

# Under-five Child Survival and Associated Risk Factors in Zambia

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## Research Article

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# Abstract

*Background:* Under-five mortality remains a global public health challenge faced by several developing countries particularly those in Sub-Saharan Africa. This study aimed to analyse risk factors for under-five mortality in Zambia.

*Methods:* In order to achieve this objectives, the most recent 2018 Zambia Demographic and Health Survey Children's dataset was used. Microsoft Excel 2013 and Stata 13 software were used to analyse the data by first establishing percentage and graphical distributions of variables of interest and thereafter apply Survival analysis to produce Kaplan – Meier results with the log-rank test and Cox proportional hazard regression models.

*Results:* Our findings show that various factors pose risks to under-five mortality. In this regard, the mother's education, higher birth order, being from a household classified as rich and residing in rural areas has a protective effect for under-five mortality, while older mothers and being in female headed household increases the risk of under-five mortality.

*Conclusion and Policy Implication:* It is clear that Under-five mortality remains high in Zambia and influenced in a significant way by two major factors – older ages at birth for mothers and female headed households. While the latter is a result of society and community settings and how they interact with various cultural and traditional norms as well as power relations and the gender perspective, the former could be associated with access to comprehensive reproductive health services coupled with access to education. In view of the findings, the study has important policy implications at national level in monitoring the implementation of various infant and under five interventions aimed at reducing IMR and U5M and also to ensure that it achieves the SDG 3.2, as such, all interventions should have a demographic and socio-economic lens at all levels of service provision and implementation. Nonetheless, these should be implemented in line with known high impact under-5 interventions already being implemented if maximum results are to be achieved.

## Introduction

There is global consensus that child health is a fundamental component of sustainable development. For this reason, “reducing infant mortality and under five mortality” was set as a target for achieving the Sustainable Development Goal (SDG) number 3 on healthy lives and wellbeing for all. Target 3.2 aims to reduce neonatal and under-five mortalities to 12 and 25 deaths per 1000 live births, respectively [1]. As one of the measures of child health and the health status of the population, under-five mortality is defined as the number of deaths between birth and the fifth birthday per 1000 live deaths.

Globally, the rate of under-five mortality had fallen from 93 deaths in 1990 to 39 per 1,000 live births in 2018 [2]. Even with this notable drop, under-five mortality remains a global public health challenge faced by many developing countries, particularly in Africa. According to [2] 5.3 million children under the age of five died in 2018 compared to 4.4 million in 2017. The highest under-five mortality for the years 2017 and

2018 and occurred in Sub-Saharan African (SSA) countries with 78 deaths per 1000 live births translating to 1 death in every 13 under-five children. Majority of these deaths (47%) were among neonates (newborns). In the same way, projected estimates by [3] suggests that about 52 million children below the age 5 will die between 2019 and 2030

The decline in under-5 mortality in sub-Saharan Africa (SSA), has been uneven across countries and age groups [4]. As a whole, the SSA countries will not achieve the SDG target 3.2 at the current rate unless they accelerate their efforts. According the World Population Prospects of 2019, SSA will only reach 40 deaths per 1000 live births by 2030 [5], Population Division, 2019). Zambia has made strides in reducing the under-five mortality in recent years. Figure 1.1 compares infant mortality rate for Zambia with the SSA country's average. It shows that Zambia has a lower rate in comparison with the SSA average. In addition Figure 1.2 highlights the fact that mortality is not equally distributed in Zambia with about four provinces having lower than the average national under-five mortality rate while six other provinces have higher than the national average figure. Luapula province for example has the highest rate of 110 deaths per 1000 live births while North-Western province has the lowest at 22/1000 live births. In addition, figure 1.3, shows that between 2002 and 2018, under-five mortality reduced from 168 to 61 deaths per 1000 live births. Between 2013-14 and 2018, under-five mortality reduced by an average constant rate of about 4.13% per annum. In order to meet the SDG target 3.2, Zambia needs to accelerate the average annual reduction rate to about 7.43% so as to move the under-five mortality rate from the current 61 to the targeted 25.

### **Programmes and policies on under-five mortality in Zambia**

Like many other developing countries, Zambia is also adhering to the 2030 Agenda for sustainable development, adopted by all United Nations Member States in 2015. Sustainable Development Goal number 3.2 aims to end preventable deaths of newborns and children under 5 years of age. Specifically relating to under five mortality is the goal to reduce under-5 mortality to a low rate of 25 per 1,000 live births by 2030. At national level, Zambia has taken steps to address the challenge around under 5 mortality; Vision 2030 and the current Seventh National Development Plan (SNDP) as well as other pieces of policies such as The National Health Strategic Plan of 2017-2021 all to reduce the under-five mortality rate from 61 to 56 per 1000 by 2021. In order to achieve this, various practical interventions based on the pieces of legislation highlighted already have been put in place and they include immunization programmes such as the e the Expanded Programme on Immunization (EPI), the Integrated Management of Childhood Illnesses (IMCI), vitamin A supplementation and integrated community case management (ICCM) to mention a few.

