
**ADDIS ABABA UNIVERSITY**

**COLLEGE OF HEALTH SCIENCES**

**SCHOOL OF PUBLIC HEALTH**

**DEPARTMENT OF REPRODUCTIVE, FAMILY AND POPULATION HEALTH**

# Trend, disease burden and determinants of mortality among children 5-14 years in south-central Ethiopia: analysis using Butajira Health and Demographic Surveillance System data (1987-2022)

**HAILEMARIAM NEGASH (BSc)**

A THESIS TO BE SUBMITTED TO ADDIS ABABA UNIVERSITY, COLLEGE OF HEALTH SCIENCES, SCHOOL OF PUBLIC HEALTH FOR THE PARTIAL FULFILLMENT OF THE DEGREE OF MASTERS OF PUBLIC HEALTH IN REPRODUCTIVE, FAMILY AND POPULATION HEALTH SPECIALTY

**October, 2024**

**Addis Ababa, Ethiopia**


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## APPROVAL BY THE EXAMINATION BOARD

This thesis, by Hailemariam Negash is accepted in its present form by the board of examiners as fulfilling for the degree of Masters of Public Health in Reproductive, Family and Population Health.

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| Internal examiner | Signature | Date |

Chairperson of the Department

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# DEDICATION

This thesis is dedicated to my beloved brother, Mr. Awoke Negash, whose unwavering support and inspiration have guided my journey, and to my entire family for their steadfast encouragement throughout my life.

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## ACRONYM

| | |
|---|---|
| AIDS | Acquired Immuno Deficiency Syndrome |
| BRHP | Butajira Rural Health Program |
| CCVA | Computer-Coded Verbal Autopsy |
| CDs | Communicable Diseases |
| CoD | Causes of death |
| ECs | External Causes |
| GBD | Global Burden of Disease |
| HDSS | Health and Demographic Surveillance System |
| HIV | Human Immunodeficiency Virus |
| ICD-10 | International Classification of Diseases Version 10 |
| IHME | Institute for Health Metrics and Evaluation |
| INDEPTH | International Network of Demographic Evaluation of Population and Their Health |
| LRTIs | Lower Respiratory Tract Infections |
| NCDs | Non-Communicable Diseases |
| PCVA | Physicians Coded Verbal Autopsy |
| SDGs | Sustainable Development Goals |
| SNNPR | Southern Nations Nationalities and Peoples Region |
| SSA | Sub Saharan Africa |
| UNIGME | United Nation Inter Agency Group for Child Mortality Estimation |
| VA | Verbal Autopsy |
| WHO | World Health Organization |

# ABSTRACT

**Background:** Nearly, 0.9 million children aged 5-14 died globally in 2020. The death is especially unacceptable since the majority died of preventable or treatable causes. Although communicable diseases are still the leading causes, non-communicable diseases, and external causes account for half of all deaths, posing a triple burden.

**Objective:** To assess the trend, disease burden, and determinants of mortality among children 5-14 years in Butajira, south-central Ethiopia from 1987 through 2022.

**Methods:** The Butajira Health and Demographic Surveillance System open prospective cohort (1987-2022) and cause of death data acquired via verbal autopsy procedures (2007- 2022) were analyzed. Event history analysis was used to study mortality trends and the incidence of child death by covariates. The broad and specific causes of death burden for children aged 5-14 years were measured. The adjusted Incidence rate ratio (aIRR) with its 95% confidence interval in the Poisson regression model was used to measure strength, direction, and significance of the association between child mortality and exposure variables.

**Results:** A declining trend in the incidence child mortality was observed (Kendall's tau = - 0.83; P-value < 0.0001). The overall incidence of child mortality was 6.31 (5.99, 6.64) deaths per 1000 person-years. Communicable diseases (39.2%) were the major causes of death followed by non-communicable diseases (35.4%) and external causes (23.4%). HIV/AIDS (14.6%), severe malnutrition (13.1%), accidental drowning & submersion (8.5%) and RTA (8.5%) were the leading specific causes of death. The incidence of child mortality was higher among males with aIRR/95% CI (1.27 (1.15, 1.41)), older children (2.06 (1.84, 2.29)), ruralists (2.42 (1.88, 3.12)), lowlanders (1.37 (1.17, 1.60)), owned house (3.98 (2.33, 6.79)), small households (1.18 (1.05, 1.32)), uneducated mother (2.03 (1.80, 2.29)), lived 10 KMs away from hospital (1.34 (1.11, 1.63)), used unprotected water source (1.35 (1.18, 1.55)), had at least one ox [(1.36 (1.19, 1.54), or 2+ oxen (1.54 (1.32, 1.79))] and with a house without window (1.38 (1.18, 1.62)), latrine (1.96 (1.60, 2.40)) and media exposure (1.87 (1.60, 2.19)).

**Conclusion:** During the 36 years of study periods in Butajira HDSS, a significant declining trend in the incidence of child mortality was found. Older children and young adolescents are suffering from triple burden of diseases. A comprehensive targeted interventions needs to be delivered at societal, household and personal level to avert the mortality burden.



**Key words:** Butajira HDSS, Child mortality, Causes of death, Disease burden, Trend

# 1. INTRODUCTION

## 1.1. Background

Children in the age group of 5-14 years encompass a huge size of the population. Globally, about 17 percent of the world is between age 5 to 14 years. Africa has the youngest population worldwide with 23.1% accounted for this age group (1). Whereas 23.8% of the population of Ethiopia is estimated to be constituted by 5 to 14 year children (2). For assessing the health status of such a population pertinent mortality measures are important and play a big role (3).

Prevention of child death is a key target for public health policy intervention at the national and international levels and mortality among children and adolescents is widely used for leveling countries' economic and social development (4). A challenge for the global health community in the Sustainable Development Goals (SDGs) era is to ensure that the gains made in young child survival are equitably distributed and not lost as they mature into adulthood (5). The updated global strategy aligned to SDGs has incorporated adolescents for the first time to join women and children at the heart of the strategy as key drivers of change in the post-2015 era. It focuses on upholding the health of women, children and adolescents and their rights and recognizes the urgent need to reduce child deaths, making it an essential part of the global child survival goal (6).

The 1993 National Health Policy, which is currently under revision sets to give special attention to women and children and is also poised to address the special health problems and related needs of adolescents (7). The Federal Ministry of Health's National Newborn and Child survival strategy had set out to meet by 2035 that every child in Ethiopia achieves the highest standard of health and development with an end to all preventable child deaths but still much emphasis is given to under-five children (8). The Ethiopian national adolescent and youth health strategy has stood out to achieve full health and well-being of adolescents and youth through ensuring equitable access and utilization of comprehensive health services, by 2025 (9).

In general, the aforementioned strategies and policies show how ambitiously they stand up in making the health and survival of children and adolescents. Yet there still exists a gap in paying due attention regarding the death of children 5-14 years at national and international levels though a significant number of deaths happened (10). This study will pay enormous attention and try to comprehensively understand the mortality and diseases burden those children are facing.

### 1.2. Statement of the problem

According to the United Nations Inter-Agency Group for Child Mortality Estimation (UNIGME), nearly 900,000 children aged 5-14 died globally in 2020 (11). The annual rate of reduction of mortality was sluggish among children aged 5–14 years in contrast to under-5 children since 2000 at 2.7% and 4.0% respectively (12). Sub-Saharan Africa (SSA) has the highest mortality rate among children aged 5-14 years, accounting for nearly half a million deaths, with wide variations in mortality rates observed among the countries within the region (11). Reports showed that the average risk of dying within this age group was 14 times higher in sub-Saharan Africa than in Northern America and Europe (13). In Ethiopia, the probability of a five-year-old dying before reaching age 15 was 8 deaths per 1,000 children aged 5-14 years, with an estimated absolute number of 23,000 (14-34,000) deaths in 2020 (11).

The high magnitude of child death is a reminder of the need for better cultivation of the international human rights commitments that safeguard every child's right to survive but has largely been ignored by the global health community (14). The burden of death among children and adolescents remains enormous, though its trend has declined due to the socioeconomic improvement (15, 16). The magnitude of death differs within regions of the globe in which the developed countries encounter lower mortalities compared to the underdeveloped (17).

Though communicable diseases (CDs) are still the leading cause of mortality, non-communicable diseases (NCDs) and external causes (ECs) together account for half of all deaths among children aged 5–14 years around the globe (18). The patterns of mortality in this age group indicate the underlying risk they face with a shift away from CDs of childhood and towards NCDs and injuries. Thus, children of such age group nowadays are suffering from triple burden of diseases (19).

Low-income countries including Ethiopia face more than three-quarter of deaths in the world altogether, yet there is limited evidence on the cause of death (CoD) among children aged 5-14 years. As most of them didn't have a well-functioning vital registration system even when deaths are documented, CoD data are frequently missed which ultimately caused for knowledge gap (20). The majority of childhood mortality research focuses on children under the age of 5 years. Hence, the mortality burden in older children and young adolescents is not as such well known (21). The consequences of these deaths are very significant and huge. Foremost, those children who died prematurely are deprived of their basic human rights, families and societies also suffer from

economic loss and emotional trauma. Besides, the loss of human capital will harm the overall development of the nation (13). Therefore, this study aims to contribute much in filling those gaps by further showing the trend of mortality over 36 years, responsible CoD and its risk factors in Butajira, south-central Ethiopia.

### 1.3. Rationale and Significance of the study

Every child has the right to life, which requires addressing persistent disparities in child and adolescent health. It also demands an in-depth understanding of levels and trends in child mortality as well as the underlying causes responsible for deaths to help guide policy-making and planning at national and international level (11).

The death of 5–14 years children is especially unacceptable since the majority died of preventable or treatable causes (12, 22) but have largely been left by the health system. Although the first 1000 days of life are crucial, the subsequent 7000 days have a pivotal role in individual development and attainment of healthy adulthood. Children at such a stage of life undergo huge developments that will have major health consequences over their lifetime. It is also suggested that some relevant global health targets, including the 2030 United Nation-led SDGs, need to mainstream children aged 5-14 years and not only those younger than 5 years (23). This consideration would require a better understanding of the burden of diseases, mortality and other traits of them (24).

There is also very limited research about mortality and CoD among older children and young adolescents in Ethiopia, resulting in a knowledge gap regarding it. This study aims to generate evidence by analyzing the trend of mortality, describing the burden of diseases and identifying the determinants of mortality among children 5 to 14 years in the population of Butajira, using the Health and Demographic Surveillance System (HDSS) data from 1987 through 2022. Furthermore, the output from the study is anticipated to help in supporting health policies and strategies aimed at reducing mortality in this age group. It may provide insight to policymakers and practitioners to develop targeted interventions and policies. The findings of this study may ultimately initiate researchers to conduct extensive studies on these age group.

# 2. LITERATURE REVIEW

## 2.1. Trend of mortality among children aged 5 to 14 years

Globally, the mortality rate in children aged 5 to 14 years declined by 53 percent from 1990 to 2018 and the number of deaths dropped by 46 percent from 1.7 million to 0.9 million per year. If the trend keeps continuing like mentioned, 9.8 million children aged 5–14 years will die between 2019 and 2030 (25). Another study taking into account 129 countries of the globe after analyzing the mortality in children aged 5–14 years found a point estimate of the number of deaths decreased from 1·7 million (1.7 million -1.8 million) in 1990 to 1.0 million (0.9 million -1.1 million) in 2016 (12). Studies embracing different regions of the world also showed that during the period between 2000 to 2016 mortality rates globally among older children and young adolescents declined by 40% and 13% respectively where mortality rates for younger adolescents aged 10–14 years were substantially lower than those estimated for older children (5–9 years) and older adolescents (15–19 years) (26).

Most regions of the world showed a decrease in deaths among children aged 5–14 years from 1990 to 2016. Yet in West and Central Africa though the mortality rates decreased, the absolute number of deaths has increased since 1990 which could be explained because of rapid population growth in such regions as the magnitude of 5 to 14-year children doubled between 1990 and 2016 (12, 27). According to reports by UNIGME, mortality among 5 to 14 years in SSA reduced by 59% from 39 per1000 in 1990 to 16 per 1000 in 2020 (28). Though a reduction in mortality is observed and reported in the region still sub-Saharan accounts for most of the total deaths in these age groups along with South Asia and East Asia for 86% of deaths in 1990 and 91% in 2010 (29).

Studies done in Ethiopia also indicated a reduction in the trend in the mortality of children aged 5 to 14 years. A study about mortality and survival from childhood to old age conducted in Butajira found that the mortality rate in the 5-14 age group showed a more linear downward trend than any other age group, remaining relatively unaffected even during epidemics and famines between 1987 and 2004. However, the study primarily focused on three subgroups: children under-5 year, adults 15- 64 and the elderly 65 years and above. Ultimately, it was recommended that the 5-14 years age group be studied in-depth and given attention (30). According to the Institute for Health Metrics and Evaluation (IHME), mortality for 5 to 14 years in Ethiopia decreased by 56.6% with an absolute number of 42,302 deaths in 1990 to 18349.2 deaths in 2019 (31). Another report also

showed that in Ethiopia, the number of deaths in children aged 5 to 14 years dropped by 71 percent from 1990 to 2018 (32). On contrary, literature done from the USA showed that the age-specific death rate increased by around 4.4% for 5-14 years from 2019 to 2021, this increment could be explained by the impact of the COVID pandemic since the pandemic hit the USA at most (33, 34). Another odd finding was observed from a study in Mato Grosso state of Brazil which resulted in a stagnant trend of mortality for children aged 5 to 14 years from 2019 through 2018 (35).

A study done in Kersa on the broad causes of death by year among children aged 5–14 years, showed an increment in absolute number of deaths from 29 in 2008 to 40 in 2013 which could be due to an increment in the child population over time (22).

## 2.2. Burden of diseases among 5 to 14 years children

### 2.2.1. Overview of the burden of diseases among children aged 5 to 14 years

The burden of diseases and ailments that cause significant deaths and disabilities among the population are grouped under three important categories these are CDs, NCDs, and ECs (36, 37).

According to IHME, globally CDs were the leading cause of death among 5 to 14 years. CDs accounted for 43.4% of all causes whereas NCDs accounted for 24.6% and injury took a 26.1% share of the death in 2019 (31). Among CDs enteric infections like typhoid and paratyphoid (8.2%), diarrheal diseases (7.7%), and Lower Respiratory Tract Infections (LRTIs) (6.3%) took the lion's share. From NCDs, neoplasms (8.1%) mainly from leukemia and other malignant neoplasms, and other NCDs (6.5%) gained mainly from congenital birth defects (4.1%) contributed to the majority of deaths in the 5-14 age group. From ECs, the world suffers particularly from unintentional injuries (13.5%) attributed to - drowning (5.4%) and falls (1.7%), and road injury (8.1%) resulted for the majority of deaths in 2019 globally (31).

The Global Burden of Disease (GBD) 2016 study found out globally, the top five causes of death among 5 to 9 years children were diarrheal diseases (10%), LRTIs (10%), road traffic injuries (8%), malaria (7%) and meningitis (6%). While Road traffic injury (9%) was the leading cause of death globally among young adolescents (10–14 years) (26). Another study from GBD 2013 indicated the common CoD among these groups in the world were diarrheal diseases, followed by lower respiratory infections, road injuries, intestinal infectious diseases and malaria. Whereas road

injuries, followed by HIV/AIDS, self-harm, drowning and intestinal infectious diseases were the main cause of death among young adolescents (38).

In SSA, CDs attributed for 67.2% of deaths among older children from which malaria (12.6%), diarrhea (12.4%), LRTIs (7.4%) and HIV/AIDS (7.1%) are the four leading CoD and 59% of deaths for young adolescents of which HIV/AIDS (13.3%), malaria (10.7%) diarrheal diseases (7.5%) and LRTIs (5.7%) were the leading causes of death and those causes were predominantly affected young female adolescents than males in 2019 (31). While a decade back diarrheal diseases, HIV/AIDS and malaria were the leading causes for countries in SSA nowadays because of the adherence to and expansion of anti-retroviral treatment, mortality from HIV/AIDS has decreased (38). The burdens of NCDs were relatively similar to injuries in this region. Yet injury causes a relatively higher burden in males since they suffer from road injury, drowning and falls than females and older female children suffer more from communicable diseases particularly suffering from HIV/AIDS, measles and LRTIs compared to their counterpart (31).

Another study indicated that African Low and middle-income countries had substantially greater older children and adolescent mortality rates compared with all other regions due to the continued burden of infectious diseases including diarrheal diseases, lower respiratory infections and malaria (26). Whereas findings from high-income countries and also in particular Western Europe both older and young adolescents died primarily from NCDs of neoplasm and congenital birth defects (31).

According to IHME, mortality among children aged 5 to 14 years in Ethiopia is still majorly attributed to CDs (60.5%) followed by NCDs (20.4%) and ECs (19.1%) in 2019 (31). A study done in Kersa has shown deaths among older children and young adolescents were mainly due to CDs (56.3%), injuries (13%) and NCDs (6.5%) in their order of ranking. Over the period from 2008 to 2013, severe malnutrition, intestinal infectious disease and acute lower respiratory infection were the three leading specific CoD among children aged 5 to 14 years (22). In contrast a hospital-based study in southwest Ethiopia reported that childhood accidents had become the leading cause of morbidity and mortality within the age group of 5 to 9 and 10 to 14 years (39). Since its facility-based study may not be representative and reflective of other populations apart from it.

There are limited studies in Ethiopia regarding the burden of diseases in this age group while the different country has a different fatal burden of diseases, particularly from specific CoD and there also exists a huge difference in attribution of the burden of diseases between developed and developing countries for this particular age group.

## 2.3. Determinants of mortality among 5-to-14-year children

### 2.3.1. Socio-demographic characteristics

#### 2.3.1.1 Sex

Literature reveals that globally, males aged 5-14 years were more likely to die than their female counterparts, with the mortality sex ratio of 1.16 (1.12 to 1.20) in 2021 (40). Another study observed that for all leading CoD male children and adolescents died at larger rates than their female counterparts with the inequality broadened from a ratio of 1.2 times greater among children 1 year of age to 2.8 times as high by 19 years of age (41). A systematic empirical analysis done in low-and middle-income countries provided that male risks of dying were higher than female risks by about 12% at ages 5–9 years ($p < 0.0001$) and by about 9% at ages 10–14 years ($p = 0.0035$), both significant at a 1% level (29). A study done in Mozambique also indicated that the mortality rate ratio for males was greater after controlling for age during a decade of study period which was 1.17, (95% CI 1.10 – 1.25%; $p < 0.001$) compared to counterparts (42).

In contrast to the above, a study in India found that mortality among girls aged 5 to 14 years was nearly double of boys for both diarrheal diseases and pneumonia (43). In being neutral, a study in Iran provided no statistically significant disparity in terms of gender ($p = 0.25$) though the mortality rate was higher in boys than in girls throughout all studied years between 2013- 2019 (44).

#### 2.3.1.2 Age

A study in China found that the mortality of children aged 10–14 years was higher than those of 5–9 years of age (45). Another study in Brazil also supports the above finding that the mortality rate in the 10-14 years age group (430.0/100,000) surpassed that of 5–9 years children (321.9 /100,000), it could be explained by the fact that the deaths were predominantly among males, who tend to exhibit more aggressive behavior, combined with high traffic accidents and assaults which is common among young adolescents than their counterparts (35).

In opposite to the above findings, another piece of evidence in Iran highlighted the mortality rate in both genders to be greater in children aged 5-9 than in their counterparts (44). Also, a study in Kenya reported that older children had a slightly higher mortality rate compared to young adolescents and further indicated disparities within specific ages particularly higher mortality rates at age 5 (3.46 per 1000 person-year), at age 10 (2.91 per 1000 person-year) and age 13 (2.24 per 1000 person-year) (46).

#### 2.3.1.3 Residence

A study in Ethiopia found that the risk of death for children aged 5 to 14 who live in rural areas was much higher than those of their urban counterparts (22). Another study in Ethiopia also found that the risk of death among 5-14 years in rural areas was about 3 times higher than those of the urbanites [RR 3.4 95% CI (2.74, 4.23)] (30). The possible reasons for higher mortality for rural children could be because of the disadvantages of rural children in socioeconomic and health care services as opposed to their counterparts.

A vivid difference in the causes of death was also noticed between urban and rural areas in a more detailed investigation. In urban areas, traffic accidents remained the leading cause of death, next followed by neoplasms, unexpected events and circulatory system diseases. Yet in rural areas, unexpected events, traffic accidents, circulatory system diseases and neoplasms were the four leading causes of death in order (44). In contrast, a study in the USA showed that because of the presence of higher injury in rural settings, children and adolescents had greater mortality than those living in either suburban settings or urban settings (41).

#### 2.3.1.4 Maternal Educational Status

From existing pieces of evidence there is much regard that education plays a big role in being determinant of the child as well as adult mortality. A study done in Ethiopia indicated maternal education to be inversely related to child mortality (47). Another study done in Nigeria found maternal education to be the single most powerful determinant of the level of child mortality (48). Another research also found that the impact of a mother's education on child mortality to be significant (49). It could be explained as education increases maternal understanding of child care, disease prevention and general health which ultimately contributes to the reduction of child deaths. However, certain literature in Ethiopia and India has indicated that a mother's attainment of primary school and informal education does not have any significant effect on the survival of children (50,

51). It implies that level of education is a pertinent factor to take into account for studying the death of a child.

#### 2.3.1.5 House ownership

House ownership is an important factor in the existence of good and bad health for folks residing in the house. Literature from Finland indicated the hazard ratio for all-cause mortality among families of renters to be higher than their counterparts (52). On contrary, a study done in Butajira indicated that children from parents who lived in their own houses were more likely to die than those who lived in rented houses (53). This could mainly be due to the plethora of people in rural areas own a substandard one-room house while those who reside in rented houses are mostly living in urban areas with relatively good housing facilities.

#### 2.3.1.6 Household size

The number of family members living within a household has been one of the influencing factors to the health outcome and ultimately to mortality across the whole years of individuals' life. A literature conducted in Sweden indicated the presence of a significant association between mortality and increasing number of folks within the household. A strong association had been shown from the preliminary findings at earlier ages and for males than females (54). Another study done in China also revealed that the availability of an additional child within the family significantly disrupts the health of all other children residing in the household (55). This could be comprehended as the difficulty of meeting the demands of all family members living within the house adequately. However, a recent finding from eastern and southern SSA revealed the existence of a high risk of child death among small-sized households compared to large-sized households. Further depicted the presence of the highest risk of death when the child is the only one besides two adults since these children were more likely to suffer from firstborn child effect (56).

