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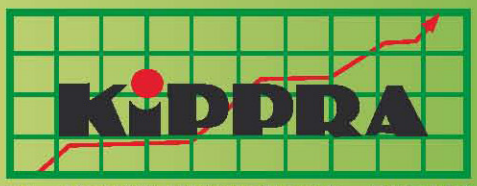

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Effects of Household Environmental Characteristics on Child Health in Kenya

Arthur Odima

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PROGRAMME

Effects of Household Environmental Characteristics on Child Health in Kenya

Arthur Odima

Kenya Institute for Public Policy
Research and Analysis

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Bishops Garden Towers, Bishops Road
PO Box 56445-00200 Nairobi, Kenya
tel: +254 20 2719933/4; fax: +254 20 2719951
email: admin@kippra.or.ke
website: http://www.kippra.org

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Abstract

Health is postulated to be the greatest asset in any nation. However, majority of the Sub-Saharan African (SSA) countries experience adverse health outcomes and a manifest of poor household environmental characteristics. Household environmental risk factors/ characteristics have been pointed out to impact on health outcomes. Different studies show that household environmental factors are linked to health outcomes. Nevertheless, there is dearth of studies in Kenya investigating the effects of household environmental characteristics on health outcomes.

This study investigates the effects of various household environmental characteristics on health in Kenya using under-five mortality as a proxy indicator of health outcome. Data from KDHS 2008-09 and Cox Proportional Hazard model are employed in the estimation. The results show that household environmental characteristics (access to water, access to sanitation and source of cooking fuel), socioeconomic factors (wealth index, residence type, mothers education level, and gender of household head) and behavioral factors (sleeping under mosquito nets and smoking) significantly affect under-five mortality rates in Kenya.

This paper recommends policies and programs such as public private partnership in water, sanitation and health promotion. In addition, there is need for a clear framework for collaboration between private, civil societies and the government in increasing access to water and sanitation facilities. Further, the government should intensify the promotion of public awareness on sanitation and support basic health education in learning institutions. Most importantly, the government and other development agencies should ensure that there is an increased supply of clean water and promote the use of low polluting fuels in rural areas. Lastly, the country should have an integrated environment and health sector policy.

Abbreviations and Acronyms

CM	Child Mortality
KDHS	Kenya Demographic Health Survey
KEPI	Kenya Expanded Programme on Immunization
KIHBS	Kenya Integrated Household and Budget Survey
KNBS	Kenya National Bureau of Statistics
LDC	Least Developed Countries
MDG	Millennium Development Goals
MHCS	Maternal Health Care Services
MOH	Ministry of Health
NGO	Non Governmental Organization
NHSSP	National Health Sector Strategic Plan
SAPs	Structural Adjustment Programs
SES	Socio Economic Status
SDGs	Sustainable Development Goals
UNICEF	United Nations Children Education Fund
WHO	World Health Organization

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1. Introduction

Human health is inextricably linked with household environmental conditions hence household environmental characteristics are major determinants of morbidity and mortality. Environmental deterioration such as air pollution, climate change, contamination with hazardous chemicals, uncontrolled waste generation and disposal, and ecosystem disruption have adverse effects on human health with higher mortality rates being experienced among children under the age of five (UNEP, 2015).

As much as various covariates may be responsible for under-five mortality in developing countries, studies reveal that some childhood diseases that often result in mortality can be explained by well-known health hazards within the child's household environment (Rutstein, 2000; United Nations, 2001).

Children are exposed to a series of health risks from household environmental hazards. Household environment related illnesses accounts for millions of deaths annually in children under the age of five globally. Both basic and traditional risks, such as unsafe water, poor sanitation, indoor air pollution, poor food hygiene, poor quality housing, inadequate waste disposal, vector-borne diseases and hazards that cause accidents and injuries, as well as "modern" environmental risks endanger children's health. Emerging environmental threats to children's health derive from high levels of natural or man-made toxic substances in the air, water, soil and food chain, global climate change and ozone depletion, electromagnetic radiation and contamination by persistent organic pollutants and chemicals that disrupt endocrine functions (WHO, 2010).

Various studies have documented relationship between socio-economic status and health outcomes (Adams et al., 2003). The association is found to hold for different populations and various measures of health (Goldman, 2001). Previous and current policy commitments including the MDGs, now Sustainable Development Goals and other health policies have focused on improving health status of the population but most targets have not been achieved. Under five mortality rates stands at 59 per 1000 live births while the target was33 per 1000 live births by 2015 (GOK 2014). It is worth noting that as much as there exists health intervention policies, inadequate attention has been given with regards to household environmental impacts on health.

It is appreciated that public health policy exists, however a gap exist especially in aspects of household environmental effect on health. Therefore policies based on research evidence needs to be designed to address household environmental disease causing risk factors.

1.1 Health Situation in Kenya

Since independence in 1963, Kenya has put remarkable efforts on improving the health of its population. By the 1980s, Kenya had increased its health facilities by about four times. This helped to improve the country's life expectancy from 40 years to 62 years and also helped improve child survival rates (Ministry of Medical Services, 2008). The economic crisis of the 1980s and the increased intensity of the HIV/AIDS pandemic in the 1990s intensified the health challenges in Kenya. These challenges include: extending health services to impoverished and geographically dispersed populations; providing sufficient funds to maintain and extend health infrastructure; and ensuring the availability of health workers where they are most needed (Ministry of Medical Services, 2008).

Besides tackling high burden of infectious diseases, Kenya faces an emerging chronic diseases problem, characterized by increasing rates of cardiovascular diseases, cancers and diabetes. Since the 1990s, some of Kenya's early achievements in health have taken a down turn. Over the past two decades, life expectancy reduced to 53 years, and under-5 mortality rate rose slightly (Ministry of Medical Services, 2008). However, in 2012 life expectancy in Kenya was estimated at 63.07 years, with child mortality taking a declining trend at 73 per 1000 live births (Kenya Economic Survey, 2013).

During the 1994-2010, health policy period, life expectancy at birth in Kenya declined to a low of 45.2 but was estimated to have risen to 60 years by 2009. However, deterioration of the health situation was seen across all ages as demonstrated by poor performance of various health indicators especially adult, infant and child mortality (WHO 2010, World Health Statistics).

During the period 1994-2010, child health interventions showed improvements in coverage. Welfare reports however indicated that ill health amongst children remained high, with no indications of significant improvement. By 2014,under five and infant mortality rates were estimated to be 52 and 39 respectively (Government of Kenya, 2014).

The health sector has been adversely affected by globalization, political instability and the emerging regional and national macroeconomic challenges, triggered by the global economic downturn, coupled with climate change. The national health risks and priorities have been influenced significantly by the increased cross-border movements of people, goods and services as well as international rules and institutions (Ministry of Public Health and Sanitation, 2012).