While noting positive strides made to improve child health, under-five mortality remains significantly high in Zambia posting a significant challenge to attain the SDG target as set by the UN Member States. In view of this therefore, this study aimed to provide some input into the policy debate on how Zambia can accelerate progress towards achieving the SDG target of between 12-25 deaths per 1000 live births by endeavouring to establish risk factors associated with the survival of children under the age of five.

## Literature

Under-five mortality has been widely studied around the world. Despite this extent studies, focusing on the length of time it takes from birth to death among children under the age of five are not so common in countries such as Zambia. Under-five mortality reviews suggest that there are various factors that can be associated with under-five mortality among which socioeconomic, biological and environmental factors play a pivotal role [6]. However, so far, there seems to be no consensus in literature on the actual risk factors associated with under-five mortality

[7] Suggest that factors such as family size, shorter birth intervals, duration of breastfeeding, water sources and mother's income are associated with under-five mortality in Ethiopia. A similar study in Ethiopia however found some more extensions to the argument and suggested that modern contraceptive use, tetanus vaccinations, mother's age, child's sex, parity, postnatal check-up, marital status, and source of drinking water were instead more associated with under-five mortality [8]. Within this complex web of factors relating to risks associated with under-five mortality, a study by [9] found that maternal age, place of residence, household wealth index, level of education, employment, marital status, religious background, birth type, birth order and interval, sex and size of child, place and mode of delivery contributed to under-5 mortality rate in much of SSA. Cementing this idea, a study by [10] in Ghana also found that shorter birth intervals increased the risk of under-five mortality; however, they also pointed out that sleeping under a mosquito net and increased labour force participation of mothers reduces the risk.

In Zimbabwe, [11] found that children whose mothers who had used contraceptives before and whose children had postnatal check-ups had lower likelihood of dying before the age of five comparatively. The study further observed that small birth size and higher birth order increased the risk of dying. In another study by [12], it was found that low wealth status, source of drinking water, having an HIV positive mother were positively related to under-five and infant mortality in South Africa.

In Zambia, a study by [6] found that malaria, diarrhoea and respiratory infections caused mortality among under five children. The study further noted that increased frequency of visits to health centre significantly reduced mortalities in children by 3 out of a 1000 live births each year. Another study by [12], established that children with marasmus were more likely to die before the age of five with HIV infected children having higher risks of dying compared to HIV negative children.

With all these studies in perspective, none was dedicated, at least in Zambia, to investigate the timing of the deaths at under five although some of the risk factors have been highlighted. In view of this visible lacuna, this study therefore was positioned to determine under-five child survival and associated risks in Zambia.

## Data And Methods

### *Data*

In order to achieve set objectives, this study used the 2018 Zambia Demographic and Health Survey (ZDHS) Children's dataset) and World Bank Development Indicators. The 2018 ZDHS is a cross-sectional nationally representative survey which uses a two-staged stratified sampling method to obtain household sample. Various questionnaires were used to collect data from selected households included among them are the Woman's questionnaire, Man's Questionnaire, Biomarkers Questionnaire and Household Questionnaire. The data used in this study was obtained from birth records obtained from each of the women interviewed. A total of 13,683 out of the identified 14,189 women age 15-49 were interviewed translating to a response rate of 96%. The data is freely obtainable from the DHS Program website ([www.DHSprogram.com](http://www.DHSprogram.com))

### *Statistical Methods*

Microsoft Excel 2013 and Stata 13 software were used to analyse the data. The first step of analysis involved establishing percentage distributions and graphical presentations of variables of interest; once this was done, data was then prepared to perform survival analysis. The Survival analysis modelling involved the production of the Kaplan – Meier outputs with associated log-rank tests; further, the Cox proportional hazard regression model was used to produce estimates for the risk factors associated with under five mortality. Kaplan Meier was used to estimate survival probabilities for children under the age of five while the log-rank test was used to compare two or more survival functions in the model [14]. For this study, the log-rank test was used to test the equality of two or more Kaplan Meier survival curves. The Cox Proportional Hazard Model was used to determine factors associated with the survival of children under the age of five in Zambia. All variables were weighted to adjust for differences in probability of sample selection. Variables used were selected based on reviewed empirical literature based on studies undertaken by [7, 12, 15]. The dependent variable was the relative risk of death occurring between age zero and 59 months. While independent variables included sex of the child, access to water, sanitation, type of residence, birth interval, place of delivery, mode of delivery, marital status, duration of breastfeeding, education level of parents, wealth index, immunization status, family size, mother's age at birth and unmet need for contraception for mothers.

## **Results**

Table 1.1 presents sample characteristics. About 51% of children were male with 78% of them having a birth interval of two years and above. Majority (21.5%) of interviewed mothers were aged between 20 to 24 years while only 6.4% were aged between 15 and 19. By education level, about 53% of mothers had primary education while only 3.3% had tertiary education. About 65% of the respondents lived in rural areas. A quarter of these children belonged to households classified as poorest (25.3%) and 78% of them resided in male headed households. Most of the respondents (81%) used open well water sources and 75% used pit and traditional toilets respectively.

