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FACTORS ASSOCIATED WITH UNDER-FIVE CHILD MORTALITY IN KENYA: A SYSTEMATIC REVIEW AND META-ANALYSIS

Research Report in Biometry, Number 41, 2021

Antony Kamile Musyoka

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Submitted to the School of Mathematics in partial fulfilment for a degree in Master of Science in Biometry

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Master Thesis
Submitted to the School of Mathematics in partial fulfilment for a degree in Master of Science in Biometry

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Abstract

Introduction

Notwithstanding the notable progression in reducing the under-five child mortality in Kenya, the rate remains above the global target. The mortality levels in the under-five population is associated with various socioeconomic, environmental and demographic factors. Studies have been conducted using demographic and health surveys yielding inconclusive results on determinants of under-five mortality in Kenya. Consequently, this study involves systematic review and meta-analysis synthesis of results in existing studies on factors associated with under five mortality in Kenya.

Method

International electronic databases including Google scholar, Research gate, PubMed, Cochrane Library and other local like university of Nairobi repository were searched systematically. All identified studies written in English and reported the determinants of under-five mortality in Kenya were considered as per inclusion criteria. Data were extracted on excel sheets and transferred to the paper on tables. The associations between the factors and under-five mortality were examined and meta-analysis done by Mantel-Haenszel method using *R statistical software version 4.0.3.*

Results

After a review of retrieved 37 articles, 8 studies satisfied the criteria for inclusion and were incorporated in review and meta-analyzing the results. Three studies were meta-analyzed. The review revealed high under-five mortality in rural Kenya compared to urban Kenya ($\hat{R}R = 1.05, 95\% CI, 0.89; 1.25$). Although the point estimate shows an increased risk of 5%, the confidence interval differs by indicating no statistical difference between factors associated with under-five mortality. Although previous studies have pointed different factors as having more effect to under-five mortality such as maternal education, this study however, found no significant difference between factors associated with under-five mortality in Kenya.

Conclusion

In this review and meta-analysis, the correlation of under-five mortality and factors under examination showed no significant difference between them. Additionally, under-five population deaths are above the global target.

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Declaration and Approval

I the undersigned declare that this dissertation is my original work and to the best of my knowledge, it has not been submitted in support of an award of a degree in any other university or institution of learning.

19/08/2021

Signature Date

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In my capacity as a supervisor of the candidate's dissertation, I certify that this dissertation has my approval for submission.

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Dedication

I dedicate this work to my family and friends who have supported in different capacities. In addition, dedication goes to Kenya task force towards the achievement of the sustainable development goals for vision 2030.

Contents

Abstract ..... **ii**

Introduction ii
Method ii
Results ii
Conclusion ii

Declaration and Approval ..... **iv**

Dedication ..... **vi**

List of Figures ..... **ix**

List of Tables ..... **x**

Acknowledgments ..... **xi**

1 INTRODUCTION **1**

1.1 **BACKGROUND** 1
1.2 **PROBLEM STATEMENT** 3
1.3 RESEARCH QUESTIONS 4
1.4 **RESEARCH OBJECTIVES** 4
1.4.1 GENERAL OBJECTIVE 4
1.4.2 SPECIFIC OBJECTIVES 4
1.5 **JUSTIFICATION OF THE STUDY** 4

2 LITERATURE REVIEW **5**

2.1 Theoretical literature review 5
2.2 Empirical literature review 5

3 RESEARCH METHODOLOGY **9**

3.1 STUDY BACKGROUND AND DESIGN 9
3.2 SEARCH STRATEGIES 9
3.3 SUITABILITY STANDARD OF STUDIES 9
3.4 ASSESSMENT OF OUTCOME VARIABLES 10
3.5 DATA EXTRACTION 10
3.6 RISK OF BIAS 10
3.7 ANALYZING AND PROCESSING DATA 11
3.7.1 Mantel-Haenszel Method 11
3.7.2 Fixed effects model in Meta-analysis 13
3.7.3 Heterogeneity in Meta-analysis 14
3.8 PRISMA PROCESS RESULTS 15
3.9 DESCRIPTION OF ANALYZED STUDIES 16

4 DATA REVIEW, META-ANALYSIS AND RESULTS **18**

4.1 Introduction 18

UNDER-FIVE MORTALITY IN KENYA 22

4.2 THE UNDER-FIVE MORTALITY IN KENYA 22

SUBGROUP ANALYSIS 24

4.3 SUBGROUP ANALYSIS 24

4.4 FACTORS OF UNDER-FIVE MORTALITY IN KENYA. 25

4.4.1 Socioeconomic factors. 25

4.4.2 Environmental factors 27

4.4.3 Demographic factors 28

5 CONCLUSIONS AND RECOMMENDATIONS 31

5.1 CONCLUSION 31

5.2 RECOMMENDATIONS 31

References 32

APPENDIX 35

List of Figures

Figure 1. Fixed effects model in meta-analysis 13
Figure 2. The PRISMA flow diagram showing study selection process. 16
Figure 3. Funnel plot of the all the combined factors meta-analyzed. 22
Figure 4. A funnel plot of socioeconomic factors.. 25
Figure 5. Meta-analysis results of socioeconomic factors. 26
Figure 6. A funnel plot of environmental factors.. 27
Figure 7. Meta-analysis results of environmental factors. 28
Figure 8. A funnel plot of environmental factors.. 29
Figure 9. Meta-analysis results for demographic factors. 30

List of Tables

Table 1. Databases Search for Studies in Kenya Involving Under-Five Mortality. 10
Table 2. Outcomes Mantel-Haenszel method 11
Table 3. An illustrative brief of eight studies analyzed in the review of factors associated with under-five mortality in KENYA 17
Table 4. The data representing socioeconomic factors and associated risk/hazard ratio. 19
Table 5. The data representing environmental factors and associated risk/hazard ratio. 20
Table 6. The data representing demographic factors and associated risk/hazard ratio. 21
Table 7. The studies meta-analyzed, where U5A – under-five children who survived to fifth birth day and U5D- under-five children who died before fifth birthday on percentage values. 23
Table 8. Subgroup Analysis Results 24

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Antony Kamile Musyoka

Nairobi, 2021.

1 INTRODUCTION

1.1 BACKGROUND

Since 1970, Kenya has been experiencing a reducing under-five mortality with female under-five rate of 143.5 and male rate of 157.5 as compared to recent values for 2019 of female under-five rate of 39.22 and male rate of 46.76$(UNICEF, 2019)$. A total under-five mortality rate of 150.8 was reported in 1970 as compared to 2008/09 Kenya Demographic and Health Survey data where 74 deaths per 1,000 live births were reported and reduced to 52 deaths per 1,000 live births 2014$KDHS(UNICEF, 2017)$. In 2019, estimated under-five mortality of 43.16 was reported $(UNICEF, 2019)$. UNICEF defines under-fine mortality rate as the probability per 1,000 that a newborn baby will die before reaching age five, if subject to age-specific mortality rate of the specified year.

Despite the interventions put in place to reduce under-five deaths, the 43.16 deaths per 1,000 live births is higher by almost twice the targeted 25 or less deaths per 1,000 live births by 2030 as per UN Sustainable Development Goals(SDGs) 2015. [14]; [10] argues that since independence Kenya has made huge steps to reduce under-five mortality but the rate is still high that Kenya missed the millennium development goals of 2015. [17] acknowledged that though Kenya has a reducing mortality, the rate is still high. A report by UNICEF Kenya [7] indicated that 64,500 children die annually before reaching their fifth birthday.

The major cause was attributed to diarrhea and pneumonia which are elements linked to environmental setting and socioeconomic state in which a child lives (UNICEF, 2020; Healthy People, 2020). The under-five deaths indicate the social economic and health status of a country ([17]; [1]) while death of under-five population is a wastage of potential future manpower ([4]). Therefore, Kenya requires acknowledging its changing demographics [10] and reduce under-five deaths to achieve sustainable development goals and improve its future workforce.

In Kenya, environmental, socioeconomic and demographic factors account for most under-five mortality as the survival of under-five mortality is dependent on these factors ([17]; [18]). The 2014 Kenya Demographic and Health Survey report, indicated under-five mortality is highest in birth interval of less than two years with 83 deaths per 1,000 live births whereas children born with birth interval of three years have under-five mortality of 42 deaths per 1,000.The less than two years birth intervals risk child survival by two fold.

The 2014 KDHS report further indicates under-five mortality is the same between rural and urban areas but varies in regions with highest in Nyanza 82 deaths and lowest in central 42 deaths per 1,000 live births.The wealth of a family is inversely proportional to under-five mortality whereas mothers education showed no strong variation (KDHS, 2014).Malnutrition, malaria, pneumonia and diarrhea were reported as child heath factors dependent on wealth, region and education of mother (UNICEF, 2019). The 74,000 deaths every year can be prevented averted by using simplistic, low budget and modest action. Building up government policies and intervention programs can help reduce children deaths (UNICEF, 2017). In 2015, United Nations embraced the Sustainable Development Goals (SDGs) to promote the well-being of children and reduce mortality.

The SDG three target 3.2 aims at ending preventable deaths of newborns and under-five children by 2030. Similarly, the Kenyan administration in turn developed plan of action such as, Big 4 agenda in which one is the Universal Health Care (UHC) and Food security and Nutrition towards reducing under-five mortality.Despite the innovations and intervention programs by the government and a range of stakeholders both international and local, the under-five mortality related to environment, demography and socioeconomic factors remains a vital concern, mostly in developing countries like Kenya (World Development Indicators, [26]).

