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Proximate Determinants of Fertility in Eastern Africa: The case of Kenya, Rwanda and Tanzania

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Abstract: This study presents some determinants of fertility for three countries in east Africa. It examines the role of the proximate determinants of fertility to total births during last five years before the surveys in Kenya, Rwanda and Tanzania. The study is based on the analysis of secondary data obtained from Demographic and Health Surveys in the three countries. The surveys were conducted between 2014 and 2016. The response variable used in this study is the number of births in the last five years before the survey. The study employed Quasi-Poisson regression model as the main method of data analysis. The results show that place of residence, working status, number of union, age at first birth, age at first cohabitation, age at first sex, contraceptive use and intention, unmet need and educational level mothers are significant determinants of fertility. Moreover, the findings of this study indicate that educational level of mothers has negative impact on fertility. For current contraceptive users, the mean birth for the last five years is highest for Kenya followed by Tanzania. For those who never use contraception, the mean births for the last five years for Rwanda is lower as compared to Tanzania and Kenya. The mean births for working mothers is also lower than that of non-working mothers for all three countries. The study suggests that improving the educational level of mothers, increasing the use of contraception, and involving more women to work force can reduce fertility in the three countries.

Keywords: Children ever born; Fertility status; Negative binomial regression; Quasi-Poisson regression.

1. Introduction

Fertility is the principal factor in population dynamics. It is the main contributor to the change in the age and sex structure of a given population. High fertility negatively affects the health, economic and social wellbeing of any society. High fertility and the resulting population growth can cause the depletion of natural resources. The relationship between high fertility and economic growth is mostly negative as there are more mouths to feed with high population growth. Families with substantial number of children are less likely to have quality education as school expenditure per family increases [1]. The risk of child mortality is high for families with enormous number of children. The rates of population growth are not the same in all parts of the world. Developed countries have lower fertility and mortality rates. In developing countries, fertility rates are higher due to the lack of access to contraceptives and generally lower levels of female education. The main issue in developed world is population ageing [2]. The lower fertility rates coupled with low mortality rates lead to the growing number and proportion of elderly persons in developed world. Population ageing will tend to lower labor-force participation since it increases the proportion of economically inactive population. This issue raises concern among developed nations as it might slow future economic growth. Now, the issue of population ageing has received renewed attention in many developed countries. The recent abandoning of one child policy by China also indicates that China (although not categorized as developed country) has faced the problem of aging population. In Sub-Saharan Africa, total fertility was 5.1 births per woman from 2005 to 2010 [3]. This was more than twice the replacement level of fertility. In 2010, there were only five countries with a total fertility rate (TFR) of less than 4 children. These are Cape Verde (2.9), the Republic of South Africa (2.1), Lesotho (3.3), Namibia (3.6) and Swaziland (3.8). The estimated total fertility rate (TFR) for 2005-2010 has increased in several countries, including by more than 5 per cent in 15 high-fertility countries from sub-Saharan Africa [4]. Resources for supporting such population growth in terms of health, education, housing, jobs, food, water, and security do not match the current economic growth of sub-Saharan Africa. More than half of global population growth between now and 2050 is expected to occur in Africa. Africa has the highest rate of population growth among major areas, growing at a pace of 2.55 per cent annually between 2010-2015 [3]. Therefore, high fertility rate remains a considerable problem in Sub-Saharan Africa.

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Eastern part of Africa is the poorest and least developed part of the world. Although fertility has declined in recent years, it remained high in east Africa compared to the other part of the world. The decline in fertility is slow in this region and some countries still experiencing highest birth rate. For instance, Somalia is among the top countries with the highest birth rate (40.87 per 1000 births in 2014) in the world [5]. Ethiopia is the other east African country which is the second most populous country in Sub-Saharan Africa. The east African region has also Tanzania with total population nearly 50 million according to 2014 estimates with a growth rate of 2.8%. The median age of the population of Tanzania is 17.4 years which indicates a very young population and its possible contribution towards high population growth. The rate of urbanization in this region low. The urbanization rate for Kenya is 25.2% based on 2014 estimate while it is 19.1% for Rwanda based on 2011 estimate [5]. The less the level of urbanization the more will be the fertility. Therefore, the eastern African region will contribute considerable amount to the future population of the world due to its high fertility rate.

Fertility estimates in Kenya are available starting from the 1962 Post Enumeration Sample Census, the 1969 Census and the 1977 National Demographic Survey. These sources indicate a dramatic increase in fertility from 5.3 births per woman in 1962 to 8 births per woman in 1977. Cohen [7] finds that Kenya and Tanzania are among those countries for which distinct patterns of fertility decline have emerged. Kirk and Pillet [6] have categorized the two countries with those countries that have more advanced fertility transition. In the same study, Rwanda was classified among those countries with less advanced fertility transition [6, 7]. However, this is in the past. The latest information shows contrary to what was observed in the past. According to United Nations, Department of Economics and Social Affairs, and Population Division ,2015, Tanzania is among the high fertility countries that have experienced only limited fertility decline. Between 2015 and 2050, half of the world's population growth is expected to be concentrated in nine countries and Tanzania is one of them. Tanzania is also among those countries whose population is projected to increase at least five-fold between 2015 and 2100. Although Kenya and Rwanda are not among these nine countries they are among the countries with lower median age. The median age, that is, the age at which half of the population is older and half is younger, is 18.9 years and 19.2 years for Kenya and Rwanda respectively [8]. The median age at first birth is 20.3 years for Kenya and 23 years for Rwanda based on the 2014 estimates. Age at first birth has a direct effect on fertility. Early initiation of childbearing lengthens the reproductive period and subsequently increases the fertility level of a woman [9]. Numerous studies show that women who begin reproduction at an early age are likely not only to have more children but are also more likely to experience a higher level of unwelcome births later in their reproductive life [10, 11]. The arguments outlined above suggest that the serious problems of high fertility in the three countries need substantial attention.

2. Methods and Materials

2.2. Study Materials and Setting

This study uses secondary data, records from Demographic and Health Surveys (DHS) conducted in Kenya, Rwanda and Tanzania. The study was cross-sectional, targeted for 40,3000 households from 1,612 clusters spread across the country, with 995 clusters in rural areas and 617 in urban areas in Kenya for 2014 DHS. Similarly, in Rwanda a total of 12,793 households were selected, of which 12,717 were occupied at the time of the survey with 492 clusters were selected, 113 in urban areas and 379 in rural areas. In Tanzania, a total of 608 clusters prior to the fieldwork were selected. In the survey, a representative probability sample of 13,376 households for the 2015-16 were included. All women aged 15 – 49 and men aged 15 – 54 were included in the surveys [12-14].