### **Table 1.1: Percentage distribution of the study population by demographic and socio-economic characteristics**

<b>Variable Names</b>	<b>Percentage</b>	<b>n</b>
<b><i>Sex of child</i></b>		
Males	50.9	6,380
Female	49.1	6,157
<b><i>Birth Order</i></b>		
0 to 1 Years	2.9	263
Above 1 to 2 Years	19.2	1,752
above 2 years	77.9	7,110
<b><i>Age of Mother</i></b>		
15-19	6.4	804
20-24	21.5	2,699
25-29	20.8	2,611
30-34	18.1	2,275
35-39	16.1	2,014
40-44	10.3	1,290
45-49	6.7	844
<b><i>Highest educational level</i></b>		
No Education	11.9	1,494
Primary	53.1	6,658
Secondary	31.6	3,966
Tertiary	3.3	419
<b><i>Type of place of residence</i></b>		
Urban	35.3	4,420
Rural	64.7	8,117
<b><i>Wealth Quintile</i></b>		
Poorest	25.3	3,166
Poorer	22.5	2,816
Middle	18.7	2,339
Richer	19.1	2,395

Richest	14.5	1,821
<b><i>Sex of Household Head</i></b>		
Male	77.8	9,759
Female	22.2	2,777
<b><i>Source of Drinking Water</i></b>		
Piped water	19.1	2,395
Open well water	80.9	10,142
<b><i>Type of Toilet</i></b>		
Flush toilet	11.3	1,415
Pit and traditional toilet	74.7	9,366
No toilet	14	1,755

Figures 1.4 and 1.5 present the Kaplan-Meier survival curve. In Figure 1.4, overall survival probabilities for all children aged below the age of five are shown. There is a steady drop in survival up to the 24<sup>th</sup> month and thereafter the drop is slower. In Figure 1.5 survival Probabilities of Children under the Age of Five disaggregated by mother's level education are indicated.. Results show that, children from mothers who had tertiary education had higher under-five survival while those with no education had the lowest under-five survival.

### **Coz-Proportional Hazard Regression Model for Risks Factors of Under-Five Mortality in Zambia**

Table 1.2 presents hazard ratios, with their corresponding probability values, for under-five mortality. Results indicate that hazards for under-five mortality increases with age of the mother. The highest hazards were observed among women aged 45 to 49 years. Education was associated with lower hazards of under-five mortality. Compared to children whose mothers had no education, children born from mothers with secondary education had 20% lower hazards while those with tertiary education had 55% lower hazards of under-five mortality. Children who belonged to households classified as richest had lower (32%) hazards compared to those from households classified as poor. Results further show that there is an inverse relationship between birth interval increases and under-five mortality, in that an increase in birth interval time (period) the hazard for under-five mortality reduces. Children born between 1 and 2 years birth interval had 46% lower hazards while those with over two years of birth interval had 78% lower hazards of experiencing under-five mortality. Further, Children from rural areas had lower hazards of under-five mortality, compared to those living in urban areas. Finally, female headed households had 31% higher hazards of under-five mortality, compared to male headed households.

In this study, the test for the Cox proportional hazard model's assumption was also performed. Results for this test are presented in appendix Table 1.3. These test results show that independent variables are not

statistically significant. Similarly, the global test results are also not statistically significant and hence we can assume the proportional hazards.

**Table 1.2: Results of the Cox proportional hazard regression model for infants in Zambia**

<b>Explanatory Variables</b>	<b>Hazard Ratio</b>	<b>P-Value</b>
<b><i>Sex of Child</i></b>		
Male	1	
Female	0.96	0.41
<b><i>Age of Mother</i></b>		
15-19	1	
20-24	0.38	0.04
25-29	0.56	0.20
30-34	1.19	0.70
35-39	2.08	0.10
40-44	4.11	0.00
45-49	7.24	0.00
<b><i>Education Level of Mother</i></b>		
None	1	
Primary	0.95	0.44
Secondary	0.80	0.02
Tertiary	0.45	0.00
<b><i>Wealth Quintile</i></b>		
Poorest	1	
Poorer	1.04	0.58
Middle	1.00	0.99
Richer	0.92	0.43
Richest	0.68	0.02
<b><i>Birth Interval</i></b>		
0 to 1 Years	1	
Above 1 to 2 Years	0.54	0.00
above 2 years years	0.22	0.00
<b><i>Water Source</i></b>		
Piped Water	1	

Open well water	0.85	0.12
<b><i>Type of Place of Residence</i></b>		
Urban	1	
Rural	0.69	0.00
<b><i>Toilet Type</i></b>		
Flush Toilet	1	
Pit and traditional toilet	0.92	0.55
No toilet	1.04	0.81
<b><i>Sex of the Household Head</i></b>		
Male	1	
Female	1.31	0.00

## Discussion Of Findings

Results from this study has established that under-five mortality is affected by various risk factors which include mother's age, mothers education, birth interval, wealth status, type of place of residence and sex of the household head. The hazards for under-five mortality increase with age of the mother, with highest hazards observed among women aged 45 to 49. These findings are similar to a study by [16] who undertook to investigate under five mortality patterns and associated maternal risk factors in SSA countries where it was observed that children in older women were more likely to die before attaining age 5. According to [16], older women lose their children mainly due to either being less educated or have higher parity comparatively. However, [18] found that under-five mortality was in fact lower among children born from older mothers in Bhutan.