#### 2.3.1.7 Altitude

Literature witnessed that altitude is not just a physical phenomenon but also a complex social, environmental and healthcare characteristic that ultimately impacts mortality at different stages of life (57). Even though there is a scarcity of evidence to exactly depict the association of altitude with 5-14 years of child mortality, studies showed that high altitude is associated with high neonatal mortality since those who reside in high altitudes are at increased risk of hypoxemia (58, 59). Contrary to the above findings, a study done in Butajira evidenced that mortality among

children residing in lowland zones was found to be higher than that of highlanders with a mortality rate of 2.02 (1.58, 2.59) and 1.31 (1.04, 1.66) respectively compared to midland residents (60). A community-based longitudinal study conducted in rural Ethiopian population noticed an insignificant increment in mortality among highlanders (P = 0.33) and statistically significant decreasing mortality in those who lived in the midland area (61).

### 2.3.2 Environmental-related characteristics

#### 2.3.2.1 Availability of window

Poor housing conditions including the absence of windows are highly related to different health conditions and ailments like respiratory infections, indoor air pollution, asthma, and other mental health problems which ultimately lead to the death of everyone (62). Evidence obtained from a study in Britain found modest associations between inadequate ventilation in the house with overall mortality (63). Another study evidenced that the presence of inadequate ventilation in the house may increase respiratory infections and activation of tuberculosis, exposure to smoke and indoor air pollution and cause folks to die (64).

#### 2.3.2.2 Water source

The relative advantages of living in urban areas include better access to clean and safe water. A strong relationship between unprotected poor water supply with mortality has been witnessed in study done in Ethiopia (30). Unsafe water sources coupled with poor sanitation practices have been largely responsible for diarrheal and other infectious-related deaths (65).

#### 2.3.2.3 Oxen ownership

Owning oxen is one of the proxy indicators for socioeconomic status which may be an important determinant of child mortality. Although findings are scarce in showing an association between owning oxen to exact 5 to 14 years of child mortality, a prospective study in Butajira observed that neonates whose parents didn't own oxen have a high mortality rate as compared to neonates whose families own oxen (53). Opposed to the above, another study on under five-year children indicated the risk of mortality to be higher among households who have oxen compared to their counterparts (60). This might be explained by poor sanitation in the households that have oxen as most animals stay in their house with their feces and urine not cleaned right away particularly in rural agricultural households where under five-year children stayed in such environments relatively longer time than neonates so the longer the exposure the higher risk of child mortality.

#### 2.3.2.4 Distance to hospital

An observational study evidenced that increased journey distance to the hospital tends to be related to increased risk of death, even after potential confounding by the severity of diseases is taken into account. The study posed to equalize an approximation of 1% absolute increase in mortality to be related to each 10-km straight-line distance (66). A study done in Ethiopia also highlighted the strong relationship that exists between distance to hospitals or health facilities with the death of people (30).

#### 2.3.2.5 Latrine availability

Having an improved latrine within the household is highly regarded as a core component of strategies to reduce child mortality. Studies conducted in Eritrea, and South Africa showed the presence of lower child mortality in the household which had a latrine (67, 68). Evidence found in Zimbabwe indicated that the relative risk of death among children residing in households with access to a latrine was lower than that of children living in houses that lacks toilets with a 60% reduction in risk ($P < 0.01$) (69). On the contrary, a matched case-control study done in southern Ethiopia found that the availability of latrine was not statistically significantly associated with childhood mortality, particularly of under-fives with an AOR of 1.03 (0.60, 1.76) (70).

#### 2.3.2.6 Media exposure

Media with its capacity to disseminate information about health issues could ultimately galvanize the well-being of mothers and children. Though there existed a shortage of literature to show an association between media exposure and that of 5-14 years of child mortality, a study in Ethiopia evidenced that newborns from the community with a high level of media exposure had decreased odds of death with a 36% reduction in deaths (AOR = 0.64 (0.41, 0.98)) as compared to neonates in the community with lack of or low exposure to media (71). However, a study conducted in Nigeria did not find a significant association between child mortality and exposure to media even with increasing levels of exposure (72). Besides a first cluster randomized controlled trial of a radio intervention done to decrease child mortality did not find any effect upon reducing child mortality (73).

#### 2.3.2.7 Roof type

Many studies found a significant association between the type of roof of the household and child mortality. A study done in Butajira showed the presence of higher risk of death among under-five

children who lived in a house with a thatched roof than those children who resided under a corrugated iron roof with an IRR of 2.13 (1.79, 2.53) (60). A prospective cohort study also indicated the presence of a high risk of neonatal mortality among those who lived under a thatched roof with an adjusted IRR of 2.9 (2.4, 3.5) compared to neonates who resided in the household with a roof of iron sheet (53).

#### 2.3.2.8 Kitchen availability

The availability of a separate kitchen within the household has been considered to play a great role in improving the well-being of children. Household air pollution mostly from cooking fuel is one of the major causes of respiratory illness and ultimately leads to deaths among children in low- and middle-income countries. Higher odds of death were observed among children who resided in a house that lacked a separate kitchen as compared to those with access to a separate kitchen in their house (74). The odds of death among under-five children lived in a household that lacked a separate kitchen was about 1.8 times higher than those living in a house with access to a separate kitchen (70). Similarly, the odds of death among infants who lived in a house without a separate kitchen were about 1.9 (AOR = 1.94 (1.13, 3.33)) times higher than that of their counterparts (70).

## 2.4. Conceptual Framework

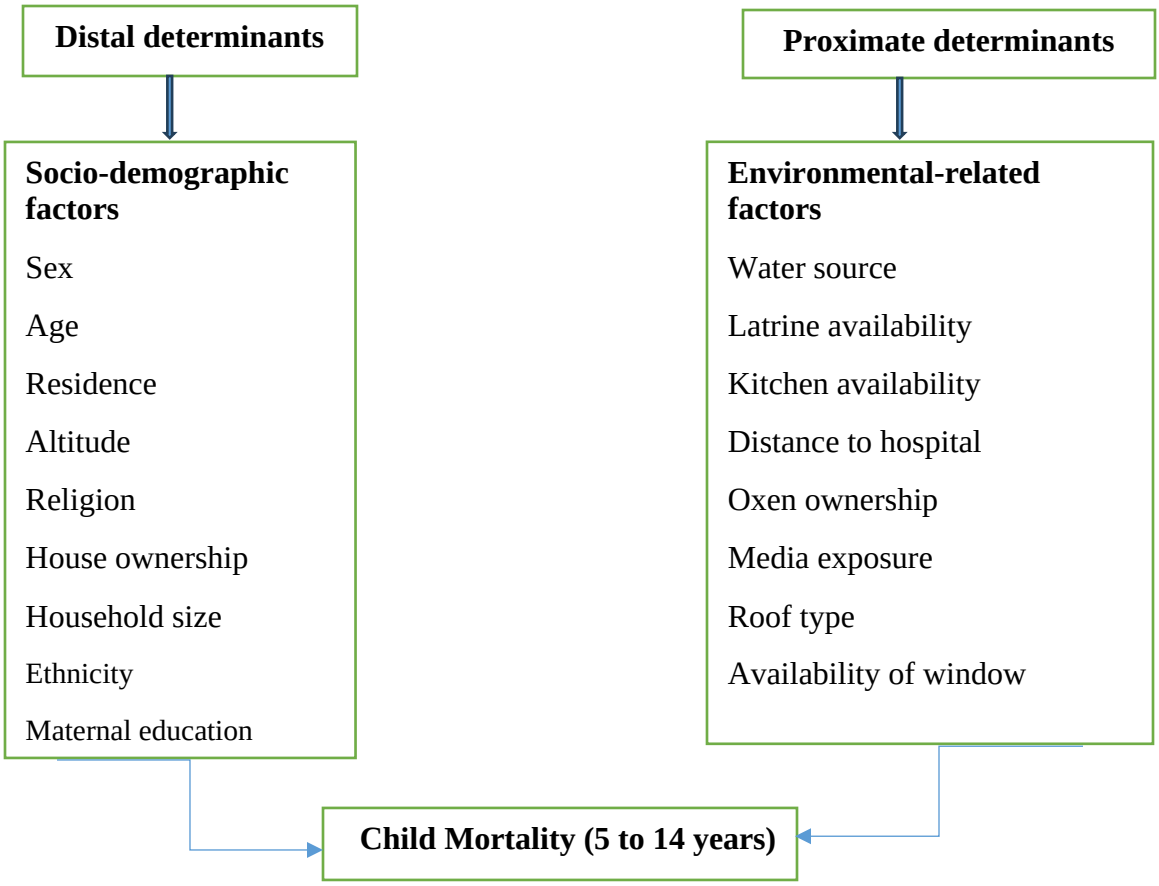


**Figure 1: Conceptual framework**

The above visualized conceptual framework for five to fourteen years mortality is adopted from Mosley and Chen's theoretical framework which illustrates how the different factors contribute to the death of children (75). From the distal determinants this study will take all the above-mentioned socio-demographic factors for analysis which could affect mortality. Again, among the proximate determinants all the afore-mentioned environmental-related characteristics in the conceptual framework will be taken into account. Generally, child mortality is determined by complex and interrelated factors.

## 2.5. Research Question

This study plans to answer the following three questions:

1. what does the trend of mortality among children 5 to 14 years in Butajira over 36 years (1987-2022) look like?
2. What are the major disease burdens among children 5 to 14 years from 2007 through 2022?
3. What are the factors associated with the death of 5 to 14-year-old children?

# 3. OBJECTIVES

## 3.1. General objective

- ✓ To assess the trend, disease burden and determinants of mortality among children 5-14 years in Butajira, south-central Ethiopia from 1987 through 2022

## 3.2. Specific objectives

- ✓ To investigate the trend of mortality among 5-14 years children over 36 years (1987-2022)
- ✓ To describe the disease burden in children 5-14 years attributed to communicable, non-communicable diseases and external causes (2007-2022)
- ✓ To identify factors associated with the death of 5-14-year-old children

# 4. METHODS

## 4.1. Study area

The study was held in the Butajira Demographic Surveillance site. It is situated in the south-central Ethiopia in the Guraghe zone of Central Ethiopia Region formerly part of the Southern Nations Nationalities and Peoples Region (SNNPR), previously assigned from eighty-two rural and four urban Kebeles from one district, Meskan and Mareko. It is now delineated into four districts and two zones (namely Meskan, Mareko and Silti -rural districts and Butajira town- urban district). The Butajira Demographic Surveillance area covers ten kebeles (one urban and nine rural Kebeles) that were randomly selected using a probability proportionate to size technique out of the former 86 kebeles (76). Butajira is located 130 km to the South of Addis Ababa. The estimated area of the district is 797 $km^2$, of which Butajira town covers approximately 9 $km^2$ (77). The districts lie at an average of 2100 m above sea level from 1750 m in lowlands to 3400 m in mountainous areas. The major rainy season is manifested from June to September. The area has rich soil and farming is the main mode of living for the rural population (78).

The initial census of the population in the selected kebeles was done in 1987 to obtain the baseline population, which was around 28,000 and grew over 23 years to be about 70,000 individuals (77). There are two hospitals of which one is governmental, and the other is a nongovernmental hospital. In addition, there were three health centers (currently 7 health centers) and several private clinics and dispensaries that give health services to the population (60, 78). There are 30 schools in the district including, one technical school and one high school, the rest are primary schools (78).

## 4.2. Study design

A longitudinal population-based study design of the Butajira HDSS was deployed to achieve the objectives of the study. The cohort of 5-14 years children through tracking the 36 years of surveillance data (1987-2022) was used to assess the trends in mortality and risk factors. This study used secondary data from two databases: the HDSS and CoD databases. The HDSS is a system for continuous registration of vital events including birth, death, migration and internal movements, marriage and household characteristics which has been updated periodically. The Butajira HDSS site has been tracking those vital events starting from 1987 onwards. CoD in the population from registered deaths has been identified using VA procedure initiated since 2007 and to describe the fatal burden of diseases VA data was taken.

### 4.3. Source and Study Population

All children aged 5 to 14 years who have been living in the formerly delineated 86 kebeles or in the previous single district of Meskan and Mareko in Guraghe and Silti Zones of the SNNPR (currently in the Central Ethiopia Region), were the reference or source population.

And all children aged between 5 to 14 years who have been tracked by the Butajira Demographic Surveillance System between 1987–2022 were considered as the study population.

### 4.4. Sample size and sampling procedure

Since the HDSS is conducting a longitudinal study, all children aged 5 to 14 years who have been captured by the program from 1987-2022 were taken into account. A total of 37,008 children within this age group were included. The individuals have been recruited into the open cohort by enumeration, birth or in migration and leave the database through death and outmigration.

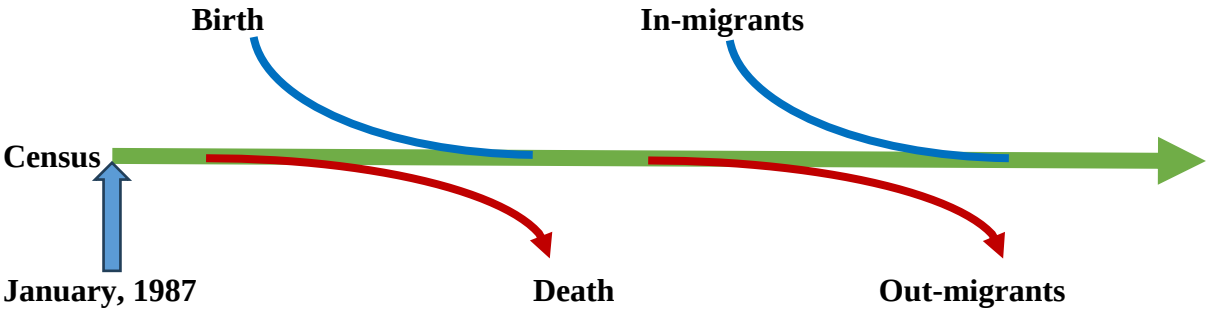


**Figure 2: Dynamic cohort of Butajira Rural Health Program (BRHP)**

Since the Butajira HDSS site CoD identification via VA procedures was started being implemented from 2007 (79), all deaths of children between the ages 5 to 14 years were taken and considered for assessing the fatal burden of diseases beginning from 2007 till 2022. A total of 130 child deaths were identified with VA conducted.

The ten kebeles (one urban and nine rural kebeles) from the previous 86 kebeles (82 rural and 4 urban kebeles) were randomly selected using a probability proportionate to size technique. It is a sampling technique in which the probability of selecting a unit is proportional to its size which includes providing larger clusters (rural kebeles) with greater probability and smaller ones (urban kebeles) with lower probability of selection. It is cost-effective method to take a representative sample of the population and keep the heterogenicity of the population.

### 4.5. Variables of the study

The outcome variable of the study was child death (5 to 14 years) and the exposure variables were sex, age, altitude, residence, distance to hospital, availability of window, maternal educational status, oxen ownership, house ownership, ethnicity, kitchen availability, roof type, water source, religion, household size, latrine availability and media exposure. These explanatory variables were stratified into different levels for manipulating the analysis accordingly.

### 4.6. Operational definition

**Verbal autopsy:** a method which is significant to determine CoD via having interviews with the family or caregivers or close living people next to the deceased person.

**Child mortality (5 to 14 years):** is the measurement of mortality between the ages of five to fourteen years. It is computed through dividing the number of deaths of children aged 5 years before celebrating their $15^{th}$ birthday by the person years contributed by 5 to 14 years children.

**Right censoring:** those children who may have out-migrated from the surveillance site or by any means withdraw from the database, but they aren't dead. Or children who have been registered in the system, yet stayed alive until the end of 2022.

**Physician review:** is a process in which physicians assess the completed VA tools collected by the CoD team in depth to identify the cause responsible for the death of an individual.

**Disease burden:** refers to the impact of diseases and ailments on a population, typically measured by the underlying CoD.

### 4.7. Data collection procedures

This study used secondary data. The data has been collected using a structured standard questionnaire adopted from the International Network of Demographic Evaluation of Population and Their Health (INDEPTH). The questionnaire has seven forms in total but for this study house registration form, family registration form, individual movement registration form, new individual registration form, death form and birth registration form were taken. All questionnaires have been translated into Amharic and administered to the study participants (60). All personnel entered into the database were followed monthly by visiting each household until 1999 then the period of the visit was changed from monthly to every three months thereafter. The data collection has been

carried out by a team of secondary school graduate enumerators who reside in the surveillance kebeles. The data collectors have always been equipped with training for the field work.

Deaths captured by the demographic data collection team were then shared with the CoD data collection team to conduct VA after the cultural mourning period of 40 days. The VA involved a structured interview with the deceased family or caregiver about signs, symptoms, and events encountered before death, which is customized for neonates (age at death 0–28 days), children (29 days–14 years) and adults (15 years plus) by referring the World Health Organization (WHO) VA tool (80). The data collection tools have two major sections: pre-coded questions and a place to write narratives of signs, symptoms, and events leading to death. The VA data collection questionnaires have also been translated into the Amharic language (81). From January 2007 to April 2017 physicians' coded VA (PCVA) data was applied. After 2017 the InterVA4 probabilistic method or computer-coded VA (CCVA) method was used (79). The two methods have been using WHO's International Classification of Diseases Version 10 (ICD-10) as a standard code of diseases/conditions.

PCVA method was used to determine the CoD for the data set from 2007 to April 2017 (79). Two trained and blinded physicians would have independently reviewed the completed VA questionnaires and provided a single probable underlying CoD. If any disagreement occurred, the case would be sent to a third physician. If two of the three physicians agreed, the final CoD would be assigned. If the three physicians assigned different codes, the case could be labeled undetermined (76).

CCVA or the InterVA4 model uses probabilistic modeling to arrive at a likely CoD for each VA case compatible with the ICD-10. It has been used to determine the CoD for data collected after May 2017 (79). It assigned one to three likely CoD with respective statistical likelihoods or indeterminate result for each case after the collected VA data are entered into the InterVA-4 algorithm. The addition of the likelihoods of assigned causes has a maximum value of one. If no single cause had a final probability of at least 0.4 (the cut-off value) or if the sum of their likelihoods became less than one, then the CoD would be labeled indeterminate (80). The interVA4 CoD codes would be translated into ICD-10 equivalent codes. Finally, the data collected through both PCVA and CCVA was combined into similar CoD categories for the analysis. The proportion

of undetermined CoDs was minimized to an acceptable level (3%) from the two approaches combined.

### 4.8. Data quality management

Data quality checking methods have been in practice in many ways to make sure of the integrity of the data. The most critical step is field supervision. Field supervisors perform the immediate supervision of data collection procedures. Their tasks include checking of each completed data form and visiting randomly selected households each month on a weekly-distributed timetable. The research assistants conduct the further level of supervision. The other is performing data entry using software previously DBASE IV platform and currently replaced with HRS II that provides an internal consistency check mechanism (60). Surveys in the surveillance system have been used as an external quality check for the system. In longitudinal data analysis, censoring is crucial for clearly identifying the residency of an individual in the demographic surveillance area. The dates at which each individual has started to be observed and the dates at which the observation ended are considered to be delineated and spelled out, which is a meticulous step. Proper censoring is the main aspect of data quality management as it helps prevent inaccuracies and biases in the study's results (82).

For CoD team, the VA has been conducted by data collectors separated from the regular surveillance data collectors. Data collectors and supervisors have been recruited from the study area. The data collectors are at least high school graduates with better experience in such type of work. They receive timely training like that of surveillance data collectors. They go house to house to collect information about the deceased person. In the situation when respondents may not be available on the first visit, repeated visits have been arranged on at least two occasions to avoid missing important data.

### 4.9. Data analysis procedures

Primarily, the original 36-year data were extracted from the HDSS database after using a codebook to select important and mandatory variables relevant to the study's objective and scope, followed by an extensive data cleaning using STATA. To address missing values, various mechanisms were used, including imputation, closely examining the relationship between variables, and consulting regular data collectors, many of whom have been working there for more than 10 years. Further coding and categorization for the selected exposure variables were carried out step by step.

Descriptive analyses including frequency distribution and cross-tabulation with the outcome variable were performed. The mortality rate estimations were done using number of deaths and person-years lived by children for each year.

Data analysis was accomplished using STATA version 14 software. Event history analysis, which was manipulated to study the trend of child mortality, is a statistical method that allows to study of the timing and occurrence of an event (death). The incidence of child mortality rate with its associated 95% CI was done for each year and it was also computed about each covariate. To comprehend patterns of the incidence of child mortality Kaplan-Meier estimates, along with smoothed hazard curves, were presented. The trends in the incidence of child mortality rate were computed across selected covariates. After running the incidence of child mortality to each covariate, the test of its significance was checked by observing the 95% CI whether they cross over each other or not. To declare the presence of any significant or insignificant trend across the overall study period Mann-Kendall trend test was used, when the P-value became $< 0.05$, the presence of a significant trend would be ensured. The mortality trend curve was also finally presented. Microsoft Excel was used to do the trend graphs.

The VA data was also extracted commencing from 2007 through 2022 using both the PCVA and CCVA. Coding for CoD was manipulated using the WHO's ICD-11 and categorization for broad CoD as CDs, NCDs, ECs and undetermined was done after cleaning the extracted data. A descriptive analysis of mortality rates for broad CoD and further analysis of specific CoDs by selected covariates was conducted. Along with the top CoD for 5-14 years children had been identified taking into account data started from 2007 until 2022.

The Poisson regression model was deployed to see the association of variables with the incidence of child mortality since the outcome variable death is a count per unit of time and of a rare event plus the observations in the data are independent of one another meaning survival status of one observation doesn't affect others survival status. In addition, before applying the Poisson regression model, the presence of overdispersion was checked. As the mean and variance of the outcome variable were found to be equal, it was determined that overdispersion was not present, confirming that the data fit the assumptions of the Poisson regression model. Since taking more than ten variables at once would possibly disrupt model stability and also presence of high

multicollinearity would compromise the statistically significant findings, two models in Poisson were used which resulted in more significant findings. For even better support of the work done, the output found after running all variables in one model has been presented in **Annex 1**. A wealth index, taking into account nine variables, was created using principal component analysis to assess the combined effect of wealth on child mortality, with the findings presented in **Annex 3**. Variables found statistically significant during the bivariate analysis in Poisson had been taken for multivariate analysis. After that the degree of association was declared through the incidence rate ratio (IRR) with the 95% CI to confirm whether or not the association was statistically significant.

