MODELLING DETERMINANTS OF CHOICE OF CONTRACEPTIVE METHODS IN RWANDA

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Abstract: **The purpose of this research project is to model determinants of choices of contraceptive methods in Rwanda. Reviews show that Rwanda has dramatically increased the contraceptive prevalence rate from 4% in 2000 to 29% in 2010. Injectables dominates the national contraceptive prevalence in Rwanda (50.9) but no clear patterns about this selection. To inform policy makers, a secondary analysis of RDH2010 was done. Descriptive statistics was used to summarize categorical data, and chi-square test was used to show dependence between covariates and outcome. The test of collinearity between explanatory variables was done prior fitting a bi- and multi-variable multinomial logistic models so to produce a multivariate efficient model. Results have shown that relative to injectables, older women (35+ years), women with secondary or higher education and women with higher parity were more likely to choose sterilization (RRR=12.0, p=0.028; RRR=2.5, p=0.049; RRR=3.5, p=0.040), IUD (RRR=5.9, p=0.04; RRR=7.2, p=0.012; RRR=1.5, p=0.006) than their counterparts. Rural residents and unemployed women or women involved in informal agricultural activities were less likely to use sterilization (RRR=0.5, p=0.041; RRR=0.4, p=0.026) relative to the use of injectables than their fellow rural and employed women. Partner's approval has a significant effect on the choice of sterilization (RRR=14.3, p=0.002) and barrier methods (RRR=6.0, p<0.001) over injectables. To increase contraception uptake, we recommend spousal involvement and giving priority and more focus on rural, non-educated and unemployed women by raising their awareness about a variety, free choice of contraceptive methods and their reproductive health.**

Keywords: **Family planning, contraceptive methods, contraceptive prevalence, multinomial logistic, relative risk ratio.**

I. INTRODUCTION

1.1. Problem statement:

Despite various global, regional and national initiatives to improve maternal and child health outcomes, eradicate poverty; population growth remains a barrier to development for many countries, particularly the low-income settings.

Rapid population growth is closely linked to persistent poverty as it reduces overall economic growth and prospects for poverty reduction. It strains the environment as competition for scarce resources and public goods expands [1].

The World population is expected to rise from 7.3 billion today to 9.7 billion by 2050, and virtually all this future growth will be concentrated in the world's less-developed countries, especially in Africa. The United Nations, as of mid-2015, estimated approximately 83 million people being added every year and roughly a quarter of this growth occurring in the least developed countries [2].

Family planning (FP) promotion, through increased access to FP and reproductive health services is a powerful tool of the reduction of poverty, and maternal and child mortality; empowerment of women by lightening the burden of excessive childbearing; and enhancement of environmental sustainability by lowering or stabilizing the population[3].

Contraceptive methods play a key role in family planning and there is no best method as beneficiaries' preference change overtime according to individuals' circumstances. Having choices and balanced information increases the likelihood that women and couples will choose a method and use it effectively. However, in many countries, contraceptive users rely on one or two methods due but not limited to government policies, the way that family planning programs have evolved, and cultural or social preference[4].

Rwanda has prioritized family planning as part of its effort to reduce the country's high population growth rate, address poverty, and achieve development goals[5].Despite its effort, modern contraceptive prevalence is still low (25.2%) among women in the reproductive age with the woman's fertility rate estimated at 4.6 [6] and the average annual population growth of 2.6%[7].

Failure to understanding factors influencing the choice of some contraceptive methods over others contributes to low contraceptive practices and constitutes a major problem for a family planning program to promote effective use and increase uptake of contraceptives. In addition, the high fertility rates subjected to the low contraceptive prevalence in the least developed countries, and specifically the sub-Saharan region, and in particular Rwanda is a serious challenge to sustainable development and a barrier to achieving development goals.

1.2. Objectives:

1.2.1. General objective:

To model the determinants influencing the choice of contraceptive methods in Rwanda.

1.2.2. Specific Objectives:

This study aimed at the following specific objectives:

1. To determine the distribution of typical contraceptive methods among users in Rwanda.
2. To identify potential demographic and socio-economic determinants associated with choice of contraceptive methods in Rwanda
3. To model potential determinants associated with choice of contraceptive methods in Rwanda.

1.3. Research questions:

1. How are typical contraceptive methods distributed by background characteristics among users in Rwanda?
2. What are the determinants associated with the choice of contraceptive methods in Rwanda?
3. What's the effect of demographic and socio-economic characteristics on the choice of contraceptive methods in Rwanda?