Apart from the significant effects of age on child survival, education of a mother, both at secondary (20%) and tertiary (55%) level, has a protective effect against under-five mortality.. This finding is not in isolation as several other studies confirm this relationship [17, 19, 20, 21]. These findings underscore the importance of education to the health of children since educated women may be more enlightened on the importance of the health of children and able to engage in health seeking behaviour such as better child care, use of modern health facilities and curtailing of known cultural practices that may inadvertently promote IMR and U5M.

As observed by other studies [19, 22] in other countries the wealth status of a household plays a very important role in child survival. In this study, results show that children in households classified as richest had lower (32%) hazards compared to those from households classified as poor. This is because wealth

gives women the ability to access and utilize the health care services for themselves and their children. However, a study by [23] found that children born in households classified as rich and richer had no significant impact on child survival in Sierra Leone.

This study further found that hazard for under-five mortality reduces as birth interval increases. These results are similar to those by [7, 10]. On the contrary however, [11] observed that higher birth order increased the risk of under-five mortality in Zimbabwe.

Contrary to expectations and norms in child health, this study found that children from rural areas had lower hazards of under-five mortality, compared to those living in urban areas. This may be explained only in speculative forms; that various community based health care programmes [24], such as the Community Health Assistant (CHA) Program, being undertaken in rural areas of Zambia may already be yielding positive results in helping reduce under-five mortality in Zambia. Other similar studies in other countries had mixed findings; for example [17] found that place of residence had no significant effect on under-five mortality in Ghana. A study by [25] however found contrary results where they observed that living in rural areas increase the hazards of under-five mortality.

Finally, female headed households had 31% higher hazards of under-five mortality, compared to male headed households. A similar study by [26] made similar conclusions. These could be a result of a mixture of aspects including general disadvantages that women, especially single women, face in society which are also comingled with power, access to resources and other traditional and cultural undertones that affect women, and by extension affect the survival of their children as well.

## **Policy Implication**

In view of the findings, the study has important policy implications at national level in monitoring the implementation of various infant and under five interventions aimed at reducing IMR and U5M. Determinants affecting under-five mortality are multifaceted and a mixture of both demographic and socio-economic factors. In order for Zambia to achieve SDG 3.2, all interventions should have a demographic (access to reproductive services for older women) and socio-economic (enhance income and education levels to female headed households) lens at all levels of service provision and implementation. Nonetheless, these should be implemented in line with already known high impact under-5 interventions already being implemented if maximum results are to be achieved.

## **Conclusion**

In our study, we explored various factors likely to be associated with the risk of under-five mortality in Zambia. Based on our findings, it is clear that Under-five survival is greatly influenced by various bio-demographic and socio-economic factors. The Cox regression model established that mother's education, higher birth order, being from a household classified as rich and residing in rural areas reduces under-five mortality. However, older mothers and female headed household increase the risk of under-five mortality. It is clear that Under-five mortality remains high in Zambia and influenced in a significant way by two

major factors – older ages at birth for mothers and female headed households. While the latter is a result of society and community settings and how they interact with various cultural and traditional norms as well as power relations and the gender perspective, the former could be associated with access to comprehensive reproductive health services coupled with access to education.

## Abbreviations

CHA	Community Health Assistants
DHS	Demographic and Health Survey
EPI	Expanded Programme on Immunisation
GRZ	Government of the Republic of Zambia:HIV:Human Immunodeficiency Virus
ICCM	Integrated Community Case Management:IMCI:Integrated Management of Childhood Illnesses
IMR	Infant Mortality Rate
JSI	John Snows International
SDG	Sustainable Development Goal
SNDP	Seventh National Development Plan
SSA	sub-Saharan Africa
UN	United Nations
UNIGME	United Nations Inter-agency Group for Child Mortality Estimation
USAID	United States Aid for International Development
U5M	Under-five Mortality
ZDHS	Zambia Demographic and Health Survey
ZamStats	Zambia Statistics Agency

# Declarations

## Ethics approval and consent to participate

Although this data included human beings, this data analysis was secondary and all methods were carried out in accordance with relevant guidelines and regulations based on the permission granted to us by DHS program and ZamStats for us to use the ZDHS dataset in particular the women's (ZMIR71FL) stata data file. All experimental protocols for survey methodology, biomarker measurements, and all instruments prior to data collection were approved by National and international Institutional Review Boards (IRBs) that is Tropical Diseases Research Centre (TDRC) in Zambia and at ICF in the USA. During data collection, informed consent was obtained from all subjects and/or their legal guardian(s) (ZamStats, MoH and ICF 2019). In addition, no potentially identifying information is part of this dataset.