2.3. Sample Size and Sampling Technique

For Kenya, the sample for the 2014 KDHS was drawn from a master sampling frame, the Fifth National Sample Survey and Evaluation Programme. The clusters were drawn with a stratified probability proportional to size sampling methodology from 96,251 enumeration areas (EAs) in the 2009 Kenya Population and Housing Census. For the survey, two subsamples from the sampling frame were developed in 2013. The total size of Kenya is divided into 47 counties that serve as devolved units of administration. Each of the 47 counties was stratified into urban and rural strata; since Nairobi county and Mombasa county have only urban areas, with a total of 92 sampling strata [12].

For Rwanda, the sampling frame used for the 2014-15 RDHS was the 2012 Rwanda Population and Housing Census (RPHC). The sampling frame consisted of a list of enumeration areas (EAs) covering the entire country. An EA in Rwanda, is a village or part of a village created for the 2012 RPHC. The 2014-15 RDHS followed a two-stage sample design and was intended to allow estimates of key indicators at the national level as well as for urban and rural areas, five provinces, and each of Rwanda's 30 districts [14].

The sample design for the 2015-16 TDHS-MIS was done in two stages and was intended to provide estimates for the entire country, for urban and rural areas in Tanzania Mainland, and for Zanzibar. The sampling frame used for the 2015 TDHS is the Tanzania Population and Housing Census, which was conducted in Tanzania in 2012. The sampling frame is a complete list of enumeration areas (EAs) covering the country in Tanzania, The first stage involved selecting sample points (clusters), consisting of enumeration areas (EAs) delineated for the 2012 Tanzania Population and Housing Census [13].

2.4. Data Collection tools and Procedures

In Kenya, fieldwork for the main survey took place from May 7 to October 20, 2014. Field staff was divided into 48 teams according to counties and languages spoken in the areas where they conducted the interviews. Each team had one supervisor, one field editor, three female interviewers, one male interviewer, a driver, and a vehicle. Data collection was overseen by 18 coordinators who had also served as trainers during the pretest and main training and by a staff of 28 quality assurance personnel.

Data collection for the 2014-15 RDHS was carried out by 17 field teams from November 9, 2014, to April 8, 2015. Each team was provided a vehicle with a driver. All questionnaires and blood specimens were transferred to the NISR office every 3-4 days by 10 supervisors from the NISR and NRL/RBC who also coordinated and supervised fieldwork activities. ICF International provided technical assistance during the entire five months of data collection period.

In Tanzania, data collection was carried out by 16 field teams: three teams in Zanzibar and 13 teams on Tanzania Mainland. The teams consisted of a team supervisor, four female interviewers, one male interviewer, and one field editor, who also entered data into a tablet. The field editor and supervisor were responsible for reviewing all questionnaires for completeness, quality, and consistency before entering data into the tablet. Data collection was conducted from August 2015 to March 2016 [12-14].

2.5. Variable of Interest

The variable of interest for this study was births in the last five years. The response variable was count data.

2.6. Independent Variable

The potential predictor variables for this study were type of Place of residence, educational level, currently pregnancy status, knowledge of ovulatory cycle, pattern of use, contraceptive use and intention, last birth a caesarean section, current marital status, number of union, recent sexual activity, unmet need, working status, total children ever born, number of household members, number of children 5 and under in household, duration of current pregnancy, month pregnancy ended, age of respondent at 1st birth, age at first cohabitation and age at first sex.

2.7. Statistical Methods

Poisson distribution is the standard model for count data. Therefore, it is important to review some fundamental concepts and describe results of the Poisson distribution. If the discrete random variable Y has Poisson distribution with intensity or rate parameter μ, μ > 0 and t is the exposure defined as the length of time which the event recorded, then Y has the density [15].

$$P\ (Y = y) = \frac{e^{-\mu t}(\mu t)^{y}}{y!}, \quad y = 0, 1, \ldots \qquad (1)$$

where $E(y) = var(y) = \mu t$. If we assume that the time period equals to unity, then equation (1) equals

$$P\ (Y = y) = \frac{\boldsymbol{e^{-\mu}(\mu)^{y}}}{\boldsymbol{y!}}, \quad y = 0, 1, \ldots \qquad (2)$$

Equality of mean and variance of Poisson distribution is denoted as the equi-dispersion property. This property is mostly violated in real life data [16]. The method of maximum likelihood estimation for generalized linear models is usually used to estimate the parameters [17]. For the definition of likelihood, it is important to specify the form of distribution of observation. To define quasi-likelihood function, the specification of the mean–variance relationship and then apply quasi-likelihood for parameter estimation is needed [18]. For Poisson model with over-dispersed effect, an extra parameter is included to estimates the magnitude of the variance other than the mean [19]. The effect of larger variance on P-Values is used for parameter estimate [20]. To accounts for the extra variance for a Quasi-Poisson model with the over-dispersed distribution, one alternative approach is to fit extra dispersion parameter. These parameters are mean, μ and over-dispersion parameter θ such that variance is a linear function of mean [21]. Therefore, for random variable y that follows Quasi-Poisson distribution,

$$E(y) = \mu \text{ and} \qquad (3)$$

$$var(y) = \emptyset\, E(Y) = \emptyset\, \mu$$

for $\emptyset > 1$, there is over-dispersion relative to Poisson distribution. The application of iteratively re-weighted least squares in the more general case involves working with weights. This weight can be given as $W^{*} = \frac{\mu}{\emptyset}$. This is related when variance is proportional to the mean. But, this implies that the value is not necessarily equal to mean. The estimator for Poison distribution is maximum Quasi-Poisson likelihood estimator. This model is known as Quasi-Poisson regression model [18]. The quasi- likelihood function $K(y_i, \mu_i)$ for each independent observation y_i can be defined as

$$\frac{\partial K(y_i, \mu_i)}{\partial \mu_i} = \frac{y_i - \mu_i}{V(\mu_i)}. \qquad (4)$$