1.4. Justification:

Rwanda has one of the highest population density in Africa with 415 inhabitants per square kilometer. Its population is young with an average annual growth of 2.6% [7] and the fertility rate is high 4.6 [6]. Despite its effort to meet family planning needs and availability of wide range of contraceptive methods, predominance in method choice is skewed to some and little is known about drivers of preference of specific method relative to others. Therefore, identifying patterns and determinants of choice of contraceptive methods in Rwanda will help reinforce existing and orient new family planning interventions.

II. METHODOLOGY

2.1. Survey design:

This research is a secondary analysis of the 2010 Rwanda Demographic Health Survey (RDHS) datasets. DHSs are cross sectional, and usually repeated approximately every five years in low and middle income countries. In 2010 RDHS, all women aged 15-49 who were either permanent residents of the household or visitors present in the household on the night before the survey were eligible to be interviewed and a subsample of half of all households selected for the survey, all men aged 15-59 were eligible to be interviewed if they were either permanent residents or visitors present in the household on the night before the survey[6].

2.2. Sampling techniques:

The 2010 RDHS sample selection process was multi-stage sampling methods. In the first stage, the sample was geographically stratified in 30 districts. In every stratum, all primary sampling units (PSUs) that are villages typical to the enumeration areas of 2002 Rwanda Household and Populations Census were listed with their population size. Then a sample of 492 villages was selected with probability proportionate to village size.

In the second stage of sampling, a specific number of households were selected systematically from the selected villages depending on whether the village is classified as urban or rural. Village maps were used by planners to select which households would be included in the final sample and it is done outside of the field to prevent any conscious or subconscious bias [8].

Due to non-proportional allocation of the sample to the different provinces and to their districts and the possible differences in response rates, sampling weights is required for any analysis using 2010 RDHS data; this ensures the actual representativeness of the survey results at the national level as well as at the domain level. As the 2010 RDHS sample is a two-stage stratified cluster sample, sampling weights was calculated based on separate sampling probabilities for each sampling stage and for each cluster. The Following notations were used:

P_{1hi} : First-stage sampling probability of the i^{th} village in stratum *h*.

P_{2hi} : Second -stage sampling probability within the i^{th} village (household selection)

Let a_h be the number of villages selected in stratum h, M_{hi} be the total population according to the sampling frame in the i^{th} village and $\sum M_{hi}$ be the total population in the stratum *h*. The probability of selecting the i^{th} village in the 2010 RDHS sample is calculated as follows:

$$\frac{a_h M_{hi}}{\sum M_{hi}} \quad (1)$$

Let b_{hi}be the proportion of households in the selected segment compared with the total number of households in the village i in stratum h if the village is segmented; otherwise b_{hi} =1. Then the probability of selecting village i in the sample is:

$$P_{1hi} = \frac{a_h M_{hi}}{\sum M_{hi}} * b_{hi} \quad (2)$$

A 2010 RDHS cluster is either a village or a segment of a large village. Let L_{hi} be the number of households listed in the household listing operation in the cluster *i* in stratum *h*. Let g_{hi} be the number of households selected in the cluster. The second stage's selection probability for each household in the cluster is calculated as follows:

$$P_{2hi} = \frac{g_{hi}}{L_{hi}} \quad (3)$$

The overall selection probability of each household in cluster i of stratum h is therefore the production of the two stages of selection probabilities:

$$P_{hi} = P_{1hi} * P_{2hi} \quad (4)$$

The design weight for each household in cluster *i* of stratum h is the inverse of its overall selection probability:

$$W_{hi} = \frac{1}{P_{hi}} \quad (5)$$

The next is design weights, design weights was adjusted for household nonresponse as well as for individual non-response to get the sampling weights for women's and men's surveys, respectively. The differences in the household sampling weights and the individual sampling weights are introduced by individual nonresponse. The final sampling weights was normalized to give the total number of unweighted cases, equal to the total number of weighted cases at the national level, for both household weights and individual weights, respectively. The normalized weights are relative weights, which are valid for estimating means, proportions, and ratios.

2.3. Data analysis

2.3.1. Descriptive analysis:

This analysis covered descriptive statistics using percentages to summarize categorical data and at times graphs for data visualization.