### 4.10. Ethical consideration

Ethical clearance was taken from the School of Public Health at Addis Ababa University's research ethics committee. Besides access to use the dataset was obtained from the advisory committee of the Butajira data center or HDSS technical management committee. The main ethical principles such as autonomy, beneficence, confidentiality and non-maleficence have been highly regarded. Since this study uses ongoing population data, the confidentiality of the data was kept and ensured. No individual was given access to the information collected except for the principal investigator. The study shall declare no harm to the population and the information collected had not been used for other purposes apart from the research objective.

### 4.11. Dissemination of results

After finalizing this research project, the paper will be submitted both in hard copy and soft copy to the School of Public Health at Addis Ababa University. Another copy will also be handed to the Butajira HDSS. The result will be reported to the concerned organizations situated in the study site and may also be communicated to policy and decision makers particularly those engaged with child health issues. The result of the study will be presented at different institutions. Publication in known journals will be highly contemplated.

# 5. RESULTS

## 5.1 Characteristics of the study population

During the time of study period between 1987-2022, a total of 37,008 children aged 5-14 years were captured by the HDSS database. The study participants had been differentiated through demographic and social characteristics as shown in Table 1. More than half of the population (51.9%) were females. The mean age of the children under study was 9.6 years with SD $\pm$ 2.9. The majority of the population (71.2%) resided in rural areas and ecologically, about 41% of them were distributed in the midland zone. Besides, over 44% of the children belonged to Other Guragae ethnicity. In respect to religion, around three-quarters (76%) were from Muslims. About 84% of children lived in owned houses. The average household size was 4.0 persons with SD $\pm$ 2.2. In addition, about 54% of children's mothers had no formal education.

**Table 1: Distribution of children aged 5-14 years by different characteristics (demographic and social) in Butajira, 1987-2022 (N= 37,008)**

| Variables | Number | Percent |
|---|---|---|
| **Sex** | | |
| Male | 17,783 | 48.1 |
| Female | 19,225 | 51.9 |
| Total | 37,008 | 100 |
| **Age** | | |
| 5-9 | 17,885 | 48.3 |
| 10-14 | 19,123 | 51.7 |
| Total | 37,008 | 100 |
| **Residence** | | |
| Rural | 26,367 | 71.2 |
| Urban | 10,641 | 28.8 |
| Total | 37,008 | 100 |
| **Altitude** | | |
| Highland | 9,485 | 25.6 |
| Lowland | 12,316 | 33.3 |
| Midland | 15,207 | 41.1 |
| Total | 37,008 | 100 |
| **Ethnicity** | | |
| Mareko | 2,071 | 5.8 |
| Meskan | 11,407 | 32.3 |
| Other Guragae | 15,630 | 44.3 |
| Siliti | 4,288 | 12.2 |
| Other | 1,887 | 5.4 |
| Total | 35,283 | 100 |
| **Religion** | | |
| Christian | 8,388 | 23.8 |
| Muslim | 26,865 | 76.2 |
| Total | 35,253 | 100 |
| **Household size** | | |
| Large (>4) | 12,851 | 34.7 |
| Small (<=4) | 24,157 | 65.3 |
| Total | 37,008 | 100 |
| **Maternal education** | | |
| Never been to school | 17,022 | 54.7 |
| Literate | 14,089 | 45.3 |
| Total | 31,111 | 100 |
| **House ownership** | | |
| Owned | 31,133 | 84.1 |
| Rented | 5,875 | 15.9 |
| Total | 37,008 | 100 |

Furthermore, children aged 5-14 years who had been captured in the database per the study period also differed in the distribution across environmental and related characteristics (see Table 2). About 52% had access to protected water sources. Nearly 65% and more than 67% of children had no access to a latrine and a separate kitchen respectively. Although almost 60 % of children lived under a thatched roof, 57% of children lived in a house that had at least one window. Around 70% of the parents where children lived with didn't own any ox. Besides, they were fairly distributed in accessing the health facility. The mean distance between the house where the children live and the health facility was 7.5 KM with SD $\pm$ 5.4. Only about 39% had access to media particularly either radio or TV.

**Table 2: Distribution of children aged 5-14 years by environmental-related characteristics in Butajira, 1987-2022 (N= 37,008)**

| Variables | Number | Percent |
|---|---|---|
| **Potable water source** | | |
| Protected | 17,956 | 52.8 |
| Unprotected | 16,066 | 47.2 |
| Total | 34,022 | 100 |
| **Latrine availability** | | |
| Yes | 11,788 | 35.1 |
| No | 21,807 | 64.9 |
| Total | 33,595 | 100 |
| **Roof type** | | |
| Thatched | 21,794 | 59.5 |
| Corrugated iron | 14,804 | 40.5 |
| Total | 36,598 | 100 |
| **Ox ownership** | | |
| No | 26,254 | 70.9 |
| Single | 6,756 | 18.3 |
| 2+ | 3,998 | 10.8 |
| Total | 37,008 | 100 |
| **Windows availability** | | |
| Yes | 20,904 | 57.5 |
| No | 15,447 | 42.5 |
| Total | 36,351 | 100 |
| **Kitchen availability** | | |
| Yes | 11,905 | 32.8 |
| No | 24,443 | 67.2 |
| Total | 36,348 | 100 |
| **Distance to hospital** | | |
| <5Km | 12,733 | 34.4 |
| 5-9Km | 11,527 | 31.1 |
| >=10Km | 12,748 | 34.5 |
| Total | 37,008 | 100 |
| **Media exposure** | | |
| Yes | 12,868 | 39.1 |
| No | 20,075 | 60.9 |
| Total | 32,943 | 100 |

## 5.2 Levels of child (5-14 years) mortality in Butajira HDSS

A total of 1483 child deaths aged 5-14 years had been identified in the Butajira HDSS which contributed to 235,078 person-years between 1987 through 2022. This has resulted in an overall incidence of child (5-14 years) mortality rate of 6.31 deaths per 1000 person-years of observation with 95% CI (5.99, 6.64). Out of 1483 deaths captured during this study, 804 (54.3%) of child deaths were observed among males while 679 (45.7%) deaths were among females. The HDSS database constituted 957 (64.5%) deaths among older children and 526 (35.5%) deaths among young adolescents. (see Table 3 below)

**Table 3: Levels of the 5-14 years child mortality rate by different differentials, Butajira HDSS, 1987-2022**

| Variables | | Deaths | Person-years | Child MR/1000 (95%CI) |
|---|---|---|---|---|
| **Sex** | Male | 804 | 116,608 | 6.89 (6.43, 7.38) |
| | Female | 679 | 118,470 | 5.73 (5.31, 6.17) |
| **Age** | 5-9 | 957 | 90,645 | 10.55 (9.90, 11.24) |
| | 10-14 | 526 | 144,433 | 3.64 (3.34, 3.96) |
| **Residence** | Rural | 1379 | 187,029 | 7.37 (6.99, 7.77) |
| | Urban | 104 | 48,049 | 2.16 (1.78, 2.62) |
| **Altitude** | Highland | 420 | 67,398 | 6.23 (5.66, 6.85) |
| | Midland | 325 | 79,961 | 4.06 (3.64, 4.53) |
| | Lowland | 738 | 87,718 | 8.41 (7.82, 9.04) |
| **Distance to hospital** | <5 KM | 203 | 62,506 | 3.24 (2.83, 3.72) |
| | 5-9 KM | 581 | 81,637 | 7.11 (6.56, 7.71) ** |
| | >= 10 KM | 699 | 90,935 | 7.68 (7.13, 8.27) |
| **House hold size** | Small (<=4) | 1016 | 159,026 | 6.38 (6.00, 6.79) ** |
| | Large (>4) | 467 | 76,051 | 6.14 (5.60, 6.72) |
| **Religion** | Christian | 303 | 48,179 | 6.28 (5.61, 7.03) ** |
| | Muslim | 1157 | 173,347 | 6.67 (6.30, 7.07) |
| **Ethnicity** | Mareko | 44 | 13,041 | 3.37 (2.51, 4.53) ** |
| | Meskan | 128 | 71,472 | 1.79 (1.50, 2,12) |
| | Other Guragae | 1202 | 97,391 | 12.34 (11.66, 13.05) |
| | Siliti | 77 | 26,362 | 2.92 (2.33, 3.65) |
| | Other | 19 | 9,573 | 1.98 (1.26, 3.11) |
| **Maternal education** | Literate | 368 | 86,026 | 4.27 (3.86, 4.73) |
| | Illiterate | 1085 | 111,006 | 9.77 (9.20, 10.37) |
| **Kitchen** | Yes | 292 | 69,172 | 4.22 (3.76, 4.73) |
| | No | 1181 | 161,289 | 7.32 (6.91, 7.75) |
| **Windows** | Yes | 485 | 123,785 | 3.91 (3.58, 4.28) |
| | No | 988 | 106,705 | 9.25 (8.69, 9.85) |
| **Water source** | Protected | 385 | 101,738 | 3.78 (3.42, 4.18) |
| | Unprotected | 921 | 113,155 | 8.13 (7.63, 8.68) |
| **Oxen** | No | 849 | 161,141 | 5.26 (4.92, 5.63) |
| | 1 | 398 | 47,712 | 8.34 (7.56, 9.20) ** |
| | 2+ | 236 | 26,224 | 8.99 (7.92, 10.22) |
| **House ownership** | Own | 1464 | 211,773 | 6.91 (6.56, 7.27) |
| | Rent | 19 | 23,305 | 0.81 (0.52, 1.27) |
| **Roof type** | Thatched | 1224 | 155,036 | 7.89 (7.46, 8.34) |
| | Corrugated | 250 | 76,745 | 3.25 (2.87, 3.68) |
| **Latrine availability** | Yes | 147 | 65,550 | 2.24 (1.90, 2.63) |
| | No | 1158 | 147,063 | 7.87 (7.43, 8.34) |
| **Media exposure** | Yes | 220 | 75,708 | 2.90 (2.54, 3.31) |
| | No | 1082 | 134,210 | 8.06 (7.59, 8.55) |
| **Wealth quintile** | Poorest | 551 | 53,354 | 10.32 (9.49, 11.22) |
| | Poorer | 353 | 42, 674 | 8.27 (7.45, 9.18) |
| | Middle | 251 | 46,381 | 5.41 (4.78, 6.12) |
| | Richer | 106 | 39,353 | 2.69 (2.22, 3.25) |
| | Richest | 40 | 26,512 | 1.51 (1.11, 2.05) |
| **Overall CMR** | | 1483 | 235,078 | 6.31 (5.99, 6.64) |

** indicates the presence of non-significant variation across the categories of the covariates

Unequal variations in child mortality rates were noted between the years 5 through 14. Relatively a higher number of child mortality observed beyond 12 years as compared to the mortality rates among older children and at the very early young adolescents. The hazards of mortality rates between ages 5 through 11 were approximately at the same level. There was a significant cumulative increase in mortality rate after children survived to the age of 11, with a widening 95% CI, which could be related to the relatively fewer mortality events observed beyond it, as shown in the figure below (Fig 3).

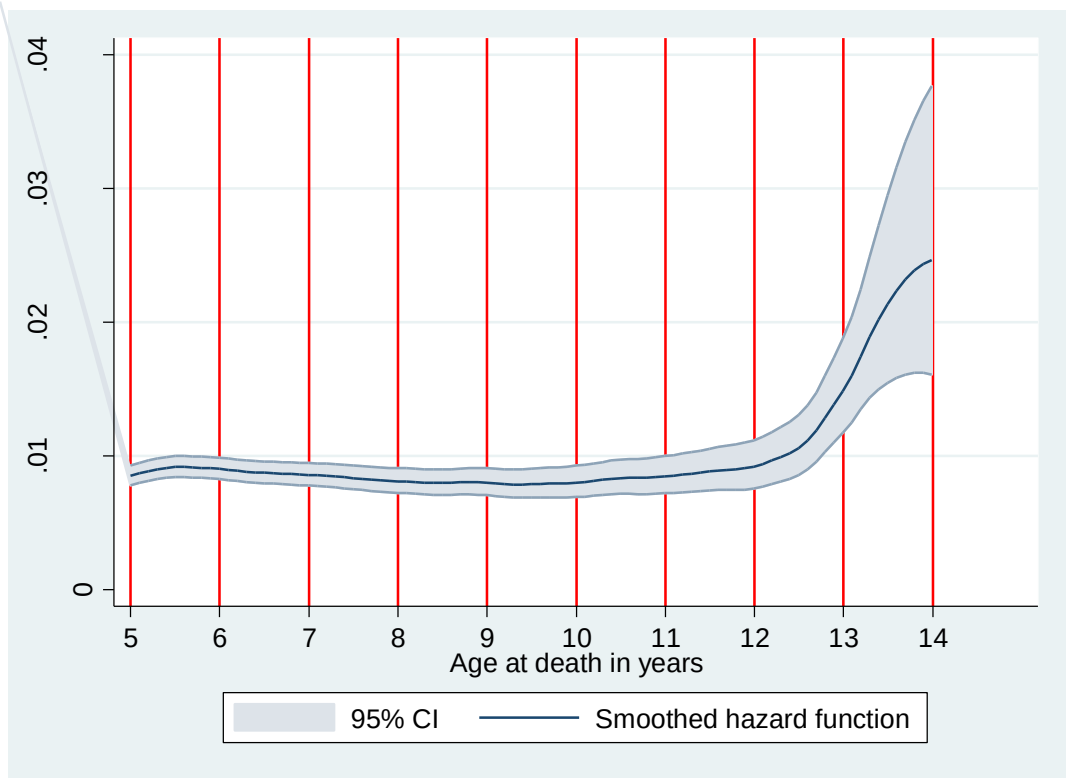


**Figure 3: Smoothed hazard incidence of child (5-14 years) mortality in Butajira HDSS, 1987-2022**

### 5.2.1 The incidence of child (5-14 years) mortality by selected covariates

#### 5.2.1.1 Child (5-14 years) mortality incidence rate by sex

The levels of child (5-14 years) mortality rate notably varied across sexes in the Butajira HDSS. The distribution of child mortality rate by sex during the study period depicted that males constituted 805 deaths out of 1483 contributing a total of 116,608 person-years. That lead to a child mortality incidence rate of 6.89 deaths per 1000 person-years of observation with 95% CI (6.43, 7.38) whereas among females there were 679 deaths contributed to 118, 470 person-years which resulted in a child mortality rate of 5.73 deaths per 1000 years of follow up with 95% CI (5.31, 6.17). Hence, during the follow-up period males had a significantly higher mortality rate as compared with females. (Table 3)

The hazards of mortality by sex varied across ages. Between the ages 5 to 8 years the hazard was higher among males and from 9 to 11 years it was at the same level, yet starting from the late 12 years and beyond, the hazards of mortality among females had been escalated. (See Fig. 4)

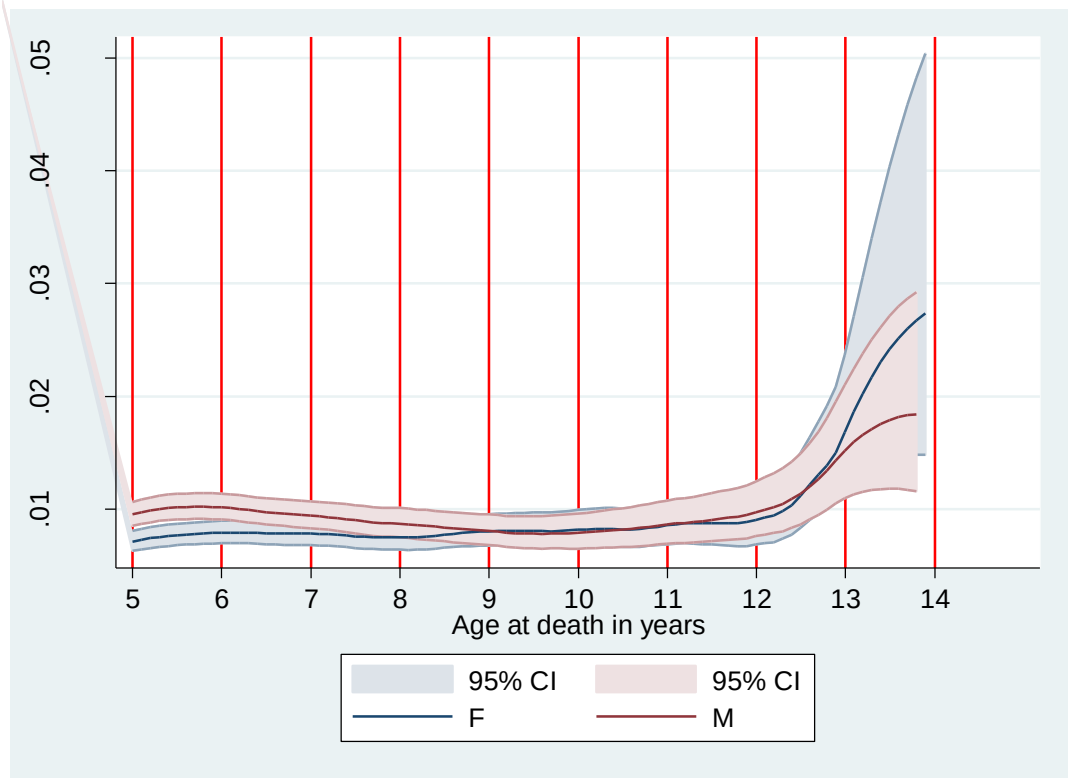


**Figure 4: Smoothed hazard incidence of child (5-14 years) mortality by sex in Butajira HDSS: 1987-2022**

### 5.2.1.2 Child (5-14 years) mortality incidence rate by residence

During the study period, there were 1379 child deaths among rural residents contributing to 187,029 person-years, this resulted in a mortality incidence rate of 7.37 (with 95 %CI 6.99, 7.77) deaths per 1000 years of follow-up. Whereas, in the case of urban residents there existed only 104 deaths with 48,049 person-years of observation making a mortality rate of 2.16 deaths (with 95% CI 1.78, 2.62) per 1000 person-years. Thus, Children aged 5-14 years who resided in rural areas had significantly higher mortality incidence rates compared to those who lived in urban areas. (Table 3)

A higher magnitude of mortality among rural residents was observed between the ages of 5 to 14 years. The difference became highly pronounced in the ages 5 to 10 years. (Fig. 5)

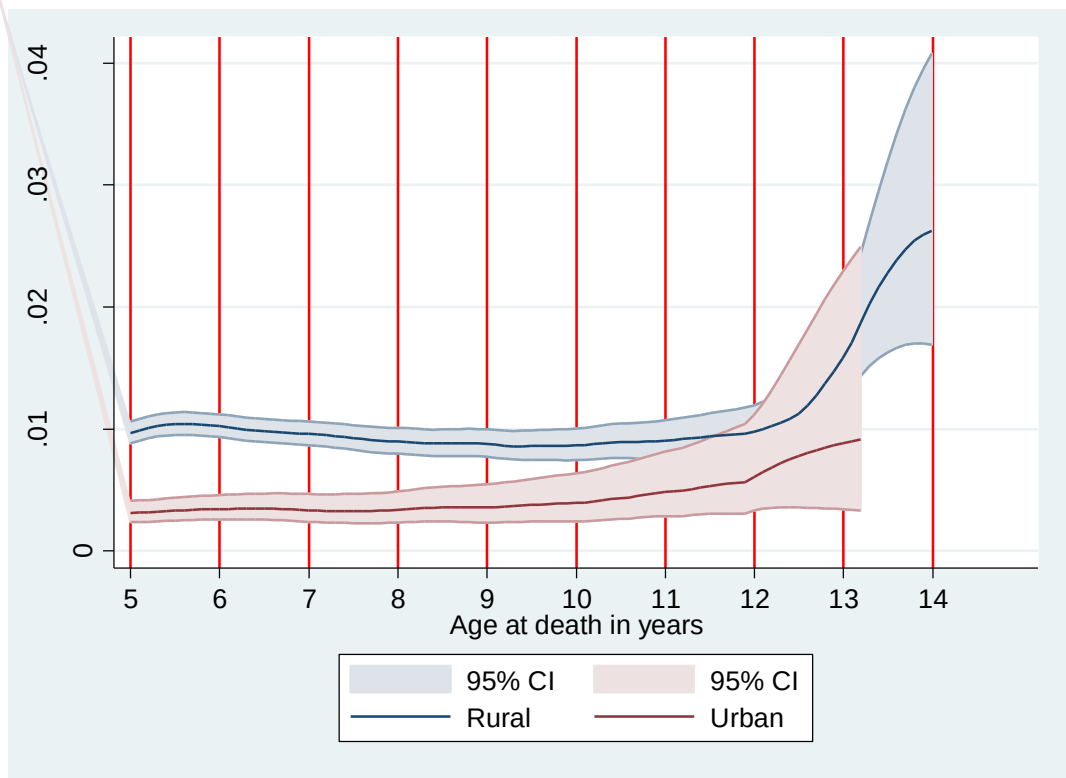


**Figure 5: Smoothed hazard incidence of child (5-14 years) mortality by residence in Butajira HDSS: 1987-2022**

### 5.2.1.3 Child (5-14 years) mortality rate by altitude

5-14 years children who lived in lowland areas had higher mortality incidence rates of 8.41 deaths per 1000 person-years of follow-up (with 95% CI 7.82, 9.04) as compared with those who lived in highland areas (6.23 child deaths with 95% CI (5.66, 6.85) per 1000 person-years) and those resided in midland zones 4.06 deaths (with 95% CI 3.64, 4.53) per 1000 person-years. (Table 3)

A higher mortality was visualized among lowland and highland area residents between the ages 5 to 8 years compared to the midland zone dwellers. The hazards of child mortality become relatively at the same level at the ages 9 through mid-11 years across the three ecological zones. Starting from late-12 years excess hazards of mortality were observed in midland and highlanders compared to lowland dwellers. (Fig. 6)

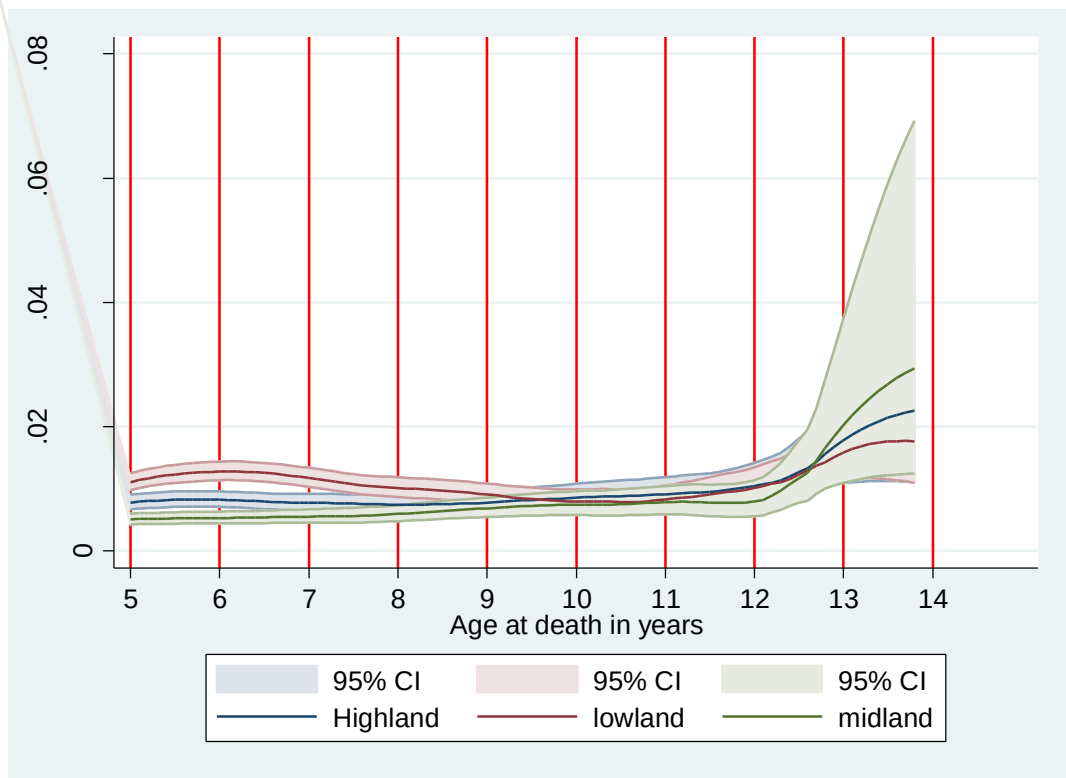


**Figure 6: Smoothed hazard incidence of child (5-14 years) mortality by altitude in Butajira HDSS: 1987-2022**

As presented in table 3, the incidence of child mortality rate varied across different covariates. The mortality incidence rate for children whose mothers had never been to school was found to be even higher (9.77 child deaths per 1000 person-years with 95% CI: 9.20, 10.37) than that of children whose mother was literate (4.27 deaths per 1000 person-years with 95% CI: 3.86, 4.73).

