
x≤2	2.107	1.687	0.212	8.225	0.301 - 224.441

3≤x≤4	2.224	1.146	0.042	9.248	0.979 - 87.389
Type of housing					
Durable housing	-	-	-	-	-
Non-durable housing	-0.579	0.967	0.550	0.561	0.084 - 3.734
Good housing	1.739	3.103	0.996	3.575	0.000
Level of education qualification of the mother					
Secondary+	-	-	-	-	-
None	-0.794	0.701	0.258	0.452	0.114 - 1.787
Primary	0.068	1.152	0.953	1.071	0.112 10.228
Maternal occupation					
Agriculture	-	-	-	-	-
Not employed	-0.567	0.763	0.457	0.567	0.127 - 2.531
Pro./Tech./Man./Clerical	-2.255	0.943	0.017	0.105	0.017 - 0.666
Other	1.983	2.116	0.994	2.373	0.000
Age of the mother at the birth of her child					
20≤x≤34	-	-	-	-	-
x<20	1.164	0.915	0.203	3.203	0.533 - 19.266
35≤x≤49	2.611	1.518	0.035	1.361	0.695 -2.665
Order of the index birth					
2 - 3 birth	-	-	-	-	-
First birth	0.677	0.771	0.380	1.968	0.434 - 8.924
4+ birth	0.843	0.709	0.235	2.324	0.579 - 9.334
Wait period prior to the index birth					
> 24 months	-	-	-	-	-
≤ 24 months	0.689	0.672	0.305	1.992	0.533 - 7.436
Distance (in kilometers)					
x≤1	-	-	-	-	-
1.1≤x≤3.9	-0.092	1.098	0.933	0.912	0.106 - 7.845
x≥4	-0.877	0.687	0.202	0.416	0.108 - 1.599
Travel-time (in minutes)					
x≤ 30	-	-	-	-	-
31≤x≤60	1.143	1.133	0.313	3.137	0.341 - 28.877
x>60	0.948	1.110	0.393	2.581	0.293 - 22.721

Appendix 10: Multinomial logistic regression models of the association of infant mortality with geographical, socioeconomic, demographic and distance factors in rural areas of Kakamega Central Sub-County

Model 1: Geographical factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Population density					
x≤599	-	-	-	-	-
600≤x≤999	0.143	0.393	0.716	1.154	0.534 - 2.493
x≥1000	-	-	-	-	-
Nature of roads					
Tarmacked roads	-	-	-	-	-
Murram roads	0.221	0.505	0.062	1.247	0.463 - 3.358
Mud roads	0.731	0.394	0.044	2.077	0.959 - 4.499
Number of health facilities					
x≥5	-	-	-	-	-
x≤2	0.049	0.804	0.952	1.050	0.217 - 5.08
3≤x≤4	-0.101	0.492	0.837	0.904	0.345 - 2.369
Type of housing					
Durable housing	-	-	-	-	-
Non-durable housing	0.059	0.499	0.906	1.061	0.399 - 2.822
Good housing	0.776	1.268	0.541	2.173	0.181 - 26.089

Model 2: Socioeconomic factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Level of education qualification of the mother					
Secondary+	-	-	-	-	-
None	0.394	0.383	0.303	1.484	0.700 - 3.144
Primary	1.162	0.634	0.047	3.196	0.922 - 11.07
Maternal occupation					
Agriculture	-	-	-	-	-
Not employed	0.193	0.400	0.630	1.213	0.553 - 2.658
Pro./Tech./Man./Clerical	0.064	0.436	0.884	1.066	0.453 - 2.505
Other	-0.319	0.672	0.635	0.727	0.195 - 2.714

Model 3: Demographic factors

Exposure variable	β	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Age of the mother at the birth of her child					
20≤x≤34	-	-	-	-	-
x<20	0.584	0.455	0.199	1.793	0.736 - 4.371
35≤x≤49	0.137	0.550	0.803	1.147	0.390 - 3.370
Order of the index birth					
2 - 3 birth	-	-	-	-	-
First birth	0.560	0.394	0.156	1.750	0.808 - 3.790
4+ birth	0.140	0.413	0.735	1.150	0.512 - 2.583
Wait period prior to the index birth					
> 24 months	-	-	-	-	-
≤ 24 months	-0.098	0.423	0.816	0.906	0.396 - 2.076