Here, V is some known function and expectation, μ_i is some function of parameters β_i. The other alternative method to model over-dispersion is a negative binomial regression model [22]. This model has two parameters and a form of the Poisson distribution. The distribution's parameter is considered as random variable. Therefore, the first two moments of negative binomial regression model are

$$\text{Mean}, E(y) = \mu \text{ and}$$
$$\text{Variance}, var(y) = \mu\,(1 + \theta\,\mu) \quad (5)$$

For $\theta = 0$, there is no unobserved heterogeneity. Poison model is a special case of negative binomial for $\theta = 0$). But, for $\theta > 0$, variance will be greater than mean and this leads to over- dispersion [15]. Using weighted least squares; the models have a little difference when compared to weight-mean relation. This can be shown as follows [18],

$W = diag\,(\frac{\mu_i}{\theta}, \frac{\mu_2}{\theta}, \ldots, \frac{\mu_n}{\theta})$ for Quasi-Poisson and

$$W = diag\,(\frac{\mu_1}{1+k\mu_1}, \frac{\mu_2}{1+\mu_2}, \ldots, \frac{\mu_n}{1+\mu_n}) \text{ for Negative Binomial} \quad (6)$$

for all other factors, equal to zero. The full comparison between Quasi-Poisson and negative binomial models where Quasi-Poisson weights are directly proportional to the mean and have concave relation to the mean of negative binomial based on the mean-weight relation that is given in equation (6) [18].

3. Data Analysis

At the initial stage, it is important to study the description of variables. These variables were summarized using descriptive statistics for continuous variable and proportions for categorical variables. To identify proximate determinants of fertility the data was analyzed using Quasi-Poisson regression model (generalized linear models). To identify the model that fits the data, the mean–variance relation, information criteria and the value of Chi square divided by its degree of freedom were used. To measure the extent of the fit of the model, change of deviance was used. By adding variables, the model was improved. After the model fit, the main effects and two-ways interaction effects were fitted. This was done by giving attention for hierarchical principle of model fitting. To find the cut-off points, the mean–variance relations for negative binomial and Quasi-Poisson were solved simultaneously. This was achieved by identifying the point where the two curves meet each other. Using the mean of response variable and cut-off points, the one with smaller variation for response variable was chosen. To select the model for analysis, the one with smallest information criteria and smallest dispersion parameter and its goodness-of-fit was assessed using Hosmer–Lemeshow goodness-of- fit statistic. To identify influential observations, Cook's distance against observations were used. For data analysis, SAS 9.4, SPSS version 24 and R version 3.2.3 were used.

4. Results

In Table 1A, the percentage distribution of the categorical variables was given. As the result indicates, out of the total respondents, 32.6% in Kenya, 22% in Rwanda and 23.4% in Tanzania were from urban areas while 67.4%, 78% and 76.6% were residing in rural areas for Kenya, Rwanda and Tanzania respectively. On the other hand, 58.5%, 85.7% and 78% were employed for Kenya, Rwanda and Tanzania respectively. From the total respondents in Kenya, Rwanda and Tanzania, 79.3%, 52.9 and 62.6% were married respectively and 6.2%, 8.8% and 4.9% were never in union for Kenya, Rwanda and Tanzania respectively. About 47.4% in Kenya, 48.3% in Rwanda and 34.9% in Tanzania of the respondents disclosed that currently using contraceptives. Based on contraceptive use and intention, 43.8%, 43.8% and 29.3% are using modern method for Kenya, Rwanda and Tanzania respectively. Lastly, 93.3%, 90.5% and 83.8% of the respondents have relationship once for Kenya, Rwanda and Tanzania respectively (Table 1A).

Births in the last five years count ranged from 1 to 5 births with mean 2, standard deviation 1 and median 2 for Kenya, 1 to 4 births with mean 2, standard deviation 1 and median 1 for Rwanda and 1 to 6 births with mean 2, Standard deviation 1 and median 2 for Tanzania (Table 1B). Respondent's current age ranged from 15 to 49 for Kenya, Rwanda and Tanzania. The mean age of respondents is 29, 30 and 29 for Kenya, Rwanda and Tanzania respectively (Table 1B). Similarly, Age at first sex ranges from 6 to 41, 6 to 29, and 8 to 42 with mean 17, 20 and 17 for Kenya, Rwanda and Tanzania respectively.

From Table 2, it can be observed that deviance was less than Pearson Chi square for both models, but AIC and BIC were smaller for Quasi-Poisson. This indicates that Quasi-Poisson model was preferable. Therefore, parameter estimation and identification of predictors of births in the last five years count should be conducted using the Quasi-Poisson model.

Therefore, the Quasi-Poisson and negative binomial regression models; are the appropriate models for fitting over-dispersed data. Various researchers [18, 21, 23, 24] studied and gave different decisions and comments about the models appropriate to over-dispersed data. Furthermore, for this study, comparison between the two models were performed. The comparison was done based on two approaches; comparing the values of log-likelihood, AIC and BIC to assess goodness-of-fit based on the data for the two models (Table 2) [25]. Moreover, the use of mean–variance and mean-weight relation and finding the cut-off- point (boundary value) where the two curves cross each other as is also valuable tool to compare the two results as given in Equations (3), (5), (6) and (Figure 1). Using separate predicted model of equation 3 and 5, i.e., two mean–variance relation equations, can give the cut-off point value. This technique will help to find the mean value that makes the two graphs cross each other. Therefore, if the mean of the response variable (Births in the last five years) is less than the cut-off point, negative binomial model can be considered. But, when mean of the response variable is greater than the cut-off point, then a Quasi-Poisson model can be considered (Figure 1) [18].

From Table 3, considering type of place of residence as a predictor variable, compared to urban residence, the expected births in the last five years count change difference was 0.018 (C.I. (0.002, 0.070). In other words, the

births in the last five years count change for rural was 0.018 times that higher compared to urban respondents. For educational level of respondents, the log of expected births in the last five years count change decreased by 0.014, 0.054 and 0.03 for primary, secondary and higher educational level respectively compared to respondents who have no education.

The other predictor variable with significant effect on the variable of interest was found to be contraceptive use and intention (Table 3). For the log of births in the last five years count change decreases by 0.083 for traditional method and increased by 0.68 for non-user or intend to use later compared to using modern methods. Unmet need was found to be significant predictor for births in the last five years count (Table 3). As can be seen in the table, for failure for spacing and limiting, not married/no sex in last 30 days, infecund, menopausal and no unmet need by 0.008, 0.126, 0.171 and 0.042, respectively for births in the last five years decreases as compared to unmet need for spacing and limiting.