In Kenya, studies have been conducted to identify factors related to under-five mortality for example environmental factors ([18]). Understanding determinants (maternal literacy, household wealth and sexual and reproductive health) of under-five mortality ([10]), determinants of under-five mortality in rural and urban Kenya [6]) and socioeconomic, environmental and demographic factors ([19]); however, the studies are varied and remain inconclusive to give an in-depth status of under-five mortality hence need for a pooled study to examine any differences between the study reports.

The lack of a nationwide-pooled study remains a remarkable gap. Hence, this paper review and meta-analyzing results aims at producing a pooled totality of evidence on factors associated with under-five mortality in Kenya. The findings of this systematic review can inform policies towards achieving Universal Health Care, one of big four agendas in Kenya to reduce under-five mortality and the attainment of SDGs by 2030.

1.2 PROBLEM STATEMENT

Kenya is expected to meet the SDGs target by 2030. Despite the interventions and efforts that Kenya has put to achieve the SDGs on child mortality, the country remains at high under-five mortality rate of 43.2 deaths against targeted 25 or less deaths per 1000 live births.

Studies have been conducted in Kenya to understand the factors associated with the under-five mortality. The studies used different statistical methods to analyze socioeconomic, demographic and environmental variables based on census and Demographic and Health Surveys. Whereas these studies yield different findings, no study has been conducted that attempts to pull totality of evidence on factors associated with under-five mortality in Kenya. Therefore, this review compares studies conducted in Kenya to determine the key factors associated with under-five mortality. The findings may inform polices aimed at addressing the impending factors towards achieving the SDGs.

1.3 RESEARCH QUESTIONS

1. What factors are associated with under-five child mortality in Kenya ?
2. What is the difference in the effects of these factors ?

1.4 RESEARCH OBJECTIVES

1.4.1 GENERAL OBJECTIVE

To produce a pooled review of factors associated with under-five mortality in Kenya.

1.4.2 SPECIFIC OBJECTIVES

1. To examine under-five child mortality in Kenya.
2. To determine the factors associated with under-five child mortality in Kenya.

1.5 JUSTIFICATION OF THE STUDY

Reducing under-five mortality is one of the sustainable development goals (SDGs). SDG 3 section 2 target states, *By 2030, end preventable deaths of newborns and children under 5 years of age, with all countries aiming to reduce neonatal mortality to at least as low as 12 per 1,000 live births and under-5 mortality to at least as low as 25 per 1,000 live births.* Given that the world welcomed the decade (2021-2030) with a COVID-19 pandemic, more effort is required to reduce the under-five mortality and fight the pandemic. Its unforeseen occurrence that requires more resources and may affect immensely a population characterized by low immune system such as under-five years. In Kenya, the under-five survival has improved over time with a decline in mortality by 50% from 1993 to 2014 ([10]), however, the reported under-five mortality of 43.2 deaths per 1,000 live births is still high compared to the country target ([24]).

Research show that survival of under-five population is depended more on environmental and socioeconomic factors than any other population group ([15]; [17]). Therefore, examining factors associated with under-five mortality is important in informing strategies and policies to reduce the under-five mortality and improve the health status of this sub-population. This will accelerate the achievement of the population policies of Kenya towards vision 2030 and assessing the impact of government programs.

2 LITERATURE REVIEW

2.1 Theoretical literature review

There are different theories and literature explaining the determinants of under-five mortality [25]. Further, he, [25] remarked that there is a need to understand mortality technology to disentangle the correlation between offspring mortality and fertility by evaluating exogenous factors (social, cultural, economic and environmental factors). [16], in analytical approach to determinants of child mortality integrated both social and medical scientist's research methods. The framework postulated that all social and economic determinants of child mortality operate through a common set of biological mechanisms (proximate determinant) to exert an impact on mortality. [22] identified a structural relation between health outcomes and the household behavioral variables for example breast feeding, nutrition and birth spacing.

The combined studies by [16] complemented by [22] differentiated exogenous variables (socioeconomic) that is, cultural, social, economic, community, and regional factors from the endogenous variables_(biomedical) that is, breastfeeding patterns, hygiene, sanitary measures, and nutrition to have confounding effect on each other in child health. [16] framework on child survival based their theory that socioeconomic factors of child mortality operate essentially through an ordinary set of intermediate factors.

Clearly the identification of proximate and socioeconomic determinants of infant and child mortality were outlined as fourteen proximate determinants grouped to five categories i.e. maternal factors (age, parity, maternal health and interval of births), environmental contamination (safety of drinking water and sanitation),nutrient deficiency(breast feeding effect), injury (accidentally or intentional) and personal illness control (malaria prophylaxis and treatment, and vaccination). These proximate determinants link to socioeconomic determinants; individual level (mother education, skills, and time), household level (income and/or wealth and decision power in the household) and community level (environment exposure to disease and availability of health centers). Contiguous determinants with socioeconomic factors influence the infant and child mortality while socioeconomic, biological and environmental are driving factors behind infant and child mortality [16]. Therefore, Mosley and Chen analytical framework informed the current conceptualization of factors determining under-five mortality in this study.

2.2 Empirical literature review

It is sub-section; a review of studies done in Kenya on under-five mortality is discussed. These include research using census and survey data to identify determinants of under-five mortality and are based on different statistical models.

[14] assessed the sub national variation and inequalities in under-five mortality in Kenya since 1965. Household surveys and census data collected between 1989 and 2014 were analyzed using Bayesian spatio-temporal Gaussian process modeling allowing for heteroscedastic error. The study found that between 1988 and 2000, the under-five mortality rate was stagnant due to socioeconomic factors such as increased spread of HIV and poverty, poor child health care, low immunization coverage rate, and insufficient health workers, and environmental setting such as malaria spread due to El Niño rains. Additionally, the western part of Kenya reported higher mortality explained by high HIV prevalence and malaria whereas higher mortality in Northern Kenya such as Turkana were described by harsh arid conditions leading to food insecurity and malnutrition. The disparities in wealth, education levels and geographic location were identified as factors determining under-five mortality in different counties. The study reported that central Kenya had the lowest mortality, which was explained by fertile lands supporting agriculture and economic activities and political stability and low HIV prevalence. The geographical location of central and eastern Kenya is associated with low prevalence of malaria compared to Lake Region and coast Kenya [13] which explains the high under-five mortality in counties around Lake Region (Migori, Siaya, Kisumu, Homa Bay, Vihiga and Kakamega) and coast region(Kwale and Kilifi) compared to Central Kenya.

[5] examined factors associated with urban and rural under-five mortality differentials using the 2014 KDHS data. Analyzing the data using Weibull with gamma frailty model, it was found that in urban setting, maternal age, source of water, region of residence, maternal education and household wealth linked to under-five mortality as opposed to rural setting where maternal education and region of residence were found influencing.

A study by [10] sought to understand the determinants of under-five mortality from 1990 to 2015 towards accelerating Kenya's progress to 2030.The hierarchical multivariate linear regression was used to analyze in which DHS from 1989 to 2014 were analyzed. The study highlighted household wealth, maternal literacy, reproductive health of the mother and nutrition as important contributing factors.

[23] studied the under-five mortality in Rongo Sub-county of Migori County in Kenya using a cross-sectional survey with evidence from Lwala Community Alliance from 2007-2017 experience. Data were collected in January 2017 using stratified sampling in which children born from 1 January 1999 were involved through mother and father respondents. Using survival analysis techniques including cox regression model it was found that malaria respiratory infections and anemia

were associated with under-five mortality in Rongo. Additionally, multiple gestation pregnancies, short birth spacing and season of birth (rainy season) were associated with under-five mortality.

[17] studied determinants of infant and child mortality in Kenya using cox-proportional hazard model with reference to 2008/09 KDHS data. The study found child mortality as related to education and occupation of the mother, age of mother with less than 20 years and greater than 40 years mothers having high mortality. Birth order 1 and 6+ were found to have higher risk than birth order 2-5 and for gender, male children had higher risk of death compared to females. With regards to weight, those born less than average had higher risk of death than those born average. The place of birth had the greatest impact on mortality whereby children living in rural areas reported to have higher risk of dying than those in urban settings.

[12] studied the trends in childhood mortality in Kenya with reference to KDHS data of years 1993 and 2008 and Nairobi Urban Health and Demographic Surveillance System (NUHDSS) data between 2003 and 2010. Cox regression model was used to estimate under-five death rate, infant mortality, and childhood mortality by place of residence. The study reported that the gap narrowed between urban and rural under-five mortality and infant mortality. The rural-urban ratio on under-five and infant mortality reversed in favor of rural settings. The results were an indication of a reversal in the ratio between urban and rural areas of various determinants of child mortality including adolescent child bearing, child immunization, and exclusive breastfeeding favored the rural areas.

Determinants of child mortality in Kenya, a study by [19] using 2008/2009 KDHS data and multivariate analysis focusing on socioeconomic, demographic and environmental factors found that there are variations depending on regions. The study found that access to piped water, religion, region and intervals between births as major determinants. Further, the mortality of the children without piped water was noted to be less than those with access to piped water.

[6] used multivariate cox proportional hazard regression in a study of determinants of under-five mortality in rural and urban Kenya. The 2008/2009 KDHS data was used in the study. Rural areas were reported to have higher under-five mortality than urban areas with a hazard ratio of 3.6. For both rural and urban settings maternal age was found to be a significant factor in determining under-five mortality with mothers aged 32 years and above having higher child survival. Education of the mother and sex of the child were not significant in both rural and urban setting in determining under-five mortality. On the contrary, higher birth order was significantly associated with increased mortality especially in urban settings. Wealthier families in rural settings had lower mortality compared to poorest in rural settings while in urban settings there was no association. In this study, breastfeeding was found to be significant in under-five mortality whereby children breast-fed for less than six months had higher mortality than those breastfed for more than six months. By location, Nyanza, Coast and Western provinces had higher mortality than central province.