Model 4: Distance factors

Exposure variable	β	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Distance (in kilometers)					
x≤1	-	-	-	-	-
1.1≤x≤3.9	-0.293	0.502	0.559	0.746	0.279 - 1.997
x≥4	-0.427	0.364	0.240	0.653	0.320 - 1.331
Travel-time (in minutes)					
x≤ 30	-	-	-	-	-
31≤x≤60	0.073	0.473	0.877	1.076	0.426 - 2.718
x>60	0.333	0.479	0.487	1.395	0.546 - 3.566

Model 5: Full model

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Population density					
x≤599	-	-	-	-	-
600≤x≤999	-0.429	0.839	0.609	0.651	0.126 - 3.372
x≥1000	-	-	-	-	-
Nature of roads					
Tarmacked roads	-	-	-	-	-
Murram roads	0.191	0.777	0.806	1.210	0.264 - 5.546
Mud roads	1.352	0.651	0.038	3.867	1.079 - 3.857
Number of health facilities					
x≥5	-	-	-	-	-
x≤2	1.086	1.328	0.414	2.962	0.219 - 9.988

3≤x≤4	0.310	0.827	0.708	1.363	0.270 - 6.891
Type of housing					
Durable housing	-	-	-	-	-
Non-durable housing	0.433	0.914	0.635	1.543	0.257 - 9.260
Good housing	1.060	1.657	0.523	2.885	0.112 - 74.26
Level of education qualification of the mother					
Secondary+	-	-	-	-	-
None	0.654	0.588	0.266	1.923	0.608 - 6.082
Primary	1.129	0.930	0.225	3.094	0.500 - 19.16
Maternal occupation					
Agriculture	-	-	-	-	-
Not employed	-0.294	0.629	0.640	0.745	0.217 - 2.556
Pro./Tech./Man./Cler.	-0.635	0.715	0.375	0.530	0.130 - 2.155
Other	-0.152	1.272	0.905	0.859	0.071 - 10.382
Age of the mother at the birth of her child					
20≤x≤34	-	-	-	-	-
x<20	0.669	0.796	0.401	1.952	0.410 - 9.293
35≤x≤49	-1.108	1.149	0.335	0.330	0.035 - 3.141
Order of the index birth					
2 - 3 birth	-	-	-	-	-
First birth	1.250	0.642	0.051	3.492	0.992 - 2.291
4+ birth	0.447	0.451	0.322	1.563	0.646 - 3.786
Wait period prior to the index birth					
> 24 months	-	-	-	-	-
≤ 24 months	0.216	0.564	0.702	1.241	0.411 - 3.748
Distance (in kilometers)					
x≤1	-	-	-	-	-
1.1≤x≤3.9	-0.703	0.847	0.406	0.495	0.094 - 2.603
x≥4	-0.524	0.607	0.388	0.592	0.180 - 1.948
Travel-time (in minutes)					
x≤ 30	-	-	-	-	-
31≤x≤60	1.749	1.058	0.098	5.747	0.723 - 4.569
x>60	2.006	1.051	0.046	7.436	0.948 - 5.834

Appendix 11: Multinomial logistic regression models of the association of neonatal mortality with geographical, socioeconomic, demographic and distance factors in urban areas of Kakamega Central Sub-County

Model 1: Geographical factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Population density					
x≤599	-	-	-	-	-
600≤x≤999	-	-	-	-	-
x≥1000	0.427	0.510	0.402	1.533	0.564 - 4.164
Nature of roads					
Tarmacked roads	-	-	-	-	-
Murram roads	-0.072	0.354	0.838	0.930	0.465 - 1.862
Mud roads	0.314	1.116	0.778	1.369	0.154 - 12.202
Number of health facilities					
x≥5	-	-	-	-	-
x≤2	-	-	-	-	-
3≤x≤4	-0.498	0.521	0.339	0.608	0.219 - 1.687
Type of housing					
Durable housing	-	-	-	-	-
Non-durable housing	-0.161	0.380	0.672	0.852	0.405 - 1.792
Good housing	0.386	0.457	0.399	1.471	0.600 - 3.606