## Consent for publication

Not Applicable

## Availability of Data and Materials

The datasets generated and/or analysed during the current study are not publicly available due the fact we had to get permission from DHS and Zamstats for us to use the dataset as such it requires us to get permission to allow others to use it, hence them being, available from the corresponding author on reasonable request.

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## Authors Contribution

JNM and BBB conceived, designed, analysed, interpreted and participated in the drafting of the manuscript. CCM, ES and JB participated in the interpretation and drafting of the manuscript. JNM and BBB were responsible for coordinating the study. All authors have read and approved the final version of the manuscript.

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## Figures

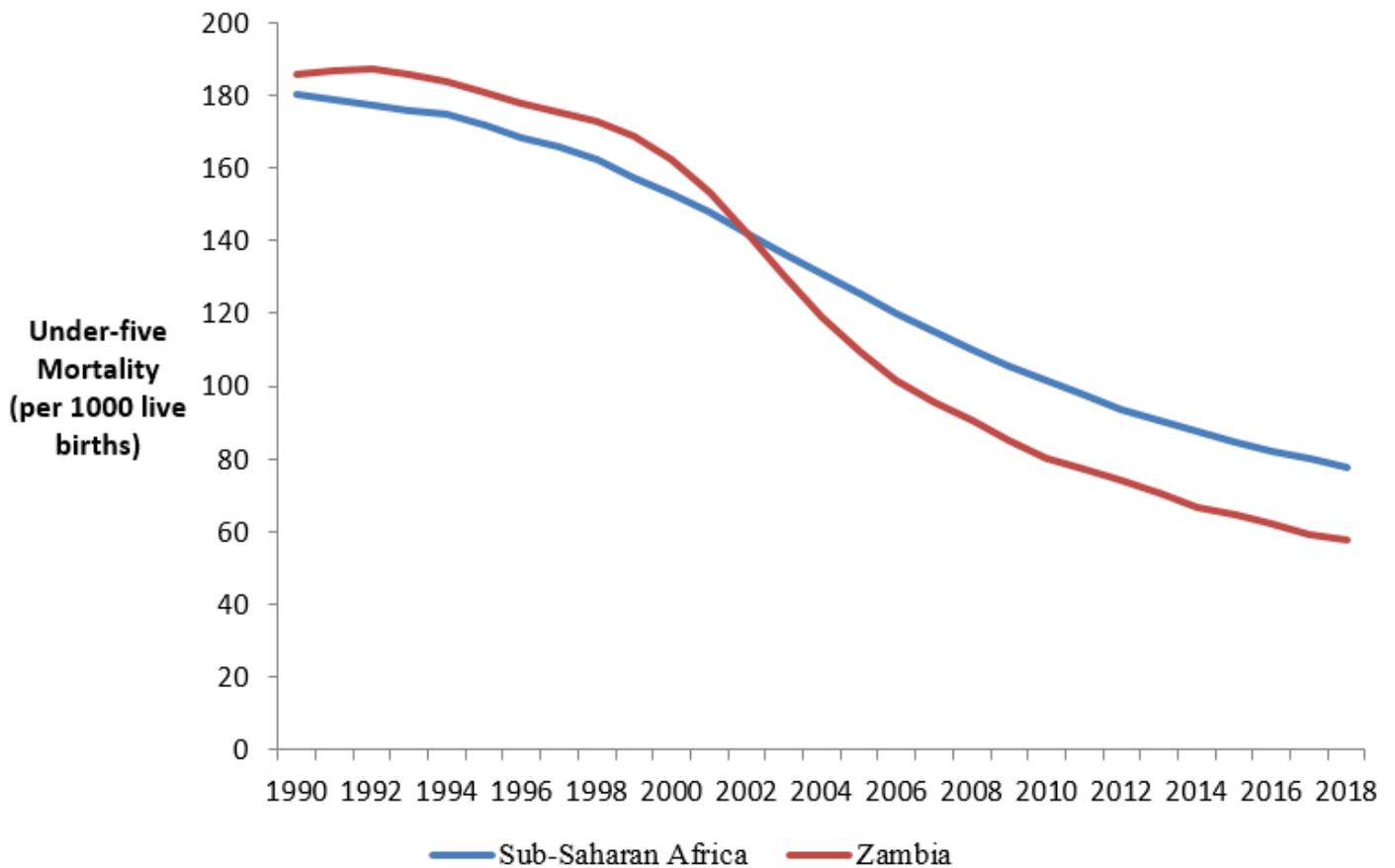


Figure 1

Trends in Under – five Mortality for Zambia and SSA countries: 1990 to 2018 *Source: Authors Analysis*