Children aged 5 to 14 years who lived in the house without a separate kitchen had a higher mortality incidence rate of 7.32 deaths per 1000 person-years (95% CI: 6.91, 7.75) than those children who lived in the house with a separate kitchen (4.22 deaths per 1000 person-years).

Children who had access to protected water sources had a lower mortality incidence rate of 3.78 deaths per 1000 person-years as compared to those who didn't have access to protected water sources with a mortality rate of 8.13 deaths (95% CI: 7.63, 8.68) per 1000 person-years of observation.

The child mortality incidence rate was seen to be significantly different with the availability of windows in the houses where children lived. The mortality rate in the houses that didn't have a window was higher than that of houses that had at least a window with 9.25 child deaths per 1000 person-years and 3.91 deaths per 1000 years of follow-up respectively.

Child mortality also differed prominently with the availability of latrines in the house where 5-14-year-old children lived. Lower incidence of mortality had been manifested among children who lived in a house that had a latrine with a rate of 2.24 deaths per 1000 person-years (95%CI: 1.90, 2.63) as compared to children whose house had no latrine (with 7.87 deaths per 1000 person-years, 95%CI: 7.43, 8.34).

Excess child mortality incidence rate was observed among children who lived in owned houses with 6.91 deaths per 1000 person-years (95% CI: 6.56, 7.27). whereas, very low incidence of mortality was seen among children who lived in rented houses (0.81 deaths per 1000 person-years of observation with 95% CI: 0.52, 1.27).

Levels of child mortality seemed to be varied across access to media exposure in the house. Those children who had access to either TV or radio in their home had a lower incidence of mortality rate with 2.90 deaths per 1000 person-years (95% CI: 2.54, 3.31). While, those children who hadn't been exposed to any media had an even higher incidence of mortality rate with 8.06 deaths per 1000 person-years (95% CI: 7.59, 8.55).

Children who lived in the households with a thatched grass roof had a higher incidence of mortality rate (7.89 deaths per 1000 person-years, 95% CI: 7.46, 8.34) as compared to those who lived under corrugated iron sheet roof with a mortality incidence rate of 3.25 deaths per 1000 person-years (95% CI: 2.87, 3.68). Hence, significant variation in the incidence of child mortality has been observed regarding the type of roof children resided.

### 5.3 Temporal trends of child (5-14 years) mortality in Butajira HDSS (1987-2022)

#### 5.3.1 Overall trend of child (5-14 years) mortality

The trend of child mortality rates is shown using a 36-year data of the Butajira HDSS by calculating the mortality incidence rate of every year beginning from 1987 through 2022. Uneven variations in child mortality rates were depicted across the years of follow-up. While doing 36 years of analysis, there was a tendency for an increment in child mortality trend between the years 1987 through 1999. Meanwhile, starting from the year 2000 until the end of years of follow-up, a declining pattern in the trend of child mortality was observed. Overall, a statistically significant declining trend was observed among mortality rates of 5-14-year-old children from 1987-2022, though there existed an increment and decrement in the trend of child mortality with an overlap in the confidence interval of rates with one another at some stages (Table 4).

**Table 4: Child (5-14 years) mortality incidence rate per year in Butajira HDSS, South Central Ethiopia: 1987-2022**

| Year | Person-year | No of deaths | Rate/1000 | 95%CI |
|---|---|---|---|---|
| 1987 | 349 | 38 | 108.87 | (79.22, 149.62) |
| 1988 | 963 | 103 | 106.95 | (88.17, 129.73) |
| 1989 | 1498 | 120 | 80.07 | (66.95, 95.75) |
| 1990 | 1656 | 55 | 33.19 | (25.48, 43.24) |
| 1991 | 1910 | 105 | 54.96 | (45.39, 66.55) |
| 1992 | 1887 | 47 | 24.90 | (18.70, 33.14) |
| 1993 | 2343 | 67 | 28.59 | (22.50, 36.32) |
| 1994 | 3166 | 95 | 29.99 | (24.53, 36.68) |
| 1995 | 3086 | 67 | 21.70 | (17.08, 27.58) |
| 1996 | 3003 | 45 | 14.98 | (11.40, 20.46) |
| 1997 | 4734 | 75 | 15.84 | (12.63, 19.86) |
| 1998 | 6009 | 98 | 16.30 | (13.37, 19.87) |
| 1999 | 6895 | 193 | 27.98 | (24.30, 32.22) |
| 2000 | 6484 | 44 | 6.78 | (5.04, 9.11) |
| 2001 | 4391 | 29 | 6.60 | (4.58, 9.50) |
| 2002 | 5767 | 38 | 6.58 | (4.79, 9.05) |
| 2003 | 5945 | 41 | 6.89 | (5.07, 9.36) |
| 2004 | 5180 | 11 | 2.12 | (1.17, 3.83) |
| 2005 | 5369 | 22 | 4.09 | (2.69, 6.22) |
| 2006 | 5571 | 21 | 3.76 | (2.45, 5.78) |
| 2007 | 5537 | 22 | 3.97 | (2.61, 6.03) |
| 2008 | 6388 | 23 | 3.60 | (2.39, 5.41) |
| 2009 | 5473 | 15 | 2.74 | (1.65, 4.54) |
| 2010 | 5096 | 12 | 2.35 | (1.33, 4.14) |
| 2011 | 4768 | 18 | 3.77 | (2.37, 5.99) |
| 2012 | 4661 | 13 | 2.78 | (1.61, 4.80) |
| 2013 | 5045 | 5 | 0.99 | (0.41, 2.38) |
| 2014 | 5706 | 15 | 2.62 | (1.58, 4.36) |
| 2015 | 5506 | 11 | 1.99 | (1.10, 3.61) |
| 2016 | 5037 | 9 | 1.78 | (0.92, 3.43) |
| 2017 | 5767 | 2 | 0.34 | (0.08, 1.38) |
| 2018 | 3148 | 10 | 3.17 | (1.70, 5.90) |
| 2019 | 4027 | 2 | 0.49 | (0.12, 1.98) |
| 2020 | 3964 | 2 | 0.50 | (0.12, 2.01) |
| 2021 | 3661 | 4 | 1.09 | (0.41, 2.91) |
| 2022 | 85,072 | 6 | 0.07 | (0.03, 0.15) |

The unequal decreasing pattern in mortality trend was observed between 1987 to 1990 though not statistically significant due to the presence of wide and overlapping CI. An abrupt significant increasing trend was seen between the years 1990 through 1991 with a subsequent significant decline observed till 1992. Uneven insignificant increments and declining patterns have been observed starting from the year 1992 up to 1998. A significant increasing pattern of mortality was observed for a brief year from 1998 to 1999, followed by a decreasing pattern of mortality until 2002. Onwards to 2002, again uneven increment and declining pattern have been observed. Nearing the end of the observation periods, the mortality rate was found to be at a lower level and even the lowest rates of mortality were observed at the end of the study period (2022) since the population level was increasing through and through with a low level of mortality existed on 5-14 years children most of them contributing full years resulting in the highest number of person-years contribution (Fig 7).

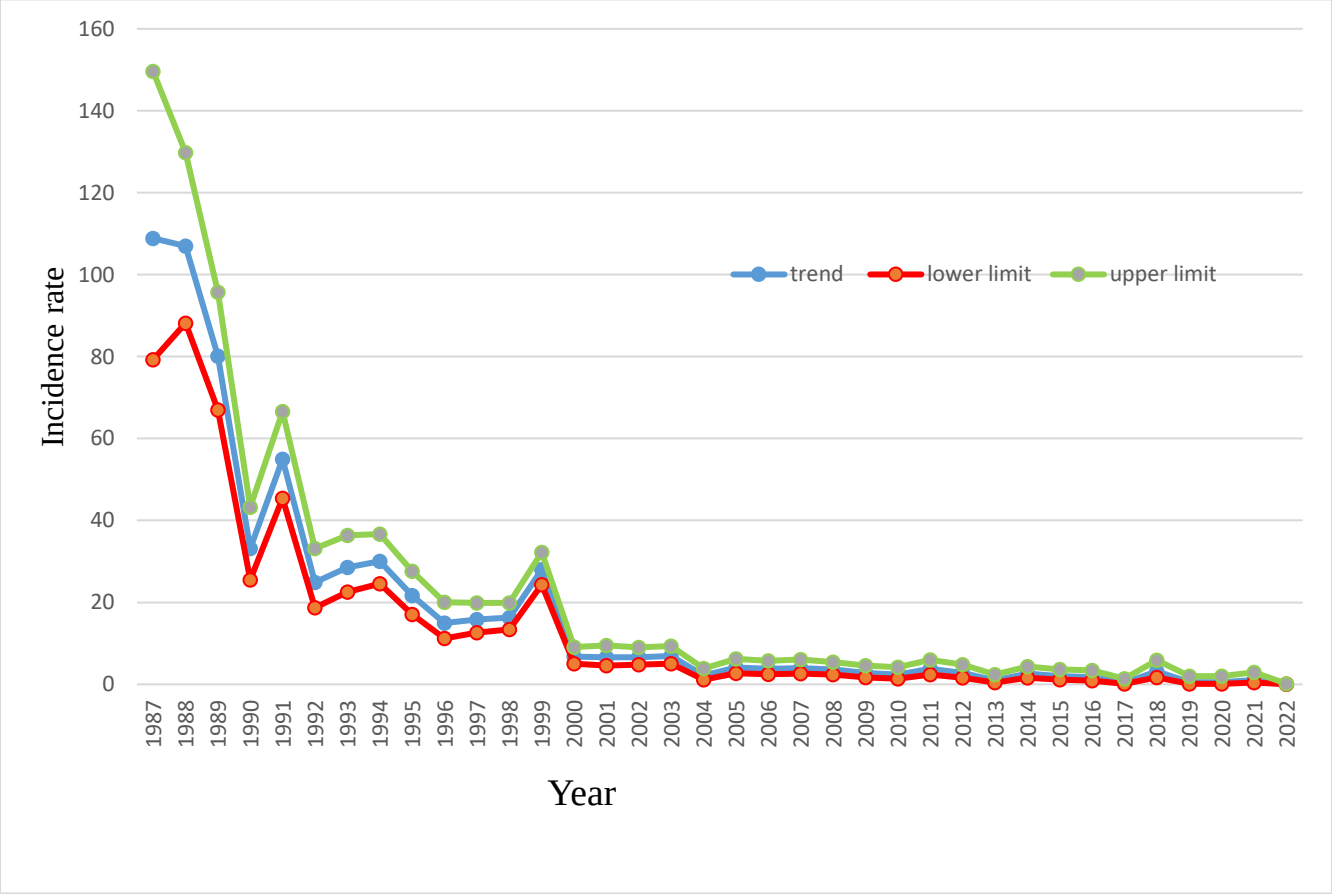


**Figure 7: The trend of the incidence of child (5-14 years) mortality rates by year in Butajira HDSS: 1987-2022**

A statistically significant decreasing trend change was noticed for 5-14 years of child deaths over the study years using the linear trend analysis (Kendall's tau (measures the strength and direction of association) = - 0.83; P-value < 0.0001). For every year increment in the study site beginning from the year 1987 onwards, the rate of child (5-14 years) mortality decreased by 1.96. $R^2$ (coefficient of determination) = 0.548, depicted that 54.8% of the variation in the rate of child mortality could be explained by the years encountered (X-axis). And R (correlation coefficient) = -0.74, implies the presence of a relatively strong correlation between the rates of mortality and passing of years from 1987-2022 (Fig. 8).

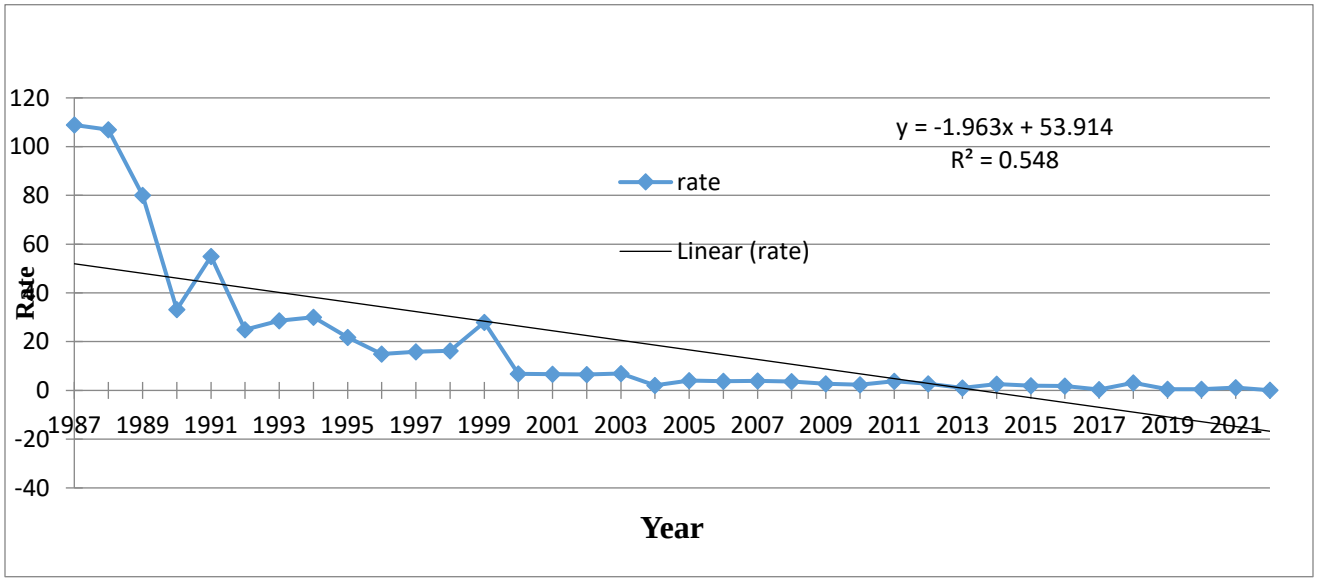


**Figure 8: A 36-year child mortality trend observed rates in Butajira HDSS fitting the linear line**

### 5.3.2 The trend of child (5-14 years) mortality by sex

The trend graph depicts that for both males and females, there was a declining incidence of child mortality over the study periods. The incidence of child (5-14 years) mortality rates for females had declined from its peak in 1987 with 94.2 deaths (95% CI: 59.35, 149.25) per 1000 person-years to 0.12 (0.05, 0.29) deaths per 1000 person-years in 2022. Besides, at the year 2020, the lowest mortality with 0 death was recorded among females. While, also a declining child mortality trend among males was observed at its highest in 1987 with 126 deaths (81.68, 196.25) per 1000 person-years to 0.02 deaths (0.03, 0.15) per 1000 person-years in 2022. In most years of follow up, the trend of child mortality for males was higher than that of females (Figure 9).

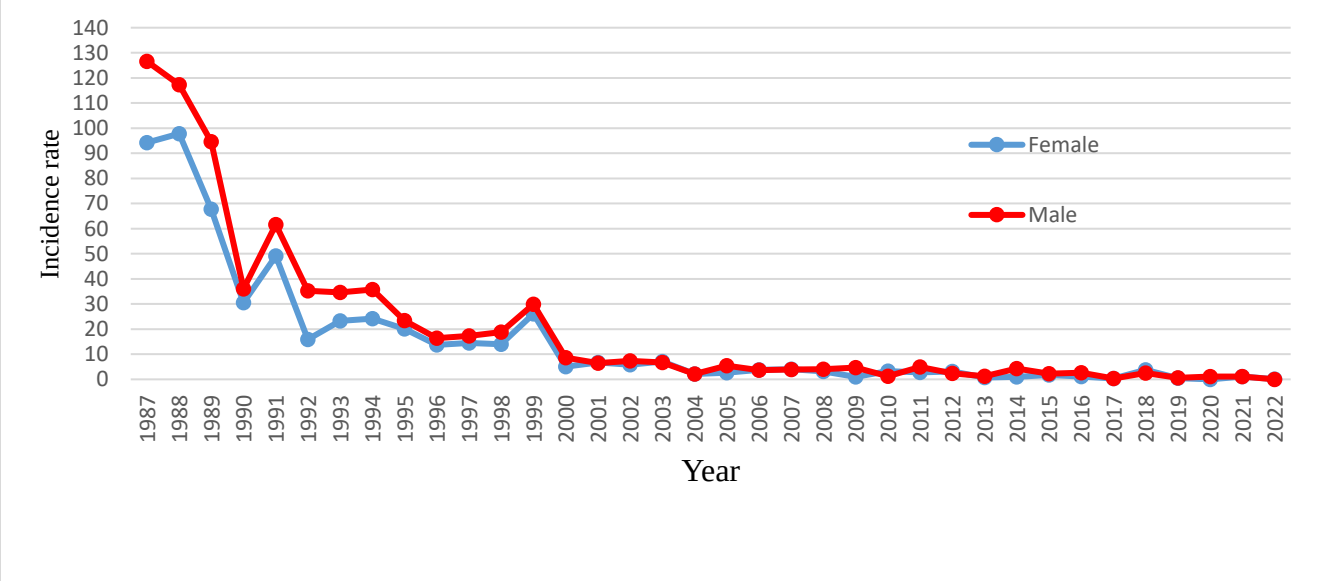


**Figure 9: The trend of the incidence of child (5-14 years) mortality rates by sex in Butajira HDSS, 1987-2022**

### 5.3.3 The trend of child (5-14 years) mortality by residence

The child mortality incidence rate was higher among rural residents than urban residents in the Butajira HDSS. Except in the year 2001, the incidence of child mortality was lower throughout a 36-year follow-up among children who lived in urban areas. As shown in the figure below, the incidence of child mortality clinched highest among rural residents in 1987 with a mortality rate of 126.32 deaths (95% CI: 91.92, 173. 60) per 1000 person-years. Whereas, in the year 1989, the maximum mortality rate was observed among children who resided in urban areas with 29.87 deaths (95% CI: 14.93, 59.73) per 1000 person-years (Fig. 10).