Model 2: Socioeconomic factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Level of education qualification of the mother					
Secondary+	-	-	-	-	-
None	-0.127	0.370	0.731	0.881	0.427 - 1.818
Primary	-0.740	0.456	0.104	0.477	0.195 - 1.165
Maternal occupation					
Agriculture	-	-	-	-	-
Not employed	0.512	1.094	0.640	1.668	0.195 - 14.249
Pro./Tech./Man./Clerical	-0.439	0.353	0.213	0.645	0.323 - 1.287
Other	-0.177	0.596	0.766	0.838	0.260 - 2.695

Model 3: Demographic factors

Exposure variable	β	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Age of the mother at the birth of her child					
20 - 34 years	-	-	-	-	-
< 20 years	0.879	0.478	0.046	2.408	0.943 - 6.148
35 - 49 years	0.886	0.550	0.107	2.424	0.825 - 7.125
Order of the index birth					
2 - 3 birth	-	-	-	-	-
First birth	0.393	0.448	0.381	1.481	0.616 - 3.562
4+ birth	-0.399	0.400	0.318	0.671	0.307 - 1.469
Wait period prior to the index birth					
> 24 months	-	-	-	-	-
≤ 24 months	-0.580	0.504	0.250	0.560	0.208 - 1.504

Model 4: Distance factors

Exposure variable	β	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Distance (in kilometers)					
x≤1	-	-	-	-	-
1.1≤x≤3.9	0.587	0.633	0.354	1.799	0.520 - 6.225
x≥4	0.199	0.605	0.742	1.220	0.372 - 3.997
Travel-time (in minutes)					
x≤ 30	-	-	-	-	-
31≤x≤60	-0.350	1.163	0.764	0.705	0.072 - 6.883
x>60	0.594	1.217	0.625	1.812	0.167 - 19.663

Model 5: Full model

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Population density					
x≤599	-	-	-	-	-
600≤x≤999	-	-	-	-	-
x≥1000	-0.366	1.076	0.734	0.694	0.084 - 5.719
Nature of roads					
Tarmacked roads	-	-	-	-	-
Murram roads	-0.220	0.746	0.767	0.802	0.186 - 3.459
Mud roads	1.641	2.461	0.669	1.641	1.341 - 7.495
Number of health facilities					
x≥5	-	-	-	-	-
x≤2				-	-

3≤x≤4	0.366	1.076	0.734	1.442	0.175 - 11.886
Type of housing					
Durable housing	-	-	-	-	-
Non-durable housing	-0.985	0.988	0.319	0.373	0.054 - 2.589
Good housing	-0.207	0.944	0.827	0.813	0.128 - 5.174
Level of education qualification of the mother					
Secondary+	-	-	-	-	-
None	-0.703	0.968	0.468	0.495	0.074 - 3.300
Primary	0.977	1.575	0.535	2.656	0.121 - 58.216
Maternal occupation					
Agriculture	-	-	-	-	-
Not employed	1.553	9.048	0.099	1.556	0.000
Pro./Tech./Man./Clerical	-2.228	1.017	0.028	0.108	0.015 - 0.791
Other	0.025	1.127	0.982	1.025	0.113 - 9.335
Age of the mother at the birth of her child					
20 - 34 years	-	-	-	-	-
< 20 years	2.760	1.327	0.038	1.579	0.117 - 2.307
35 - 49 years	2.147	7.029	0.998	2.123	0.000
Order of the index birth					
2 - 3 birth	-	-	-	-	-
First birth	-0.835	0.847	0.324	0.434	0.082 - 2.282
4+ birth	1.376	4.232	0.882	2.130	0.947 - 1.913
Wait period prior to the index birth					
> 24 months	-	-	-	-	-
≤ 24 months	0.435	0.774	0.574	1.545	0.339 - 7.049
Distance (in kilometers)					
x≤1	-	-	-	-	-
1.1≤x≤3.9	3.057	1.468	0.037	2.127	1.197 - 3.781
x≥4	1.278	1.360	0.348	3.588	0.249 - 51.603
Travel-time (in minutes)					
x≤ 30	-	-	-	-	-
31≤x≤60	1.875	1.927	0.331	6.524	0.149 - 28.512
x>60	2.906	2.101	0.167	18.28	0.297 - 11.231