Interaction effect between country of study and pattern of contraceptive use found to be significant (Table 4). The result is presented in Figure 2. Based on the figure, current contraceptive users have higher mean birth for Kenya followed by Tanzania for births in the last five years. But, current users are small for Rwanda. In contrast, respondents who have used contraceptive before last birth have higher births in the last five years in Tanzania followed by Kenya compared to Rwanda. Similarly, respondents who used contraceptives since last birth have higher births (in the last five years) in Tanzania followed by Kenya compared to Rwanda. Respondents with births in the last five years who have never used contraceptive are higher for Kenya followed by Tanzania compared to Rwanda.

The mean of births in the last five years is higher in Tanzania among respondents who use of contraceptive methods (Figure 3). But, for Kenya and Rwanda, births in the last five years is higher for respondents who does not intend to use any contraceptives. In contrary, the highest births in the last five years is occurred among respondents who are using traditional contraceptive methods for Tanzania. Respondents who uses modern contraceptive have lower births in the last five years for the three countries.

Another significant interaction effect on mean births in the last five years count was between country of study and working status. The result is presented in Figure 4. The result indicates that for respondents who are not working, the highest mean births in the last five years was found for Tanzania followed by Kenya and Rwanda. In contrary, the lowest mean births in the last five years was found for respondents who are working was found for Kenya followed by Tanzania and Rwanda.

The other interaction effect which was found to be significant is between country of study and age of respondent (Table 3). The mean births in the last five years for respondents who lives in the three countries increases as age of respondents increases (Figure 5). But, the highest births in the last five years was found to be in Tanzania followed by Rwanda and Kenya. The rate of increase is 0.003, 0.012 and 0.032 for Kenya, Rwanda and Tanzania respectively.

From Table 4, the interaction effect found to be significant between country of study and age of respondent. The mean births in the last five years for respondents who lives in the three countries increases as age of respondents at 1st birth increases (Figure 6). Unlike for the case of age of respondents, the highest births in the last five years was found to be in Tanzania followed by Kenya and Rwanda. The rate of increase is 0.023, 0.012 and 0.047 for Kenya, Rwanda and Tanzania respectively.

The other interaction effect which was found to be significant is between country of study and total children ever born (Table 3). The mean births in the last five years for respondents who lives in the three countries increases as total children ever born increases (Figure 7). But, the highest births in the last five years was found to be in Tanzania followed by Kenya and Rwanda in relation to total children ever born. The rate of increase for total children ever born for the three countries was found to be 1.44, 1.27 and 1.64 for Kenya, Rwanda and Tanzania respectively.

5. Discussions

Regarding fertility in the Eastern African countries for the case of Kenya, Rwanda and Tanzania, mean of births in the last five years count was highly affected by type of Place of residence, educational level, currently pregnant, pattern of use, contraceptive use and intention, number of union, unmet need, working status, total children ever born, number of household members, month pregnancy ended, age of respondent at 1st birth, age at first cohabitation, age at first sex and current age of respondents. This finding can be supported by previous studies [6, 26].

Closer look at the desired fertility shows that Rwanda has the lowest average preference (3.3) followed by Kenya (3.8) and Tanzania (4.9). But, the difference between the actual fertility and the desired family size is significant in all three countries. Regarding fertility rate, the highest is in Tanzania and followed by Kenya and Rwanda [27]. The extent to which urban-rural differences in fertility are mostly linked to differences in educational level, age at first cohabitation and contraceptive use. The analyses specify that urban areas show a key role in the process of fertility reduction that is presently relating in sub-Saharan Africa. But, fertility is remaining stable in rural areas. In general, fertility falling in both settings but more rapidly in urban places. Contraceptive use, pattern of contraceptive use and unmet need have effects on mean births in the last five years count. These findings are showing encouraging progress in the three countries. Changes in contraceptive use and type are important indicators for the country of study for fertility decline. The study provides evidence to support the hypothesis that quality of services is a crucial element in raising the level of contraceptive prevalence and this leads to lowering fertility. But,

the magnitude of the effect of contraceptive on the mean of births in the last five years depends upon the country's level of socioeconomic status and development.

One of limitation of this study was that the interactions between variables were identified in model fit techniques which were not pre-specified or expected during data collection. Therefore, detail information on why these interactions affect the mean births in the last five years count change was not collected and therefore, the reason for some of these findings cannot be explained.

In conclusion, quasi-Poisson regression model was found to be a better fit for the given data, and variables that significantly predict the response variable were identified using this model. The result under this investigation indicated that births in the last five years had been affected by several factors. There should be a special attention and intervention for respondents to use contraceptive method, especially for those who have not used contraceptive and have no intention to use.

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Disclosure Statement

No potential conflict of interest was reported by the authors.

Authors' Contributions

DGA acquired the data, performed the analysis. DGA and SFM designed the research problem and drafted the manuscript. All authors discussed the results and implications and commented on the manuscript at all stages. All authors contributed extensively to the work presented in this paper. All authors read and approved the final manuscript.

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Table-1A. Distribution of respondents by different factor variables.