[18], studied environmental determinants of child mortality in Kenya using KDHS data 2003. Weibull and Cox regression model were used for the analysis in which house hold's socioeconomic and environmental factors were associated with under-five child mortality. Environmental factors such as access to safe drinking water, sanitation facilities and households using less polluting fuels as their main source of cooking reported association with under-five child mortality. Additionally, socioeconomic variables such as better wealthier families, having good roofing material (i.e. iron sheets or tiles), and having assets such as radio and television reported lower mortality rates.

[11] in a study determining factors influencing under-five mortality in urban and rural Kenya used bi-variate and multivariate analysis and Cox's proportional hazard to analyze 2003 KDHS data. The study focused on socio-economic, bio-demographic, environmental and socio-cultural factors influencing under-five mortality. The study found an association between maternal education, marital status and under-five mortality in urban areas using bi-variate analysis .In rural areas the preceding birth interval, maternal education and source of drinking water were found to be associated with under-five mortality. Nonetheless, wealth index, birth order, occupation and maternal age, religion and type of toilet were not significant in both rural and urban areas.

[20] used the 1998 Kenya demographic and health survey data to study determinants of infant and child mortality. The Weibull hazard model was used to analyze the data. The study revealed that infant mortality was highly determined by bio demographic factors whereas socioeconomic, socio-cultural and hygienic factors explained child mortality. The study highlighted that children born in low socioeconomic status have high risk of dying before age of five years. Further, children born to educated mothers had better child survival compared to those from uneducated mothers. Environmentally, toilet facility and source of water were associated with with under-five mortality. Additionally, cultural traditions such as value of children, food preferences and beliefs about disease causation and demographic factors (e.g., birth spacing after child death were found to be associated to under-five child mortality.

3 RESEARCH METHODOLOGY

3.1 STUDY BACKGROUND AND DESIGN

A systemic review was carried out to assess the generality of under-five mortality and determine factors associated with under-five mortality in Kenya. Meta-analysis was performed to determine any difference in the causal factors. Kenya is low middle-income country with a fast growing economy with a fledgling democracy [10] in East Africa. The population setting is either rural or urban. It is bounded to North by Ethiopia, Tanzania to the south, Somalia to the East, Uganda to the West, and North West by South Sudan. According to National Council for Population and Development report of June 2020, the estimated population was 47.6 million in 2019 with 53% child population.

3.2 SEARCH STRATEGIES

A systemic review was prepared according to Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA, 2020) guidelines. In order to discover possibly pertinent articles and research papers, an all-inclusive exploration without limits in dates was executed in databases such as: Google scholar, Science Direct, Research gate, PubMed and Cochrane library. Searches were restricted to articles and research papers done in English language for it is used for articles and research in Kenya. Additionally, to include unpublished relevant to this systematic review, other centers like University of Nairobi repository were searched. The literature search was conducted between 22nd of March to 22nd of April 2021. The papers that were published up to 22nd April 2021 were considered. The search used the following key words "under-five mortality +Kenya" or "environmental factors +under-five mortality +Kenya" or "socioeconomic factors + Kenya" or "demographic factors +Kenya +under-five mortality" and "under-five mortality rate +Kenya" .The terms for searching were used separately and/or combined by Boolean operators such as "AND" and "OR".

3.3 SUITABILITY STANDARD OF STUDIES

SUITABILITY: The study involved only articles and research papers within Kenyan population. The study sub-population involved children under-five years. Published and unpublished articles were considered suitable for inclusion. At best, papers in English were incorporated. The study design of the articles considered is observational (cross-sectional studies) and reporting under-five mortality in Kenya and associated factors.

EXCLUSION Articles with limited access due to unavailability of full text were eliminated. Others were excluded after contacting primary author through an e-mail and no response received. The exclusion of these articles was due to incapacity in assessing reliability of the article in absentia of all text.

Database	Search terms used	Number of Studies
Google scholar	"under-five mortality AND Kenya" OR "environmental factors AND under-five mortality AND Kenya" OR "socioeconomic factors AND Kenya" OR "demographic factors AND under-five mortality " AND "under-five mortality rate AND Kenya"	20
Research gate	"under-five mortality" AND "Kenya"	4
PubMed	"under-five mortality AND Kenya"	8
Cochrane Library	"child mortality AND Kenya"	1
Others(University of Nairobi repository)		4
Total		37
Full articles found relevant to the review		8

Table 1. Databases Search for Studies in Kenya Involving Under-Five Mortality.

3.4 ASSESSMENT OF OUTCOME VARIABLES

The outcome of interest is under-five mortality, defined as the number of deaths per 1,000 live births before a child celebrates the fifth birthday. This outcome is dependent on factors, which are varied, including, environmental (e.g. source of drinking water and toilet facility); socioeconomic (e.g. wealth index of the family, the maternal education): and demographic (e.g. gender of the child, birth order and spacing and maternal age at first birth). To determine the association of these factors with under five mortality, the binary outcomes from the primary studies were meta-analyzed. The analysis was performed on relative risk ratio based on rural versus urban setting effects by environmental, social and demographic factors. The risk/hazard ratios from the primary studies were also compared.

3.5 DATA EXTRACTION

Retrieving data from selected articles was guided by modified Joana Briggs Institute (JBI) data extraction tool. The data extraction layout followed the order author and publication year, and topic of the article, the data used and the sample size of the study for the articles included. The factors associated with under-five mortality were extracted on the hazard/risk ratio. The risk/hazard ratio was based on the Cox proportional hazard model or Weibull's proportional hazards model. For meta-analysis, the studies were based on rural versus urban setting and data extracted as percentages on under-five children who died and those who lived.

3.6 RISK OF BIAS

[9] developed a tool for assessing the risk of bias when pooling prevalence studies. The tool assesses internal and external validity of a study using a 10 question criteria. This review adopted [9] tool to address risk of bias The 10 questions in the tool focused on (1) study population representation, (2) sampling frame, (3) sample selection, (4) likelihood of non response bias minima, (5) data collection method, (6) case definition acceptability, (7) study instrument validity and reliability, (8) uniformity in data collection for all subjects, (9) appropriateness of prevalence period, and (10) appropriate denominator(s) and numerator(s) used. Using 5-point ordinal scale (low=1, medium=2, moderate=3-4, high=5), risk of bias of the studies was assessed. The review and meta-analysis include studies which scored moderate and below.

3.7 ANALYZING AND PROCESSING DATA

Data was exported to R software in Microsoft Excel sheet. Analysis was performed using R statistical software package version 4.0.3. Meta-analysis was conducted for three studies of the eight studies. The heterogeneity of prevalence among factors was done using the I^2 statistic and τ^2 [21]. The test static showed that there was no heterogeneity (I^2=0.0%; τ^2=0). The analysis showed H=1 an indication of homogeneity ([8]). A funnel plot was performed to examine the bias of each factor to the analysis and found a symmetrical funnel plot, indication of little bias. All factors reflected symmetric funnel plot around standard error of 0.5 and within boundaries. The data analyzed was binary and involved three studies; therefore, Mantel-Haenszel (M-H) method was used with **Risk Ratio**($\hat{R}R$) as the effect measure. M-H was preferred since data was analyzed as reported in percentages without transformation and that few studies were available for combination.

3.7.1 Mantel-Haenszel Method

Let's consider a contingency table with the following outcomes;

	Outcome Present	**Outcome Absent**	**Total**
Risk factor present (Exposed)	a	b	a+b
Risk factor Absent (Unexposed)	c	d	c+d
	a+c	b+d	n

Table 2. Outcomes Mantel-Haenszel method

From the table the relative risk ratio may be calculated as;
Risk Ratio

$$\hat{R}R = \frac{a/(a+b)}{c/(c+d)}$$

Considering that, M-H method can be used to calculate relative risk for combined 2×2 contingency tables, i.e. strata; we look at calculating the relative risk of the $i^t h$ stratum;

$$\hat{R}R_{CMH} = \frac{\sum \frac{a_i(c_i+d_i)}{n_i}}{\sum \frac{c_i(a_i+b_i)}{n_i}} \tag{1}$$

Where, a_i, b_i, c_i and d_i are participants of the i^{th} stratum of $2*2$ table.

If we consider pooling the $\hat{R}R$ of $2*2*k$ tables,where $k = 1,2,3....i^{th}$ stratum then Cochrane M-H $\hat{R}R$ is given by,

$$\hat{R}R_{CMH} = \frac{\sum_{i=1}^{k} \frac{a_i(c_i+d_i)}{n_i}}{\sum_{i=1}^{k} \frac{c_i(a_i+b_i)}{n_i}} \tag{2}$$

Lets define;

$a_i + b_i = E_i$
$c_i + d_i = \bar{E}$
$a_i + c_i = D_i$
$b_i + a_i = \bar{D}$

Therefore, M-H $\hat{R}R_{CMH}$ becomes;

$$\hat{R}R_{CMH} = \frac{\sum_{i=1}^{k} \frac{a_i\bar{E}}{n_i}}{\sum_{i=1}^{k} \frac{c_iE_i}{n_i}} \tag{3}$$

Equation 1 becomes:

$$\hat{R}R_{CMH} = \frac{\sum \frac{a_i\bar{E}}{n_i}}{\sum \frac{c_iE_i}{n_i}} \tag{4}$$

The standard error for the calculated $\hat{R}R$ is estimated as;

$$Se(\ln \hat{R}R_{CMH}) = \sqrt{\frac{\sum(E_i\bar{E}_iD_i - a_ic_i)/n_i^2}{(\sum(a_i\bar{E}_i/n_i))(\sum(c_iE_i/n_i))}} \tag{5}$$

Therefore, the 95% Confidence limits $CI(L_{\log}, U_{\log})$ for $\hat{R}R_{CMH}$ are calculated as;

$$L_{\log} = \ln(\hat{R}R_{CMH}) - 1.96Se(\ln \hat{R}R_{CMH})$$
$$U_{\log} = \ln(\hat{R}R_{CMH}) + 1.96Se(\ln \hat{R}R_{CMH}) \quad (6)$$

Generally,
$CI_{\log} = \ln(\hat{R}R_{CMH}) \pm Z_{\alpha/2}Se(\ln \hat{R}R_{CMH})$
Therefore the lower and upper limits are;

$$L = \exp(L_{\log})$$
$$U = \exp(U_{\log}) \quad (7)$$

3.7.2 Fixed effects model in Meta-analysis

The model assumes all the studies incorporated are sharing an effect size that is common and the distribution of the observed effect is around μ, with a variance σ^2. The within study error is labeled ε_1.