2.3.2. Bivariate analysis using Pearson Chi-square test of independence:

Chi-square test, is a non-parametric statistical test used to see if there is a relationship between two categorical variables, it is also used as a test of goodness-of-fit [9]. This test of independence was first introduced in 1900s by Karl Pearson [10].

The computation of the Pearson chi-squared test statistic denoted by χ^2 is given by the formula:

$$\chi^2 = \sum_{ij} \frac{(O_{ij} - E_{ij})^2}{E_{ij}}$$

Where O_{ij} and E_{ij} stand respectively for observed and expected frequencies. This statistic approximates the chi-square distribution with degrees of freedom, $df = (I-1)(J-1)$, where I and J stand respectively for number of rows and columns in the contingency table. To determine the significance of the test, the computed χ^2 statistic is compared to a critical χ^2 -value read through chi-square table for a chosen α-level. We reject the null hypothesis (H_0) that states no association between independent and dependent variables if the Pearson chi-squared statistic χ^2 is greater than the critical value $\chi^2_{\alpha,df}$ (i.e. Reject if $\chi^2 \geq \chi^2_{\alpha,df}$) or simply if the p-value (that is the probability of rejecting H_0 when it is true) was less than the α-level [11].

The chi-squared value χ^2 takes its minimum value of zero when all $O_{ij} = E_{ij}$. For a fixed sample n, greater differences $\{O_{ij} - E_{ij}\}$ results in larger χ^2 and suggest stronger evidence against H_0. Since larger χ^2 values are more contradictory to H_0 the p-value is the null probability that χ2 is at least as large as the observed value [12].The chi-square test assumes that cells expected values should be 5 or more in at least 80% of the cells in the contingency, and no cell should have an expected value of less than one [13].

In the context of our research, the chi-square test helped to identify potential covariates that were worth testing in the model. If a variable was independently associated with the outcome, it might continue to explain the outcome once other factors were taken into consideration. Hence, when bivariate statistics were used for the purpose of filtering potential covariates for the regression analysis, we used a generous threshold of *p-value<0.1* to ensure that we do not drop any potentially useful variable from the analysis. The same statistical test was used to compare two groups in logistic regression. The only difference was in purpose of the test, and therefore our interpretation of its results was also different.

Pearson's chi-square was used to test whether the distribution in a categorical variable was statistically different in two or more groups and if a p-value less than the threshold was obtained, then, the difference between the two comparing groups was recognized.

Prior the fitting of a multivariable model whether a general explanatory model, we tested for collinearity. Collinearity occurs when two covariates in a multivariable model are highly related; usually this is because the two variables represent the same thing (the same concept or they happen simultaneously). As a result, the model becomes unstable. To produce parsimonious multivariable model, and to prevent strange, unstable results, we tested for strong associations among covariates and removed any collinear covariates from the analysis.

The Pearson's R correlation coefficient was used to identify binary, ordinal, and continuous covariates that are correlated. Correlations of *r>0.5* was considered as collinear. When two or more covariates were found to be collinear, we would keep the one variable that was the most strongly associated with the outcome, unless there was a conceptual reason to keep one over the other.

2.3.3. Introduction to regression analysis:

Regression is one of the most popular statistical tools to study dependence of one variable with respect to another or more explanatory variables. It was introduced by Sir Francis Galton back in 1889 in his book "Natural Inheritance" while describing certain genetic relationships[14]. Its process of finding a mathematical equation that best fits the noisy data and there are two main forms of regression namely linear regression and non-linear regression.

Linear regression is a method for modelling the relationship between a scalar dependent variable y and one or more explanatory variables denoted X. Data are modelled using linear predictor functions, and unknown model parameters are estimated from the data [15].

Considering a random continuous variable Y and a set of non-random continuous predictors $X_1, X_2, X_3, \ldots, X_k$. A general linear model relating the random outcome variable Y to the predictors $X_1, X_2, X_3, \ldots, X_k$ is an equation of the form:

$$y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots.. + \beta_k x_k + \varepsilon \quad \textbf{(1)}$$

Where $\beta_0, \beta_1, \ldots, \beta_k$ are unknown regression coefficients referred to as model parameters and ε stands for the error term.