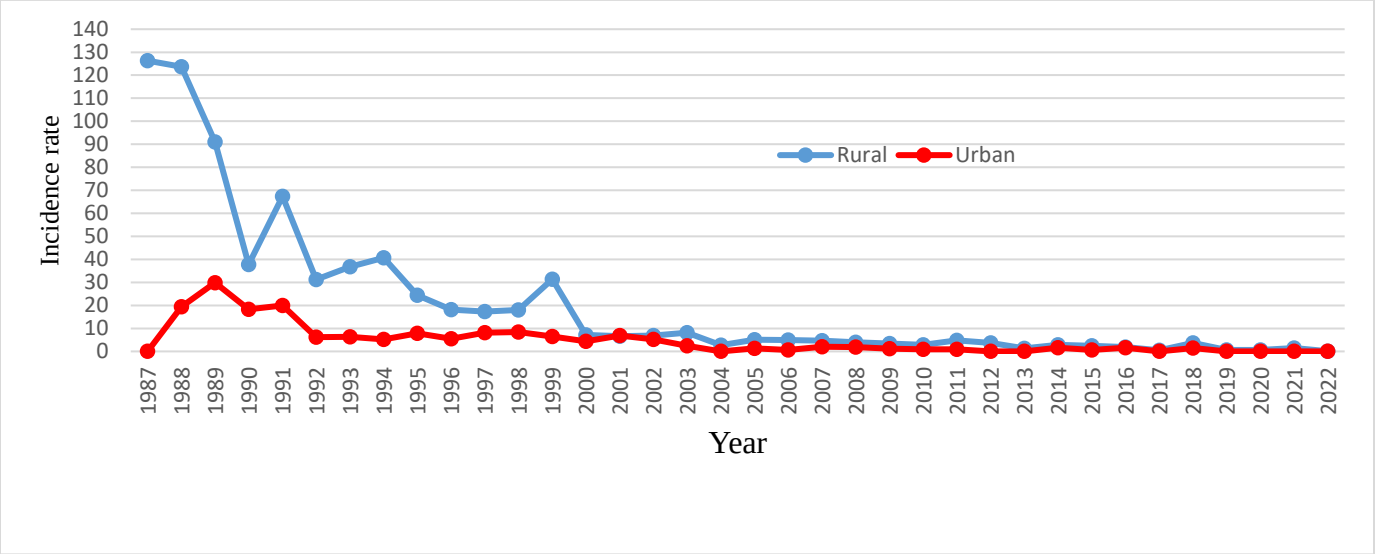


**Figure 10: The trend of the incidence of child (5-14 years) mortality rates by residence in Butajira HDSS, 1987-2022**

### 5.3.4 The trend of child (5-14 years) mortality by altitude

The trend visualizes that there was a declining incidence of child mortality across the three ecological zones. Throughout the study period, the incidence of child mortality was higher among those children who lived in lowland areas as compared to highland and midland zones exceptional in the years 1996, 2010, 2016, 2017 and 2021. Compared to the others, the lowest mortality rate was seen almost throughout the observation periods in children who lived in the midland zone. The maximum child mortality rate was observed among lowlanders in 1988 with 177.76 deaths (95% CI: 138.59, 228.01) per 1000 person-years. Meanwhile, in both highland and midland areas, the highest mortality rate was recorded in 1987 with 114.58 deaths (70.19, 187. 03) per 1000 person-years and 87.29 deaths (95% CI: 45.2, 167.77) per 1000 person-years respectively. (Fig. 11)

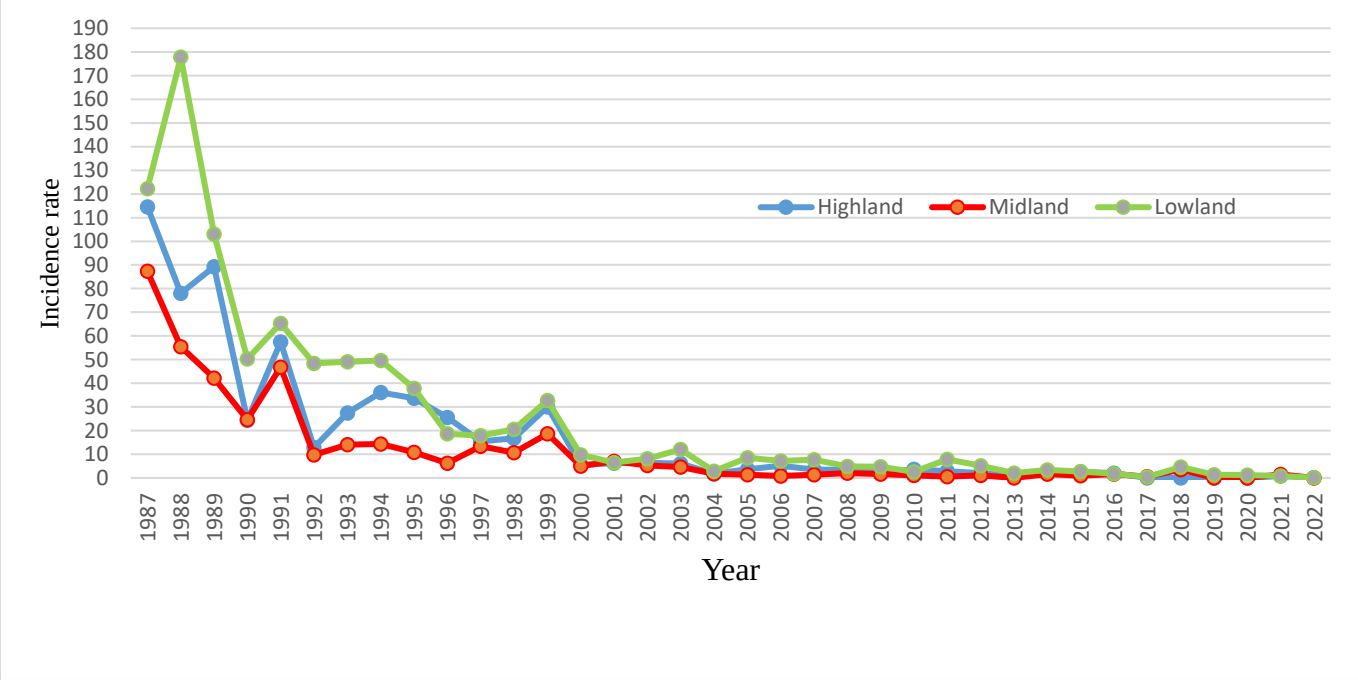


**Figure 11: The trend of the incidence of child (5-14 years) mortality rates by altitude in Butajira HDSS, 1987-2022**

### 5.4. Disease burden among children aged 5-14 years, Butajira HDSS (2007-2022)

#### 5.4.1 Socio-demographic characteristics of the deceased, 2007-2022

A total of 130 deaths of children had been captured with complete information from the VA data set during the observation period between 1 January, 2007 through 31 December, 2022. Out of 130 deaths, 76.9% of deaths were ascertained through physician review and the remaining 23.1% were via inter-VA algorithm. Of the overall captured deaths, 53.1% were female deaths and 46.9% were male deaths. The median age at death was 8 years (with SD $\pm$ 2.89). The majority (91.5%) of the deceased occurred in rural areas. More than half (52.3%) of the deceased captured in the VA data resided in lowland zones followed by highland (26.9) and midland (20.8%) ecological areas. Out of 130 deceased 5-14-year-old children, about 42.4% of them had been attending school (primary school and above). (Table 5)

**Table 5: Socio-demographic characteristics of the deceased in Butajira HDSS, 2007-2022 (N = 130)**

| Variables with categories | Number | Percent |
|---|---|---|
| **Sex** | | |
| Male | 61 | 46.9 |
| Female | 69 | 53.1 |
| Total | 130 | 100 |
| **Age** | | |
| 5-9 | 80 | 61.5 |
| 10-14 | 50 | 38.5 |
| Total | 130 | 100 |
| **Residence** | | |
| Rural | 119 | 91.5 |
| Urban | 11 | 8.5 |
| Total | 130 | 100 |
| **Altitude** | | |
| Highland | 35 | 26.9 |
| Lowland | 68 | 52.3 |
| Midland | 27 | 20.8 |
| Total | 130 | 100 |
| **Child education** | | |
| Never been to school | 72 | 57.6 |
| Primary school and above | 53 | 42.4 |
| Total | 125 | 100 |

### 5.4.2 Broad causes of death (2007-2022) for 5-14 years children

The broad CoD was majorly classified into CDs, NCDs and ECs. Besides for those cases with unspecified causes of death were grouped as undetermined CoD (UCoD). The CoD was specified for 97.3% of cases, leaving only 2.3% of the deceased that their causes of death were undetermined. This study revealed that the major CoD among 5-14-year-old children was attributed to CDs covering 39% followed by NCDs (35%) and ECs (23%) (Fig. 12).

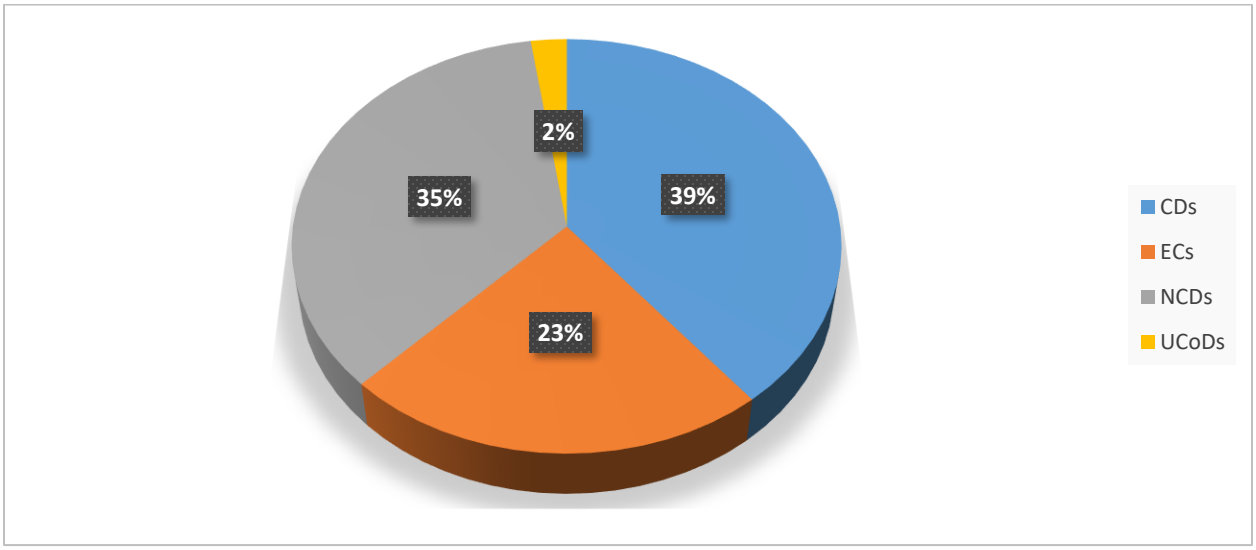


**Figure 12: Broad CoD classification for 5-14 years children, Butajira HDSS, 01 Jan 2007-31 Dec 2022**

### 5.4.3 Specific cause of death for 5-14 years children, 2007-2022

HIV/AIDS (14.6%), severe malnutrition (13.1%), accidental drowning & submersion (8.5%), RTA (8.5%) and acute lower respiratory infections (including pneumonia and acute bronchitis) (7.7%) were found to be the leading top 5 specific causes of death for 5-14 years children (Fig. 13)**.**

In constituting the broad CoD; HIV/AIDS, acute lower respiratory infections (including pneumonia and acute bronchitis), intestinal infectious deaths (including diarrheal diseases) and Pulmonary TB constituted the top major specific causes of death for the CDs category. Whereas severe malnutrition, congestive heart failure, epilepsy and renal failure were the major specific causes in contributing for NCDs. Meanwhile, accidental drowning & submersion (36.7%), RTA (36.7%), accidental fall (6.7%) and accidental exposure to smoke, fire & flames (lightning) (6.7%) were the leading specific CoD attributed for ECs.

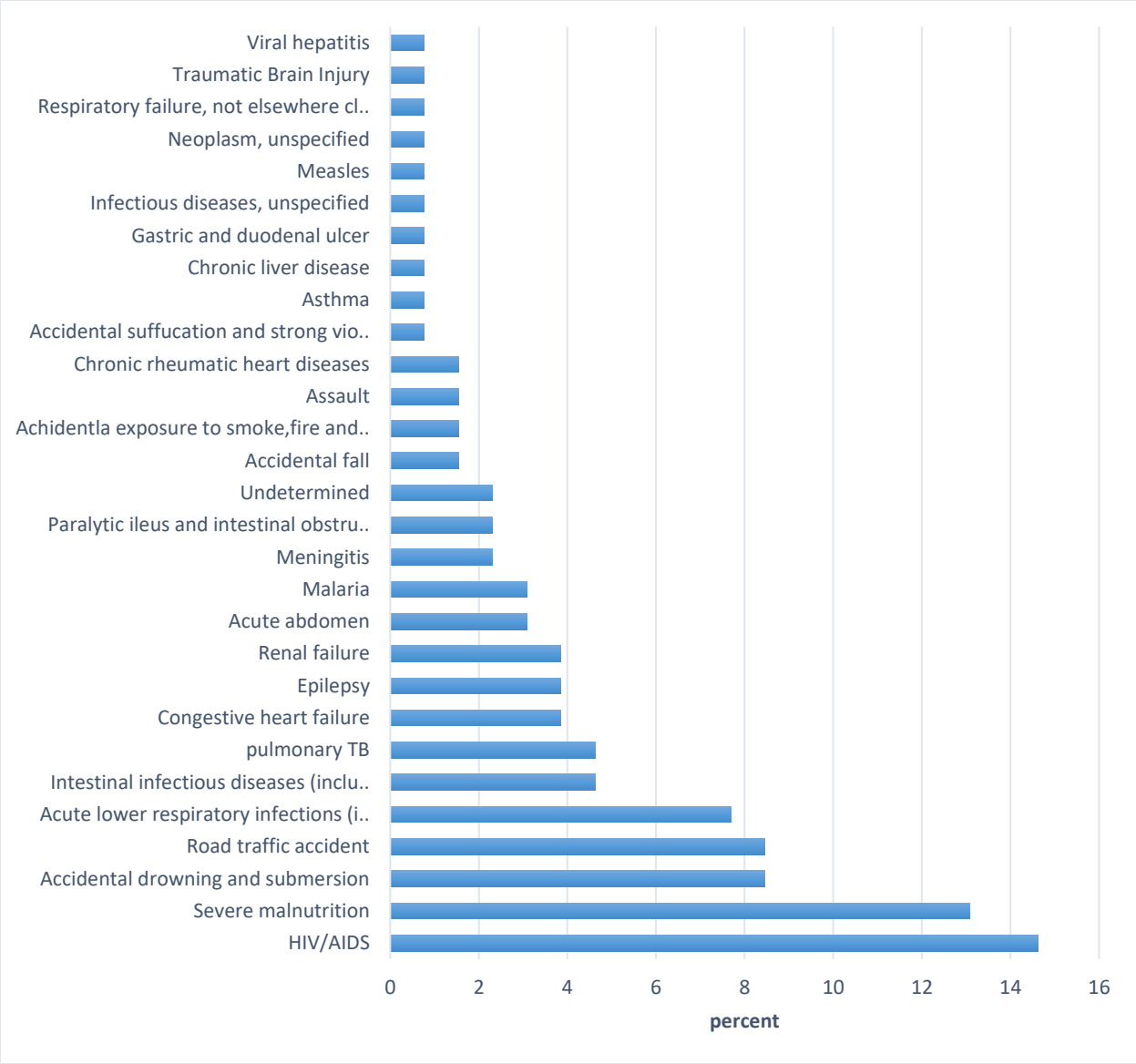


**Figure 13: Specific CoD for 5-14 years children, Butajira HDSS, 01 Jan 2007- 31 Dec 2022, Ethiopia**

### 5.4. 4 Causes of death for 5-14 years children by selected covariates

#### 5.4.4.1 Major CoD by Sex

The main CoD for female and male children differed considerably. Severe malnutrition, HIV/AIDS and acute lower respiratory infections (including pneumonia and acute bronchitis) were the leading CoD among male children aged 5-14 years constituting 18.0%, 14.8% and 11.5% respectively. On the other hand, HIV/AIDS (14.5%), accidental drowning and submersion (11.6%) and RTA (10.1%) were the major CoD among female children. (Figure 14)

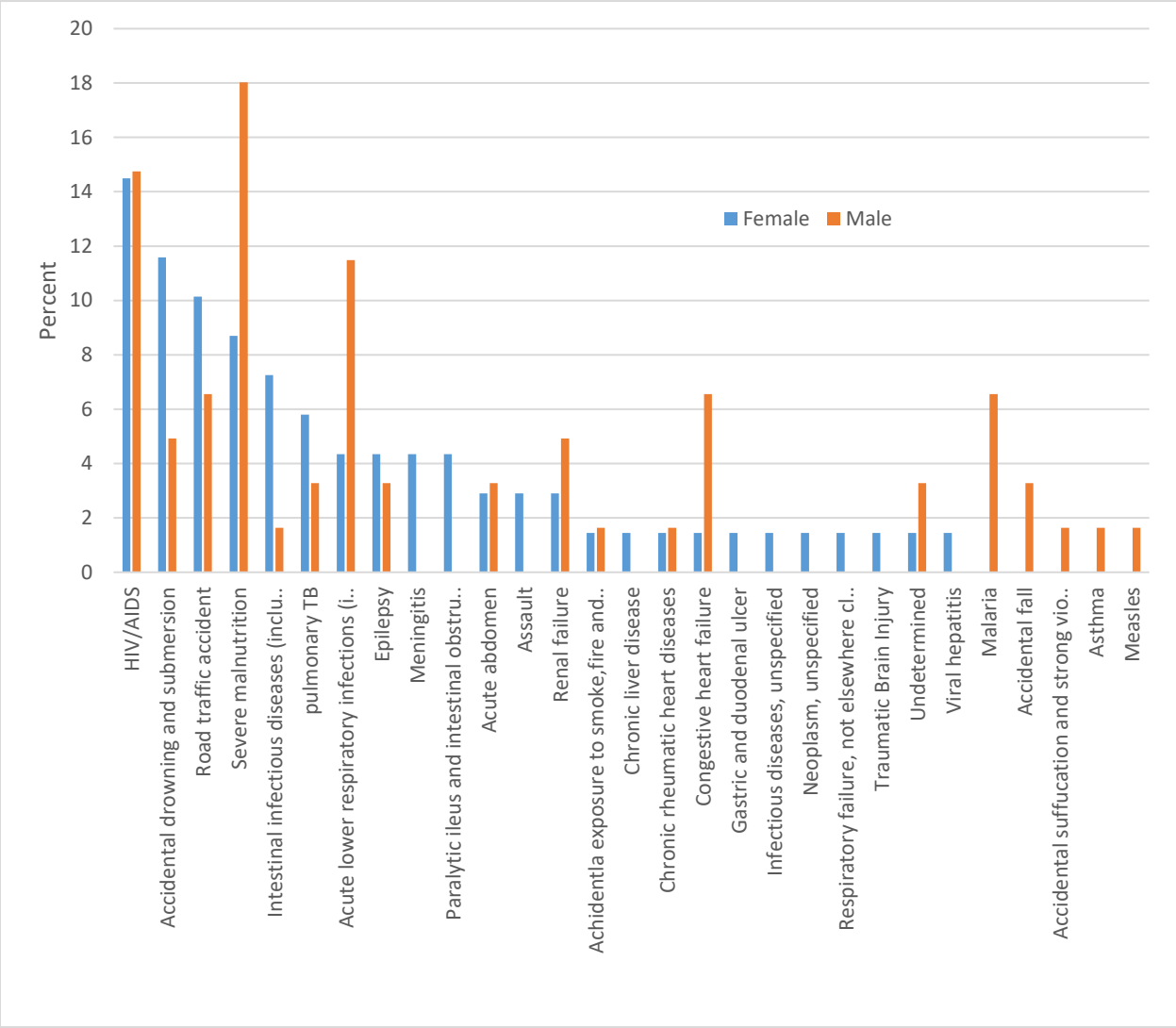


**Figure 14: Major CoD among 5-14 years children by sex, Butajira HDSS: 01 Jan 2007- 31 Dec 2022**

### 5.4.4.2 Major CoD by Age

The major CoD also varied across the age groups classified through a five-year interval. As described above, excess deaths were captured in the age group 5-9 years (61.5%) during the follow-up period. The leading CoD among 5-9-year-old children were severe malnutrition (15%) followed by HIV/AIDS (13.8%), acute lower respiratory infections (including pneumonia and acute bronchitis) (11.3%) and accidental drowning and submersion (10%). Whereas, among the age group 10-14 years, HIV/AIDS (16%), epilepsy (10%), RTA (10%) and severe malnutrition (10%) were found to be the major CoD (Fig. 15).

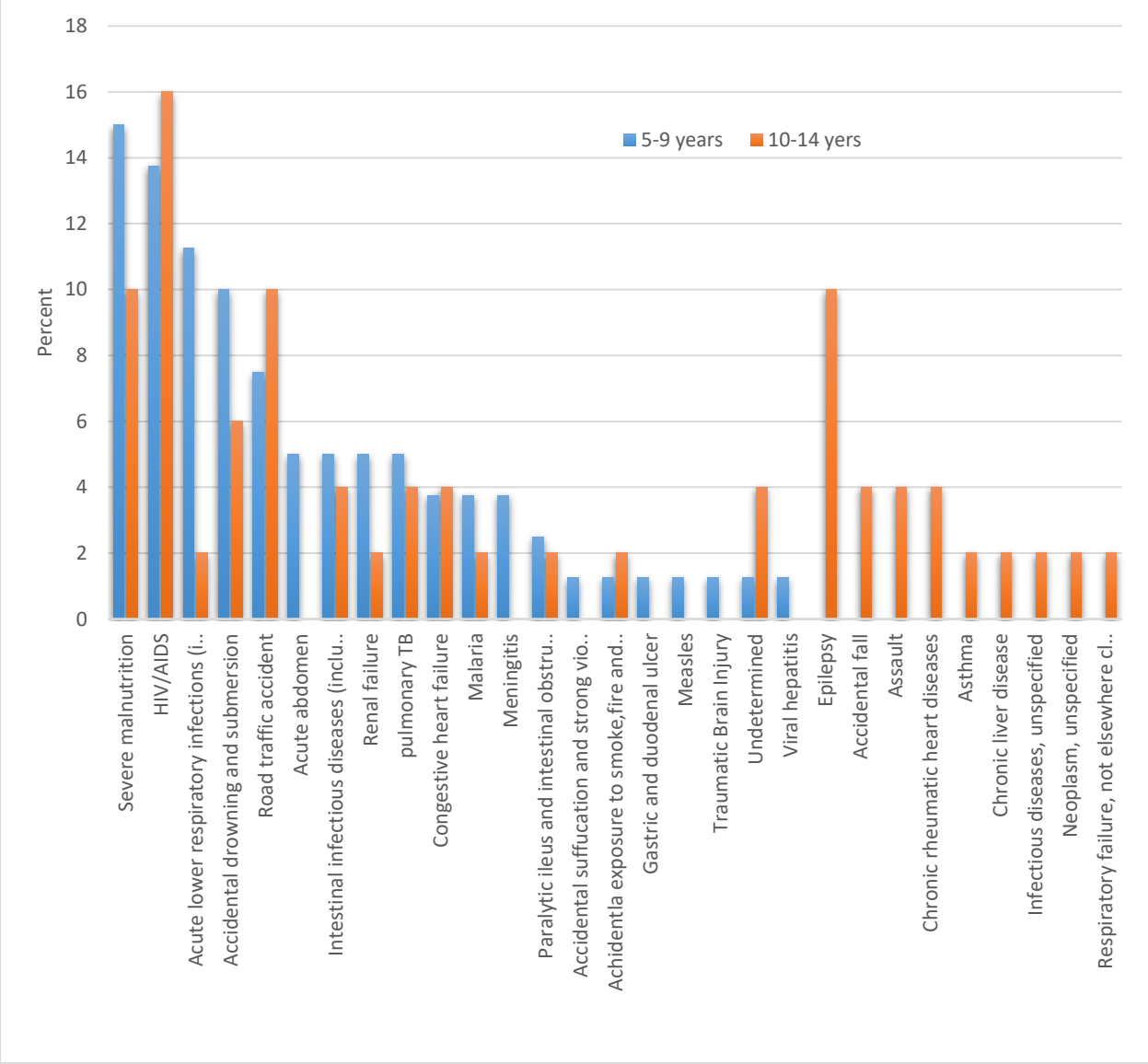


**Figure 15: Major CoD among 5-14 years children by age group, Butajira HDSS: 01 Jan 2007- 31 Dec 2022**

### 5.4.4.3 Major CoD by Residence

Variation in CoD among 5-14 years children was observed in relation to the area of residence. During the follow-up period, more child deaths were found to exist on rural residents. As shown below in the figure 16, the major leading CoD among children who resided in rural areas were severe malnutrition and HIV/AIDS. While HIV/AIDS and epilepsy were the major CoD among 5-14 years children who lived in urban area.