1.2 Child Mortality

Child mortality is the probability of a child dying between the first and the fifth birthday. Infant mortality refers to the probability of a child dying before the first birthday, while under-five mortality refers to the probability of dying between birth and the fifth birthday (KDHS 2008-09).

Table 1.1: Child Mortality in Kenya: Levels and Trends

Year	1962	1969	1979	1989	1993	1998	2000	2003	2006	2008	2014
Under 5 Mortality	219	190	157	113	93	105	116	115	92	74	52
Infant Mortality	126	119	104	59	62	71	73	77	60	52	39

Sources; KDHS, 1993, 1998, 2003, 2008 and 2014 series.

As much as the trends have been declining, the country is yet to achieve the set targets of 33 and 15 per 1000 births for under five and infant mortality respectively by 2015. The targets have since been set higher in the Sustainable development Goals at 25 and 12 per 1000 live births for under-five and infant mortality.

1.3 Linking environmental factors and child health

Household environmental risk factors play an important role in child survival even when controlling for socio-economic variation (Anderson et al., 2002). Child survival just like all other population health outcomes is linked to the household environment (Rainham and McDowell, 2005).

Poor household environments make the populations susceptible to diarrheal diseases caused by unsafe drinking water and poor disposal of waste. In addition, hazardous working environment with inadequate health and safety protection increases vulnerability to health risks (Ezzati, 2004). Air pollution is a key threat to human health and well being and is the single largest health risk associated to childhood diseases like pneumonia, lung cancer, bronchitis, cardiovascular disease and low birth weight (WHO, 2014)

The burning of coal and biomass, such as firewood, agricultural wastes and animal wastes, is the primary origin of air pollution in rural communities and some urban areas. Burning solid fuels in traditional cooking stoves and open fires in poorly ventilated indoor spaces, the primary means of cooking and heating for 2.8 billion people in developing countries, results in exposure to dangerous levels of various toxic air pollutants (UNEP, 2015).

Housing a fundamental human right determines health outcome and quality of life. Poor housing quality with lack of thermal comfort, dampness and mould, indoor air pollution, infestations, home safety, noise, accessibility and other factors all impact on health (Franz and FitzRay, 2006).

1.4 Statement of the problem.

In Kenya, one in every 19 children under the age of five does not live to see his/her fifth birthday (GOK, 2014) with household environmental characteristics accounting for a larger percentage of the mortality and morbidity amongst under-five children. This translates to 52 deaths per 1000 live births against a target of 33 deaths per 1000 live births, representing a bigger percentage of loss of human life which needs to be lowered. The situation is not any better in other developing countries in Sub-Saharan Africa. On the other hand, household environmental factors: sanitation, hygiene and access to water are ranked the second highest cause of mortality in Kenya after HIV/AIDS (Kenya Health Policy 2014-2030).

Due to lack of access to water and sanitation, diarrhea is second after pneumonia as the main cause of mortality in children under five years in Kenya (excluding neonatal). Water, sanitation and hygiene related illnesses and conditions are the number one cause of hospitalization in children under age five (Kenya Health Policy, 2014-2030). Only 82 percent of urban Kenyans had access to safe water compared to 59 percent in rural areas by 2014 (WASREB, 2015). However, some regions such as arid and semi-arid areas have very poor access to safe drinking water and experience higher cases of child mortality as a consequence of poor sanitation given that about 8 million Kenyans lack toilet facilities (Ministry of Health, 2015). Globally, 21 per cent of the burden of disease is accounted for by household environmental risk factors (WHO, 2014).

Sickness impoverishes already poor households, consequently sinking them into a progressive spiral of decline in health and economic status. This is due to outcomes of adopting coping strategies like selling their income earning assets, stopping participation in income earning activities and children missing schools to take care of the sick (Corbett, 1989: Kyegombe, 2003).

There is increasing research attention in the socio-economic determinants of health in the public health studies. The emphasis being that the determination of health disparities goes beyond medical treatments and health care services, which are traditionally believed as the key determinants of health, to socio-economic factors. (Wilkinson & Marmot, 1998; Marmot & Wilkinson, 1999).

Previous work seem to have focused more on the effect of health on socioeconomic

status, particularly the effect of health on labour supply and wages (Cai, 2009a, b; Grossman and Benham, 1974).

There is limited empirical work on the effects of household environmental risk factors on health outcomes in Kenya. Past studies in Kenya relating to child mortality used KDHS data for 2003 and KIHBS data of 2005/06 and focused on different specific variables. For instance, Amina (2008) focused on levels, patterns and differentials in child mortality with respect to poverty. Mariara et al. (2012) focused on physical environment and child survival. Mutunga (2004) investigated the impact of socioeconomic and environmental characteristics of households on infant and child mortality. These empirical studies in Kenya have not specifically explored the effect of household environmental risk factors on health outcomes in reference to the latest demographic health data.

The study uses under-five mortality as the health indicator in analyzing how household environmental risk factors (access to sanitation, source of drinking water and source of cooking fuel impact) impacts on health outcomes in Kenya.

1.5 Research Questions

The research paper seeks to answer the following:

1. What are the effects of type of sanitation facility on under five mortality in Kenya
2. What is the effect of the source drinking water on under five mortality in Kenya
3. What is the effect of the type of cooking fuel on under fiver mortality in Kenya

1.6 Research Objectives.

The specific objective of the paper is to explore how aspects of the household environment characteristics affect under-five mortality and to establish the effect of environmental determinants on child mortality in the presence of socio-economic and behavioral factors in Kenya.

The specific objectives are:

1. To investigate the effect of type of sanitation facility on under five mortality in Kenya
2. To investigate the effect of the source of drinking water on under-five mortality in Kenya
3. To investigate the effect of type of cooking fuel on under five mortality in Kenya

1.7 Significance of the study

The study outcomes will be used in the design and implementation of health interventions that take into account child healthcare needs based on household environmental factors. The study will enable policy designers and implementers to come up with policy interventions that are bi-dimensional tackling both household environmental risk factors and adverse health outcomes in an integrated manner. In addition, integrated policy making will equip environment and health authorities with a structured framework to jointly identify, asses and manage tradeoffs that are an outcome of new or reformed policies. Partnership between environment and health authorities may result in cost savings through economies of scale and importantly by reducing healthcare costs both at individual and government levels

The study will also be a reference point for action by Non Governmental Organizations, Civil Societies and other health sector actors when advocating for provision of improved sanitation facilities, increased supply and access to clean water and increased connectivity of electricity and use of less polluting fuels in addition to improving the existing child healthcare policies. The proposed study therefore will inform policy on any changes that might be required to improve health outcomes. Lastly, the proposed study would contribute to the existing literature on household characteristics and under-five mortality based on demographic and health survey data and form a basis for further research for policy formulation.

1.8 Organization of the Study

This study has five chapters. Chapter two presents the literature review while the methods used in the study are presented in chapter three. Chapter four presents the analysis results and interpretation of the findings. Lastly, summary, conclusions, policy recommendations/suggestions and further research are presented in chapter five.