For example, if we consider Study 1,the observed effect T_1 is expressed as;

$$T_1 = \mu + \varepsilon_1 \quad (8)$$

Diagrammatically represented as,

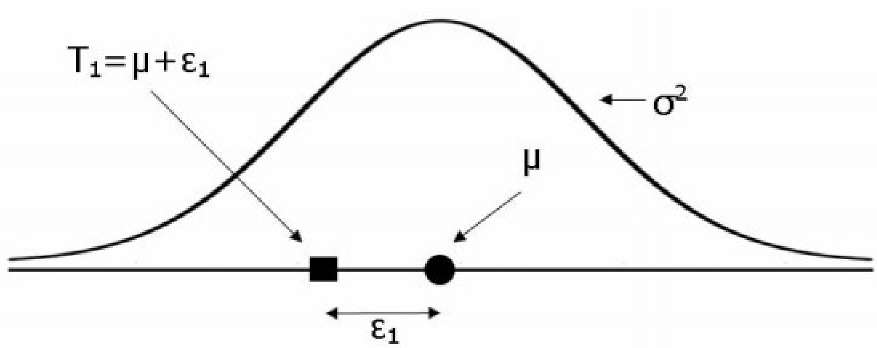

Figure 1. Fixed effects model in meta-analysis

In each study, a weight is assigned to determine is contribution to analysis which is given by;

$$W_i = \frac{1}{V_i} \quad (9)$$

Where, V_i is the within study variance of the i^{th} study. After the weight of each study, then a weighted mean for all the included studies is calculated as;

$$\bar{T}_{\bullet} = \frac{\sum_{i=1}^{k} W_i T_i}{\sum_{i=1}^{k} W_i} \tag{10}$$

Therefore, getting the reciprocal of the sum of the weights of the studies a combined effects variance is obtained;

$$V_{\bullet} = \frac{1}{\sum_{i=1}^{k} W_i} \tag{11}$$

Computing the square root of the combined effects variance gives the standard error of the combined effect, that is;

$$SE(\bar{T}_{\bullet}) = \sqrt{V_{\bullet}} \tag{12}$$

Therefore, the 95% CI of the fixed effects model would be given by;

$$LowerLimit = \bar{T}_{\bullet} - 1.96 * SE(\bar{T}_{\bullet}) \tag{13}$$

$$UpperLimit = \bar{T}_{\bullet} + 1.96 * SE(\bar{T}_{\bullet}) \tag{14}$$

The Z-value is hence calculated ;

$$Z = \frac{\bar{T}_{\bullet}}{SE(\bar{T}_{\bullet})} \tag{15}$$

When interested by the *p-value* for a one-tailed test is,

$$p = 1 - \phi(Z) \tag{16}$$

And the for a two-tailed test would be;

$$p = 2\left[1 - (\phi(|Z|))\right] \tag{17}$$

3.7.3 Heterogeneity in Meta-analysis

This refers to the variation between outcome of the studies. The percentage of variation described by I2 statistic derived from the Cochrane Q-statistic ([8]; Higgins et al, 2003).

According to [2] the Q-statistic is given by;

$$Q = \sum_{i=1}^{k} \frac{1}{V_i} (T_i - \bar{T}_{\bullet})^2 \tag{18}$$

Where, $\frac{1}{V_i} = W_i$ and define $T_i = Y_i$ and $\bar{T}_{\bullet} = M$.

$$\therefore Q = \sum_{i=1}^{k} W_i (Y_i - M)^2$$

But $M = \bar{T}_{\bullet} = \frac{\sum_{i=1}^{k} W_i T_i}{\sum_{i=1}^{k} W_i}$ substitute $T_i = Y_i$

$$Q = \sum_{i-1}^{k} W_i \left(Y_i - \frac{\sum_{i=1}^{k} W_i Y_i}{\sum_{i=1}^{k} W_i} \right)^2,$$

By expanding,

$$Q = \sum_{i=1}^{k} \left(W_i Y_i^2 - \frac{2W_i Y_i \sum_{i=1}^{k} W_i Y_i}{\sum_{i=1}^{k} W_i} + \frac{W_i \sum_{i=1}^{k} W_i^2 Y_i^2}{\sum_{i=1}^{k} W_i^2} \right)$$

Hence,

$$Q = \sum_{i=1}^{k} W_i Y_i^2 - \frac{\left(\sum_{i=1}^{k} W_i Y_i\right)^2}{\sum_{i=1}^{k} W_i} \tag{19}$$

Therefore I^2 - $Statistic$,

$$I^2 = \left(\frac{Q - df}{Q} \right) \times 100\% \tag{20}$$

Where $df = K - 1$,

$$\tau^2 = \frac{Q - df}{C} \tag{21}$$

Where;

$$C = \sum W_i - \frac{\sum W_i^2}{\sum W_i} \tag{22}$$

The value C puts the measure back to its original metric, in other words a scaling factor. Generally,

$$\tau^2 = \begin{cases} \frac{Q-df}{C}, & if Q > df \\ 0, & if Q \leq df \end{cases} \tag{23}$$

3.8 PRISMA PROCESS RESULTS

There were 33 articles retrieved that reported the determinants of under-five mortality in Kenya from the range of databases as described above. Five duplicates of articles were eliminated. A remainder of 30 articles, 12 were ruled out during assessment of titles and abstracts while seven were excluded due to inaccessibility of full text. Therefore, the fully accessed articles were 11 and assessed according to preset criteria. Further, three articles were excluded due to methodology and data inextricable. Ultimately, eight articles through the suitability standard and exclusion were analyzed in the final review. (See Figure 2)

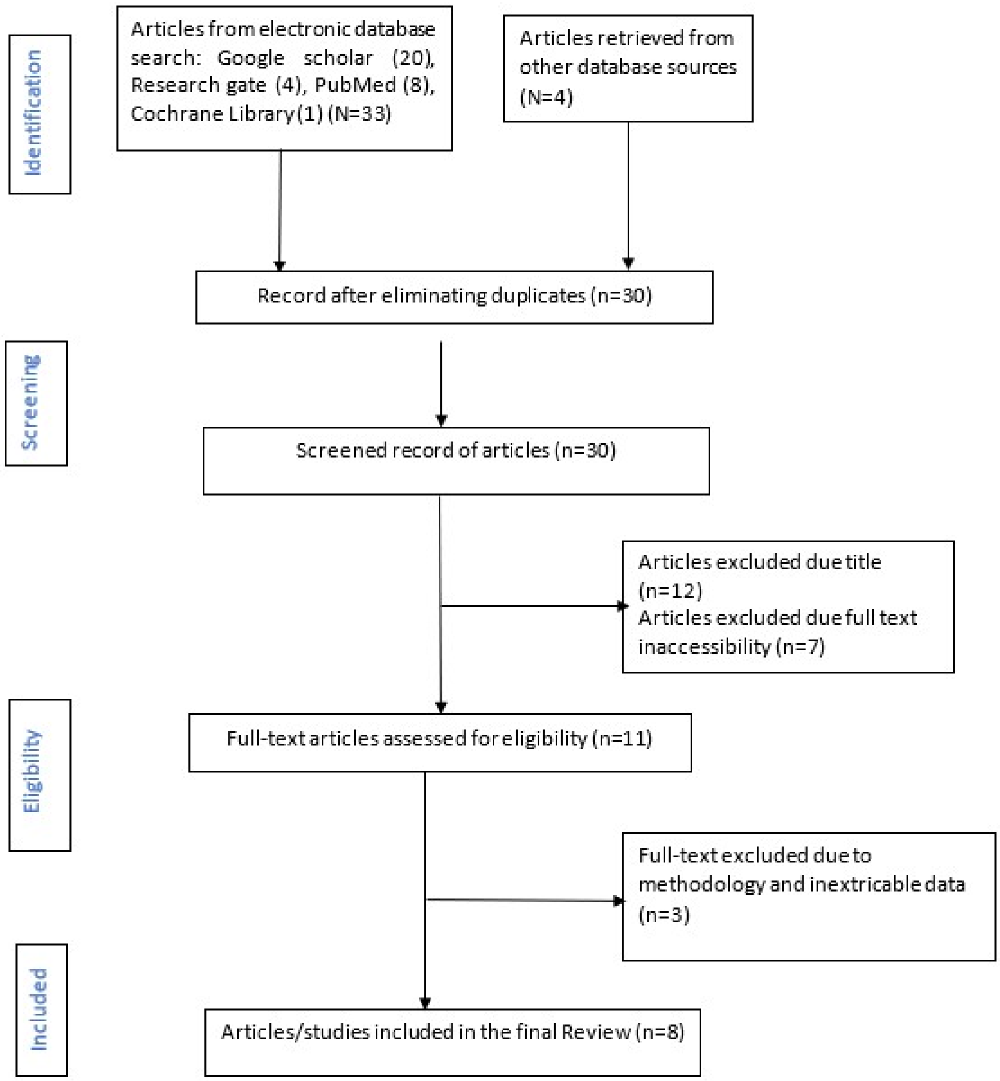

Figure 2. The PRISMA flow diagram showing study selection process.