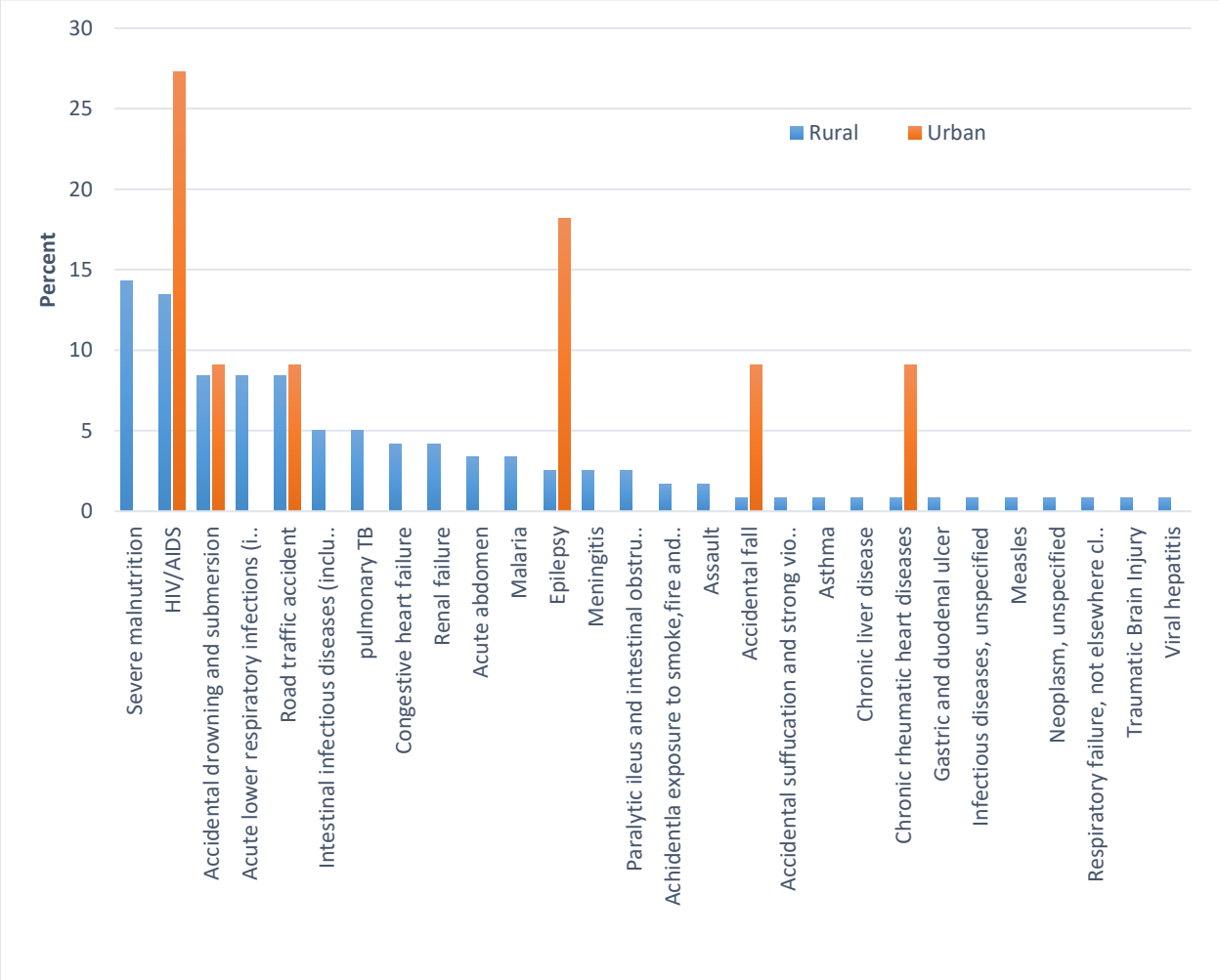


**Figure 16: Major CoD among 5-14 years children by residential area, Butajira HDSS: 01 Jan 2007- 31 Dec 2022**

### 5.5 Determinants of child (5-14 years) mortality

A separate Poisson regression model (two models) was deployed. Mainstreaming sex, age, residence, altitude, house ownership, household size, religion and maternal education at model one showed that male children had a significantly higher mortality rate with an adjusted incidence rate ratio of 1.27 (95% CI: 1.15-1.41) than females. The incidence of child mortality rate within the age group 5-9 years was 2.06 (with 95% CI: 1.84, 2.29) times higher than that of the age group 10-14 years. Child mortality rates were significantly higher by an adjusted IRR of 2.42 (95% CI: 1.88, 3.12) among those who resided in rural areas compared to their urban counterparts. Regarding altitude, the risk of child mortality in lowland areas was 1.37 (95% CI: 1.17, 1.60) times higher compared to those in midland areas. However, there were no statistically significant differences observed between highland and lowland zones.

The incidence of mortality among children who lived in owned houses was 3.98 (2.33, 6.79) times higher than those who resided in rented houses. The risk of child mortality was a little bit higher in households containing small family members with an adjusted IRR of 1.18 (95% CI: 1.05, 1.32). Yet, religion was not statistically significantly associated with the incidence of child (5-14 years) mortality. Furthermore, this study revealed that the risk of child mortality was significantly higher among children whose mothers had never been to school with an adjusted IRR of 2.03 (1.80, 2.29) as compared with children whose mothers were literate. (Table 6)

**Table 6: Determinants of child mortality in the Butajira HDSS, (1987-2022); Model 1**

| Variables | Deaths | Person-years | Unadjusted IRR (95%) | Adjusted IRR (95%) |
|---|---|---|---|---|
| **Sex** | | | | |
| Male | 804 | 116,608 | 1.29 (1.17, 1.43) | 1.27 (1.15, 1.41) ** |
| Female | 679 | 118,470 | Ref. | Ref. |
| **Age** | | | | |
| 5-9 | 957 | 90,645 | 1.94 (1.74, 2.15) | 2.06 (1.84, 2.29) ** |
| 10-14 | 526 | 144,433 | Ref. | Ref. |
| **Residence** | | | | |
| Rural | 1379 | 187,029 | 5.66 (4.64, 6.91) | 2.42 (1.88, 3.12) ** |
| Urban | 104 | 48,049 | Ref. | Ref. |
| **Altitude** | | | | |
| Highland | 420 | 67,398 | 2.05 (1.77, 2.37) | 0.88 (0.74, 1.04) |
| Lowland | 738 | 87,718 | 2.97 (2.60, 3.38) | 1.37 (1.17, 1.60) ** |
| Midland | 325 | 79,961 | Ref. | Ref. |
| **House ownership** | | | | |
| Own | 1464 | 211,773 | 16.20 (10.30, 25.47) | 3.98 (2.33, 6.79) ** |
| Rent | 19 | 23,305 | Ref. | Ref. |
| **Household size** | | | | |
| Small (<=4) | 1016 | 159,026 | 1.14 (1.02, 1.27) | 1.18 (1.05, 1.32) ** |
| Large (>4) | 467 | 76,051 | Ref. | Ref. |
| **Religion** | | | | |
| Muslim | 1157 | 173,347 | 1.16 (1.02, 1.31) | 1.14 (0.98, 1.32) |
| Christian | 303 | 48,179 | Ref. | Ref. |
| **Maternal education** | | | | |
| Never been to school | 1085 | 111,006 | 2.56 (2.28, 2.89) | 2.03 (1.80, 2.29) ** |
| Literate | 368 | 86,026 | Ref. | Ref. |

** Shows statistically significant values

The second model taking into account window availability, media exposure, roof type, latrine availability, distance to hospital, kitchen availability, ox ownership and potable water source revealed that kitchen availability and type of roof were not statistically significantly associated with child mortality. Children who lived in a house having no window had a significantly higher mortality rate with an adjusted IRR of 1.38 (1.18, 1.62) compared to those who lived in a house that had at least a window. The risk of death among children who had no access to protected water sources was 1.35 (95% CI: 1.18, 1.55) times higher than that of their counterparts. The incidence of child mortality was 1.96 (1.60, 2.40) times higher among children who hadn't have access to latrine compared to children who had access to latrine.

Besides, a statistically significant association was found between media exposure and incidence of child mortality, that the risk of child death was 1.87 (1.60, 2.19) times higher among those who had no access to either of TV or radio compared to their counterparts. Regarding ox ownership, the incidence of child mortality increased while the availability of oxen in the house increased. For instance, the incidence of child mortality was 1.36 (1.19, 1.54) times higher among children who lived in a house owning only one ox compared to those children whose family didn't own any oxen, while the incidence of mortality was 1.54 (1.32, 1.79) times higher when the family of child owns two and above oxen as compared to children whose family didn't have any oxen. A statistically significantly higher mortality was observed when the distance to the hospital became farther than 10 KM (≥ 10 KM) with an adjusted IRR of 1.34 (1.11, 1.63) as compared to the distance to the hospital became less than 5 KM. However, there was no statistically significant mortality difference observed when the distance to the hospital became less than 10 KM (Table 7).

**Table 7: Determinants of child mortality in the Butajira HDSS, (1987-2022); Model 2**

| Variables | Deaths | Person-years | Unadjusted IRR (95%) | Adjusted IRR (95%) |
|---|---|---|---|---|
| **Kitchen** | | | | |
| No | 1181 | 161,289 | 1.97 (1.74, 2.24) | 1.00 (0.85, 1.17) |
| Yes | 292 | 69,172 | Ref. | Ref. |
| **Windows** | | | | |
| No | 988 | 106,705 | 2.88 (2.58, 3.21) | 1.38 (1.18, 1.62) ** |
| Yes | 485 | 123,785 | Ref. | Ref. |
| **Water source** | | | | |
| Unprotected | 921 | 113,155 | 2.75 (2.44, 3.10) | 1.35 (1.18, 1.55) ** |
| Protected | 385 | 101,738 | Ref. | Ref. |
| **Oxen** | | | | |
| 1 | 398 | 47,712 | 1.87 (1.66, 2.11) | 1.36 (1.19, 1.54) ** |
| 2+ | 236 | 26,224 | 1.89 (1.64, 2.19) | 1.54 (1.32, 1.79) ** |
| No | 849 | 161,141 | Ref. | Ref. |
| **Roof** | | | | |
| Thatched | 1224 | 155,036 | 3.52 (3.07, 4.03) | 1.16 (0.94, 1.42) |
| Corrugated | 250 | 76,745 | Ref. | Ref. |
| **Latrine availability** | | | | |
| No | 1158 | 147,063 | 4.40 (3.70. 5.22) | 1.96 (1.60, 2.40) ** |
| Yes | 147 | 65,550 | Ref. | Ref. |
| **Media exposure** | | | | |
| No | 1082 | 134,210 | 3.22 (2.78, 3.72) | 1.87 (1.60, 2.19) ** |
| Yes | 220 | 75,708 | Ref. | Ref. |
| **Distance to hospital** | | | | |
| 5-9 KM | 581 | 81,637 | 3.29 (2.80, 3.86) | 1.12 (0.91, 1.37) |
| >= 10 KM | 699 | 90,935 | 3.60 (3.08, 4.21) | 1.34 (1.11, 1.63) ** |
| <5 KM | 203 | 62,506 | Ref. | Ref. |

**Shows statistically significant values

As presented in **Annex 1**, an alternative modelling which takes into account all variables simultaneously were conducted. Running all these variables in a single model didn't bring about more significant changes. Additionally, including more than 10 covariates at once may have compromised the model's stability, leading to fewer significant results compared to manipulating the variables using the two-model approach. Therefore, the output from this alternative model was not included in the main body of the thesis.

In the model shown in **Annex 2**, after controlling for variables such as sex, age, residence, altitude, distance to hospital, household size, religion, and maternal education, a statistically significant association was found between wealth status and the incidence of child mortality. The incidence of mortality was found to increase as wealth inequality increased. The risk of child mortality among the poorest wealth quintile was 5.31 (95% CI: 3.41, 8.27) times higher compared to the richest quintile, followed by 4.15 (2.65, 6.49), 3.31 (2.14, 5.13), and 1.84 (1.22, 2.77) times higher among the poorer, middle, and richer quintiles, respectively.

# 6. DISCUSSION

This study showed an overall statistically significant declining trend in the incidence of 5-14 years of child mortality. Among the broad CoDs, CDs are found to be the major CODs for older children and young adolescents followed by NCDs and ECs. HIV/AIDS (14.6%), severe malnutrition (13.1%), accidental drowning & submersion (8.5%) and RTA (8.5%) were found to be the leading CoDs among 5-14-year-old children. In this study, high level of child mortality was significantly associated with males, older children, rural residents, lowlanders, children who lived in owned houses, small-sized households, mothers of children who had never been to school, who lived further than 10 km distance to hospital, access to the unprotected water source, families who owned oxen and those lived under houses without window, latrine & media exposure.

In the current study, the overall incidence of 5-14 years of child mortality over a 36-year period was 6.31 deaths per 1000 person-years of observation. As this result represents the average for the past 36 years, any comparisons with other findings should be interpreted with caution. It is relatively comparable to the child mortality estimated by UNIGME for Ethiopia (11). Whereas, it is even lower than the 5-14 years mortality estimate of SSA (28). The lower incidence of child mortality found in this study could be associated with the recent economic development (83), enhancement in health care services, and related social services especially the introduction of child policies and strategies that would ultimately benefit these age groups. In addition, the lower child (5-14 years) mortality in the Butajira HDSS could be because the site represented a small geographical area. On the other hand, the finding of this study is higher than that of a study done by Kersa HDSS with a reported incidence of 219.6 deaths per 100,000 children within the age group 5-14 years (22). The findings of the study should be carefully comprehended since the denominator in this study was presented per 1000 person-years and the existence of significant variation in the follow up years. It is also higher than a study mainstreaming an INDEPTH member HDSS sites such as: Kilite-Awulalo (Ethiopia), Kilifi (Kenya), Nairobi (Kenya), Dodowa (Ghana), Agincourt (South Africa), Africa Center (South Africa), FilaBavi (Vietnam), Matlab (Bangladesh), Bandarban (Bangladesh), Chakaria (Bangladesh) and AMK (Bangladesh) with even lower child (5-14 years) mortality rate (84). The possible explanation for a higher incidence of mortality compared to the above findings might be that this study takes into account a much longer period of surveillance more than a generation (36 years of data). Besides the study site repeatedly suffered from the existence of political instability, famine and epidemics like malaria in the early

surveillance years may contribute to a higher mortality rate. This result implies the need for programs focused on strengthening management of crisis and resilience in the health system during and post periods of political and economic instability. In addition, it calls for consolidated policies that invest in healthcare access, education and social protection in such areas.

A statistically declining trend of child mortality was observed through 36 years of follow-up. It is in line with a study done about mortality and survival from childhood to old age done in Butajira which found that the mortality in the age group 5-14 years had a more linear downward trend than any other age group though the study took the age group under-5, 15-44 & 65 years and above as a main subgroup (30). The current finding is also consistent with a study in Brazil found that for the whole country of Brazil, there was a significant reduction trend of mortality between 2009 and 2020 (35). Throughout the study periods the number of actual child deaths in this study dropped by 84%. The reduction observed exceeds UNICEF's 2020 report on Ethiopia with 77% reduction in deaths among 5-14 years children (32). It is even higher compared to the UNIGME report of SSA with a 59% reduction from 39 per 1000 in 1990 to 16 per 1000 in 2020 (28). However, the index finding is contrary to literature from the USA which showed an increment of 5-14 years of child death by 4.4% from 2019 to 2021, the odd increment in mortality could be explained by the impact of the COVID-19 pandemic in which the USA had suffered at most by it (33, 34).

Though an overall declining trend of child mortality was observed across 36 years of observation, some fluctuation in the trend could easily be visualized. It could have been explained through various reasons. The higher number of deaths observed between 1987 through 2003 could be explained by the presence of political instability, famine, the high burden of malaria and HIV epidemics (85). Single-handedly the highest absolute number of deaths was visualized in the year 1999. In the same year, epidemics of malaria and diarrheal disease attributed to the humanitarian crisis in the population of Butajira (86). The lower mortality trend pattern onwards from 2000 particularly commencing from the year 2004 may be related to the national health and development efforts supported by the global communities with the introduction of global initiatives such as MDGs, SDGs and global strategies (6). Furthermore, the introduction of child and adolescent policies & strategies in Ethiopia to enhance the well-being of individuals and in combating of fatal diseases like malaria, TB and HIV/AIDS could have played a great role and such efforts needs to be strengthened (8).

Out of the total deaths for which VA had been done, 39.2%, 35.4% and 23.4% of deaths were attributed to CDs, NCDs and ECs respectively. In the current study, CDs were found to be the major CoDs. This finding is consistent with IHME estimates made for across globally, SSA and Ethiopia that CDs took the lion's share more than other broad causes (31). Though there exists variation in the percentage attribution, 39.2% attribution of CDs in this study is relatively comparable to the global IHME CDs attribution with 43.4% and lower than the attribution for SSA (67.2%) and Ethiopia (60.5%) (31). It is also lower compared with the findings of Kersa HDSS where CDs accounted for 56.3% (22). The lower proportion of CDs in this study might be related to the conduct of several child health studies in the area that incorporated health education, which has ultimately raised community awareness. Hence, this study highlights upon strengthening ongoing efforts and strategic investments to further reduce mortality from CDs.

NCDs (35.4%) were found to be higher compared to the IHME estimate for Ethiopia and to the globe (31). The attribution of NCDs in this study is even higher than that of a study in Ethiopia where NCDs contributed to 6.5% of deaths (22). The higher proportion of deaths attributed to NCDs in this study may be related to the fact that many children died of severe malnutrition, which could be linked to the poor early childhood feeding (87). Additionally, genetic predisposition may have played a significant role. This finding demands for enhanced child nutrition program and also a stronger focus on the prevention and management of NCDs in these age groups.

ECs (23.4%) attribution as a major broad CoDs is relatively in line with the IHME estimate for Ethiopia and the globe (31). However, this finding is higher than the findings from Kersa HDSS (13.1%) and IHME estimate for SSA (22, 31). The difference in the contribution of ECs for the death of 5-14 years children may be explained by variations in the study settings which took place in different environment with significant alteration in the socio-economic and health care opportunities for children. In addition, child labor is very common among this community, with poverty being the major reason that drives children to enter the realm of work at an early age, which may lead to exploitation and ECs (88). It implies that in such areas, target interventions such as safety campaigns, improved labor standards, and child safety programs needs to be prioritized.

In this study deaths related to HIV/AIDS were found to be the leading specific CoDs among 5-14 years children. It is inconsistent with the findings of other global studies done recently (26) and in Kenya where respiratory tract infections was found to be the leading CoDs (46). The higher

magnitude of HIV/AIDS in the area may be associated with poor awareness regarding HIV and limitation in accessing antiretroviral therapy especially the area being rural. HIV/AIDS being the major specific CoD implies the need for public health intervention though redundant work has been done on combating HIV/AIDS, local customized intervention needs to be applied.

Among NCDs, severe malnutrition were the leading Causes of 5-14 years child death in this study. It is consistent to a study done in Ethiopia which found severe malnutrition to be the major CoDs (22). However, it is not in line with the report made by IGME global estimate where neoplasms were the main CoDs among NCDs (31). The high attribution of severe malnutrition for the death of older children and young adolescents might be associated with poor feeding practices in the area, which could, in turn, be related to low food diversity (87, 89).

In the index study, accidental drowning and submersion, and RTA were found to equally contribute to the high magnitude of death across ECs. This result is consistent with the findings from Ethiopia, GBD studies in 2013 and 2016 (22, 26, 38). These could be comprehended since the study area is majorly represented by the rural population, children will most likely engage in swimming activities and be accidentally drowned. Furthermore, there was a campaign in the area to store rainwater to use it for farming during the dry season through having a storage hole, which have claimed the lives of several children (90). While those children come to town or crosses main road, they may probably suffer from car accidents since most of rural children didn't know much about cars. It could also be due to inadequate road infrastructure, which forces pedestrian to share roads with fast moving vehicles, along with the poor quality of drivers who often exceed speed limits and drive under the influence of substances like Kchat and alcohol (91, 92).

The current study also showed the presence of variation in CoDs among sex, age group and residence. Severe malnutrition was found to be the main CoD for male children compared to HIV/AIDS for females. It is unlike a study in Kenya in which injuries and meningitis were the leading CoDs across males and females respectively (46). The result also showed variation in CoDs among age groups that severe malnutrition became the major CoDs for 5-9-year-old children and HIV/AIDS among 10-14-year-olds. Oddly, the finding from a recent systematic analysis which indicated diarrhea to be the most common CoD for 5-9 years children and malaria among 10-14 years (93). Differences in the major CoDs about the residence of a child were noticed. Among rural residents'- severe malnutrition was found to be the single most CoD for children

whereas HIV/AIDS was found to be the major CoD for children living in Urban areas. The possible variation in CoDs across different covariates compared to other findings may be related to the sample size used and the settings where studies took place. Overall, this study highlights that children aged 5-14 years are suffering from a triple burden of diseases with a relatively higher proportion.