Variables		Kenya		Rwanda		Tanzania	
		No.	%	No.	%	No.	%
Type of place of residence	Urban	6828	32.6%	1725	22.0%	2392	23.4%
	Rural	14136	67.4%	6131	78.0%	7841	76.6%
Highest educational level	No education	4585	21.9%	1141	14.5%	2199	21.5%
	Primary	11055	52.7%	5624	71.6%	6170	60.3%
	Secondary	4003	19.1%	891	11.3%	1775	17.3%
	Higher	1321	6.3%	200	2.5%	89	0.9%
Respondent currently working	No	4182	41.5%	1126	14.3%	2252	22.0%
	Yes	5898	58.5%	6724	85.7%	7981	78.0%
Currently pregnant	No or unsure	19229	91.7%	7217	91.9%	9237	90.3%
	Yes	1735	8.3%	639	8.1%	996	9.7%
Current marital status	Never in union	1301	6.2%	693	8.8%	498	4.9%
	Married	16634	79.3%	4157	52.9%	6402	62.6%
	Living with partner	1136	5.4%	2294	29.2%	2206	21.6%
	Widowed	497	2.4%	155	2.0%	165	1.6%
	Divorced	391	1.9%	202	2.6%	478	4.7%
	No longer living together/separated	1005	4.8%	355	4.5%	484	4.7%
Knowledge of ovulatory cycle	During her period	348	3.5%	145	1.8%	200	2.0%
	After period ended	3636	36.1%	3883	49.5%	3939	38.5%
	Middle of the cycle	2408	23.9%	1508	19.2%	1916	18.7%
	Before period begins	1461	14.5%	993	12.7%	794	7.8%
	At any time	1338	13.3%	955	12.2%	2140	20.9%
	Other	7	0.1%	3	0.0%	10	0.1%
	Don't know	881	8.7%	356	4.5%	1233	12.1%
Ever had a terminated pregnancy	No	9113	90.3%	6676	85.0%	8478	82.8%
	Yes	977	9.7%	1180	15.0%	1755	17.2%
Pattern of use	Currently using	9940	47.4%	3793	48.3%	3572	34.9%
	Used since last birth	6470	30.9%	757	9.6%	924	9.0%
	Used before last birth	1155	5.5%	1180	15.0%	1354	13.2%
	Never used	3399	16.2%	2126	27.1%	4383	42.8%
Contraceptive use and intention	Using modern method	4419	43.8%	3439	43.8%	3002	29.3%
	Using traditional method	355	3.5%	354	4.5%	570	5.6%
	Non-user - intends to use later	2873	28.5%	3201	40.7%	4112	40.2%
	Does not intend to use	2445	24.2%	862	11.0%	2549	24.9%
Last birth a caesarean section	No	19534	93.3%	6765	86.1%	9663	94.4%
	Yes	1412	6.7%	1091	13.9%	570	5.6%
Currently breastfeeding	No	15303	73.0%	2376	30.2%	4297	42.0%
	Yes	5661	27.0%	5480	69.8%	5936	58.0%
Number of unions	Once	18090	93.3%	6486	90.5%	8152	83.8%
	More than once	1308	6.7%	677	9.5%	1581	16.2%
Ever been married or in union	No	1301	40.7%	693	49.3%	498	30.6%
	Formerly married	1585	49.6%	156	11.1%	618	38.0%
	Lived with a man	308	9.6%	556	39.6%	509	31.3%
Recent sexual activity	Active in last 4 weeks	6483	64.3%	6054	77.1%	6973	68.1%
	Not active in last 4 weeks (postpartum abstinence)	1558	15.5%	829	10.6%	1712	16.7%
	Not active in last 4 weeks (not postpartum abstinence)	2035	20.2%	970	12.4%	1548	15.1%
Unmet need	Unmet need for spacing and limiting	2081	20.7%	1534	19.5%	2854	27.9%
	Using for limiting and spacing	4774	47.4%	3793	48.3%	3572	35.0%
	Failure for spacing and limiting	180	1.8%	232	3.0%	154	1.5%
	Not married/no sex in last 30 days	853	8.5%	936	11.9%	875	8.6%
	Infecund, menopausal	118	1.2%	47	0.6%	88	0.9%
	No unmet need	2067	20.5%	1312	16.7%	2676	26.2%

Table-1B. Summary measures of different quantitative explanatory variables.

Variables	Kenya				
	Mean	**Median**	**Maximum**	**Minimum**	**SD**
Respondent's current age	29	28	49	15	7
Number of household members	6	5	23	1	2
Number of children 5 and under in household	2	2	7	0	1
Total children ever born	4	3	15	1	2
Births in last five years	2	2	5	1	1
Age of respondent at 1st birth	19	19	44	6	4
Duration of current pregnancy	5	5	9	1	2
Month pregnancy ended	6	6	12	1	3
Age at first cohabitation	19	18	44	9	4
Age at first sex	17	17	41	6	3
	Rwanda				
Respondent's current age	30	30	49	15	6
Number of household members	5	5	22	1	2
Number of children 5 and under in household	2	2	7	0	1
Total children ever born	3	3	13	1	2
Births in last five years	2	1	4	1	1
Age of respondent at 1st birth	22	22	41	12	4
Duration of current pregnancy	5	5	9	1	2
Month pregnancy ended	6	6	12	1	3
Age at first cohabitation	21	21	39	12	4
Age at first sex	20	20	39	6	4
	Tanzania				
Respondent's current age	29	28	49	15	7
Number of household members	7	6	48	1	4
Number of children 5 and under in household	2	2	16	0	1
Total children ever born	4	3	17	1	3
Births in last five years	2	2	6	1	1
Age of respondent at 1st birth	19	19	46	7	3
Duration of current pregnancy	5	5	9	1	2
Month pregnancy ended	6	6	12	1	3
Age at first cohabitation	19	18	42	7	4
Age at first sex	17	16	42	8	3

Table-2. Comparison of Quasi-Poisson and Negative Binomial using information criteria

	Quasi-Poisson			**Negative Binomial**		
	Value	**df**	**Value/df**	**Value**	**df**	**Value/df**
Deviance	3300.17	2687	1.228	2928.02	2687	1.090
Scaled Deviance	3300.17	2687		2928.02	2687	
Pearson Chi-Square	3339.93	2687	1.243	2949.42	2687	1.098
Scaled Pearson Chi-Square	3339.93	2687		2949.42	2687	
Log Likelihood [b]	-3379.77			-4506.24		
Akaike's Information Criterion (AIC) [a]	6761.54			9014.48		
Finite Sample Corrected AIC (AICC)	6761.54			9014.48		
Bayesian Information Criterion (BIC)	6767.44			9020.38		
Consistent AIC (CAIC)	6768.44			9021.38		

Dependent Variable: Births in last five years

a. Information criteria are in smaller-is-better form.

b. The full log likelihood function is displayed and used in computing information criteria.