In a case a simple linear regression model where we have a single predictor variable, equation (1) reduces to:

$$y = \beta_0 + \beta_1 x + \varepsilon \quad \textbf{(2)}$$

The assumptions underlying the linear model are as follows:

- The relation is, in fact, linear, so that the errors all have expected value zero:

$$E(\varepsilon_i) = 0 \forall i, i = 1, \ldots., k \quad \text{i.e.} \quad E(y) = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \ldots.. + \beta_k x_k$$

- The errors all have the same variance:

$$Var(\varepsilon_i) = \sigma^2 \forall i, i = 1, \ldots., k$$

- The errors are independent of each other.
- The errors are all normally distributed; ε_i is normally distributed for all i.

From the generalization of ordinary linear regression, derive logistic regression a non-linear regression which is meant to measure the relationship between the categorical dependent variable and one or more independent variables, which are usually but not necessarily continuous, by estimating probabilities using a logistic function. In case of binary dependent variable, we have binary logic regression while in case of polychotomous dependent variable, use of multinomial logistic regression is appropriate. The use of logistic modelling has exploded during the past decades. From its original acceptance in epidemiologic research, the method is now commonly employed in many fields including but not limited to biomedical research, business and finance, criminology, ecology, health policy, linguistic and wild biology [16].

In many research studies, the response variable may be represented as one of two possible values. Thus, the response variable is a binary random variable taking on the values **0** and **1**. When the response variable y is binary, the distribution of y reduces to a single value, the probability $p = P(y = 1)$. We can relate *p* to a linear combination with the independent variables. The difficulty is that *p* varies between zero and one, whereas linear combinations of the explanatory variables can vary between $-\infty$ and $+\infty$. Using the transformation of probabilities into an odds ratio, as the probabilities vary between 0 and 1, the odds ratio varies between 0 and $+\infty$. By taking the natural logarithm of the odds ratio, we will have a transformed variable that will vary between $-\infty$ and $+\infty$ when the probabilities vary between 0 and 1 [17].

The model often used to study the association between a binary response and a set of explanatory variables is given by **binary logistic regression analysis.** In this model, the natural logarithm of the odds ratio is related to the explanatory variables by a linear model. We will consider the situation where we have a single independent variable, but this model can be generalized to multiple independent variables. Let $p(x)$ be the probability that y equals 1 when the independent variable equals x. We model the log-odds ratio to a linear model in x, a **simple logistic regression model:**

$$\ln\left(\frac{p(x)}{1-p(x)}\right)=\beta_0+\beta_1 x \qquad \textbf{(3)}$$

This transformation can be formulated directly in terms of $p(x)$.

We can interpret the parameters β_0 and β_1 in the logistic regression model in terms of $p(x)$. The intercept parameter β_0 permits the estimation of the probability of the event associated with y=1 when the independent variable x=0. The slope parameter β_1 measures the degree of association between the probability of the event occurring and the value of the independent variable x. When β_1=0, the probability of the event occurring is not associated with size of the value of x. If β_1>0, the probability of the event occurring increases as the value of the x increases. If β_1< 0, the probability of the event occurring decreases as the value of the independent variable increases. If both β_0=0 and β_1=0, the event occurring is unlikely to happen [17].

2.3.4. Multinomial logistic regression:

The multinomial logistic regression was used to construct a model explaining our outcome "*currently used contraceptive method*" because it's a polychotomous variable. Results were reported as relative risk ratios (odds ratios), a ratio of the odds that the outcome occurs over the odds the outcome does not occur. At first, a bivariate multinomial logistic regression was convenient so to identify net effect of individual variables explaining the outcome. We then considered the effects/associations of multiple variables at once, thus multivariable multinomial logistic regression modelling was appropriate as it had an advantage over bivariate modelling by identifying the additional explanatory power of a given variable, accounting for any overlap with other explanatory variables.Finally, after obtaining an explanatory model, we interpreted all variables that remained statistically significant in the model so to answer the question "What are the determinants of choice contraceptive method in Rwanda?".

2.3.5. Multinomial model function:

When one considers a regression model for a qualitative variable with more than two responses, one must pay attention to the measurement scale as it could be either nominal or ordinal scale. On our focus, the multinomial model is simply the extension of the binary logistic model with an outcome variable which is nominal with more than two levels, say, categories [16].

We could use an outcome variable with any number of levels to illustrate the said model extension and methods. However, the details are most easily with three categories. Further generalization to more than three categories is a problem more of notation than of concept.