3.9 DESCRIPTION OF ANALYZED STUDIES

A representation in table 1, sketchily illustrates eight cross-sectional studies included for analysis. They were published between 2007 and 2019. The sample sizes range from the lowest 1,362 to the highest 23,348. The pooled review has a cumulative sample size of 84,259 study participants used to determine factors associated with under-five mortality and assess the its magnitude. All the studies were conducted in Kenya using national data except one done in Migori county Kenya. The oldest data used in the review is of 1998 and the latest being 2019 (See Table 3).

No.	Study	Topic	Data used	Sample size
1	**Chepkwony 2019**	Factors associated with urban and rural under-five mortality differentials in Kenya	2014 KDHS data	20,964
2	**Starnes 2018**	Under-five mortality in the Rongo Sub-County of Migori County	Interviews in January,2017 by Lwala Community Alliance	1,362
3	**Muriithi 2015**	Determination of infant and child mortality in Kenya using cox-proportional hazard model.	2008/2009 KDHS data	5,878
4	**Ettarh 2012**	Determinants of under-five mortality in rural and urban Kenya.	2008/2009 KDHS data	16,162
5	**Njiri 2012**	Determinants of child mortality in Kenya	2008/2009 KDHS data	5,181
6	**Mutunga 2011**	Environmental determinants of child mortality in Kenya.	2003 KDHS data	4,415
7	**Kilobi 2009**	Factors influencing under-five mortality in urban and rural Kenya	2003 KDHS data	6,949
8	**Omariba 2007**	Determinants of infant and child mortality in Kenya: an analysis controlling for frailty effects.	1998 KDHS data	23,348

Table 3. An illustrative brief of eight studies analyzed in the review of factors associated with under-five mortality in KENYA

4 DATA REVIEW, META-ANALYSIS AND RESULTS

4.1 Introduction

The chapter presents the data extracted from the included studies and the review of the factors associated with under-five mortality. The data shows the hazard ratio of each study calculated based on Cox hazard proportional model and Weibull proportional hazard model. Meta-analyzed studies and results are discussed as well. [3]

No	Factors and Author	Risk/Hazard ratio		No	Factors and Author	Risk/Hazard ratio		
1	***Omariba et al 2007***			5	***Ettarh and Kimani 2012***			
	Maternal education				*Maternal education*	*Urban*	*Rural*	*overall*
	Primary(ref)	1			Primary or less(ref)	1	1	1
	None	1.3			Secondary and more	0.68	0.79	0.78
	Secondary or higher	0.52						
	Wealth index				*Wealth index*			
	Medium(ref)	1			Low (ref)	1	1	1
	Low	1.24			Middle	1.59	0.73^{*}	0.74^{*}
	High	0.69			Highest	0.94	0.78^{*}	0.77^{*}
2	***Kilobi 2009***	**Risk/Hazard ratio**		6	***Muriithi and Muriithi 2015***	***Risk/Hazard ratio***		
	Maternal education	*Urban*	*Rural*		*Maternal education*			
	No education (ref)	1	1		Secondary +(ref)	1		
	Primary	0.565	0.946		No education	1.07		
	Secondary plus	0.372	0.643		Primary	1.059		
	Wealth index				*Wealth index*			
	Low(ref)	1	1		Richest(ref)	1		
	Medium	1.188	0.921		Poorest	1.68		
	High	1.29	0.931		Poorer	1.321		
3	**Mutunga 2011**	**Risk/Hazard ratio**			Middle	1.069		
	Maternal education				Richer	0.905		
	No education	1.4095		7	***Chepkwony 2019***	***Risk/Hazard ratio***		
	Secondary educatiion	1.4229			*Maternal education*	*Urban*	*Rural*	
	Wealth index				No education(ref)	1	1	
	poor(mabati houses)	0.9942			Primary	4.047	0.56	
	High(Tile houses)	7.0514			Secondary	3.762	0.586	
	Household has radio	0.8891			Higher	1.116	0.761	
	Household has Tv	0.8022			*Wealth index*			
4	**Njiri 2012**	**Risk/Hazard ratio**			Low (ref)	1	1	
	Maternal education				Average	0.563	1.238	
	No education(ref)	…			Higher	2.85	1.925	
	Primary	0.831						
	Secondary and higher	0.785						
	Wealth index							
	Low (ref)	…						
	Medium	0.921						
	High	0.776						

Table 4. The data representing socioeconomic factors and associated risk/hazard ratio.

No	Factors and Author	Risk/Hazard ratio	
1	***Omariba et al 2007***		
	Maternal age at birth		
	20-24 (ref)	1	
	Below 20	1.44	
	25 - 29	0.94	
	30 - 34	1.2	
	35 or more	1.37	
	Birth interval		
	19 - 35 months(ref)	1	
	less than 19 months	1.48	
	36 + months	0.68	
2	***Kilobi 2009***	**Risk/Hazard ratio**	
	Birth order	*Urban*	*Rural*
	1 child(ref)	1	1
	2 to 3 children	0.004	2.351
	4 plus	0.003	2.695
	Maternal age at birth		
	15-19 (ref)	1	1
	20-29	0.951	1.109
	30+	1.289	1.213
	Birth interval		
	less than 24 months(ref)	1	1
	24 months plus	0.768	0.526
	First births	0.003	1.599
3	***Mutunga 2011***	**Risk/Hazard ratio**	
	Child gender		
	Female (ref)	1	
	Male	1.2433	
	Birth order		
	2 and 3 years	0.6751	
	4 and 6 years	0.8307	
	7 years and above	1.6784	
	Birth interval		
	Preceding birth is 2 years	1.999	
	Maternal age at birth	1.0132	
4	***Njiri 2012***	**Risk/Hazard ratio**	
	Birth order		
	0 - 3 (ref)	1	
	4 and 5	0.075	
	6 +	0.074	
	Maternal age at birth		
	Less than 25 years	1	
	25 - 34 years	0.916	
	35 + years	0	
	Birth interval		
	less than 24 months(ref)	1	
	24 months plus	0.06	

No	Factors and Author	Risk/Hazard ratio		
5	***Ettarh and Kimani 2012***			
	Child gender	*Urban*	*Rural*	*Overall*
	Male (ref)	1	1	1
	Female	1.21	0.88	0.9
	Birth order			
	1 (ref)	1	1	1
	2 to 3	4.8	1.85	2.6
	4 and more	5.63	2.64	3.77
	Maternal age at birth			
	15 - 20 (ref)	1	1	1
	21 - 27	0.23	0.97	0.71
	28 - 31	0.13	0.87	0.6
	32 and more	0.06	0.46	0.32
6	***Muriithi and Muriithi 2015***	**Risk/Hazard ratio**		
	Child gender			
	Female (ref)	1		
	Male	1.243		
	Maternal age at birth			
	35 - 49 (ref)	1		
	25 - 34	0.646		
	15-24	1.092		
7	***Starnes et al 2018***	**Risk/Hazard ratio**		
	Maternal age at birth	0.979		
	Birth interval			
	More than 18 months	0.345		
8	***Chepkwony 2019***	**Risk/Hazard ratio**		
	Birth order and interval			
	2 to 3 and ≤24months(ref)	1		
	First birth	1.499		
	2 to3 and >24months	2.107		
	4 + and ≤ 24 months	1.782		
	4 + and >24 months	1.599		
	Maternal age at birth	*Urban*	*Rural*	
	Less than 20 years (ref)	1	1	
	20 tp 34 years	3.278	0.417	
	35 to 49 years	8.672	0.309	

Table 5. The data representing environmental factors and associated risk/hazard ratio.

No	Factors and Author		Risk/Hazard ratio	
1	***Omariba et al 2007***			
	Source of drinking water			
	River,Lake,Rain water(ref)		1	
	Well water		0.93	
	Piped water		1.05	
	Type of toilet facility			
	Pit latrine	(ref)	1	
	water closet		0.77	
	No facility		1.2	
2	***Kilobi 2009***		**Risk/Hazard ratio**	
	Source of drinking water		*Urban*	*Rural*
	Piped (ref)		1	1
	Unpiped		1.044	1.514
	Type of toilet facility			
	Have toilet(ref)		1	1
	No toilet		0.837	0.95
3	***Mutunga 2011***		**Risk/Hazard ratio**	
	Source of drinking water			
	Safe water		0.4102*	
	Type of toilet facility			
	Pit latrine		2.7071*	
	No toilet facility		2.4018*	
4	***Njiri 2012***		**Risk/Hazard ratio**	
	Source of drinking water			
	Piped sources(ref)		1	
	Non piped sources		0.064*	
	Type of toilet facility			
	Flush/pit toilet (ref)		1	
	No toilet		0.076*	
5	***Muriithi and Muriithi 2015***			
	Source of drinking water			
	Tank truck	(ref)	1	
	Piped dwelling		0.502	
	Piped to yard plot		0.501	
	Public tap		0.947	
	Borehole		0.854	
	Protected well		0.482	
	Unprotected well		1.257	
	Protected spring		0.513	
	Unprotected spring		1.037	
	River,Lake/Dam		1.326	
	Rain water		0.714	
	Type of toilet			
	Basket toilet(ref)		1	
	Flush piped to water system		1.832	
	Flush to septic tank		0.486	
	flush to latrine		0.963	
	Flush to somewhere else		0	
	Flush to I don't know		7.126	
	pit latrine with slab		0.985	
	Pit taltrine without slab		0.943	
	Bush		2.667	
6	***Starnes et al 2018***		**Risk/Hazard ratio**	
	Type of toilet			
	Non improved/None(ref)		1	
	Improved toilet		0.482	
7	***Chepkwony 2019***		**Risk/Hazard ratio**	
	Source of drinking water		*Urban*	*Rural*
	Piped (ref)		1	1
	Tube well		6.216	0.479
	Dug well		5.755	1.225
	Surface and others		3.11	1.622

Table 6. The data representing demographic factors and associated risk/hazard ratio.