2. Literature Review

2.1 Introduction

This chapter presents theoretical and empirical evidence that point out the relationships that exist between household environmental risk factors and health outcomes.

2.2 Theoretical Literature

This sub-section provides some of the theories that have been fronted in relation to health outcomes.

Wealthier is Healthier Hypothesis

This was fronted by Pritchet and Summers (1996) and states that income is the key determinant of health outcome. Increase in income results in better health via higher spending on goods and services that improve health either indirectly or directly. There are two possible explanations for the wealth-heath nexus; healthier households have higher output and consequently wealthier; and additional variables may result in increased income and improved health (incidental association). Income ranking is therefore a signal of wellbeing. Individual's/household income consequently has a relationship with the physical environment. However, the hypothesis only focuses on income which is a key drawback. Further, the hypothesis fails to show whether there is reverse causality between wealth and health.

Neo-materialist Hypothesis.

This is of the opinion that inequalities in health are a manifestation of inequalities in material environment (Lynch et al., 2000). The inequalities in material environment are generated from inequalities in social infrastructure including, housing, electricity connection, availability of improved sanitation infrastructure, parks, recreational system and education (Lynch et al., 2000). Inequalities in health therefore is an outcome of inequalities in social infrastructure generated from underlying historical, cultural, political and economic developments. More justification for inequalities in health, however, could be provided for by variables other than material environment. Bottero, 2005, however faults the theory on the basis that it is not easy to comprehend how ownership of given goods can affect health as depicted by the theory.

Absolute Deprivation Hypothesis.

The hypothesis posits that very low standards of living, which is a reflection of one's environment, is dreadful for health. It further states that persons living on very low income will encounter undesirable physical environment that may in turn impact negatively on their health including hazards from poor environmental quality, health limiting behaviors such as smoking and sedentary lifestyle (Phipps, 2003). The hypothesis may be criticized on the basis that it does not provide additional explanations for other factors apart from standard of living.

The theoretical framework by Schultz (1984) points out that health outcomes are a factor of proximate determinants (environmental factors), regional prices, biological endowments, preferences, economic endowments and program variables. It is on this framework that the study is anchored (Lynch et al., 2000).

Gee and Payne-Sturges (2004) Stress-Exposure Disease framework postulates that that both individual and community environmental factors can impact on a person's health through psychosocial stress increasing vulnerability. Community environmental risk factors can either be physical e.g. noise, air quality, temperature or psychosocial e.g. fear or stress. The risks can be thought-out in two ways: One is direct exposure to an impurity along a physical conduit resulting into an express contact with the human body causing illness, for instance, a company could be discharging its effluents into a water body used as a drinking-water supply leading to various illness in the neighbouring community. Second could be exposure to a condition in the neighbourhood leading to high depression due to the discernment of the populace. This could be for instance establishment of a new waste dumpsite in the neighbourhood. The framework had the shortfall of not giving adequate explanation for other stressors beyond environmental stressors.

2.3 Empirical Literature

2.3.1 Studies from Kenya and Africa

According to Ezeh et al. (2014), water and sanitation was a key factor in child mortality in Nigeria. The interest was whether children under five years without access to improved water and sanitation were at higher risk of death. They utilized Nigeria's Demographic and Health Survey data for 2003, 2008 and 2013 series and employed Cox proportional regression in their analysis. The results indicated that children without access to improved water and sanitation facilities had

significantly higher level of mortality. This is contrary to the findings by Elmahdi (2008).

The research study by Kabagenyi and Ruteremwa (2013) on the relation between household characteristics and mortality among children under the age of five in Uganda using case study data, Brass type indirect technique and logistic regression, found out that household type, place of residence, household size, and mothers' education level were significantly related to under five mortality. This is in disagreement with Elmahdi (2008) who pointed out that breastfeeding was the most significant determinant of infant mortality. The study however, did not attempt to investigate the impact of other environmental factors like access to water and sanitation.

Mariara et al. (2012) studied the factors that affect child survival in Kenya. The study utilized Demographic and Health Surveys data for the period 1993-2003. The proximate determinant framework was used to analyze child survival. The findings indicated a significant relationship between poverty and child survival. Further, rural children were more likely to die than their counterparts in urban areas. A major critique of the study could be on the data used given that since 2003, a number of child interventions have been implemted.

Wafula et al. (2012) investigated the factors behind the upsurge of infant mortality in Kenya during the period 1988-2003 using merged data set from Kenya Demographic and Health Surveys of 1993, 1998 and 2003. Regression decomposition techniques were employed in their analysis. They found that breastfeeding, maternal education, regional HIV prevalence and malaria endemicity were the driving factors behind the observed upsurge in infant mortality in Kenya during the period. The finding reinforces Elmahdi (2008) specifically on effect of breastfeeding on infant mortality. The study however, did not attempt to examine if household environmental factors could be responsible for the rise.

Ettarh and Kimani (2012) analyzed the impact of geographical location and maternal factors on under-five mortality in rural and urban Kenya using KDHS data for 2008-09. Multivariate analysis and Cox proportional Hazard models were utilized in the analysis. The results indicated that residence type, household wealth, duration of breastfeeding, maternal age, birth order and maternal education significantly impacted on under-5 mortality. The findings by Elmahdi (2008) are further affirmed here. The study however, did not attempt to investigate the impacts of environmental factors on under-5 mortality.

Kayode et al. (2012) studied maternal, child, family and other risk factors associated with under five mortality in Nigeria. Data from Nigeria Demographic and Health

Survey for 2008 was used in the study. In the analysis, multivariate logistic regression was employed. The findings pointed out that mothers age at marriage, health seeking behavior, breastfeeding, household size, use of contraceptives, child spacing, residence type and sanitation were the major risk factors to under-5 mortality in Nigeria. However, no attempt was made with respect to household environmental factors.

Godonson and Nnamdi (2011) examined environmental determinants of child mortality in Nigeria using Nigeria 2009 Demographic and Health Survey data. They employed principal component analysis in achieving the study objective. The findings were that sanitation type, source of cooking fuel, floor material and type of roofing material had significant effect on child mortality. These findings concur with Fayohum (2010) who studied household environmental health and child mortality in Sub-Saharan Africa using Demographic and Health Survey data for 8 SSA countries and employed Kaplan Mier method and Cox proportional Hazard. He showed that source of drinking water, type of sanitation facility, type of flooring material and source of cooking fuel were significantly related to child mortality.

Ugal (2010) examined the effects of household environmental conditions on maternal health among rural women in Northern Cross State in Nigeria. He used primary data obtained from a case study. Context and Bivariate analysis were utilized in the study. The findings were that sanitation, hygiene, access to water and source of cooking fuel had significant impact on maternal health.