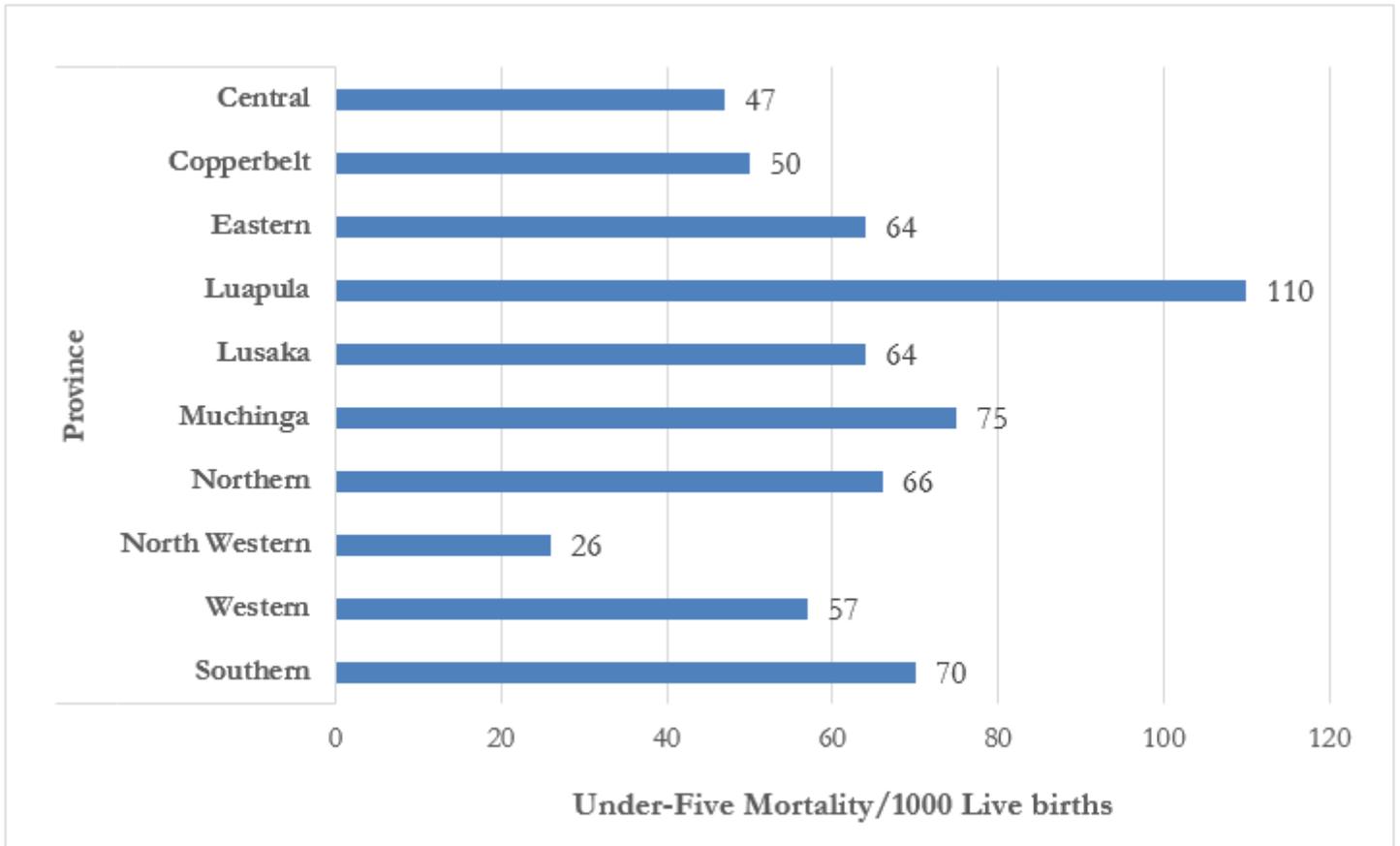


Figure 2

Distribution of Under-Five Mortality by Province *Source: Authors Analysis using information from 2018 ZDHS Report*