Appendix 12: Multinomial logistic regression models of the association of post-neonatal mortality with geographical, socioeconomic, demographic and distance factors in urban areas of Kakamega Central Sub-County

Model 1: Geographical factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Population density					
x≤599	-	-	-	-	-
600≤x≤999	-	-	-	-	-
x≥1000	-0.348	0.378	0.358	0.706	0.336 - 1.482
Nature of roads					
Tarmacked roads	-	-	-	-	-
Murram roads	0.015	0.301	0.960	1.015	0.563 - 1.832
Mud roads	-0.652	0.758	0.390	0.521	0.118 - 2.303
Number of health facilities					
x≥5	-	-	-	-	-
x≤2				-	-
3≤x≤4	0.453	0.394	0.250	1.574	0.727 - 3.407
Type of housing					
Durable housing	-	-	-	-	-
Non-durable housing	0.160	0.338	0.637	1.173	0.605 - 2.277
Good housing	-0.409	0.364	0.261	0.664	0.325 - 1.357

Model 2: Socioeconomic factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Level of education qualification of the mother					
Secondary+	-	-	-	-	-
None	0.155	0.307	0.051	1.168	0.640 - 2.130
Primary	0.098	0.437	0.823	1.103	0.469 - 2.595
Maternal occupation					
Agriculture	-	-	-	-	-
Not employed	-0.592	0.668	0.376	0.553	0.149 - 2.050
Pro./Tech./Man./Clerical	0.459	0.295	0.119	1.583	0.889 - 2.820
Other	0.241	0.495	0.626	1.273	0.482 - 3.360

Model 3: Demographic factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Age of the mother at the birth of her child					
20 - 34 years	-	-	-	-	-
< 20 years	-0.142	0.480	0.768	0.868	0.339 - 2.222
35 - 49 years	0.480	0.551	0.068	1.615	0.549 - 4.752
Order of the index birth					
2 - 3 birth	-	-	-	-	-
First birth	0.331	0.342	0.332	1.393	0.713 - 2.722
4+ birth	0.846	0.349	0.015	2.331	1.176 - 4.623
Wait period prior to the index birth					
> 24 months	-	-	-	-	-
≤ 24 months	0.757	0.343	0.027	2.132	1.088 - 4.179

Model 4: Distance factors

Exposure variable	β	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Distance (in kilometers)					
x≤1	-	-	-	-	-
1.1≤x≤3.9	-0.045	0.538	0.933	0.956	0.333 - 2.744
x≥4	0.221	0.509	0.664	1.248	0.460 - 3.385
Travel-time (in minutes)					
x≤ 30	-	-	-	-	-
31≤x≤60	1.334	0.955	0.163	3.797	0.584 - 24.701
x>60	1.346	0.977	0.168	3.842	0.567 - 26.047

Model 5: Full model

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Population density					
x≤599	-	-	-	-	-
600≤x≤999	-	-	-	-	-
x≥1000	-1.312	0.803	0.102	0.269	0.056 - 1.298
Nature of roads					
Tarmacked roads	-	-	-	-	-
Murram roads	-0.043	0.559	0.939	0.958	0.320 - 2.867
Mud roads	-3.195	1.842	0.083	0.041	0.001 - 1.515
Number of health facilities					
x≥5	-	-	-	-	-
x≤2				-	-