Assume that the categories of the outcome variable, Y, are coded 0, 1, or 2. Recall that the logistic model used for a binary outcome is parameterized in terms the logit of $Y=1$ versus $Y=0$. In the three outcome category we need two logit functions and we have to decide which outcome categories to compare. The obvious extension is to use $Y=0$ as baseline or referent category and to form logits comparing $Y=1$ and $Y=2$ to it.

To develop the model, assume we have k covariates and a constant term, denoted by a vector X, of length $k+1$ where $X_0=1$. We denote the two logits functions as follows:

$$g_1(x)=\ln\left[\frac{P(Y=1|X}{P(Y=0|X}\right]$$
$$=\beta_{10}+\beta_{11}x_1+\beta_{12}x_2+\ldots+\beta_{1k}x_k \qquad \textbf{(4)}$$
$$=x'\beta_1$$

and

$$g_2(x) = \ln\left[\frac{P(Y=2|X}{P(Y=0|X}\right]$$
$$= \beta_{20} + \beta_{21}x_1 + \beta_{22}x_2 + \ldots + \beta_{2k}x_k \quad \textbf{(5)}$$
$$= x'\beta_2$$

It follows that the conditional probabilities of each outcome category given the covariate vector are:

$$P(Y=0|X) = \frac{1}{1+e^{g_1(x)}+e^{g_2(x)}} \quad \textbf{(6)}$$

$$P(Y=1|X) = \frac{e^{g_1(x)}}{1+e^{g_1(x)}+e^{g_2(x)}} \quad \textbf{(7)}$$

$$P(Y=2|X) = \frac{e^{g_2(x)}}{1+e^{g_1(x)}+e^{g_2(x)}} \quad \textbf{(8)}$$

Following the convention for the binary model, we let $p_j(x) = P(Y=j|X)$ for $j = 0,1,2$.

Each probability is a function of the vector of $2(k+1)$ parameters $\beta' = (\beta_1', \beta_2')$.

A general expression for the conditional probability in the three category model is:

$$P(Y=j|X) = \frac{e^{g_j(x)}}{\sum_{j=0}^{2} e^{g_j(x)}} \quad \textbf{(9)}$$

where the vector $\beta_0 = 0$ and $g_0(x) = 0$.

2.3.6. Estimating model parameters:

To construct the likelihood function, we create three binary variables coded 0 or 1 to indicate the group membership of an observation. We note that these variables are introduced only to clarify the likelihood function and are not used in the actual multinomial logistic regression analysis. The variables are coded as follows: if Y=0 then Y_0=1, Y1=0, and Y_2=0; if Y=1 then Y_0=1, Y_1=1, and Y_2=0; and if Y=2 then Y_0=0, Y_1=0, and Y_2=1.We note that no matter what value Y takes on, the sum of these variables is $\sum_{j=0}^{2} Y_j = 1$.Using this notation if follows that the conditional likelihood function for a sample of n independent observation is:

$$l(\beta) = \prod_{i=1}^{n}\left[p_0(x_i)^{y_{0i}}.p_1(x_i)^{y_{1i}}.p_2(x_i)^{y_{2i}}\right] \quad \textbf{(10)}$$

Taking the log and using the fact that $\sum_{i=0} Y_{ji} = 1$ for each i, the log-likelihood function is:

$$L(\beta) = \sum_{i=1}^{n} y_{1i}g_1(x_i) + \sum_{i=1}^{n} y_{2i}g_2(x_i) - \ln\left(1+e^{g_1(x_i)}+e^{g_2(x_i)}\right) \quad \textbf{(11)}$$

The likelihood equations are found by taking the first partial derivatives of $L(\beta)$with respect to each of $2(k+1)$ unknown parameters. To simplify the notation somewhat, we let $p_{ji} = p_j(x_i)$.

The general form of these equations is:

$$\frac{\partial L(\beta)}{\partial \beta_{jk}} = \sum_{i=1}^{n} x_{ki}(y_{ji} - p_{ji}) \quad \textbf{(12)}$$

For $j = 1,2$ and $k = 0,1,2,..., p$, with $x_{0i} = 1$ for each subject.

The maximum likelihood estimator, $\hat{\beta}$, is obtained by setting these equations equal to zero and solving for β.The solutions require same type of iterative computation that is used to obtain estimate in a binary outcome case.