UNDER-FIVE MORTALITY IN KENYA

4.2 THE UNDER-FIVE MORTALITY IN KENYA

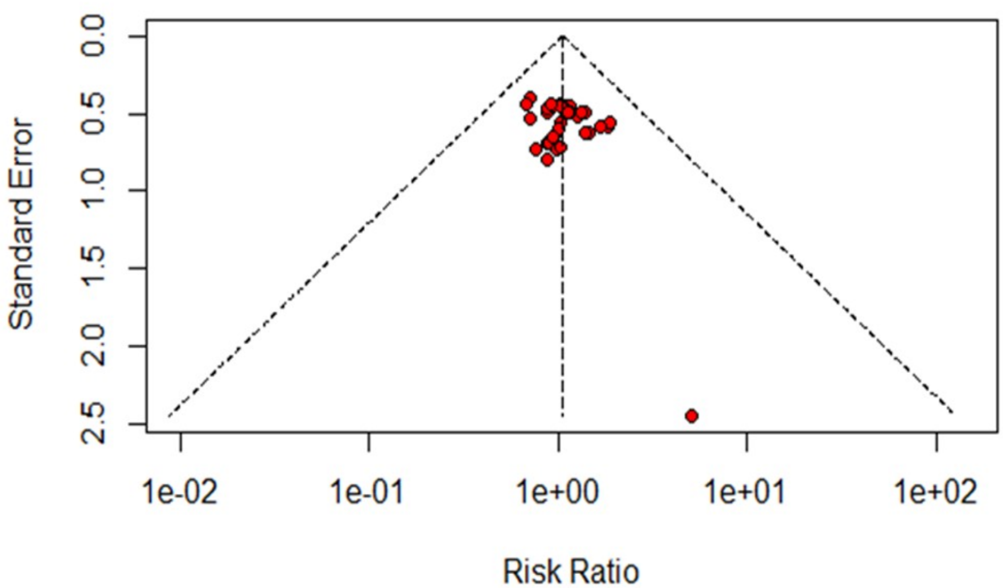

Figure 3. Funnel plot of the all the combined factors meta-analyzed.

Across the eight studies included in the review, there is general concurrence that under-five mortality in Kenya (43 deaths per 1,000 live births) is still high compared to the global target of 25 deaths per 1,000 live births (SDG 3.2, UN 2015). The meta-analysis of all the studies and factors indicated a ($\hat{R}R$=1.05, 95% CI, 0.89; 1.25) *Z-value* 0.62 and *p-value* 0.5323 by fixed effects model. The random effects model generated ($\hat{R}R$ = 1.05, 95% CI, 0.89; 1.24) *Z-value* 0.57 and *p-value* 0.5671 which are the same. The results indicate the risk of under-five by point estimate to be high by 5%. However, the p-value shows no significance effect as well as confidence interval. Although, the trend in under-five mortality has been going down [14] some factors may be the reason of the 5% risk value. The factors are examined through review of data collected from studies done in Kenya. A meta-analysis was done on three studies using Mantel-Haenszel method for its effectiveness with few studies involving binary data. M-H method is also preferred for is use when Meta analyzing raw data. A funnel plot was plot asymmetry was performed to examine any publication bias. The result of the funnel plot indicated symmetric contribution of factors (see Figure 6). In this review, the factors are discussed and analyzed in three categories: socioeconomic, environmental and demographic factors.

No.	Author	Year	Factor	Status	RuralU5D	RuralU5A	UrbanU5D	UrbanU5A
1	Kilobi	2009	Maternal education	No education	9.4	90.6	12.8	87.7
2	Chepkwony	2019	Maternal education	No education	3.8	96.2	4.3	95.6
3	Kilobi	2009	Maternal education	Primary	8.9	91.1	8.4	91.6
4	Ettarh and Kimani	2012	Maternal education	Primary or less	8.3	91.7	6.5	93.5
5	Chepkwony	2019	Maternal education	Primary	4.5	95.5	4.7	95.3
6	Kilobi	2009	Maternal education	Secondary plus	6	94	5.9	94.1
7	Ettarh and Kimani	2012	Maternal education	Secondary plus	6	94	4.2	95.8
8	Chepkwony	2019	Maternal education	Secondary	3.2	96.8	4.2	95.8
9	Chepkwony	2019	Maternal education	Higher	2.9	97.1	3.3	96.7
10	Kilobi	2009	Wealth index	Low	9.4	90.6	8.3	91.7
11	Ettarh and Kimani	2012	Wealth index	Low	9	91	6.6	93.4
12	Kilobi	2009	Wealth index	Medium	7.9	92.1	8.5	91.5
13	Ettarh and Kimani	2012	Wealth index	Medium	7.8	92.2	11.1	88.9
14	Kilobi	2009	Wealth index	High	7.1	92.9	8	92
15	Ettarh and Kimani	2012	Wealth index	High	5.3	94.7	5.3	94.7
16	Kilobi	2009	Source of drinking water	Piped	5.6	94.4	7.7	92.3
17	Chepkwony	2019	Source of drinking water	Piped	4	96	4.4	95.6
18	Kilobi	2009	Source of drinking water	Unpiped	9.1	90.9	8.7	91.3
19	Chepkwony	2019	Source of drinking water	Tube well	3.8	96.2	4.2	95.8
20	Chepkwony	2019	Source of drinking water	Dug well	3.5	96.5	3.6	96.4
21	Chepkwony	2019	Source of drinking water	Surfce and other	4.3	95.7	4.6	95.4
22	Kilobi	2009	Toilet facility	Have toilet	8.3	91.7	8	92
23	Kilobi	2009	Toilet facility	No toilet	9.1	90.9	8.6	91.4
24	Kilobi	2009	Birth order	1 child	7.9	92.1	6.3	93.7
25	Ettarh and Kimani	2012	Birth order	1 child	1	99	0.2	99.8
26	Kilobi	2009	Birth order	2 to 3 children	7.8	92.2	8.8	91.2
27	Ettarh and Kimani	2012	Birth order	2 to 3 children	5.8	94.2	4.2	95.8
28	Kilobi	2009	Birth order	4 plus	9.5	90.5	9.3	90.7
29	Ettarh and Kimani	2012	Birth order	4 plus	8.9	91.1	8.6	91.4
30	Kilobi	2009	Maternal age at birth	15 - 19	8.1	91.9	7.3	92.7
31	Ettarh and Kimani	2012	Maternal age at birth	15 - 20	3.8	96.2	3.7	96.3
32	Kilobi	2009	Maternal age at birth	20 - 29	8.3	91.7	7.2	92.8
33	Ettarh and Kimani	2012	Maternal age at birth	21 - 27	7.5	92.5	4.2	95.8
34	Kilobi	2009	Maternal age at birth	30 +	9	91	9.8	90.2
35	Ettarh and Kimani	2012	Maternal age at birth	28 - 31	8.3	91.7	4.6	95.4
36	Ettarh and Kimani	2012	Maternal age at birth	32 +	8.2	91.8	7.3	92.7
37	Ettarh and Kimani	2012	Child gender	Female	7.2	92.8	4.4	95.6
38	Ettarh and Kimani	2012	Child gender	Male	8.7	91.3	6.7	93.3

Table 7. The studies meta-analyzed, where U5A – under-five children who survived to fifth birth day and U5D-under-five children who died before fifth birthday on percentage values.

SUBGROUP ANALYSIS

4.3 SUBGROUP ANALYSIS

A subgroup meta-analysis was performed based on the factors that risk the survival of under-five mortality. Referring to the results, maternal age at first birth and child gender were found to have higher prevalence to under-five child death with ($\hat{R}R$=1.21, 95% CI: 0.82, 1.78) and ($\hat{R}R$=1.46, 95% CI: 0.67, 3.07) respectively. Birth order $\hat{R}R$=1.09 and Toilet facility $\hat{R}R$=1.05 follow closely respectively. Maternal education, Wealth index and source of drinking water follow that order with $\hat{R}R$ values less than one. The point estimates, however, cannot be relied entirety; a look at confidence intervals indicates no statistical difference between the causal effects among the factors.