Furthermore, various differentials of child mortality were identified. The risk of 5-14 years of child mortality was higher among males as compared to females. This finding is consistent with several studies done (29, 35, 40-42). However, it is not in line with the study done in India where child mortality among females was almost double to that of males, particularly for certain diseases (43). The mortality disadvantage among males seen in this study could be attributed to many rural societies taking the study area being majorly rural, male children are mostly allowed to engage in more dangerous, stressful or strenuous activities than women.

Compared to young adolescents the magnitude of child mortality was found to be higher among older children. This result is in line with studies done in Kenya and Iran which indicated the presence of a higher risk of death among older children than young adolescents (44, 46). Contrary to the current study, findings from China and Brazil showed a higher magnitude of death among young adolescents compared to their counterparts (35, 45). The higher hazard of death among 5-9-year-old children could be explained that compared to young adolescents, older children's immune system is known to be less mature which ultimately becomes more exposed to infections and diseases. Besides, as 5-9 years children possess less motor skills and understanding of their surrounding realm, they could easily be prone to increased risk of accidents and injuries.

The incidence of child mortality was found to be higher among rural residents compared to urban. This finding is in line with the studies conducted in Ethiopia that showed a higher hazard of dying in rural areas than in urbans (22, 30). The high hazard of child death among rural residents in the index study could be explained by various reasons as rural residents are most likely to be in low socioeconomic state so is their educational status and level of knowledge in pursuing health care services and also difficulty in easily accessing health services. Further mostly rural residents favor traditional medicine rather than health facilities since most of the time they don't have enough access to media. It emphasizes the need for targeted policy interventions that improves healthcare access, socioeconomic conditions, and education in these areas.

The risk of child death was also found to be statistically associated with lowlanders. Though in bivariate analysis child mortality was found to be higher among highlanders, when other background characteristics were added to the model, residing in highland area were not statistically associated with child mortality. The finding is in line with a study in Ethiopia that mortality among children living in lowland zones was found to be higher (59). The high level of child mortality across lowland zones could be associated with the existence of outbreaks of CDs such as diarrhea and malaria (60).

Several studies witnessed that maternal level of education to be the most powerful determinant of the level of child mortality (48, 49). In this study, the hazard of dying for children aged 5-14 years was found to be higher when mothers of children had never been to school as compared to literate mothers. The finding is consistent with a study conducted in Ethiopia that showed an inverse relation between child mortality and maternal education (47). The reason for the low risk of child death among those who have literate mothers may be explained via having advanced education that improves mothers' understanding regarding caring for children, raring of children and early prevention of diseases which results in the reduction of child deaths.

The current study revealed that the incidence of 5-14 years of child mortality was higher among those who lived in small-sized households than those of large household size. This result is consistent with a recent study from eastern and southern SSA that depicted a high risk of child death among small-sized households compared to their counterparts (56). However, a plethora of studies extensively showed the presence of a significant association between child mortality and that of large household size (54, 55). Although it could be a bit difficult to put an explanation for the high risk of child death among small-sized households, it might be because when children become firstborn mothers will find it difficult on how to properly rare them, so children mostly suffer from the firstborn child effect (56). Besides, since most of them live in rural areas, mothers and fathers might engage in rural agriculture practices leaving their children at home, therefore the child may not get proper food and care until their parents return from work.

Regarding to house ownership, children who resided in owned houses had been found to have higher incidence of mortality than children lived in rented house. It is consistent with a study in Ethiopia, where a high risk of death was observed among families living in owned houses (53). In contrast to this finding, a study from Finland showed that the hazard ratio for all-cause mortality

among families of renters to be higher compared to families who lived in owned houses (52). This finding may largely be attributed that most people in country side lived in owned house where plethora of families caged under a substandard one room house while those who resided in rented houses are mostly living in urban areas with relatively good housing facilities and sanitated environments.

The presence of poor housing facilities through several means has been associated with child mortality. In the current study, lack of window in the house, absence of a latrine and unprotected potable water source were found to be statistically associated with higher incidence of child mortality compared to their respective counterparts. The hazard of dying for children who lived in a house without any window was found higher than that of children who resided in the presence of at least a window in their house. It is consistent with the findings of several studies from different countries (62-64). It could be explained that the absence of windows to be highly linked with inadequate ventilation in the house which resulted in high respiratory related ailments and it also paves the way for indoor air pollution. The risk of child mortality was excess in the houses which lack latrine facilities. This result is consistent with literature conducted in Eritrea and South Africa, which showed the presence of lower child mortality in the household which had a latrine (67, 68). Besides this study revealed the presence of a high incidence of child mortality in the house which had unprotected potable water sources. This is in line with a study in Ethiopia which depicted the strong relationship between unprotected poor water supply with mortality (30). It could be explained that access to unsafe water sources and the unavailability of latrines in the household would largely be responsible for claiming many lives out of diarrheal and other infectious-related diseases (65).

In the current study, the incidence of child mortality was higher among families who did have oxen and the risk of death became even higher when families had at least two oxen compared to children whose families didn't have any ox. This finding is consistent with a study done in Ethiopia that indicated a higher risk of child mortality among households who had oxen as compared to their counterparts (60). This might be explained by poor sanitation in the households that had oxen as most animals stay in their house with their feces and urine not cleaned right away particularly in rural agricultural households (60).

The odds of child deaths were found to be higher among families who didn't have exposure to media than families with access to media particularly to either of TV or radio. This result is in line with another study which indicated that children from the community with high levels of media exposure had a decreased magnitude of death compared to those in the community with a lack of or low exposure to media (71). The possible explanation for the high level of child death among families without exposure to media could be that those families and children may not easily acquire health-related information for better comprehension of care of children and on disease prevention which ultimately contributes for child deaths.

Regarding to distance between home to the zonal hospital, the current study found that the incidence of child death to be statistically associated with a farther distance of 10 km and above from the hospital. Even though in the bivariate analysis child mortality was found to be higher for a distance category of 5-9 km, when other background characteristics were added in the model, located within a distance of 5-9 km from the hospital were not found statistically associated with child mortality. This finding is consistent with another study that evidenced an approximation of a 1% absolute increase in mortality for each 10-km straight-line distance (66). In contrast to this study, literature depicted that the hospital located farther than 10 km hadn't any statistically significant association with child mortality yet they showed a significant association for a distance within 5-9 km (53, 60). The current study implies that geographic access could be fundamental in understanding the risk of child deaths to health care utilization. The further the distance between home and hospital, the lower the utilization of health services. Again, the longer the distance to the hospital, the more families are entitled to find other possible solutions in dealing with their health issues like engaging and believing in traditional practices which later on creates a poor perception in accessing health facilities.

As presented in **Annex 2**, the incidence of child mortality was significantly associated with each category of wealth quintile. The risk of death was found to increase with rising wealth inequality, indicating that children from low wealth status were more likely to die. This result is supported by numerous studies (94-96) showing that the risk of death is higher with increasing levels of poverty. The current finding implies that the government should enhance and maintain improved livelihood programs that promote better economic conditions, as efforts to reduce wealth inequality will ultimately have a significant impact on reducing child mortality.

# 7. STRENGTHS AND LIMITATIONS OF THE STUDY

The strength of the current study is that it uses data that has been collected for a period of more than a generation (36 years) which ensures measurements in the study to be reliable and the factors identified to be fairly predicted. Besides mainstreaming a longitudinal study design, since this study uses data that was collected from the beginning of the survey in 1987 through the year 2022, the findings truly represent the actual scenario and can be used as a tangible source for intervention strategies. Standard tools customized by the INDEPTH – network and validated instruments were deployed for the collection of longitudinal data. As the study took all the available 5-14 years of children, sample sizes were adequately ascertained for both the longitudinal and VA. The collection of data has been supervised intensively in the presence of field supervision which reassures the quality of data collected. Since the community has known the field staff for many years, there is a good level of trust between the staff and the community being under surveillance, which facilitated the capture of pertinent data. The other main strength of the current study is the use of statistical models (two models used without disrupting model stability) and test statistics. As the HDSS covers a vast range of ecological and environmental zones such as lowland, midland, highland zones and urban/rural areas, mimicking the ground truth of the country, the findings out of this study could be generalized to a certain extent accordingly.

The main limitation of the current study is the potential to miss certain deaths from VA data which would underestimate the attribution of CoDs for 5-14-year-old children as it decreased the number of samples, the magnitude of attribution to CoDs might be amplified. As encountered from a wide range of secondary data studies, missing of information had been a real challenge but through extensive work, we managed to deal with it accordingly. In addition, since there exists a wide range of research in the study site and periodic encounters with the field staff, there could be a chance that the community under surveillance might be prone to boredom & fatigue. Another limitation might be related to the introduction of wrong information by some assigned data collectors as they knew the questions to be asked and the participants' possible answers a head due to their extended contact. Yet to deal with that, supervisors are always monitoring them closely.

# 8. CONCLUSION

Analysis of the incidence of 5-14 years of child mortality in the Butajira HDSS from 1987-2022 demonstrated a statistically significant declining trend. There were some fluctuations in child mortality across different years particularly before the year 2003. The trend of child mortality was found to be higher among males until around the year 2000 and rural residents until around the year 2012 compared to their counters and in further years it became relatively overlapped for both. Whereas the trend of child mortality was found to be higher among lowlanders from 1987 through 2000 except in 1995-1997 where mortality was found in excess among highlanders. Beyond 2000 though there exists an overlap between the three zonal areas, it is prominent among lowlanders.

Moreover, this study depicted the presence of high child mortality attributed to CDs followed by NCDs and ECs. HIV/AIDS, severe malnutrition, accidental drowning and submersion, and RTA were found to be the top specific causes of death for 5-14-year-old children. The current study also revealed the presence of variations in the CoDs among sex, age, and residence.

Among the determinants; males, older children, rural residents, lowlanders, children living in owned houses, small-sized households, mothers of children who had never been to school, longer distance to hospital, unprotected water source, presence of oxen and lived under houses without window, latrine and media exposure were found to be significantly associated with the incidence of 5-14 years child mortality. However, no significant difference in the level of child mortality was observed across religion, kitchen availability, and roof type of the house. From the alternative modelling, after constructing a wealth index and conducting the analysis, wealth status was also found to be statistically significantly associated with 5-14 years child mortality.

# 9. RECOMMENDATIONS

The current study showed that children aged 5-14 years are mostly dying from HIV/AIDS, severe malnutrition, accidental drowning, and RTA. Since the findings clearly witnessed that those children are really suffering from the triple burden of diseases, it calls for the necessity of integrated interventions to effectively reduce the magnitude of deaths.

The presence of variation in the CoDs among the sex of children as highlighted in the study reminds the importance of targeted interventions to prevent specific CoDs that impact each sex significantly. For example, public health intervention can focus on male mortality caused by severe malnutrition, since it is found to severely affect males in the current study.

This study wants to ensure that 5-14-year-old children can be benefited from health policies and interventions set out by policymakers as seen to the cases of under-fives. To deal with the main CoDs and reduce mortality among these age groups, additional effort should be cultivated through coordinating various stakeholders including NGOs. Besides the health sector and other partner sectors should work in collaboration for further reduction of mortality.

Health extension workers can be involved with more focus on rural communities particularly to reiterate child health messages. Health education should focus on incorporating messages on the importance of keeping household standards and hygiene in the community mainly with poor access to media.

In communities with significantly higher child deaths, availing health infrastructures near to them will play an enormous impact in reducing not only 5-14 years of child mortality but also in every age category. It is also crucial to implement strategies that address wealth inequality; therefore, prioritizing policies that especially promote equitable access to resources must be emphasized. All in all, a comprehensive targeted interventions need to be delivered at societal, household, and personal levels to avert the mortality burden.

Even though there is a tendency for lots of research to focus on under-fives and adults aged 15 and above years, the index study highlights the need to also give attention to exploring the mortality of 5-14 years children. To have an in-depth understanding of the mortality of 5-14-year-old children, researchers are advised to conduct studies using various study designs and with the incorporation of qualitative methods.

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# 11. ANNEXES

## Annex 1: Alternative modelling output not used in the main body of thesis work

| Variables | | Deaths | Person-years | Unadjusted IRR (95%) | Adjusted IRR (95%) |
|---|---|---|---|---|---|
| **Sex** | Male | 804 | 116,608 | 1.29 (1.17, 1.43) | 1.25 (1.12, 1.40) ** |
| | Female | 679 | 118,470 | Ref. | Ref. |
| **Age** | 5-9 | 957 | 90,645 | 1.94 (1.74, 2.15) | 2.05 (1.83, 2.31) ** |
| | 10-14 | 526 | 144,433 | Ref. | Ref. |
| **Residence** | Rural | 1379 | 187,029 | 5.66 (4.64, 6.91) | 0.95 (0.66, 1.38) |
| | Urban | 104 | 48,049 | Ref. | Ref. |
| **Altitude** | Highland | 420 | 67,398 | 2.05 (1.77, 2.37) | 0.92 (0.73, 1.15) |
| | Lowland | 738 | 87,718 | 2.97 (2.60, 3.38) | 1.57 (1.25, 1.97) ** |
| | Midland | 325 | 79,961 | Ref. | Ref. |
| **Distance to hospital** | 5-9 KM | 581 | 81,637 | 3.29 (2.80, 3.86) | 0.96 (0.72, 1.28) |
| | >= 10 KM | 699 | 90,935 | 3.60 (3.08, 4.21) | 0.95 (0.69, 1.31) |
| | <5 KM | 203 | 62,506 | Ref. | Ref. |
| **Household size** | Small (<=4) | 1016 | 159,026 | 1.14 (1.02, 1.27) | 1.13 (1.00, 1.27) ** |
| | Large (>4) | 467 | 76,051 | Ref. | Ref. |
| **Religion** | Muslim | 1157 | 173,347 | 1.16 (1.02, 1.31) | 1.14 (0.98, 1.32) |
| | Christian | 303 | 48,179 | Ref. | Ref. |
| **Maternal education** | Never been to school | 1085 | 111,006 | 2.56 (2.28, 2.89) | 1.89 (1.66, 2.15) ** |
| | Literate | 368 | 86,026 | Ref. | Ref. |
| **Kitchen** | No | 1181 | 161,289 | 1.97 (1.74, 2.24) | 1.05 (0.89, 1.23) |
| | Yes | 292 | 69,172 | Ref. | Ref. |
| **Windows** | No | 988 | 106,705 | 2.88 (2.58, 3.21) | 1.23 (1.05, 1.44) ** |
| | Yes | 485 | 123,785 | Ref. | Ref. |
| **Water source** | Unprotected | 921 | 113,155 | 2.75 (2.44, 3.10) | 1.32 (1.14, 1.53) ** |
| | Protected | 385 | 101,738 | Ref. | Ref. |
| **Oxen** | 1 | 398 | 47,712 | 1.87 (1.66, 2.11) | 1.19 (1.04, 1.36) ** |
| | 2+ | 236 | 26,224 | 1.89 (1.64, 2.19) | 1.27 (1.09, 1.49) ** |
| | No | 849 | 161,141 | Ref. | Ref. |
| **House ownership** | Own | 1464 | 211,773 | 16.20 (10.30, 25.47) | 3.27 (1.91, 5.59) ** |
| | Rent | 19 | 23,305 | Ref. | Ref. |
| **Roof** | Thatched | 1224 | 155,036 | 3.52 (3.07, 4.03) | 0.97 (0.78, 1.22) |
| | Corrugated | 250 | 76,745 | Ref. | Ref. |
| **Latrine availability** | No | 1158 | 147,063 | 4.40 (3.70. 5.22) | 1.57 (1.27, 1.94) ** |
| | Yes | 147 | 65,550 | Ref. | Ref. |
| **Media exposure** | No | 1082 | 134,210 | 3.22 (2.78, 3.72) | 1.65 (1.41, 1.93) ** |
| | Yes | 220 | 75,708 | Ref. | Ref. |

**indicates statistically significant value

**Annex 2: Other alternative modelling with the wealth index**

| Variables | | Deaths | Person-years | Unadjusted IRR (95%) | Adjusted IRR (95%) |
|---|---|---|---|---|---|
| **Sex** | Male | 804 | 116,608 | 1.29 (1.17, 1.43) | 1.25 (1.11, 1.39) ** |
| | Female | 679 | 118,470 | Ref. | Ref. |
| **Age** | 5-9 | 957 | 90,645 | 1.94 (1.74, 2.15) | 2.04 (1.81, 2.29) ** |
| | 10-14 | 526 | 144,433 | Ref. | Ref. |
| **Residence** | Rural | 1379 | 187,029 | 5.66 (4.64, 6.91) | 1.13 (0.79, 1.63) |
| | Urban | 104 | 48,049 | Ref. | Ref. |
| **Altitude** | Highland | 420 | 67,398 | 2.05 (1.77, 2.37) | 0.91 (0.72, 1.15) |
| | Lowland | 738 | 87,718 | 2.97 (2.60, 3.38) | 1.52 (1.21, 1.91) ** |
| | Midland | 325 | 79,961 | Ref. | Ref. |
| **Distance to hospital** | 5-9 KM | 581 | 81,637 | 3.29 (2.80, 3.86) | 0.96 (0.72, 1.28) |
| | >= 10 KM | 699 | 90,935 | 3.60 (3.08, 4.21) | 0.93 (0.68, 1.29) |
| | <5 KM | 203 | 62,506 | Ref. | Ref. |
| **Religion** | Muslim | 1157 | 173,347 | 1.16 (1.02, 1.31) | 1.13 (0.97, 1.31) |
| | Christian | 303 | 48,179 | Ref. | Ref. |
| **Maternal education** | Never been to school | 1085 | 111,006 | 2.56 (2.28, 2.89) | 1.97 (1.73, 2.24) ** |
| | Literate | 368 | 86,026 | Ref. | Ref. |
| **Household size** | Small (<=4) | 1016 | 159,026 | 1.14 (1.02, 1.27) | 1.10 (0.97, 1.23) |
| | Large (>4) | 467 | 76,051 | Ref. | Ref. |
| **Wealth quintile** | Poorest | 551 | 53,354 | 12.05 (8.74, 16.61) | 5.31 (3.41, 8.27) ** |
| | Poorer | 353 | 42, 674 | 9.63 (6.94, 13.36) | 4.15 (2.65, 6.49) ** |
| | Middle | 251 | 46,381 | 6.18 (4.43, 8.63) | 3.31 (2.14, 5.13) ** |
| | Richer | 106 | 39,353 | 2.78 (1.93, 4.01) | 1.84 (1.22, 2.77) ** |
| | Richest | 40 | 26,512 | Ref. | Ref. |

** indicates statistically significant value

## Annex 3: Questionnaires English Version

### BRHP Family Registration Form

| |
|---|
| 1. Reason for filling out this form ☐☐ 1. Surveillance 2. Reconciliation |
| 2. Date of interview **DD MM YYYY** ☐☐ ☐☐ ☐☐☐☐ |
| 3. Name and code of interviewer ☐☐☐ / / |
| 4. House number ☐☐☐☐☐☐☐☐ |
| 5. Name and ID of head ☐☐☐☐☐☐☐☐☐☐ / / |
| 6. Name and ID of spouse ☐☐☐☐☐☐☐☐☐☐ / / |
| 7. Number of usual members ☐☐☐ |
| 8. What type of fuel is mostly used for cooking in the family? ☐☐ 1. Nothing 2. Kerosene 3. Charcoal 4. Wood 5. Leaves/ brushwood 6. Animal dung 7. Other (specify) __ |
| 9. Do domestic animals spend the night in the room where members of the family sleep in the night? ☐☐ 1. Yes 2. No |
| 10. What is the main source of water supply of the family? ☐☐ 1. River 2. Protected well3. Unprotected well4. Lake 5. Pond 6. Pipe 7. Unprotected spring 8. Other (specify)_____ 9. Protected spring |
| 11. Where do you usually dispose family refuse? ☐☐ 1. Waste disposal pit 2. Open field 3. Burning 4. Other (specify) _____ 5. On the farm plots |
| 12. What type of toilet facility does the family use? ☐☐ 1. Private 2. Shared 3. Public 4. Field |
| 13. Where did you usually seek health care when a member of the family ≥ 5 years is sick? ☐☐☐<br>01. Governmental health center 04. Traditional health care 07. Health station<br>02. CHA/HP 05. Do self-treatment 08. Do nothing<br>03. Pharmacy 06. Private clinic 09. Other (specify)_____ 10. Hospital |
| 14. Where did you usually seek health care when a member of the family <5 years is sick? ☐☐☐<br>01. Governmental health center 04. Traditional health care 07. Health station<br>02. CHA/HP 05. Do self-treatment 08. Do nothing<br>03. Pharmacy 06. Private clinic 09. Other (specify)_____<br>10. Hospital 98.No child |
| 15. Is there a radio in the household? ☐☐ 1. Yes (functional) 2. Yes (non-functional) 3. No |
| 16. Is there a television in the household? ☐☐ 1. Yes (functional) 2. Yes (non-functional) 3. No |

| |
|---|
| 17. What is the main source of income/livelihood for the family? ⎕⎕<br>1. Subsistence farming and or livestock 2. Trade or private enterprise 3. Governmental employee 4. Laborer 5. Private employee 6. Pension/remittance. 7. Other (specify) _____ |
| 18. If the main source of income of the family is farming and or livestock, how much plot of land "Timad" have the family planted? ⎕⎕‖⎕⎕‖⎕⎕ |
| 19. What do you mainly produce for family consumption? ⎕⎕<br>1. Maize 2. Pepper 3. Teff 4. Sorghum 5. Enset 6. Other (specify) _____7. Kchat 8. None |
| 20. What do you mainly produce for market consumption? ⎕⎕<br>01. Maize 0 2. Pepper 0 3. Teff 04. Sorghum 0 5. Enset 06. Other (specify) _____<br>07. Honey 08. Kchat 10. None 11. Coffee |
| 21. How many domestic animals does the family have? a. Horse or Donkey ⎕⎕⎕<br>b. Cow ⎕⎕⎕ c.Ox ⎕⎕⎕ d. Calf ⎕⎕⎕ e. Sheep or Goat ⎕⎕⎕ |
| 22. If the main source of income of the family is trade or private enterprise, what is the type of trade or enterprise? ⎕⎕ 1. Factory 2. Hotel / Grocer/ Restaurant 3. Big shop 4. Small shops 5. Petty trader 6. Other (specify) _____ |
| 23. What was the family's monthly expenditure last month for the following items?<br>⎕⎕‖⎕⎕ Food item ⎕⎕⎕⎕ Water ⎕⎕⎕⎕Transport ⎕⎕⎕⎕ House rent ⎕⎕⎕⎕<br>Edir/equib ⎕⎕⎕⎕ Electricity ⎕⎕⎕⎕ Telephone ⎕⎕⎕⎕ Savings ⎕⎕⎕⎕<br>Other (specify) |
| 24. How much is the average monthly expenditure for the family? ⎕⎕⎕⎕⎕⎕ (Birr) |