The matrix of the second partial derivatives is required to obtain the information matrix and the estimator of the covariance matrix of the maximum likelihood estimator. The general form of the elements in the matrix of second partial derivatives is as below:

$$\frac{\partial^2 L(\beta)}{\partial \beta_{jk} \beta_{jk'}} = -\sum_{i=1}^{n} x_{k'i} x_{ki} p_{ji}(1 - p_{ji}) \quad \textbf{(13)}$$

and

$$\frac{\partial^2 L(\beta)}{\partial \beta_{jk} \beta_{j'k'}} = \sum_{i=1}^{n} x_{k'i} x_{ki} p_{ji} p_{j'i} \quad \textbf{(14)}$$

With $j \,\&\, j' = 1,2$ and $k \,\&\, k' = 0,1,2,..., p$. The observed information matrix, $I(\hat{\beta})$, is the $2(k+1)$ by $2(k+1)$ matrix whose elements are negative of the values in equations (13) and (14) evaluated at $\hat{\beta}$. The estimator of the covariance matrix of the maximum likelihood estimator is the inverse of the observed information matrix,

$$\text{var}(\hat{\beta}) = [I(\hat{\beta})]^{-1}$$

2.3.7. Interpreting model parameters:

We can interpret the parameters β_0 and β_1 in the logistic regression model in terms of *p*(*x*). The intercept parameter β_0 permits the estimation of the probability of the event associated with *y* = 1 when the independent variable *x* = 0. The slope parameter β_1 measures the degree of association between the probability of the event occurring and the value of the independent variable *x*. When β_1 =0, the probability of the event occurring is not associated with size of the value of *x*. If β_1 >0, the probability of the event occurring increases as the value of the x increases. If β_1 < 0, the probability of the event occurring decreases as the value of the independent variable increases. If both β_0 =0 and β_1 =0, the event occurring is unlikely to happen [17].

III. RESULTS AND DISCUSSION

3.1. Description of the contraceptive users:

Table 1: Participants socio-demographic and economic characteristics

	N	%
Overall	**3,917**	**100**
Agegroup		
15-24	578	14.8
25-34	1,925	49.1
35+	1,414	36.1
Marital status		
Never in union	152	3.9
In union	3,555	90.8
Divorced/Widowed/Separated	210	5.4
Education level		

No education	614	15.7
Primary	2,777	70.9
Secondary/Higher	526	13.4
Number of children		
<3	1,536	39.2
3+	1672	60.8
Type of place of residence		
Urban	636	16.2
Rural	3,281	83.8
Wealth index		
Poorest	669	17.1
Poorer	719	18.4
Middle	779	19.9
Richer	843	21.5
Richest	907	23.2
Source for current method when started (includes rhythm) *		
Health facilities	3,251	92.8
Community (CHWs, Church, Friends, etc.)	173	4.9
Commercial Outlets	78	2.2
Decision maker for using contraception*		
Mainly respondent	292	8.3
Mainly husband, partner, other	121	3.4
Joint decision	3,127	88.3

* denominator does not add up to **N**

Of 13,671 women interviewed in RDHS 2010; were considered in the analysis 3,917 (29%) who reported using contraception at the time of survey with modern methods prevailing (25%) over natural methods (4%) [6].

Table 1 shows the distribution of the study subjects by characteristics. 85% of the contraceptive users were 25 years old or above. The age distribution in the three age intervals 15-24, 25-34 and 35-49 is disproportionate and corresponding %ages are 14.8%, 49.1% and 39.1 % respectively.

Almost 96% of the contraceptive users have ever been in union and around 4% have never been in union.

86.6% of respondents have less than secondary education whereas 13.4 % have secondary or higher level.

Of the respondents, 57.3% reported having no more than 3 children against 42.7% who reported having more than 3 children.

Rural residents are predominant (83.8%) against urban residents (16.2 %).