3≤x≤4	1.312	0.803	0.102	3.715	0.771 - 17.911
Type of housing					
Durable housing	-	-	-	-	-
Non-durable housing	-0.053	0.634	0.934	0.949	0.274 - 3.289
Good housing	-1.326	0.682	0.052	0.265	0.070 - 1.010
Level of education qualification of the mother					
Secondary+	-	-	-	-	-
None	1.341	0.608	0.027	3.823	1.162 - 2.578
Primary	1.841	0.946	0.052	6.304	0.987 - 4.027
Maternal occupation					
Agriculture	-	-	-	-	-
Not employed	0.516	1.417	0.716	1.676	0.104 - 26.939
Pro./Tech./Man./Clerical	0.451	0.551	0.414	1.569	0.533 - 4.624
Other	-0.834	0.819	0.309	0.434	0.087 - 2.164
Age of the mother at the birth of her child					
20 - 34 years	-	-	-	-	-
< 20 years	-0.477	0.853	0.576	0.621	0.117 - 3.302
35 - 49 years	1.409	1.572	0.370	4.093	0.188 - 8.068
Order of the index birth					
2 - 3 birth	-	-	-	-	-
First birth	0.475	0.537	0.376	1.608	0.562 - 4.605
4+ birth	1.974	2.674	0.133	2.674	0.002 - 6.274
Wait period prior to the index birth					
> 24 months	-	-	-	-	-
≤ 24 months	1.192	0.505	0.018	3.294	1.224 - 8.863
Distance (in kilometers)					
x≤1	-	-	-	-	-
1.1≤x≤3.9	-0.076	1.050	0.942	0.926	0.118 - 7.260
x≥4	0.404	1.030	0.694	1.499	0.199 - 11.274
Travel-time (in minutes)					
x≤ 30	-	-	-	-	-
31≤x≤60	2.228	1.708	0.192	9.278	0.326 - 26.376
x>60	2.598	1.827	0.155	13.436	0.374 - 48.264

Appendix 13: Multinomial logistic regression models of the association of infant mortality with geographical, socioeconomic, demographic and distance factors in urban areas of Kakamega Central Sub-County

Model 1: Geographical factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Population density					
x≤599	-	-	-	-	-
600≤x≤999	-	-	-	-	-
x≥1000	-0.066	0.363	0.856	0.936	0.460 - 1.907
Nature of roads					
Tarmacked roads	-	-	-	-	-
Murram roads	-0.031	0.276	0.911	0.970	0.565 - 1.666
Mud roads	-0.490	0.768	0.523	0.613	0.136 - 2.758
Number of health facilities					
x≥5	-	-	-	-	-
x≤2	-	-	-	-	-
3≤x≤4	0.104	0.374	0.782	1.109	0.533 - 2.307
Type of housing					
Durable housing	-	-	-	-	-
Non-durable housing	0.019	0.305	0.951	1.019	0.561 - 1.852
Good housing	-0.136	0.342	0.691	0.873	0.446 - 1.707

Model 2: Socioeconomic factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Level of education qualification of the mother					
Secondary+	-	-	-	-	-
None	0.057	0.281	0.840	1.059	0.610 - 1.838
Primary	-0.455	0.402	0.257	0.634	0.289 - 1.394
Maternal occupation					
Agriculture	-	-	-	-	-
Not employed	-0.359	0.679	0.597	0.698	0.185 - 2.642
Pro./Tech./Man./Clerical	0.120	0.272	0.660	1.127	0.662 - 1.920
Other	0.113	0.453	0.804	1.119	0.461 - 2.720

Model 3: Demographic factors

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Age of the mother at the birth of her child					
20 - 34 years	-	-	-	-	-
< 20 years	0.563	0.462	0.224	1.755	0.709 - 4.343
35 - 49 years	1.061	0.510	0.038	2.891	1.063 - 7.858
Order of the index birth					
2 - 3 birth	-	-	-	-	-
First birth	0.522	0.334	0.118	1.685	0.875 - 3.244
4+ birth	0.450	0.327	0.168	1.568	0.827 - 2.975
Wait period prior to the index birth					
> 24 months	-	-	-	-	-
≤ 24 months	0.439	0.336	0.037	1.552	0.803 - 3.000