Table-3. Parameter estimates for main effects using Quasi-Poisson model

Variables	Estimate	SE	t value	95 % C.I.	
				Lower	Upper
(Intercept)	0.353	0.055	6.378	0.244	0.461
Type of Place of residence (Ref. Urban)					
Rural	0.018	0.016	0.500	0.002	0.070
Educational level (Ref No education)					
Primary	-0.014	0.019	-0.696	-0.051	0.025
Secondary	-0.054	0.027	-2.003	-0.107	-0.001
Higher	-0.030	0.059	-0.508	-0.146	0.083
Currently Pregnant (Ref. No)					
Yes	0.048	0.039	1.217	-0.030	0.123
Knowledge of ovulatory cycle (Ref. During her period)					
After period ended	-0.080	0.044	-1.808	-0.165	0.008
Middle of the cycle	-0.040	0.045	-0.893	-0.128	0.049
Before period begins	-0.068	0.048	-1.416	-0.160	0.027
At any time	-0.011	0.046	-0.239	-0.100	0.080
Other	-0.632	0.451	-1.400	-1.665	0.142
Don't know	-0.023	0.048	-0.482	-0.116	0.072
Pattern of use (Ref. Currently use)					
Used since last birth	-0.019	0.045	-0.415	-0.107	0.069
Used before last birth	0.132	0.042	3.162	0.050	0.214
Never used	0.087	0.039	2.244	0.011	0.164
Contraceptive use and intention (Ref. Using modern method)					
Using traditional method	-0.086	0.064	-1.349	-0.214	0.037
Non-user - intends to use later	0.066	0.019	3.399	0.028	0.104
Last birth a caesarean section (Ref. No)					
Yes	-0.042	0.028	-1.514	-0.098	0.012
Current marital status (Ref. Never in union)					
Divorced	0.007	0.021	0.338	-0.033	0.047
No longer living together/separated	0.022	0.020	1.094	-0.017	0.060
Number of union (Ref. Once)					
More than once	0.040	0.019	2.108	0.003	0.077
Recent sexual activity (Ref. Active in the last 4 weeks)					
Not active in last 4 weeks - postpartum abstinence	0.022	0.030	0.742	-0.036	0.081
Not active in last 4 weeks - not postpartum abstinence	0.032	0.026	1.211	-0.019	0.083
Unmet need (Ref. Unmet need for spacing and limiting)					
Failure for spacing and limiting	-0.008	0.063	-0.131	-0.133	0.115
Not married/no sex in last 30 days	-0.135	0.039	-3.429	-0.212	-0.058
Infecund, menopausal	-0.188	0.083	-2.261	-0.354	-0.028
No unmet need	-0.043	0.050	-0.854	-0.141	0.055
Working status (Ref. No)					
Yes	-0.063	0.019	-3.386	-0.100	-0.027
Total children ever born	0.055	0.008	6.907	0.039	0.070
Number of household members	-0.042	0.007	-6.018	-0.055	-0.028
Number of children 5 and under in household	0.186	0.020	9.193	0.146	0.225
Duration of current pregnancy	0.004	0.007	0.600	-0.010	0.018
Month pregnancy ended	0.001	0.005	0.301	-0.008	0.011
Age of respondent at 1st birth	0.001	0.009	0.091	-0.017	0.018
Age at first cohabitation	0.002	0.008	0.242	-0.015	0.019
Age at first sex	0.013	0.008	1.651	-0.002	0.029

Table-4. Parameter estimates for interaction effects using Quasi-Poisson model

Coefficients			Estimate	Standard Error	t value	Wald 95% Confidence Limits	
Country of study and pattern of use (Ref. Used since last birth)							
	Kenya	Currently using	0.094	0.149	0.390	-0.199	0.387
		Never used	0.390	0.071	30.530	0.252	0.529
		Used before last birth	0.331	0.073	20.820	0.189	0.474
	Rwanda	Currently using	-0.245	0.292	0.710	-0.818	0.327
		Never used	0.068	0.072	0.910	-0.072	0.209
		Used before last birth	0.408	0.079	26.710	0.254	0.563
	Tanzania	Currently using	-0.067	0.141	0.230	-0.343	0.208
		Never used	0.322	0.059	29.500	0.206	0.438
		Used before last birth	0.314	0.068	21.350	0.181	0.447
Country of study and Contraceptive use and intention (Ref. Using traditional method)							
	Kenya	Does not intend to use	-0.202	0.052	15.300	-0.303	-0.101
		Using modern method	0.074	0.142	0.270	-0.205	0.352
	Rwanda	Does not intend to use	-0.136	0.056	5.830	-0.247	-0.026
		Using modern method	0.304	0.289	1.110	-0.262	0.870
	Tanzania	Does not intend to use	-0.186	0.045	16.770	-0.275	-0.097
		Using modern method	0.136	0.135	1.020	-0.127	0.400
Country of Study and Number of union (Ref. Once)							
	Kenya	More than once	0.168	0.057	8.590	0.056	0.280
	Rwanda	More than once	-0.023	0.058	0.160	-0.137	0.090
	Tanzania	More than once	0.063	0.043	2.130	-0.022	0.149
Country of Study and Recent sexual activity (Ref. Not active in last 4 weeks - postpartum abstinence)							
	Kenya	Active in last 4 weeks	-0.149	0.060	6.250	-0.266	-0.032
		Not active in last 4 weeks - not postpartum abstinence	-0.185	0.046	16.540	-0.275	-0.096
	Rwanda	Active in last 4 weeks	-0.114	0.076	2.240	-0.263	0.035
		Not active in last 4 weeks - not postpartum abstinence	-0.053	0.052	1.030	-0.155	0.049
	Tanzania	Active in last 4 weeks	-0.011	0.051	0.050	-0.112	0.090
		Not active in last 4 weeks - not postpartum abstinence	-0.033	0.044	0.580	-0.119	0.052
Country of Study and Respondents currently working (Ref. Yes)							
	Kenya	No	0.063	0.044	2.090	-0.022	0.149
	Rwanda	No	0.177	0.068	6.780	0.044	0.311
	Tanzania	No	0.107	0.053	4.140	0.004	0.210
Country of Study and respondent's current age							
	Kenya		-0.072	0.002	49.810	-0.075	-0.068
	Rwanda		-0.069	0.002	98.150	-0.073	-0.065
	Tanzania		-0.093	0.002	63.500	-0.096	-0.089
Country of Study and age of respondents at 1st birth							
	Kenya		0.052	0.003	344.650	0.047	0.058
	Rwanda		0.053	0.004	192.650	0.046	0.061
	Tanzania		0.532	0.073	52.770	0.388	0.675
Country of Study and age at first sex							
	Kenya		-0.002	0.002	0.450	-0.006	0.003
	Rwanda		-0.009	0.003	7.880	-0.015	-0.003
	Tanzania		0.006	0.003	4.540	0.001	0.011
Country of Study and age at first cohabitation							
	Kenya		0.012	0.002	27.830	0.007	0.016
	Rwanda		0.024	0.003	63.250	0.018	0.294
	Tanzania		0.016	0.002	44.340	0.011	0.020