Barnes et al. (2009) explored the association between household energy, indoor air pollution and acute respiratory infection amongst children less than five years old in South Africa. The study made use of content analysis of 68 studies in South African that had used diverse methods. The findings pointed out that in-door air pollution is significantly associated with Acute Respiratory Infection among under-five children. A major shortcoming of the study was that it did not incorporate other household environmental risk factors in the analysis.

Foloko (2009) examined the determinants of child mortality in Lesotho using the dataset from Lesotho DHS for 2004/05. Rosenzweig and Schultz (1983) framework and hazard model were employed in the analysis of child mortality. The findings were that sanitation facilities, household income and mother's education were significant determinants of child mortality.

Elmahdi (2008) investigated the socioeconomic determinants of infant mortality in Kenya He utilized data from KDHS for 2003 and employed logistic regression model his analysis. The findings showed wealth index and mother's occupation were the only significant socioeconomic factors that affected infant mortality in

both rural and urban areas. The findings further indicated that breastfeeding was the most important determinant of infant mortality followed by ethnicity, then fertility factors (birth order and interval) with gender being of least significance.

Amina (2008) examined the levels, patterns and differentials in childhood mortality with respect to poverty levels in Kenya using Kenya Integrated Household and Budget Survey data for 2005/06. Trussel (1974) variant form of the Brass technology was employed to determine the probability of a child dying from the time of birth to a certain age. The findings were that child mortality levels increased with poverty levels. A contrary finding was that there were higher mortality rates amongst the non-poor households than the poor in North Eastern and Central provinces. The study however focused on poverty levels and did not incorporate household environmental characteristics.

Mutunga (2004) studied the role of socio economic and environmental characteristics on child mortality. He utilized KDHS data for 2003 and employed Hazard rate model and a modified Shultz (1984) health production theoretical framework in his analysis. The finding showed that socioeconomic and environmental characteristics had significant impact on child mortality. Since 2003, Kenya has implemented several child health initiatives therefore the study could be faulted not to point the real situation with respect to child health

Becheret al. (2004) in their study examined the risk factors of child mortality in Rural Bukina Faso using data from Demographic Surveillance. Survival analysis technique and Cox proportional model were used in order to achieve the objectives of the study. It was found that death of a child's mother, being a twin, mothers' age at first child birth, birth spacing, season of birth, village ethnic group and distance to the nearest health facility impacted significantly on infant and child mortality. The study had the shortcoming of not investigating the effects of environmental risk factors on child mortality.

2.3.2 Studies from the rest of the World

Ezzati et al. (2000) studied on the contribution of selected major risk factors to global and regional burden of disease in 14 developed and developing countries. Twenty six selected risk factors were comprehensively reviewed for the selected countries. Population attribute fractions were estimated by applying potential impact fraction relation. The findings indicated that for the poorest countries of the world, unsafe water, poor sanitation, hygiene and indoor smoke were the significant cause of poor health outcomes. The study was an aggregation of several countries unlike our study which is based on one country.

Naz et al. (2012) investigated the association between household air pollution from cooking fuel and under-five mortality using Bangladesh Demographic and Health Survey dataset over the period 2004-2011. In the analysis they employed multilevel logistic regression model. The results indicate that there exists a strong association between households with in-door kitchen using polluting fuel; women who had never breastfed and under-five mortality. Household air pollution was found to be strongly associated with overall neonatal. The reviewed study however focused on a single household environmental risk factor as opposed to this study.

Chowdhury (2013) examined the determinants of under-5 mortality in Bangladesh. He made use of data from 2007 Bangladesh Demographic and Health Survey and utilized multivariate proportional hazard model in his estimation. His findings were that father's age, place of residence, number of children under five years of age, mother's age, previous death of sibling and breastfeeding had significant impact on under-five mortality. In addition, proximate determinants had a stronger influence on under-five mortality in comparison to socioeconomic factors. The reviewed study is however based in a different development context.

2.4 Literature Overview.

Existing literature have mixed findings on the role of household environmental risk factors on health outcomes (child mortality). Other studies have pointed out that household environmental risk factors have a significant effect on child mortality while others have found otherwise. This is true even in the presence of demographic and socioeconomic factors.

Household environmental characteristics: for instance access to sanitation facilities has a significant effect on child mortality. Similarly, source of drinking water has been found to be significantly associated with child mortality. Households using biomass as type of coking fuel have been found to experience more child mortality as compared to households using non-biomass fuels.

In reference to demographic factors, children born of young and old mothers experience higher mortality rates. In addition first and higher order children have higher chances of mortality. Lastly, male children have higher mortality than female children.

With respect to socio-economic status, a number of studies have found that household wealth index has a significant impact on child mortality with low rates being experienced in wealthier households. Mother's education level is also significantly associated with child mortality. The less educated the mother, the higher the probability of child mortality. Nevertheless, there is no clear consensus on the effects of household environmental characteristics on under-five mortality in Kenya.

3. Methodology

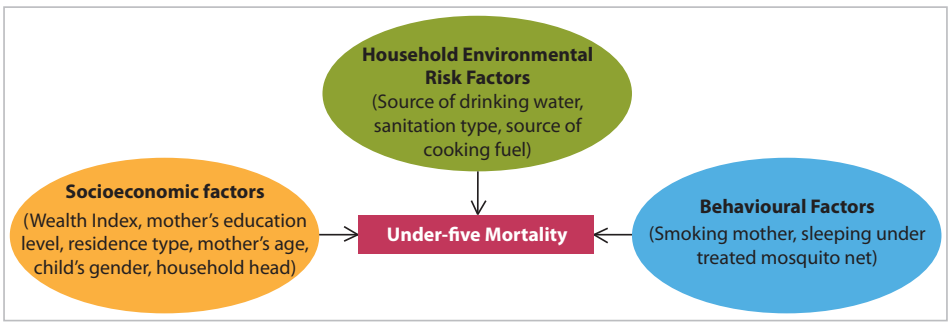
3.1 Introduction

This chapter presents the methodology and the data utilized in the analysis. The choice of methodology is guided by the literature reviewed and the variables.

3.2 Conceptual framework

The dependent variable is under five mortality while the independent variables are environmental risk factors (sanitation facility, source of drinking water, source of cooking fuel, and type of residence), socio-economic factors (wealth index, mother's education level, mother's age at first child birth, birth order, child gender and household head) and behavioral factors (smoking and sleeping under treated mosquito nets).

Figure 3.1: Conceptual Framework



Source: Author's own formulation

The conceptual framework provides in summary the anticipated linkages through which household environmental risk factors, socioeconomic and behavioral factors impact on the outcome of health by either affecting under-five mortality significantly or insignificantly.

3.4 Analytical framework

This study uses the framework proposed by Rosenzweig and Schulltz (1983), later modified by Schultz (1984) to analyze the factors affecting child health in Kenya. The basic idea of the framework is that households do allocate time and goods in producing commodities of which some are sold in the market and some for home consumption.