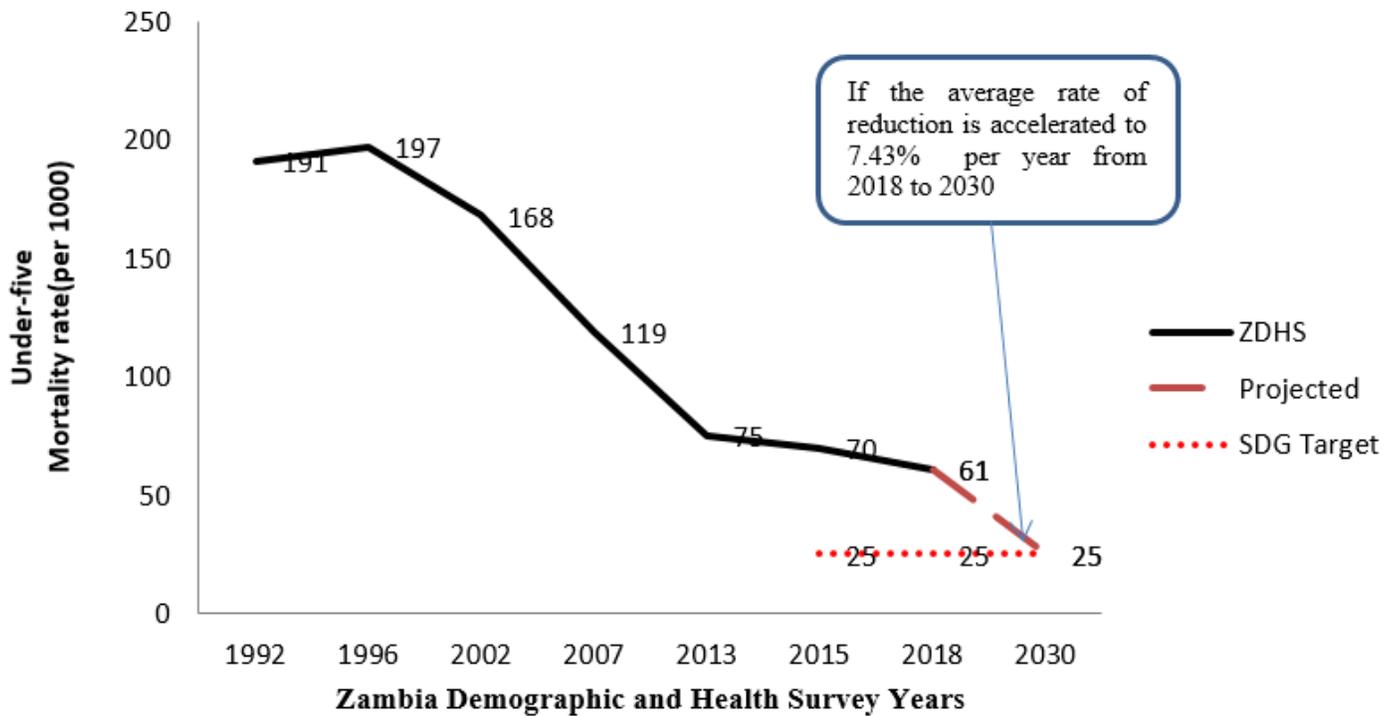


Figure 3

SDG target and the trend in Under-five Mortality in Zambia *Source: Authors Analysis using information from 2018 ZDHS Report*