Country of Study and children everborn						
	Kenya	0.226	0.005	77.470	0.217	0.236
	Rwanda	0.227	0.006	31.940	0.215	0.240
	Tanzania	0.302	0.005	46.360	0.293	0.311
Country of Study and number of household members						
	Kenya	-0.046	0.003	263.600	-0.051	-0.040
	Rwanda	-0.044	0.004	133.760	-0.051	-0.036
	Tanzania	-0.045	0.002	571.930	-0.048	-0.041
Country of Study and number of children 5 and under						
	Kenya	0.402	0.007	39.850	0.388	0.415
	Rwanda	0.448	0.008	43.340	0.432	0.463
	Tanzania	0.199	0.006	59.190	0.188	0.210

Figure-1. Mean-weight relationship for Quasi-Poisson and Negative Binomial models

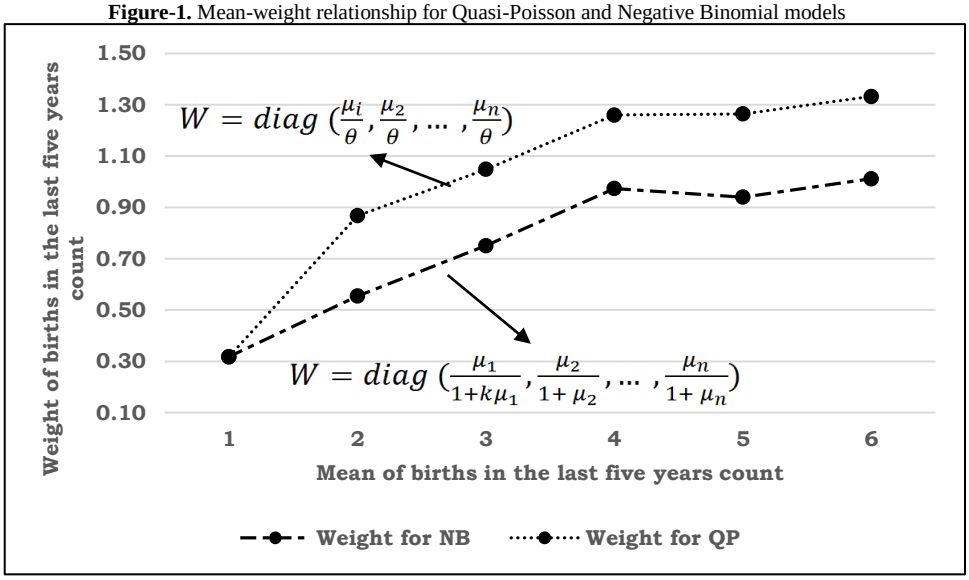

Figure-2. Interaction plot between country of study and Pattern of contraceptive use