The household choices is represented by a utility function *U*, which is a function of composite consumption good *X*, composite health environment good *Y* and *H* the health status of *n* children in the household. This is represented as:

$$U = U(X\ Y\ H) \quad \text{.....1}$$

According to Rosenzweig and Schultz (1983), child health is determined by the health environment (*Y*) (source of drinking water, cooking fuel, sanitation facilities and health service variable) a child specific health input (*I*), which does not affect parental utility directly and a child health endowment μ. Child health production is therefore as below:

$$H = F(Y, I, K, \mu) \quad \text{.....2}$$

Where

Y, I, and μ are as defined above and *K* is household health knowledge. The household choice of *Y* depends on child health endowment (*MC*), maternal household preference (*PR*), the prices prevailing in the market and specific constraints posed by the household's physical environment (*P*) and the household wealth (*W*).

The utility function (1) is maximized given the production function (2) subject to the household budget constraint. Household budget constraint is given as.

$$Z = PX + PY + PI \quad \text{.....3}$$

Where

Z – household income

PX – Price of consumption goods with a direct effect on health

PY – Price of health related goods

PI – Price of the child specific health input.

Prices and income are assumed to be exogenous to the household. Following Mwabu (2008) and from the maximization equation (1) subject to health production function (2) and budget constraint (3), the reduced form household demand function can be derived as

$$DX = D(PY, PI, K, W, \mu) \quad \text{.....4}$$

$$DY = D(PY, PI, K, W, \mu) \quad \text{.....5}$$

$$DI = D\,(PY\,,\ PI\ ,K,\ W,\ \mu)\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 6$$

Considering equations 4 and 5 above, the child's health production function constitutes the prices that households face, household income levels, household's knowledge of health issues and unobserved heterogeneity. This is expressed as below.

$$H = F\,(PY,\ PI,\ K,\ W,\ \mu)\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 7$$

From expression (7) child health can be explained by the relative prices (*PY* and *PI*), the household health knowledge (*K*), the household wealth (*W*) and the child health endowment for all children (μ).

Given that DHS data do not provide information on prices, identical prices is assumed for all household in this study. The reduced form input demand function is hence given as:

$$H = F\,(Y,\ I,\ K,\ W,\ \mu)\ \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 8$$

From equation (8) it can be seen that child health is explained by proximate inputs to child health (*Y*), child health inputs (*I*), household health knowledge (*K*), household wealth (*W*) and child health endowment (μ), (Mwabu, 2008).

3.5 Model Specification

Following Mwabu (2008), we specify Under-five mortality model anchored on equation (8) incorporating proximate child health determinants according to Schultz (1984). From existing literature, child health is determined by a vector of socioeconomic factors, which affect the proximate determinants. The proximate determinants are the intermediate variables between socioeconomic variables and morbidity and mortality risks (Mosley and Chen, 1984).Under-five mortality model can be specified as:

$$UFM = f\,(SCF, AS, RT, AW, HHW, ME, BS, CG, MA, MR, MMS, TNC, PD, TTI, \varepsilon)\ \ldots\ldots 9$$

Where:

UFM – based on the probability of a child dying before the fifth birthday, equal to (1) if reported dead and (0) if reported alive. Table 3.1 gives the variable labels, definitions and apriori expectations of the variables in (9) above.

E – error term.

3.5.1 Empirical Model

The study estimates the hazard ratio of the chance of a child dying within the next day after surviving for t days, as a result of environmental factors in the presence of other factors. The hazard rate is often referred to as the mortality rate in the context of child mortality (Ridder and Tunali, 1999). The mortality rate at age t can be interpreted as the strength at which a child loses his/her life at this age, given that the child survived until age t. The interest is on children born alive and therefore we model their mortality probabilities until the age of five.

3.5.2 Theoretical Model

We employ survival analysis to investigate the relationship between household environmental risk factors and under-five mortality. The choice of the model is based on the fact that it does not ignore survival times and censoring information. Hazard function and survival functions are the key concepts in the analysis (Woolridge, 1999; Cameron and Triveli, 2005). Survival function being the conditional probability that a child survives within the next day after being alive for strictly less than 12 months or 60 months given that he/she has interacted with various environmental risk factors. It is from the hazard function that we obtain hazard rate (conditional probability of death for the same period)

$$St = 1 - \lambda t \quad \text{.....(10)}$$

Where

St – survival function

λt – hazard function

Several estimation techniques may be fronted for survival analysis including Kaplan Meir, Gompertz, log-normal, generalized gamma, Weibul and Cox Proportional hazard (Becker, 1999). However, Cox proportional Model is used given that it is a strictly proportional model (Mills, 2011). In proportional hazard models, multiplicative effect with respect to the hazards results from one unit change in a covariate is taken care of (Owiti, 2013). In addition Cox proportional Hazard ensures robustness.

3.5.3 Cox Proportional Model

This is also known as the Cox Model. Using this model, we estimate the relationship between the hazard rate and the explanatory variables without having to make any

assumptions about the shape of the baseline hazard function. It is therefore in most occasions known as a semi-parametric model.

The model is given as:

$$H(t) = H_o(t) \times exp\ (\beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots + \beta_n X_n) \ldots\ldots\ldots\ldots\ldots\ldots\ldots (11)$$

where

$H_o(t)$ – baseline hazard at time t indicating the hazard for a child with the value o for all explanatory variables.

t – time to death

X_n – explanatory variables to be modeled for child

β – Vector coefficient

Given that the baseline hazard function is analogous to the intercept under ordinary regression (given exp0 = 1)

We obtain the below equation by dividing both sides of equation (4) by $H_o(t)$ and taking natural logs

$$In\ [H(t)/H_o(t)] = \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \ldots\ldots + \beta_n X_n \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (12)$$

Where

$H(t)/H_o(t)$ – hazard ratio

Maximum likelihood is used to estimate the coefficients $\beta_1 \ldots\ldots \beta_n$. Cox proportional results are simple to interpret in that in the situation of a dichotomous covariate (risk factor), is coded 1 if it exists and 0 otherwise. The $exp(\beta_i)$ represents the instantaneous relative risk of an event at any time for a child with the risk factor existing in comparison to a child with the risk factor non-existent given that both children are the same on all other covariates with reference to the baseline. The baseline ratio is 1. If the resultant ratio is above one then it at undesired levels, if below 1, its acceptable.

Suitability of Cox model is on the basis that unlike other econometric binary choice models like logit or probit models, it does not entail censoring problem. In addition, Cox model uses information about an infant's age in months at time of death, on the contrary probit or logit models which emphasizes on survival to the age of one.

3.5.4 Data Sources

The study utilizes the 2008 Kenya Demographic Health Survey (KDHS) data which is a national representative sample survey of women aged between 15 to 49 years and men aged 15 to 54 years selected from all counties across the country.

Other than availing information on health situation and population, the KDHS provides adequate information on household environmental characteristics hence most suited for analyzing dynamics in environmental risk factors in relation to under-five mortality.