BRHP Family registration form Version: II Print Date: November 28, 2003 Serial #: _____

## BRHP Birth registration form

0. Reason for filling out this form ⌊__⌋ 1. Surveillance 2. Reconciliation

**DD MM YYYY**

1. Date of interview ⌊__⌋⌊__⌋ ⌊__⌋⌊__⌋ ⌊__⌋⌊__⌋⌊__⌋⌊__⌋
2. Name of interviewer / / code⌊__⌋⌊__⌋
3. House number (where the mother gives birth) ⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋
4. Name of the head of family / /
5. Name and ID of child ⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋
   / /
6. Sex of the child ⌊__⌋ 1. Male 2. Female
7. Mother's name / /
8. Mother's house number ⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋ ID ⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋
9. Father's name / /
10. Father's house number ⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋ ID ⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋
11 Mother's relation to the family head ⌊__⌋⌊__⌋

01. Head 02. 1st spouse 03. 2nd spouse
04. 3rd spouse 05. 4th spouse & above 12. Child of head and 1st spouse
13. Child of head and 2nd spouse 14. Child of head and 3rd spouse 15. Child of head and 4th spouse
21. Child of head only 22. Child of 1st spouse only 23. Child of 2nd spouse only
24. Child of 3rd spouse only 25. Child of 4th spouse only 31. Parent of head
32. Parent of 1st spouse 33. Parent of 2nd spouse 34. Parent of 3rd spouse
35. Parent of 4th spouse 41. Other relative of head 42. Other relative of 1st spouse
43. Other relative of 2nd spouse 44. Other relative of 3rd spouse 45. Other relative of 4th spouse
46. Other relatives 47. Adopted child 48. None relative

12. Relation of the child to the family head ⌊__⌋⌊__⌋ (refer codes from ques. 12)

**DD MM YYYY**

13. Date of birth ⌊__⌋⌊__⌋ ⌊__⌋⌊__⌋ ⌊__⌋⌊__⌋⌊__⌋⌊__⌋
14. Status of the baby at birth? ⌊__⌋ 1. Live birth 2. Still birth
15. Was the birth single? ⌊__⌋ 1. Single 2. Twin 3. Triple & more
16. Was the new born child physically normal ⌊__⌋ 1. Normal 2. Physically abnormal
17. Place of delivery? ⌊__⌋⌊__⌋
    01. Parents' home 02. Own home 03. Neighbour's house 04. Health post 05.Clinic/Health station 06. Health center 07. Hospital 08. Private clinic 91. others (specify) _____
18. Who assisted the delivery? ⌊__⌋
    1. TBA 2. Relative 3. Neighbour 4. Health professional (doctor, nurse) 5. TTBA 6. No assistant
    7. Community health worker (CHA) 8. other (specify) _____
19. Did the mother seek health care for complications of delivery like retained placenta and post partum hemmoriage? ⌊__⌋ 1. Yes 2. No

20. If yes to question 19, where did she seek care? ⌊__⌋
1.Health post 2. Clinic/health station 3. Health center 4. Hospital 5. Private clinic 6. Others (specify) ____ 7. None

21. Total number of pregnancy (including this birth) ⌊__|__⌋

22. Total number of deliveries (including this birth and any still births) ⌊__|__⌋

23. Total number of Live births (inclding this birth ) ⌊__|__⌋

24. Total number of Live children at present? ⌊__|__⌋

25. Is your next to last child alive? ⌊__⌋ 1. Yes 2. No 3. First child _____

26. What is the religion of the child? ⌊__⌋

1.Orthodox Christians 2. Muslim 3. Catholic. 4. Protestant 5. No religion 6. 0thers (specify) _____

27. What is the ethnicity of the child? ⌊__⌋ 0. Welene 1. Sodo 2. Dobi 3. Meskan 4. Mareko 5. Silti 6. Amhara 7. Oromo 8. Other (specify) _____

BRHP: Birth registration form Version: II Print date: November 28, 2003 Serial #_____

## BRHP Death registration form

0. Reason for filling out this form? ⌊__⌋ 1. Surveillance
2.Reconciliation _____

1. Date of interview DD MM YYYY ⌊__⌋⌊__⌋⌊__⌋⌊__⌋

2. Name of interviewer code⌊__⌋⌊__⌋

3. House number ⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋

4. Name of the deceased person ID ⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋ / /

5. Date of death DD MM YYYY ⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋⌊__⌋

6. Sex ⌊__⌋ 1. Male 2. Female

7. If female, was she pregnant at the time of death? ⌊__⌋ 1. Yes 2. No 3. Under age/child (Skip to # 9)

8. If female, when was her last delivery ? ⌊__⌋ 1. Less than 6 weeks 2. 6 weeks to 3 months 3. 4-11 months ago
4. 1-4 years ago 5. five years or more 8. Unknown

9. Name of family head / /

10. Relation of deceased person to the head. ⌊__⌋⌊__⌋

| | | |
|---|---|---|
| 01. head | 02. 1st spouse | 03.2nd spouse |
| 04. 3rd spouse | 05. 4th spouse & above | 12. child of head and 1st spouse |
| 13. Child of head and 2nd spouse | 14. child of head and 3rd spouse | 15. child of head and 4th spouse |
| 21. child of head only | 22. child of 1st spouse only | 23. child of 2nd spouse only |
| 24. child of 3rd spouse only | 25. child of 4th spouse only | 31. parent of head |
| 32. parent of 1st spouse | 33. parent of 2nd spouse | 34. parent of 3rd spouse |
| 35. parent of 4th spouse | 41. other relative of head | 42. other relative of 1st spouse |
| 43. other relative of 3rd spouse | 44. other relative of 3rd spouse | 45. other relative of 4th spouse |
| 46. other relatives | 47. adopted child | 48. non-relative |

11. Cause of death (reported) ⌊__⌋⌊__⌋

| | | |
|---|---|---|
| 01. Still birth | 09. Malnutrition | 18. Suicide |
| 02. Premature birth | 11. Meningitis | 19. AIDS |
| 04. Malaria | 12. Tuberculosis | 20. Inv Abortion |
| 05. Pneumonia | 14. Sudden death | 21. Ind. Abortion |
| 06. Measles | 15. Tetanus | 22. Glandular TBC |
| 07. Whooping cough | 16. Hepatitis | 81. Accident (describe) |
| 08. Diarrhea/vomiting | 17. Pregnancy/ delivery related | 91. Other describe |

12. Place of death ⌊__⌋⌊__⌋

01. Parents house 02. Own residence 03. Neighbor

04. Health post 05. Clinic 06. Health center
07. Hospital 91. Other (specify) _____

13. Where did the deceased mainly seek health care for the illness that led him to death? |__|__|

01. Governmental health center 04. Traditional health care 07. Health station
02. CHA/HP 05. Did self-treatment 08. Did nothing
03. Pharmacy 06. Private clinic 09. Other (specify)_____
10. Hospital

BRHP: Death registration form Version: II Print date: June 2, 2004 Serial #_____

**BRHP House Registration Form**

| |
|---|
| 1. Reason for filling out this form ⎕ 1. Surveillance 2. Reconciliation |
| **DD MM YYYY**<br>2. Date of interview ⎕⎕ ⎕⎕ ⎕⎕⎕⎕ |
| 3. Name of interviewer and code ⎕⎕<br>/ / |
| 4. Is it a newly built house? ⎕<br>1. Yes, new 2. No 3. Yes, modified 4. Yes, demolished & rebuilt 5. No, demolished |
| 5. If new, the nearest house number ⎕⎕⎕⎕‖⎕⎕⎕⎕ |
| 6. House number ⎕⎕⎕⎕‖⎕⎕⎕⎕ |
| 7. Name and ID of head ⎕⎕⎕⎕‖⎕⎕⎕⎕‖⎕⎕<br>/ / |
| 8. Who is the owner of the house? ⎕<br>1. Own 2. Governmental / Kebele 3. Rented from Individuals/Private 4. Cohabitant (Un-rentable)<br>5. Other (specify) _____6. Cohabitant (Paying) |
| 9. Type of roof ⎕<br>1. Thatched 2. Corrugated iron sheet 3. Other (specify) _____ |
| 10. Characteristics of the wall of the house? ⎕<br>1. Wood and mud 2. Wood and stalk/ grass 3. Stone and cement 4. Hollow blocks<br>5. Bricks 6. Corrugated iron sheets 7. Other (specify) _____ |
| 11. Does the house have a separate kitchen? ⎕<br>1. Yes 2. No 3. Yes, shared |
| 12. How many rooms does the house have (excluding kitchen)? ⎕⎕ |
| 13. Does the house have windows? ⎕<br>1. Yes, a small opening 2. Yes, openable and closeable 3. No |
| 14. Does the house have its own source of water within the compound? ⎕<br>1. Yes, well 2. Yes, Pipe 3.No |

| |
|---|
| 15. What type of toilet facility does the house have? ⎿⎾<br>1.None 2. Pit latrine (functional) 3. Pit latrine (non-functional) 4. Flush toilet (functional) 5. Flush toilet (nonfunctional)<br>6.Other(specify)_____ |
| 16. Does the house have electricity? ⎿⎾<br>1. Yes 2. No |
| 17. Geographical position: North ⎿⎾⎿⎾.⎿⎾⎿⎾⎿⎾⎿⎾ East 038$^{o}$ ⎿⎾⎿⎾⎿⎾⎿⎾ |
| 18. Housing dimension (Tukuls) Axis ⎿⎾⎿⎾⎿⎾⎿⎾ Radius⎿⎾⎿⎾⎿⎾⎿⎾ Wall height ⎿⎾⎿⎾⎿⎾⎿⎾ (Cms) |

BRHP: House registration form Version: II Print Date: June 2, 2004 Serial #: _____

**BRHP Individual Move Registration form**

| |
|---|
| 1. Reason for filling out this form ⎕ 1. Surveillance 2. Reconciliation |
| **DD MM YYYY**<br>2. Date of interview ⎕⎕ ⎕⎕ ⎕⎕⎕⎕ |
| 3. Name and code of interviewer ⎕⎕<br>/ / |
| 4. Name and ID of the moved person ⎕⎕⎕⎕‖⎕⎕⎕⎕‖⎕⎕<br>(If already registered)<br>/ / |
| 5. Type of move ⎕ 1. In migration 2. Out migration 3. Internal move |
| 6. Previous House number ⎕⎕⎕⎕‖⎕⎕⎕⎕<br>(For out migration & internal move) |
| 7. What is your previous residential area? Region _____ Zone _____ Wereda_____<br>(For in migration only) Kebele _____ ə Abroad |
| 8. Type of previous residential area? ⎕ 1. Rural 2. Urban 3. Unknown<br>(For in migration only) |
| 9. Date of move **DD MM YYYY**<br>⎕⎕ ⎕⎕ ⎕⎕⎕⎕ |
| 10. Name and ID of the previous family head ⎕⎕⎕⎕‖⎕⎕⎕⎕‖⎕⎕<br>(If already registered)<br>/ / |
| 11. New House number ⎕⎕⎕⎕‖⎕⎕⎕⎕<br>(For in migration & internal move) |
| 12. What is the new residential area? Region _____ Zone _____ Wereda_____<br>(For out migration only) Kebele _____ ə Abroad |
| 13. Type of new residential area? ⎕ 1. Rural 2. Urban 3. Unknown<br>(For out migration only) |
| 14. Name and ID of the new family head ⎕⎕⎕⎕‖⎕⎕⎕⎕‖⎕⎕<br>(If already registered)<br>/ / |

15. What is the reason for moving? ⎕⎕

01.Marriage 02. Marital dissolution 03. Job seeking/employment 05. Health related problems

08.conflict 10. Education/training 11. Demobilization 12. Retirement

09.Other (specify) _____

**Remark: Ask the following questions for in migrants only**

16. Have you ever previously lived in the following Kebeles?

❑Yeteker (06A) ❑Bido(011) ❑Bati(007) ❑Buta(K04) ❑Wurib (06B)

❑ Hope (09B) ❑ Dirama (04B) ❑Dobena (008) ❑Majarda (09A) ❑ M/meskan (005)

❑ No

17.Did the in-migrant form a new family for the destination area? ⎕

1. Yes (Fill out Family Background form) 2. No

18. Is this person moving into a new house? ⎕

1. Yes (Fill out the house form) 2. No

19. What is the sex of the in-migrant? 1. Male 2. Female ⎕

20. Date of birth **DD MM YYYY**

⎕⎕ ⎕⎕ ⎕⎕⎕⎕

21. What is the religious affiliation of the in-migrant? ⎕

1. Orthodox Christians 2. Muslim 3. Catholic. 4. Protestant 5. No religion

6. 0thers (specify) _____

22. What is the ethnic group of the in-migrant? ⎕

0.Welene 1. Sodo 2. Dobi 3. Meskan 4. Mareko 5. Silti 6. Amhara 7. Oromo

8. Other (specify) _____

23. Does the in-migrant read and write? ⎕

1. Yes, Amharic 2. Yes, Arabic 3. Yes, both Amharic and Arabic

4. Yes, other (specify) _____ 5. No, I can't read and write 6. Too young

24. How many years have the in migrant attended schools? ⎕⎕

Grade (years) attended

25. What is the marital status of the in-migrant? |__|__|

01. Monogamous marriage 02. Polygamous, 2 wives 03. Polygamous, 3 wives

04. Polygamous, 4 or more wives 05. Divorced 06. Separated

07. Never married 08. Widowed 10. NA

26. What is the occupation of the in-migrant? |__|__|

01. Farming 02. Trading/related occupation

03. Animal husbandry 04. Professional, managerial, & administrative

05. Transport 06. Craftsman / related Production

07.Day laborer 08. Other (specify) _____

11. Student 44. Unemployed

66. House wife 88. NA

27. Mother's Name & ID |__|__|__|__|__|__|__|__|__|__|

/ /

28. Father's Name & ID |__|__|__|__|__|__|__|__|__|__|

/ /

29. What is the relation of the in-migrant to the family head? |__|__|

01. Head 02. 1st spouse

03. 2nd spouse 04. 3rd spouse

05. 4th spouse & above 12. Child of head and 1st spouse

13. Child of head and 2nd spouse 14. Child of head and 3rd spouse

15. Child of head and 4th spouse 21. Child of head only

22. Child of 1st spouse only 23. Child of 2nd spouse only

24. Child of 3rd spouse only 25. Child of 4th spouse only

31. Parent of head 32. Parent of 1st spouse

33. Parent of 2nd spouse 34. Parent of 3rd spouse

35. Parent of 4th spouse 41. Other relative of head

42. Other relative of 1st spouse 43. Other relative of 2nd spouse

44. Other relative of 3rd spouse 45. Other relative of 4th spouse

46. Other relatives 47. Adopted child 48. None relative

**BRHP New Individual Registration Form**

| |
|---|
| 1. Reason for filling out this form ⎕ 1. Surveillance 2. Reconciliation |
| **DD MM YYYY**<br>2. Date of interview ⎕⎕ ⎕⎕ ⎕⎕⎕⎕ |
| 3. Name and code of interviewer ⎕⎕<br>/ / |
| 4. House number ⎕⎕⎕⎕ ⎕⎕⎕⎕ |
| 5. Name and ID of the individual ⎕⎕⎕⎕ ⎕⎕⎕⎕ ⎕⎕<br>/ / |
| 6. Sex of the individual ⎕ 1. Male 2. Female |
| 7. Date of Birth **DD MM YYYY**<br>⎕⎕ ⎕⎕ ⎕⎕⎕⎕ |
| 8. What is the religious affiliation of the individual? ⎕<br>1. Orthodox Christians 2. Muslim 3. Catholic 4. Protestant 5. No religion<br>6. Others (specify)<br>_____ |
| 9. What is the ethnic group of the individual? ⎕<br>0. Welene 1. Sodo 2. Dobi 3. Meskan 4. Mareko 5. Silti 6. Amhara 7. Oromo<br>8. Other (specify)<br>_____ |
| 10. Does the individual read and write? ⎕<br>1. Yes, Amharic 2. Yes, Arabic 3. Yes, both Amharic and Arabic<br>4. Yes, other (specify) _____ 5. No, I can't read and write 6. Too young |
| 11. How many years have the individual attended schools? ⎕⎕ |
| 12. What is the marital status of the individual? ⎕⎕<br>01. Monogamous marriage 02. Polygamous, 2 wives 03. Polygamous, 3 wives<br>04. Polygamous, 4 or more wives 05. Divorced 06. Separated<br>07. Never married 08. Widowed 10. NA |
| 13. What is your occupational status? ⎕⎕<br>01.Farming 02. Trading/related occupation 03. Animal husbandry<br>04. Professional, managerial, & administrative 05. Transport |

| | |
|---|---|
| 06. Craftsman / related production | 07. Laborer |
| 08. Other (specify) _____ | 11. Student |
| 44. Unemployed | 66. Housewife |
| 88. NA | 98. Too young |

14. Mother's name and ID |_|_|_|_|_|_|_|_|_|_|

/

/

15. Father's name and ID |_|_|_|_|_|_|_|_|_|_|

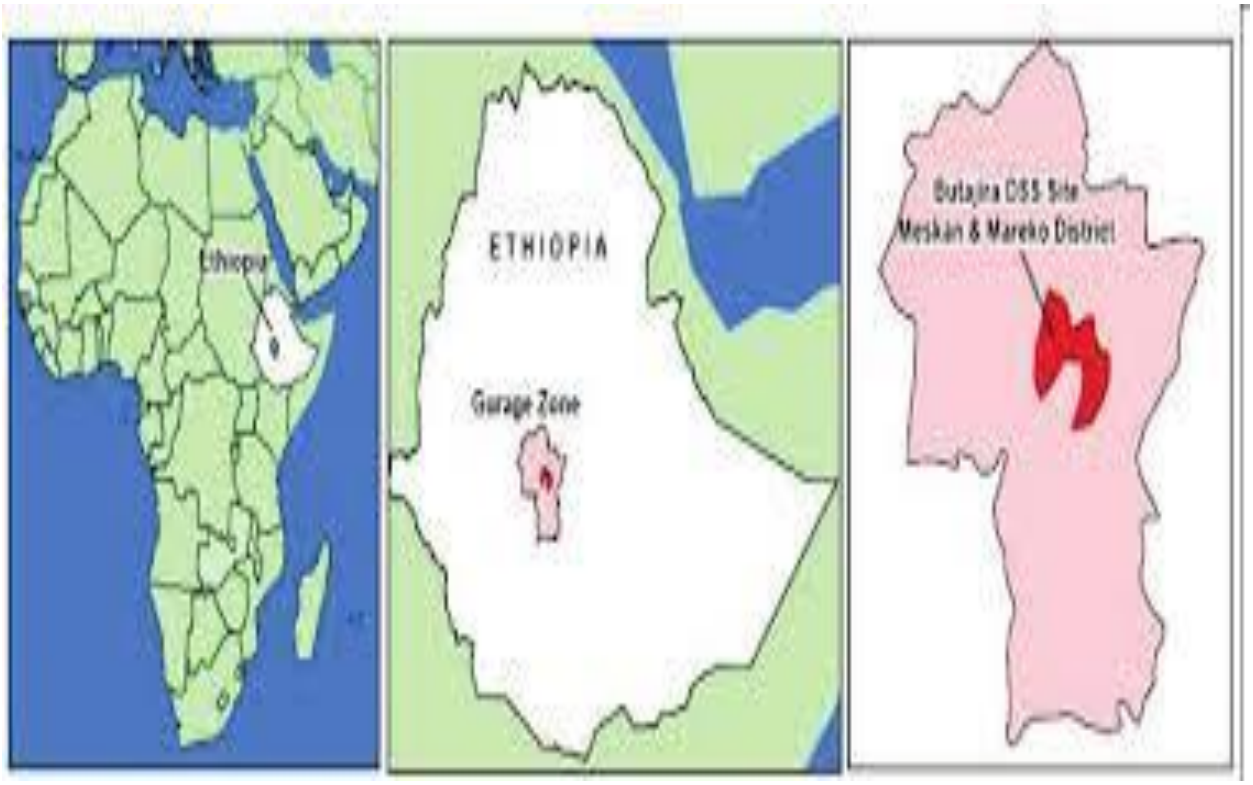
/

/

16.What is your relation to the family head? |_|_|

| | |
|---|---|
| 01. Head | 02. 1st spouse |
| 03. 2nd spouse | 04. 3rd spouse |
| 05. 4th spouse & above | 12. Child of head and 1st spouse |
| 13. Child of head and 2nd spouse | 14. Child of head and 3rd spouse |
| 15. Child of head and 4th spouse | 21. Child of head only |
| 22. Child of 1st spouse only | 23. Child of 2nd spouse only |
| 24. Child of 3rd spouse only | 25. Child of 4th spouse only |
| 31. Parent of head | 32. Parent of 1st spouse |
| 33. Parent of 2nd spouse | 34. Parent of 3rd spouse |
| 35. Parent of 4th spouse | 41. Other relative of head |
| 42. Other relative of 1st spouse | 43. Other relative of 2nd spouse |
| 44. Other relative of 3rd spouse | 45. Other relative of 4th spouse |
| 46. Other relatives | 47. Adopted child |
| 48. None relative | |

**Annex 4: Geographical map of Butajira HDSS**



## Declaration

**ASSURANCE OF PRINCIPAL INVESTIGATOR**

I, the undersigned, declare that this is my original work, has never been presented in this or any other university and all the people and institutions who gave support for this thesis work are fully acknowledged.

Name of the student: _____

Date _____ Signature _____

**APPROVAL OF THE PRIMARY ADVISOR**

This thesis work has been submitted for examination with my approval as university advisor.

Name of the primary advisor: _____

Date _____ Signature _____