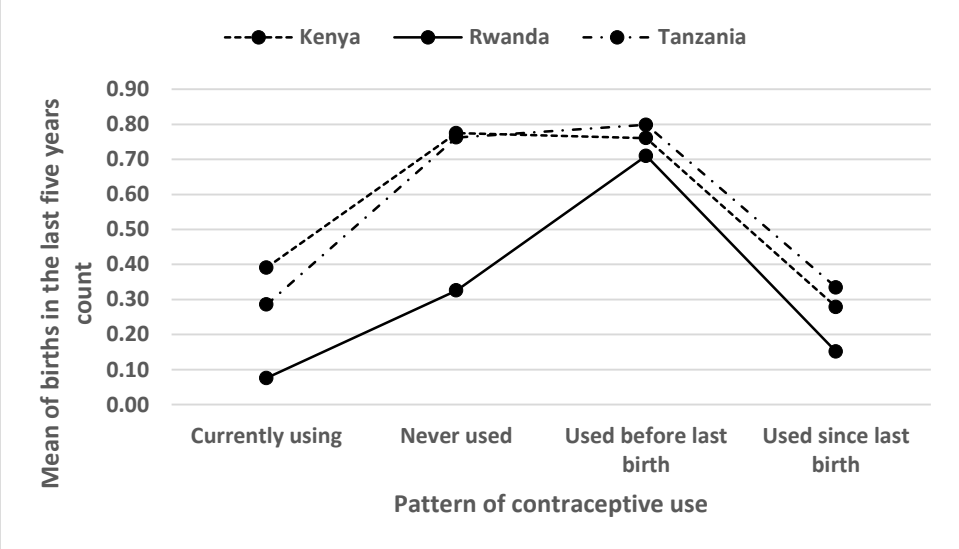

Figure-3. Interaction plot between country of study and contraceptive use

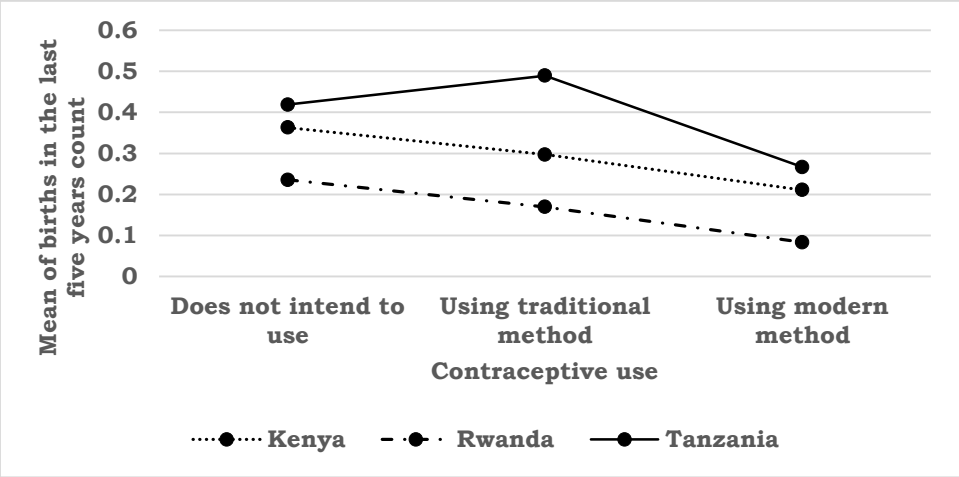

Figure-4. Interaction plot between country of study and working status

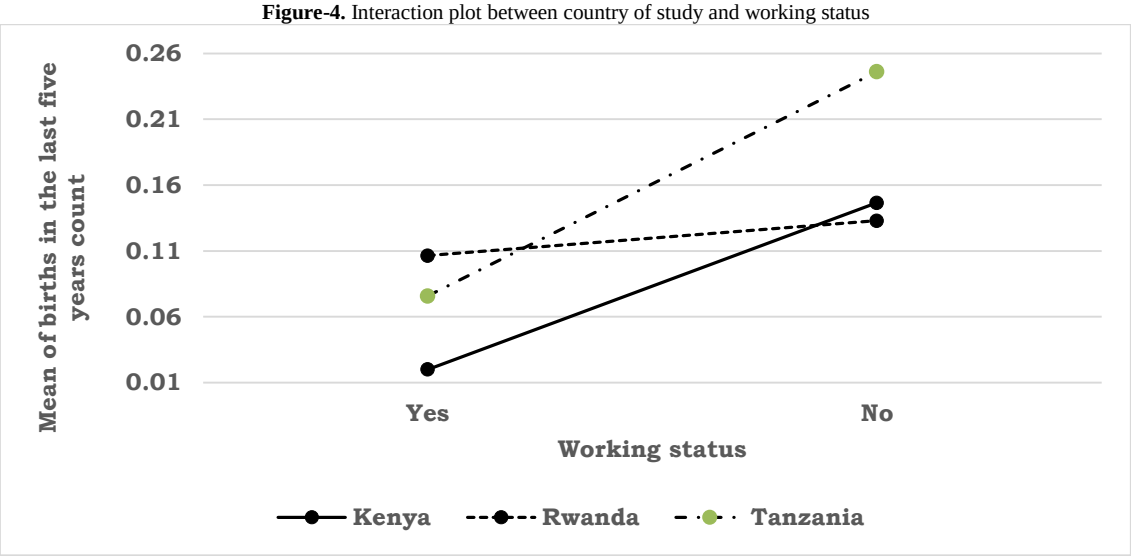

Figure-5. Interaction plot between country of study and age of respondents

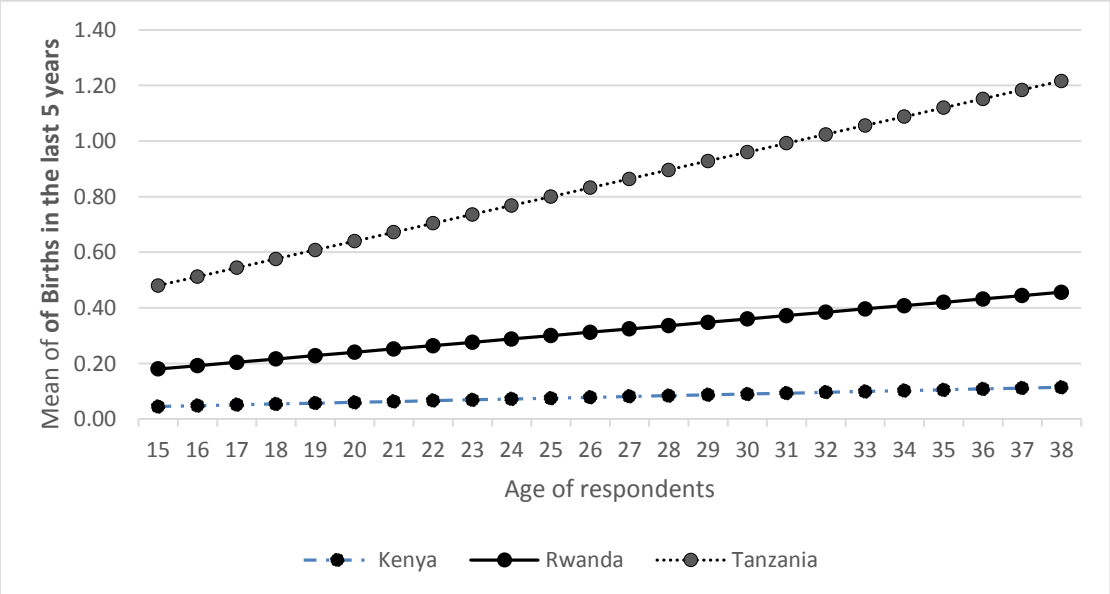

Figure-6. Interaction plot between country of study and age of respondents at 1st birth

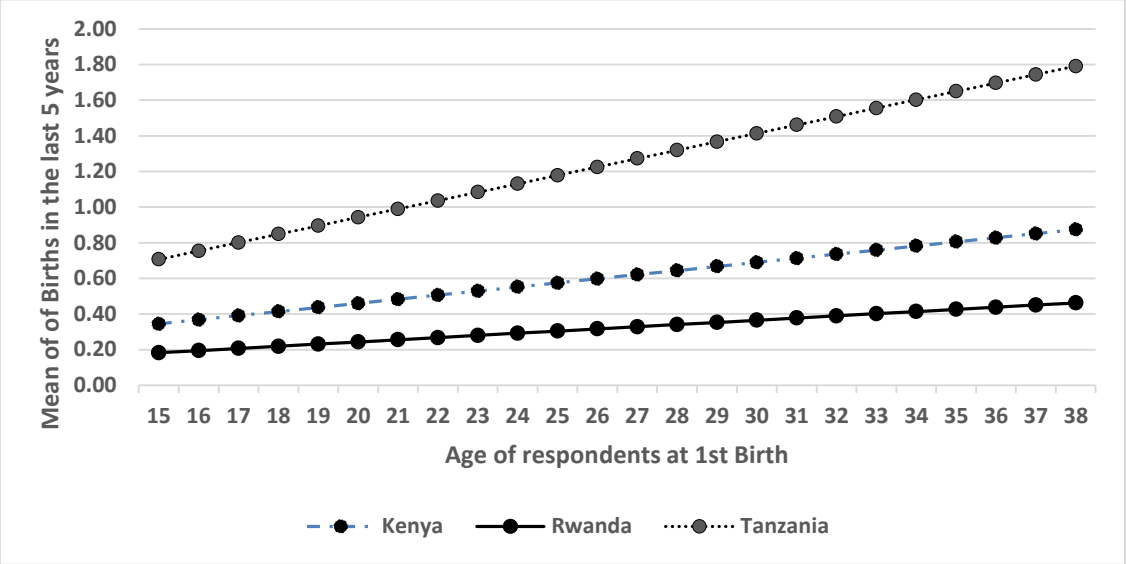

Figure-7. Interaction plot between country of study and total children ever born