Factor	**K= levels/status**	$\hat{R}R$	**95%CI**	τ^2	τ
Material education	9	0.9707	[0.6732;1.3997]	0	0
Wealth index	6	0.9688	[0.6573;1.4279]	0	0
Source of drinking water	6	0.9096	[0.5643;1.4660]	0	0
Toilet facility	2	1.0529	[0.5550;1.9976]	0	0
Maternal age at first birth	6	1.0874	[0.7101;1.6653]	0	0
Birth order	7	1.2118	[0.8239;1.7824]	0	0
Gender	2	1.4648	[0.6991;3.0688]	0	0

Table 8. Subgroup Analysis Results

4.4 FACTORS OF UNDER-FIVE MORTALITY IN KENYA.

4.4.1 Socioeconomic factors.

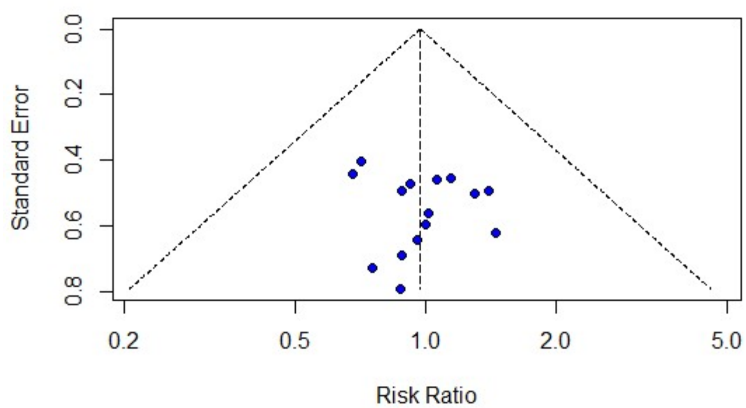

Figure 4. A funnel plot of socioeconomic factors.

In this review, seven studies were used to examine the association of socioeconomic factors and under-five mortality (Table 4). Across the studies, it is revealed that maternal education and wealth index are influential to under-five mortality . There is high risk of under-five death where a mother has no education compared to child born to a mother with primary level education. All the studies indicate that children born to mothers with secondary education and above have low risk of death. However, a meta-analysis of three studies indicated by fixed effects and random models shows ($\hat{RR}$=0.97, 95% CI 0.74; 1.27), there is no significance difference between levels of wealth and education of the mother. This is contrasting previous studies emphasizing wealthy families and educated parents exhibit a low under-five death. The results are in tandem with [12] study, which showed no difference between under-five mortality in rural and urban setting.

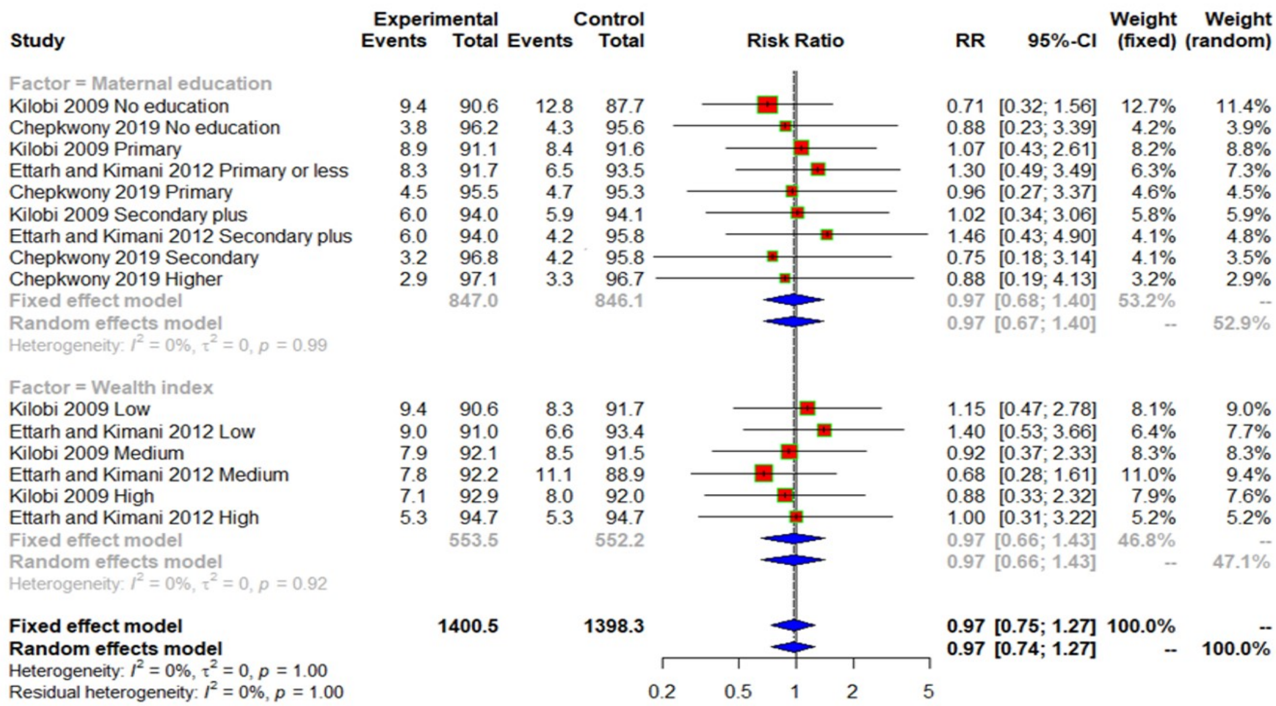

Figure 5. Meta-analysis results of socioeconomic factors.

4.4.2 Environmental factors

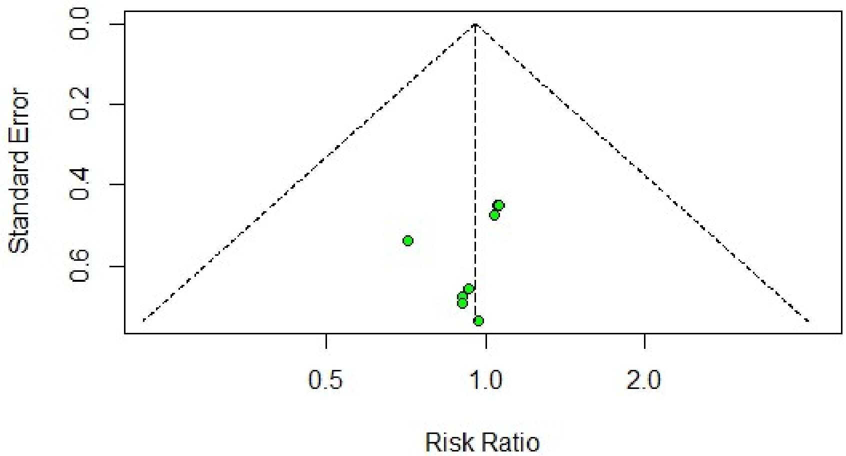

Figure 6. A funnel plot of environmental factors

Comparably, the link between source of drinking water, type of toilet facility, and risk of child death was examined using seven studies out of the eight (Table 5). Out of seven studies, six showed risks related to source of water. Out of the six, four studies agreed showing low risk of child death among households with piped water while two studies indicated high risk of child death in households utilizing piped water. All the seven studies concurred on the importance of a toilet facility. Households without toilet or poor toilet facility showed risky for child survival. Households with improved pit latrines or flush toilets have low risk of child survival; this is attributable to safe human disposal reducing spread of diseases like cholera and diarrhea to low immunity population (children under-five). A meta-analysis was performed to find any difference among different sources of water and toilet facilities. The results showed no difference between sources of water and toilet facilities as determinants of under-five mortality. Toilet facility reflected as relative risk ($\hat{R}R$=1.05) while source of drinking water is relatively low ($\hat{R}R$= 0.91) with confidence intervals crossing the null effect line. These results contrast some studies literature review that source of water from piped water is safer and improved toilet facility is better than non-improved.

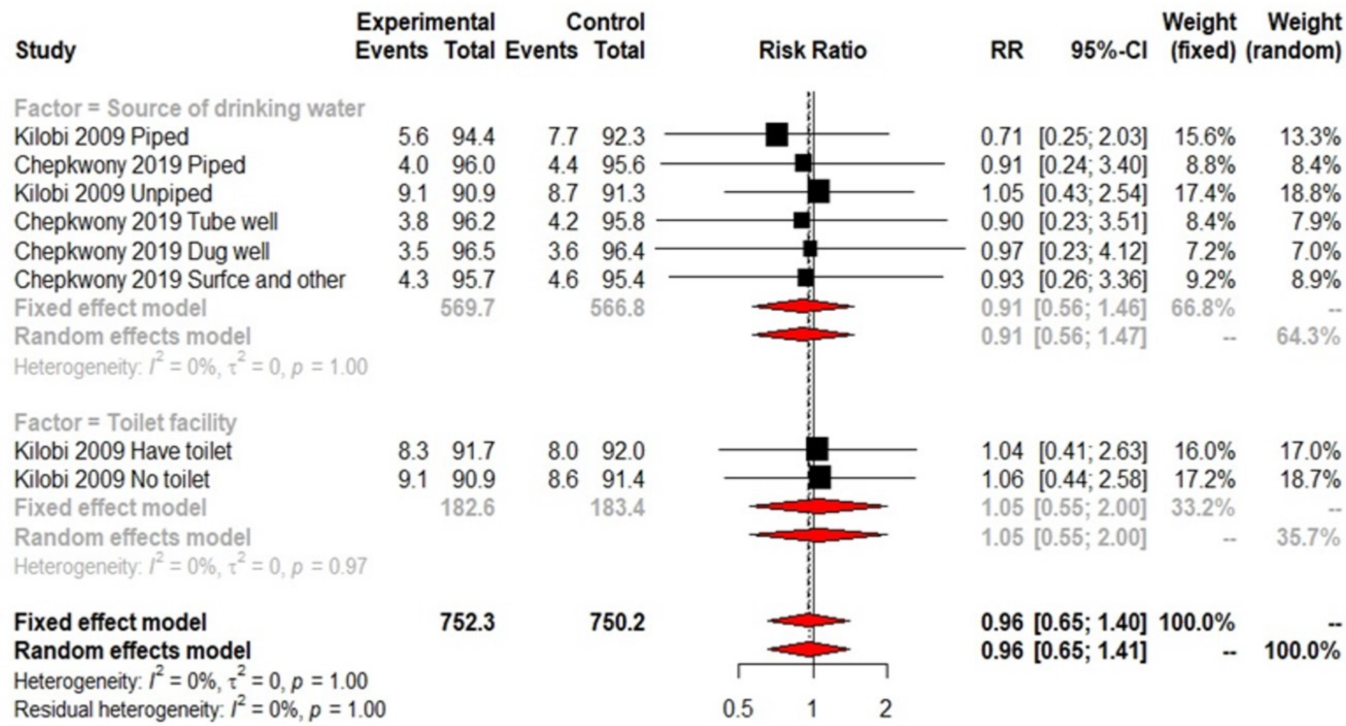

Figure 7. Meta-analysis results of environmental factors.