Model 4: Distance factors

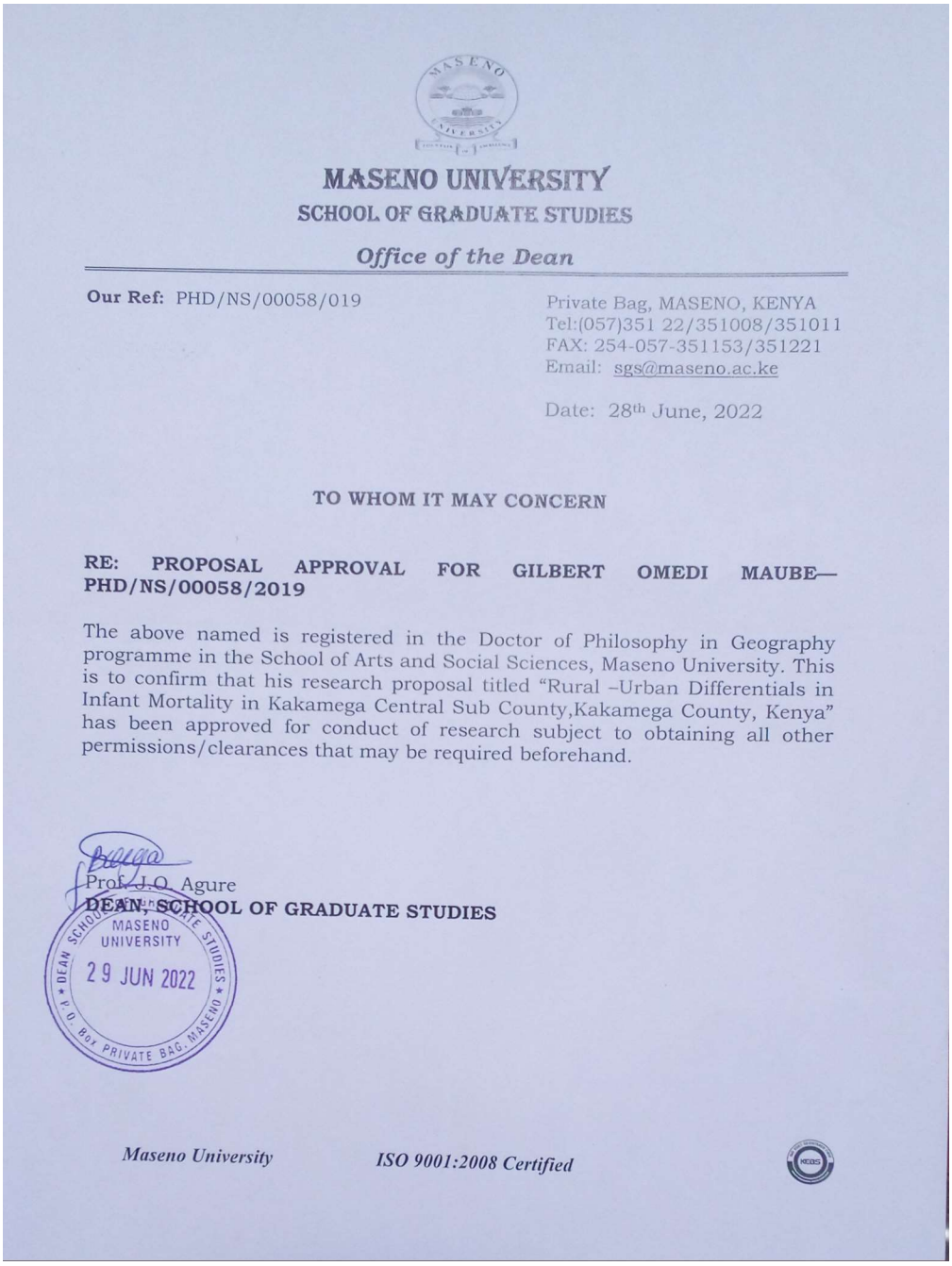
Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Distance (in kilometers)					
x≤1	-	-	-	-	-
1.1≤x≤3.9	0.342	0.507	0.500	1.407	0.521 - 3.801
x≥4	0.307	0.480	0.522	1.359	0.531 - 3.483
Travel-time (in minutes)					
x≤ 30	-	-	-	-	-
31≤x≤60	1.223	1.147	0.286	3.399	0.359 - 32.17
x>60	1.780	1.164	0.126	5.929	0.605 - 58.062

Model 5: Full model

Exposure variable	B	S.E	Sig.	Exp(β)	95% CI for Exp(β)
Population density					
x≤599	-	-	-	-	-
600≤x≤999	-	-	-	-	-
x≥1000	-1.295	0.781	0.097	0.274	0.059 - 1.266
Nature of roads					
Tarmacked roads	-	-	-	-	-
Murram roads	-0.018	0.520	0.972	0.982	0.354 - 2.723
Mud roads	-2.671	1.797	0.137	0.069	0.002 - 2.343
Number of health facilities					
x≥5	-	-	-	-	-
x≤2				-	-