Table 3.1: Variable Definition and Apriori Expectation

Variable	Measure	Apriori Expection
Household Environmental Characteristics		
Source of Cooking Fuel(SCF)	Type of cooking fuel used by the household (Non Biomass is used as reference category) Biomass include cooking fuel such firewood, grass, shrubs, charcoal, animal dung, agriculture crop Biomass – (1) Yes, (0) No Non-Biomass – (1) Yes, (0)No	Child health is expected to improve with availability of clean cooking fuel (Anjali, 2001;Mariara et al., 2012; Mutunga 2004; Foloko, 2009).
Access to water (AW)	Source of household drinking water (Protected source is used as reference category) Non improved source – (1) Yes, (0) No	Child health is expected to improve with availability of safe drinking water (Mutunga,2004; Mariara et al., 2012;Gyimah, 2002)
Access to Sanitation (AS)	Availability of sanitation facility to the household (No facility is used as reference point) Non Improved Toilet – (1) Yes, (0) No Improved Toilet facility – (1) Yes (0) No	Child mortality is expected to improve with availability of clean waste disposal facility (Gyimah, 2002;Mutunga2004; Mariara et al.,2012; Ngigi,2013)
Socioeconomic Status		
Household Wealth (HHW)	Wealth index of the household (poor is the reference category) Poor – (1) Yes (0) No Middle – (1) Yes (0) No Rich – (1) Yes (0) No	Households which are wealthy have low child mortality rates. (Elmahdi, 2008; Mariara et al.,2012; Mutunga, 2004)
Children Characteristics		
Child's Gender(CG)	Gender of child Male – (1); Female – (0)	Male children are expected to have high mortality than female children (Gupta, 1990; Mariara, Karienyeh and Kabubo,2012; Mutunga, 2004)

Variable	Measure	Apriori Expection
Birth Size (BS)	Baby size at birth as reported by the mother (Small/very small is used as a reference category) Large/very large – (1) Yes (0) No	High mortality risk is expected of very large and small infants (Anjali, 2001)
Birth Order (BO)	Child's birth order in the family. (reference category being first order) 2-3 birth order – (1) Yes (0) No Above 3 birth order – (1) Yes (0) No	With more births, a mother is expected to be more skilled in child care. High mortality is expected at first birth and the same is expected with above the3 birth order (Elmahdi, 2008; Mariara et al., 2012)
Maternal Characteristics		
Mother's Education (ME)	The level of education attained by the mother captured by several education dummies (no education used as reference category) Primary – (1) Yes (0) No Secondary+ – (1) Yes (0) No	Child mortality is expected to reduce with higher maternal education (Mutunga, 2004; Anjali 2001; Mariara et al., 2012)
Mother's age (MA)	The age of the mother at the time of child birth. (Below 30-39 Years is used as the reference category) Below 20 years 20-29 Years – (1) Yes (0) No 30-39 Years – (1)Yes (0) No	High child mortality are likely to occur with very young and very old women (Anjali, 2001; Mariara et al., 2012; Ngigi, 2013; Mariara, 2008)
Residence type (RT)	Residence type of the household shows whether the household resides in rural or urban (Rural is used as the reference category) Urban – (1); Rural – (0)	Rural residents are expected to experience high child mortality than urban residents (Anjali, 2001; Mariara et al., 2012; Mutunga, 2004).
Mother's Religion (MR)	The religion the mother subscribe to measured by several dummies. (No religion is the reference category) Roman Catholic – (1) Yes (0) No Protestant/other Christian – (1)Yes (0) No Muslim – (1) Yes (0) No	Roman Catholic, other Christians and Muslims religion impacts knowledge thus likely to improve health. Lower child mortality is expected in mother who subscribe to such religion (Anjali, 2001; Ngigi 2013; Mutunga, 2004).
Mother's Marital Status (MMS)	Mother's marital status measured as a dummy variable (1) – Married (0) – Otherwise	Lower mortality risks are expected of children born of married women since they may take time off work as their husbands work to take care of their children (Kenya Demographic Health Survey, 2008-2009; Ngigi, 2013).
Total Number of children (TNC)	No of live children a mother has had for the past 5 years. (Above three is used as a reference category) Less than 3 – (1) Yes (0) No	High mortality is expected in household with more than two children under the age of five (Elmahdi, 2008; Mariara et al., 2012)

Variable	Measure	Apriori Expection
Household Head (HH)	The head of the household whether male or female Male – (1); Female – (0)	Male headed household are expected to experience more child deaths as compared to female headed households (Adhikari and Podhisit, 2010)
Health service Variables		
Place of Delivery (PD)	Place where child was born. Measured as a dummy variable: (1) – Hospital (0) – Otherwise	Mortality risks are expected to be lower with the availability of basic health facilities (Anjali, 2001; Rutstein, 2000; Mariara et al., 2012; Mutunga, 2004; Ngigi, 2013).
Tetenus Toxiod Injection (TTI)	Mother received immunization or not. Measured as a dummy variable (1) – Immunized; (0) – Otherwise	Child health and survival improves with injection of pregnant mothers with tetanus toxoid (Mwabu, 2008; Mariara et al., 2012)
Behavioral Variables		
Smoking	Whether a mother in the household is smoking or not. Measured as a dummy variable. (1) – Smoking; (0) – Otherwise	A smoking household is expected to experience higher child mortality (Foloko, 2009)
Child sleeping under treated mosquito nets	Whether the child is sleeping under treated mosquito net or not. Measured as a dummy variable. (1) – Yes, (0) – Otherwise	Lower child mortality is expected where children sleep under treated mosquito nets (Elmahdi, 2008; Foloko, 2009)

4. Results and Discussion

4.1 Introduction

In this chapter, we present the findings for the study. First, descriptive statistics are presented thereafter the findings on the effects of the environmental risk factors on child mortality rates in Kenya.

4.2 Descriptive Statistics

The descriptive statistics of the study variables are presented in tables 4.1. There were a total of 8,444 households in the study sample. Total number of household members is the only continuous variable used in the analysis. On average there were 5 members per household with a standard deviation of 2.48. The maximum number of members in each household is 19 and the minimum is 1. The other remaining variables are categorized into dummy variables with each taking the value 1 and 0 otherwise.