4.4.3 Demographic factors

Finally, the association between child gender, birth order, maternal age at first birth and birth interval and under-five mortality was examined using the eight studies (*Table in Figure 5*). The three studies [3, 5, and 6] in *Table 6*, which included child gender, have similar risk values. From the studies, the male child has 1.2 times risk of death before attaining age five compared to female child. Across the eight studies, there is concurrence that maternal age at birth of between 20 years and 31 years has the lowest risk of child death. This can be attributed to the fact that at this age most women have acquired secondary level education and higher. In addition, most women being mature to make decision of having a child and thus ready for the childcare weather married or in single parenting can explain this.

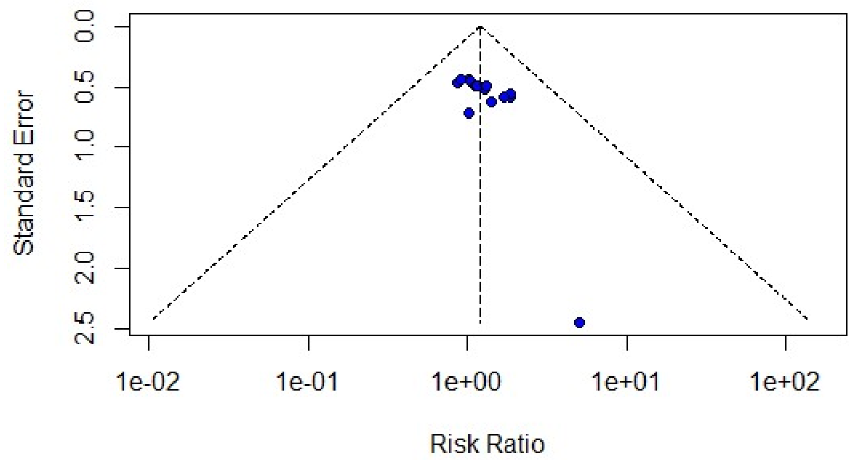

Figure 8. A funnel plot of environmental factors.

Below 20 years at first birth has highest risk of child death across all the studies. This can be attributed to teenage pregnancy and lack of knowledge of childcare. The age of women 32+ years giving birth indicates higher risk of child survival. Out of the eight studies, five included birth order in which four of them agreed on first-born child having higher risk of death than others do. This is attributable to mother inexperienced mothers at time of giving birth. The birth order 2 to 3 reduces the risk of child dying by almost 40% while higher birth order 5+ increases risk of death, which can be attributed to resource competition among siblings and tired mothers ([18]). From the eight studies, six of them included birth interval in which there is general concurrence that birth interval of 24 months and more reduces risk of child dying by almost half. A child born within a birth interval of less than 24 months increases risk of death by an average of 30% similarly to mothers giving birth above age 32 years. These findings assent to the literature review that age of the mother at birth is significant for child survival. Mothers who give birth below 20 years and those above 40 years' experience high under-five mortality with those between 20-30 years having high child survival. Performing a meta-analysis to find any difference between the levels, it reflected non-significant effect among the levels of order of birth, mother age at birth and child gender. The result ($\hat{RR}$=1.2, 95% CI, 0.92; 1.57) indicates these level factors have almost similar effects, i.e. no statistically significant difference.

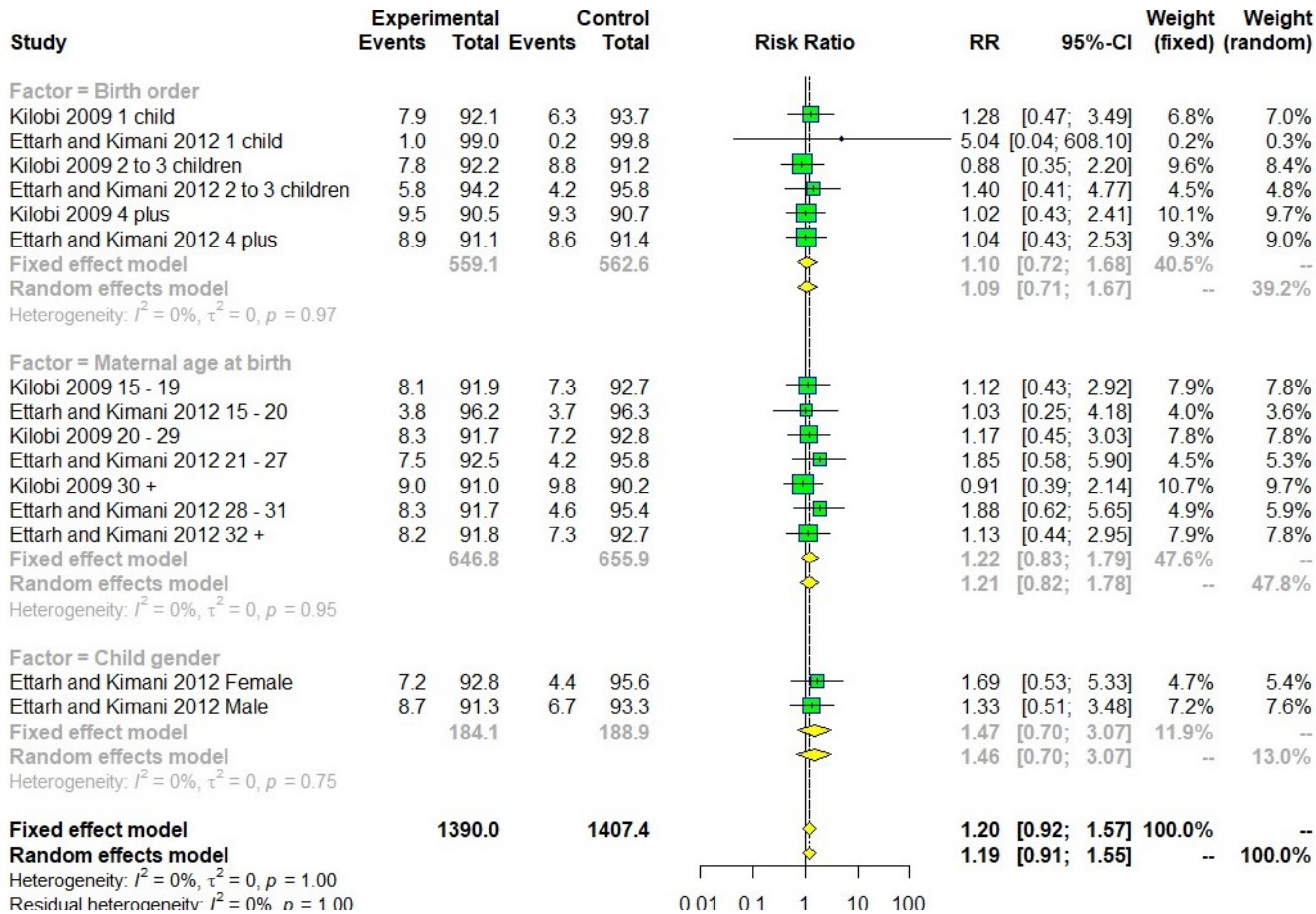

Figure 9. Meta-analysis results for demographic factors.

5 CONCLUSIONS AND RECOMMENDATIONS

5.1 CONCLUSION

In this study, a review across the studies that used the demographic survey data from 1998 to 2014 indicate there has been reducing under-five mortality in Kenya. However, the mortality of under-five children in Kenya is still high at 43 deaths per 1,000 live births. The review of previous studies indicates that demographic factors (Child gender, maternal age at first birth and Birth order) are leading causes of under-five mortality in Kenya. Socioeconomic factors (Maternal education and Wealth index) comes in second then environmental factors (Toilet facility and source of drinking water). Across the studies, there was concurrence that in socioeconomic factors maternal education is a major indicator in determining death of under-five population. The studies further agreed conclusively that the type of toilet facility is a principal environmental factor associated with under-five mortality. Although there was variation in studies with reference to source of water, piped water indicated safer for survival of under-five children. However, this study sought to find any difference in effects to under-five mortality of the aforementioned factors by meta-analysis. The result of meta-analysis indicated that no significance difference exists between any of the factors. This study found the factors to have similar effect to the death of under-five population.

5.2 RECOMMENDATIONS

Kenya looks forward to achieving the SDGs especially section 3.2 by 2030 although she missed the MDG of 2015. Therefore, based on the findings of the review and meta-analysis, it is recommended that the government policy makers focus holistically on the factors with equal measure. Allocation of resources is recommended without bias to any of the environmental, socioeconomic or demographic factors. Further, this review suggests for more future living systematic reviews and meta-analysis to keep informed decisions and the country development policies validated.

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APPENDIX

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