3≤x≤4	1.295	0.781	0.037	3.651	0.790 - 6.883
Type of housing					
Durable housing	-	-	-	-	-
Non-durable housing	-0.482	0.598	0.421	0.618	0.191 - 1.996
Good housing	-1.164	0.641	0.049	0.312	0.089 - 1.097
Level of education qualification of the mother					
Secondary+	-	-	-	-	-
None	0.922	0.574	0.108	2.515	0.817 - 7.740
Primary	1.492	0.878	0.009	4.448	0.796 - 2.866
Maternal occupation					
Agriculture	-	-	-	-	-
Not employed	0.215	1.461	0.883	1.240	0.071 - 21.745
Pro./Tech./Man./Clerical	-0.299	0.517	0.562	0.741	0.269 - 2.041
Other	-0.323	0.751	0.667	0.724	0.166 - 3.157
Age of the mother at the birth of her child					
20 - 34 years	-	-	-	-	-
< 20 years	0.871	0.788	0.269	2.390	0.511 - 11.191
35 - 49 years	3.311	1.524	0.030	2.742	1.383 - 5.435
Order of the index birth					
2 - 3 birth	-	-	-	-	-
First birth	0.065	0.502	0.898	1.067	0.398 - 2.855
4+ birth	-2.054	0.363	0.422	0.200	1.000 - 20.541
Wait period prior to the index birth					
> 24 months	-	-	-	-	-
≤ 24 months	1.285	0.506	0.011	3.616	1.342 - 9.740
Distance (in kilometers)					
x≤1	-	-	-	-	-
1.1≤x≤3.9	1.381	1.096	0.208	3.978	0.464 - 34.080
x≥4	1.048	1.057	0.322	2.852	0.359 - 22.642
Travel-time (in minutes)					
x≤ 30	-	-	-	-	-
31≤x≤60	1.945	0.822	0.029	2.672	0.534 - 1.340
x>60	2.025	0.982	0.605	6.257	5.749 - 9.007

Appendix 14: Research proposal approval by School of Graduate Studies, Maseno University



MASENO UNIVERSITY
SCHOOL OF GRADUATE STUDIES

Office of the Dean

Our Ref: PHD/NS/00058/019

Private Bag, MASENO, KENYA
Tel:(057)351 22/351008/351011
FAX: 254-057-351153/351221
Email: sgs@maseno.ac.ke

Date: 28th June, 2022

TO WHOM IT MAY CONCERN

RE: PROPOSAL APPROVAL FOR GILBERT OMEDI MAUBE— PHD/NS/00058/2019

The above named is registered in the Doctor of Philosophy in Geography programme in the School of Arts and Social Sciences, Maseno University. This is to confirm that his research proposal titled "Rural –Urban Differentials in Infant Mortality in Kakamega Central Sub County,Kakamega County, Kenya" has been approved for conduct of research subject to obtaining all other permissions/clearances that may be required beforehand.

Prof. J.O. Agure
DEAN, SCHOOL OF GRADUATE STUDIES

MASENO UNIVERSITY
29 JUN 2022
P.O. Box PRIVATE BAG, MASENO

Maseno University *ISO 9001:2008 Certified*

Appendix 15: Research proposal approval by Maseno University Scientific and Ethics Review Committee

MASENO UNIVERSITY SCIENTIFIC AND ETHICS REVIEW COMMITTEE

Tel: +254 057 351 622 Ext: 3050
Fax: +254 057 351 221
Private Bag – 40105, Maseno, Kenya
Email: muerc-secretariate@maseno.ac.ke

REF: MSU/DRPI/MUSERC/01119/22 **Date**: 29th November, 2022

TO: Gilbert Omedi Maube
PHD/NS/00058/2019
Department of Geography and Natural Resources Management
School of Arts and Social Sciences
Maseno University
P. O. Box, Private Bag, Maseno, Kenya

Dear Sir,

RE: Rural-Urban Differentials in Infant Mortality in Kakamega Central Sub-County, Kakamega County, Kenya

This is to inform you that **Maseno University Scientific and Ethics Review Committee (MUSERC)** has reviewed and approved your above research proposal. Your application approval number is MUSERC/01119/22.The approval period is 29th November, 2022 – 28th November, 2023.