Table 4.1 Descriptive Statistics

Variable	Mean	Std Dev	Min	Max
Type of Toilet Facility (Improved = 1)	0.40	0.49	0	1
Source of Drinking Water (Protected = 1)	0.59	0.49	0	1
Source of Cooking Fuel (Biomass = 1)	0.91	0.29	0	1
Mother's age at first child birth				
<20 = 1	0.62	0.49	0	1
20 to 29 =1	0.37	0.48	0	1
30 to 39 =1	0.01	0.10	0	1
Residence Type (Urban = 1)	0.24	0.43	0	1
Mother's educational attainment				
No Education = 1	0.21	0.41	0	1
Primary = 1	0.56	0.50	0	1
Secondary+ = 1	0.22	0.42	0	1
Marital Status (Married = 1)	0.79	0.40	0	1
Religion (With Religion = 1)	0.96	0.19	0	1
Sex of Child (Male dummy = 1)	0.52	0.50	0	1

Variable	Mean	Std Dev	Min	Max
Gender of Household Head (Male dummy = 1)	0.71	0.45	0	1
Household Wealth Index				
Poor = 1	0.47	0.50	0	1
Middle = 1	0.16	0.37	0	1
Rich = 1	0.37	0.48	0	1
Smoking Yes = 1	0.05	0.12	0	1
Sleeping under treated mosquito nets No = 1	0.64	0.33	0	1

From table 4.1, findings on sanitation showed that only 40% of the households used improved facilities. With respect to source of drinking water, about 59% of the households use water from protected sources. Further, findings show that 91% of the households used biomass fuel for cooking (firewood, charcoal, straw/shrub/ grass, agriculture crop and animal dung). Only 9% of the households used non-biomass (electricity, LPG/natural gas, kerosene and coal) Majority of Kenya's households therefore use high polluting fuels for coking.

About 24 % of the households resided in urban areas as compared to about 76% who resided in rural areas at the time of the survey. Distribution by education level showed that the highest level of schooling was post-secondary education but the majority of the women had primary education (56%), those who had no education were 21% while 22% had secondary education and above. Majority of the households were male headed (71%) compared to 29% female headed households. On marital status, 79% of the women were married while only 21% were unmarried (divorced or widowed).

Most of the household (96%) were Protestants, Roman Catholic or Muslims, while 4% did not belong to any religion. In addition, nearly 52 % were male children while 48 % were female implying that male children experienced child mortality more than female children. Findings on household wealth pointed out that majority of the households were poor (47%) followed by rich (37%) and the rest were the middle class representing 16 %.It is worth noting that almost half of the households were poor at the time of the survey. This study also found out that about 62% of the mothers had their first child when they were below 20 years while 37% and 1% had their first child when they were between 20 to 29 and 30 to 39 respectively.

4.3 Econometric Analysis

In an attempt to achieve the objectives of the study, two models are employed. The first model estimates the effect of environmental risk factors on under-five mortality in the presence of socioeconomic variables while controlling for behavioral variables. In the second model we include two behavioral factors (sleeping under mosquito net and smoking mothers). The study chose two behavioral factors to avoid the possibility of endogeneity problems.

Table 4.2 Results

Variables	Model 1	Model 2
Source of Drinking Water		
Improved (RC)	1	1
Un-improved	1.32***	1.328***
Type of Sanitation Facility		
Improved	1	1
Non-Improved(RC)	2.26**	2.29**
Source of Cooking Fuel		
Non-biomass(RC)	1	1
Biomass	1.63**	1.63**
Residence Type		
Urban (RC)	1	1
Rural	1.02***	1.03***
Mother's Age at First Child Birth		
30-39 Years(RC)	1	1
<20 Years	1.196	1.21
20-29 Years	0.734	0.738
Mother's Education Level		
No education(RC)	1	1
Primary	0.87**	0.87**
Secondary +	0.39**	0.38**
Household Head		
Male	1	1
Female	0.61	0.628
Child's Gender		
Male	1	1
Female	0.58	0.571
Household Wealth Index		
Poor (RC)	1	1
Middle	0.72**	0.712**
Rich	0.69**	0.67**
Smoking		
Not Smoking (RC)		1
Smoking		2.29**
Sleeping Under Mosquito net		
No (RC)		1
Yes		0.84**
2log likelihood	15911.76	15898.35

*Notes. ***, ** significance at 1% and 5% respectively.*

The reference ratio is = 1, any ratio above 1 therefore have negative effects on under-five and figures below 1 are acceptable.

The results from model one and two, analyzing the effects of environmental risk factors in the presence of socioeconomic factors (mother's education, household wealth index and residence type) show that source of cooking fuel, source of drinking water, type of sanitation facility, mother's education, wealth index, type of residence, sleeping under treated mosquito net and smoking are significant determinants of under-five mortality.

Results with respect to household environmental risk factors indicate that households that used biomass cooking fuel had 63% higher probability of experiencing under-five mortality in comparison to households that used non-biomass cooking fuel. This implies that type of cooking fuel significantly impacts on child mortality. Similar findings were also seen in studies by Wichman (2006) and Foloko (2009) which found a significant association between exposure to cooking and heating smoke from biomass fuels and under-five mortality.

Further, the findings show that source of drinking water used by a household significantly impacted on under-five mortality. Households that used non-improved source of drinking water(open well, river water and other)had a 32% higher likelihood of experiencing child mortality than households that used improved drinking water sources(piped water, public tap and rain water).

Type of sanitation facility too was found to be significant variable on child mortality. Households that used non-improved sanitation facilities had 1.26 times higher likelihood of experiencing child death than households that used improved sanitation facilities. Gyimah (2002) and Klaauw and Wang (2003) findings are similar to our findings. A substantial number of under-five deaths could be averted by ensuring that more households use improved sanitation facilities.

Mothers with no education had a higher risk of experiencing under-five mortality compared to mothers with primary education. A mother with primary education was 13% less likely to experience child mortality compared to those with no education Mothers with secondary plus education had lower chances of experiencing child mortality in comparison to mothers with no education.

Mothers with no education were 61% more likely to experience child mortality compared to those with secondary plus education. The implication being that maternal education is a key variable in child mortality. Under-five mortality risk reduces with the increase in mother's level of education.

The more educated a mother is, the better she is situated to go against traditions and employ contemporary ways of protecting their children's health. Further, they are in a position to arrive at autonomous decisions about their children's health as well as their own health consequently resulting into lower under-five

mortality. The higher the education level of a mother, the higher the probability of being employed and therefore being better placed to afford appropriate nutrition, pay for child health care costs, have enough money to pay for improved cooking fuel, use water from improved sources and use improved sanitation facilities.

This finding is consistent with findings by Mariara et al. (2012) and Caldwell (1997). According to Caldwell (1997), the direct impact of a mother's education level on child mortality is through improved health care. The argument being that less educated women are less likely to seek child healthcare services compared to their educated counterparts. Chances of a mother visiting a health facility increases with her education level.

Type of residence had a significant impact on under-five mortality. Rural households were more likely to experience higher under-five mortality compared to urban households. Poor health seeking behavior as a result poor transport network and long distance to the nearest health facility could be some of the explanation for this. Ignorance in the rural households on the importance of seeking child health services could also be a contributing factor.

This result is in line with the results by Mutunga (2004), Mariara et al. (2012) and Anjali (2001). Further, Suwal (2001) postulated that a mother's residence significantly influences a child's survival chances and could be explained by absence of key infrastructure including electricity, road networks to health facilities, running clean water, and improved sanitation facilities and use certain type of cooking fuel in rural areas.