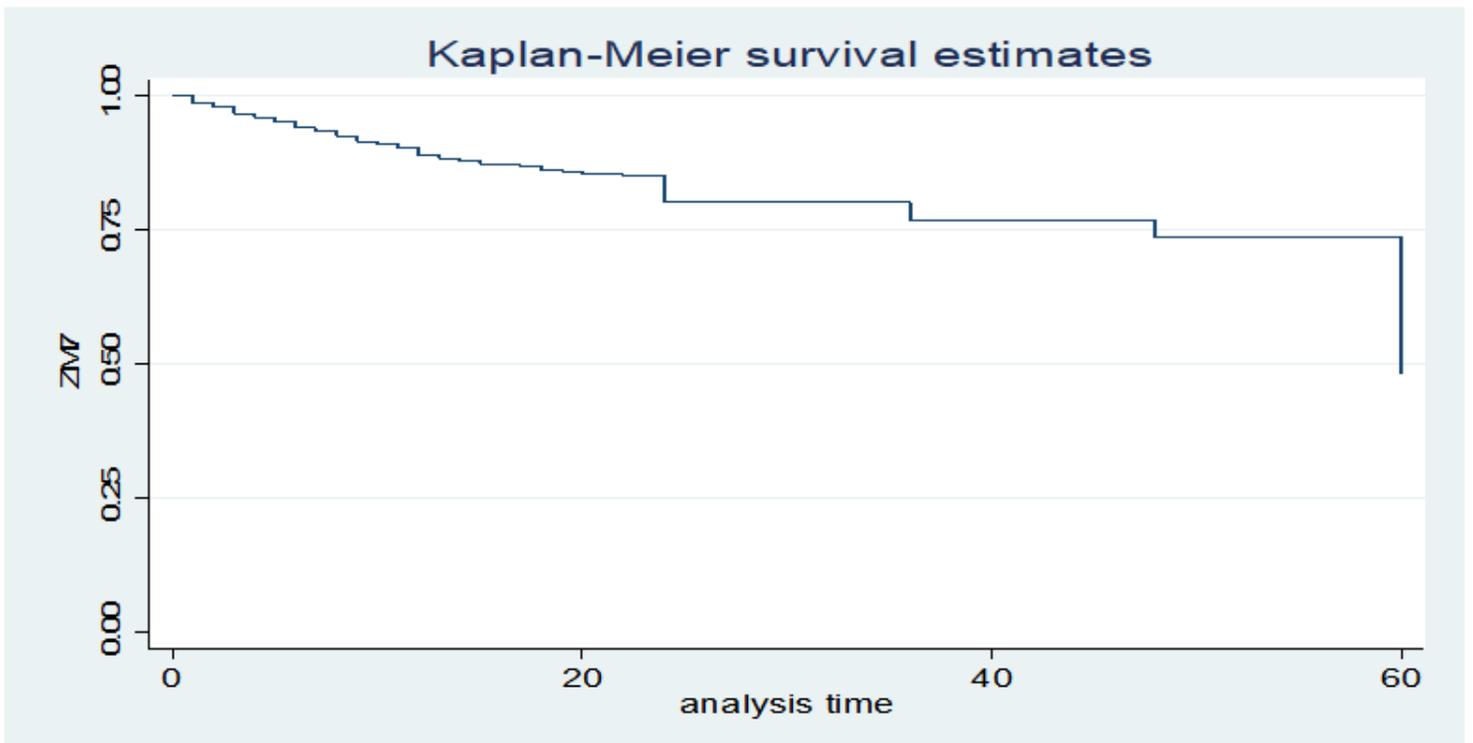


Figure 4

## Plot of the overall Kaplan – Meier average survival Probabilities of Children Under-Five in Zambia

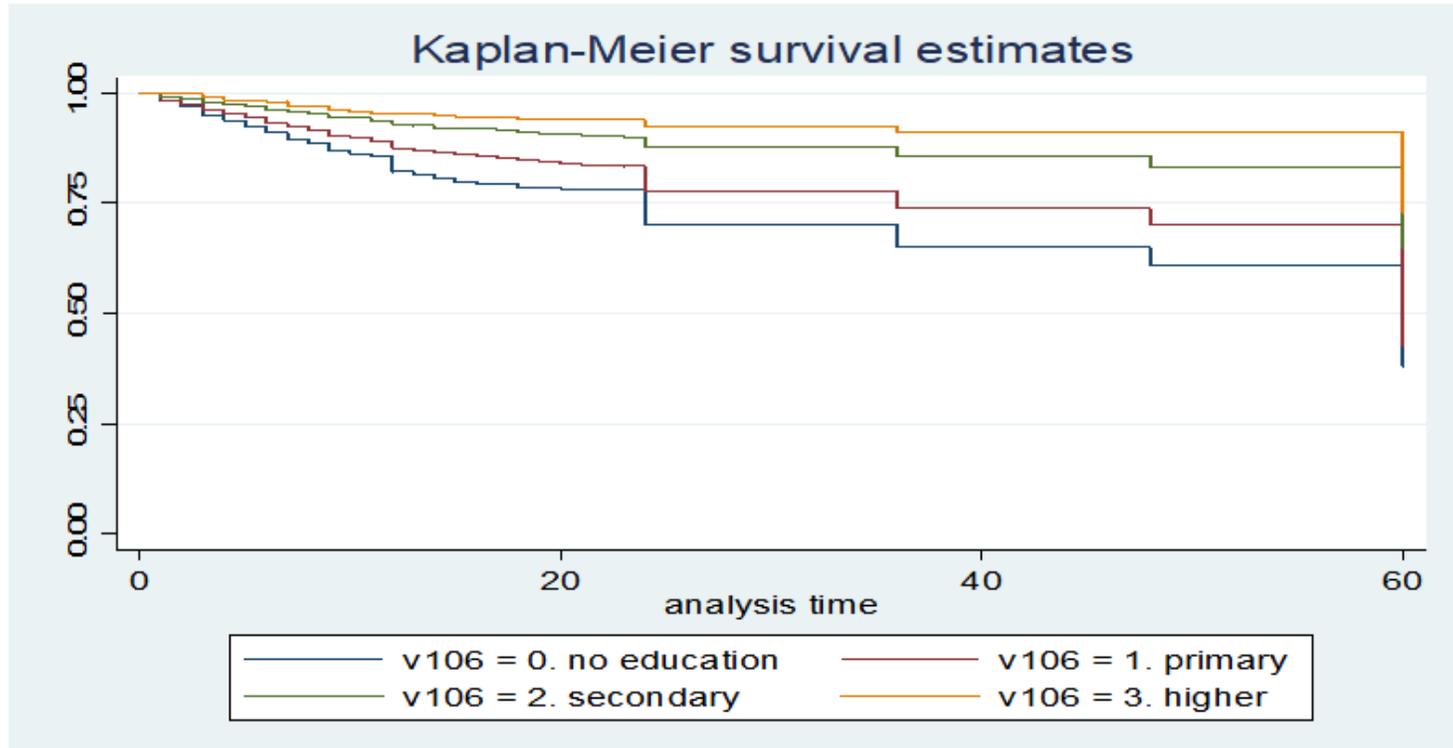


Figure 5

Kaplan – Meier survival Probabilities of Children under the Age of Five by mother's education level.

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [AppendiceTable1.3Outputonthetestproportionalhazardsassumption.docx](#)