This approval is subject to compliance with the following requirements;

i. Only approved documents including (informed consents, study instruments, MTA) will be used.
ii. All changes including (amendments, deviations, and violations) are submitted for review and approval by Maseno University Scientific and Ethics Review Committee (MUSERC).
iii. Death and life threatening problems and serious adverse events or unexpected adverse events whether related or unrelated to the study must be reported to Maseno University Scientific and Ethics Review Committee (MUSERC) within 24 hours of notification.
iv. Any changes, anticipated or otherwise that may increase the risks or affected safety or welfare of study participants and others or affect the integrity of the research must be reported to Maseno University Scientific and Ethics Review Committee (MUSERC) within 24 hours.
v. Clearance for export of biological specimens must be obtained from relevant institutions.
vi. Submission of a request for renewal of approval at least 60 days prior to expiry of the approval period. Attach a comprehensive progress report to support the renewal.
vii. Submission of an executive summary report within 90 days upon completion of the study to Maseno University Scientific and Ethics Review Committee (MUSERC).

Prior to commencing your study, you will be expected to obtain a research license from National Commission for Science, Technology and Innovation (NACOSTI) https://oris.nacosti.go.ke and also obtain other clearances needed.

Yours sincerely

Prof. Philip O. Owuor, PhD, FAAS, FKNAS
Chairman, MUSERC

MASENO UNIVERSITY ETHICS REVIEW COMMITTEE 29 NOV 2022

MASENO UNIVERSITY IS ISO 9001 CERTIFIED

Appendix 16: Research license by National Commission for Science, Technology and Innovation

REPUBLIC OF KENYA

NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Ref No: 680253

Date of Issue: 08/December/2022

RESEARCH LICENSE

This is to Certify that Mr.. Gilbert OMEDI Omedi of Maseno University, has been licensed to conduct research as per the provision of the Science, Technology and Innovation Act, 2013 (Rev.2014) in Kakamega on the topic: RURAL-URBAN DIFFERENTIALS IN INFANT MORTALITY IN KAKAMEGA CENTRAL SUB-COUNTY, KAKAMEGA COUNTY, KENYA for the period ending : 08/December/2023.

License No: NACOSTI/P/22/22577

680253

Applicant Identification Number

Director General
NATIONAL COMMISSION FOR SCIENCE,TECHNOLOGY & INNOVATION

Verification QR Code

NOTE: This is a computer generated License. To verify the authenticity of this document, Scan the QR Code using QR scanner application.

See overleaf for conditions

Appendix 17: Research authorization by County Secretary and Head of Public Service, Kakamega County

REPUBLIC OF KENYA
COUNTY GOVERNMENT OF KAKAMEGA

OFFICE OF THE GOVERNOR
COUNTY SECRETARY AND HEAD OF PUBLIC SERVICE

Telephone: 056-31850/31852/31853
Website:www.kakamega.go.ke
E-mail:countysecretary@kakamega.go.ke

When replying please Quote

Ref No: CGK/OCS/ GEN.CRR./04/ (621)

County Government of Kakamega
P.O. Box 36-50100
KAKAMEGA

Date: 19th December, 2022

Gilbert Omedi Maube
Maseno University
P. O. Box, Private Bag,
MASENO

RE: RESEARCH AUTHORIZATION

The above subject matter refers.

Following your authorization letter Ref. No.NACOSTI/P/22/22577 dated 8th December, 2022 by NACOSTI to undertake research on "**Rural-Urban Differentials in Infant Mortality in Kakamega Central Sub-County, Kakamega County**", for the period ending 8th December, 2023 I am pleased to inform you that you have been authorized to carry out the research on the same in Kakamega County.

It is therefore expected that you will give us a copy of your Thesis.

Thank you.

COUNTY SECRETARY
KAKAMEGA COUNTY
P. O. Box 36 - 50100
KAKAMEGA

Amb. James Ochami
County Secretary and Head of Public Service