Households that belong to the middle wealth index are 38% less likely to experience under-five mortality in comparison to households that are poor. In addition households that are poor are 69% more likely to experience child mortality compared to rich households.

This could be explained by the fact that rich households can afford to pay and access quality healthcare services right from conception to after delivery. In addition, the household are able to provide the appropriate nutrition for their children, use water from improved water source use improved or clean sanitation facilities and use clean sources of fuel for cooking. Moreover, the opportunity cost of a wealthier household visiting to a health facility is low in comparison to poor households since poor households have to forgo other expenditures and even sell income earning assets (Kyengombe, 2003) to accumulate finances to pay for child health care services. Resources and time have to be reallocated by poor households in order to cater for health care needs of their children. Poor households also forced to leave the activities they do for a living to visit a health facility which in turn is costly to them in comparison to rich households.

This finding is similar to finding by Kyei and Gyeke (2011), who postulated that household wealth index is a key factor in explaining child mortality. The result supports the findings by Mosley and Chen (1984) that socioeconomic factors act via given proxy variables to affect child mortality. Mariara et al. (2012) too found that poverty impacted strongly on child survival. Lastly, the results are in line with the findings by Elmahdi (2008).

In the model II, we introduce two behavioral variables (smoking and sleeping under treated mosquito nets). The variability of the factors with the introduction of behavioral factors was not significant. All the environmental risk factors (source of cooking fuel, source of drinking water and type of sanitation facility) remained significant determinants of under-five mortality. However, there was negligible change on the variable type of sanitation facility from 2.26 in model I to 2.29 in model II.

Similarly, all socioeconomic factors (mother's education, household wealth index and type of residence) remained significant determinants of under-five mortality. Mothers with primary education were still 13% less likely to experience under-five mortality in comparison to mothers with no education. This is in model 1. Mothers with secondary –plus education were however 62% less likely to face under-five mortality compared to mothers with no education. This was a 1% rise compared to model 1. There was also 1% rise for residence type with rural households being 3% more likely to experience under-five mortality than urban households. This was 2% in model 1.

Results on behavioral factors showed that households where under-five children sleep under treated mosquito nets were 16% less likely to experience under-five mortality compared to households where under-fives do not sleep under treated mosquito nets. This pointed out that sleeping under treated mosquito nets is a significant behavioral factor on under-five mortality.

Lastly, households where the mothers were smoking, were 1.29 times more likely to experience under-five mortality as compared to households where the child's mother is a non-smoker. Smoking therefore is a significant household behavioral factor. This finding is in line with the findings by Kaldewei and Pitterle (2011) who argued that smoking is of most importance as pertains to Jordan's infant and under-five mortality rates. Further, Wichmann (2006) pointed out that smoking resulted into dejected immune system responses.

5. Summary, Conclusions and Recommendations

5.1 Summary and Conclusions

The key objective of the study was to investigate the effects of household environmental characteristics on under-five mortality in Kenya. The motivation of the study was based on the fact that despite the numerous interventions the Kenyan government and other development agencies have been executing towards reducing under-five mortality, the desirable rates are yet to be realized. Contribution of the study to previous literature is provision of insights on how household environmental characteristics impact on under-five mortality and further give policy suggestions on how to address the two in an integrated manner in Kenya.

The study made use of 2008 Kenya Demographic and Health Survey data, which is a national representative survey. Cox Proportional Hazard model was employed in the analysis.

The results indicate that households that used improved sanitation facilities, improved source of drinking water and non-biomass as cooking fuel were 40%, 59% and 9% respectively in Kenya. In addition, 47% of the households were poor.

The results from the regression show that household environmental characteristics: type of sanitation facility; source of drinking water; source of cooking fuel; residence type, sleeping under treated mosquito net and smoking mothers significantly affected under-five mortality in Kenya. Other factors other than household environmental factors that had significant impact on under-five mortality were household wealth index, mother's education and sleeping under treated mosquito nets

5.2 Policy Recommendations

Maternal education is a major factor in explaining under five mortality in Kenya, there is therefore need to design and implement educational policies and programmes that promote maternal educational attainment beyond primary level, with a specific focus on women who do not succeed in joining secondary schools due to various reasons. The government should increase its allocation of funds and other educational resources to free secondary education to provide for more than just tuition fees but also cater for boarding fees. More females would therefore be motivated to advance their education beyond primary level which may in the long run result in decline in child mortality. Improving women

education would result in two fold effects by improving women socio-economic status and maternal health knowledge. The government should provide maternal health care education especially in rural areas. In addition, the government should strengthen the support on fundamental health education in learning institutions from primary level to guarantee improvement in health knowledge. Lastly, other than providing scholarships based on academic performance, education actors should also allocate scholarship opportunities for girls on vocational education.

Sanitation facility is an important factor and hence there is need to increase public campaigns and awareness about the importance of sanitation. Improving access to sanitation has significant social benefits but entails a private cost of construction of sanitation facilities. The government should therefore work more closely with both the private sector and civil society to ensure more households have access to improved sanitation facilities since this will lead to a significant reduction to child mortality rates. The government should also make it compulsory that before any housing unit is put up there has to be a sanitation facility. Moreover, there is need for various public health actors and the government to allocate additional resources to sanitation and also intensify initiatives to carry out public awareness on the importance of sanitation.

The government should provide a framework that would promote more Public Private Partnerships geared towards increasing access to sanitation facilities. This can be done through promoting social enterprises in sanitation provision in slums and rural areas. Most important, the government and other development agencies should develop rural areas through increased provision of health services, primary education and increased supply of clean water.

The government energy policy should be more focused on promoting the use of low polluting fuels and discourage the use of biomass fuels. Incentives should therefore be provided by the government to promote the use of cleaner fuels such as solar and biogas. This would also generate employment opportunities which would translate into increased earnings and reduced poverty

Finally, there should be an integrated environment and health sector policy. The government should shift towards a more integrated approach to public policy and service delivery in health and environment sectors that is sometimes referred to as “joined up government” or “whole of government” approach.

5.3 Areas for Further Research.

The study employed quantitative data to investigate the relationship between household environmental characteristics and under-five mortality in Kenya. We however note that no qualitative data was used in the study to expound the results of quantitative analysis given the fact that quantitative data does not explain as to why people behave in certain ways. A qualitative research on possible correlates of child mortality should be done. A qualitative research would be useful as it would provide much required information to policy and programme designers and implementers hence assist in improving household environmental characteristics and under- five mortality rates. With the counties in existence, there is need to carry out a study that investigates contributors of disparities in child mortality among households in various counties. Lastly, conduct a study analyzing the impact of an integrated environment and health policy

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Kenya Institute for Public Policy Research and Analysis
Bishops Garden Towers, Bishops Road
PO Box 56445, Nairobi, Kenya
tel: +254 20 2719933/4, 2714714/5, 2721654, 2721110
fax: +254 20 2719951
email: admin@kippra.or.ke
website: http://www.kippra.org