3.2. Percent distribution of the contraceptives by function and type

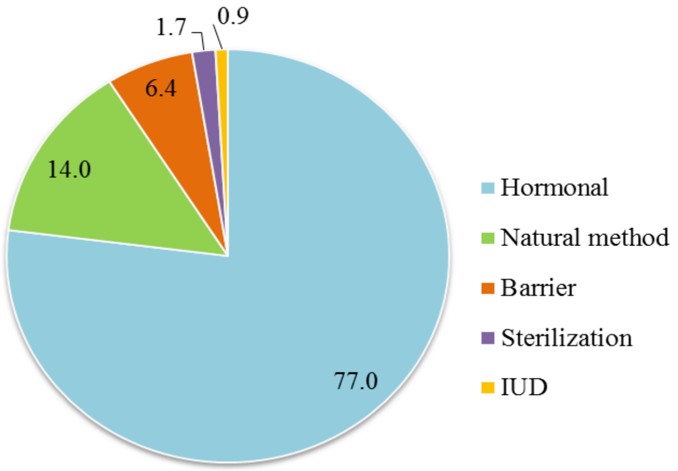

Figure 1: Percent distribution of contraceptives by function

Depending on how functional the contraceptives are, they are grouped into five major groups-the hormonal methods, barrier method, sterilization, IUD and natural methods. In Rwanda, the RDH2010 survey results show, as **Figure 2** reveals, that hormonal methods (77 %) prevail over other method. The remaining 23 % is covered by natural methods (14 %), barrier method (6.4 %), sterilization 1.7 % and IUD users represents 0.9 %.

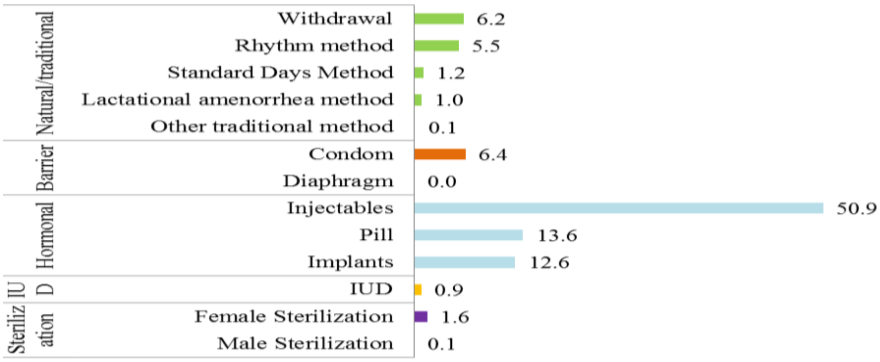

Figure 2: Contraceptive method mix in Rwanda

Figure 3 reveals that, in Rwanda, of all contraceptive users 50.9 % are "Injectable" users, 13.6 % use pills and 12.6 % use Implants. Interestingly, all the top three most used contraceptives are hormonal whereas condom, rhythm and withdrawal are used at respective rates 6.4 %, 5.5 % and 6.2 %. Other methods are used at rate low than 5 %.

3.3. Contraceptive methods mix and association with user characteristics:

Table 2: Contraceptive methods mix and association with user characteristics

	Total	Sterilization	IUD	Injectables	Implants	Pills	condom/ diaphragm	Natural	Chi-square test	
	N	%	%	%	%	%	%	%	χ^2	*P*-value
Overall	**3917**	**1.7**	**0.9**	**50.9**	**12.5**	**13.6**	**6.5**	**13.9**		
Age group									224.5	<0.001
15-24	586	0.2	0.4	62.9	6.9	14.7	7.7	7.2		
25-34	1923	0.4	0.7	53.7	13.1	14.8	6.2	11.1		
35+	1408	4.0	1.3	42.1	14.1	11.4	6.4	20.7		
Marital status									115.6	<0.001
Never in union	148	0.7	0.0	47.1	10.9	12.6	24.1	4.6		
In union	3562	1.7	0.9	50.9	12.2	13.8	5.7	14.7		
Divorced/Widowed/Separated	208	2.3	0.4	53.4	19.0	9.6	7.4	7.9		
Highest education level									200.4	<0.001
No education	629	1.6	0.3	52.6	14.2	11.5	4.2	15.6		
Primary	2799	1.4	0.4	53.7	11.8	13.4	6.3	13.0		
Secondary/Higher	489	3.4	4.6	32.8	14.8	16.9	10.1	17.4		
Number of living children									89.8	<0.001
<3	2237	0.3	0.8	56.5	11.1	9.3	7.7	10.6		
3+	1680	2.6	0.9	47.3	14.5	14.7	5.7	16.1		
Type of place of residence									135.1	<0.001
Urban	554	3.4	4.1	42.4	10.8	15.3	10.2	13.9		
Rural	3363	1.4	0.3	52.3	12.8	13.3	5.8	14.0		
Respondent's occupation (grouped)									172.5	<0.001
Employed	472	3.7	4.8	38.1	13.0	12.2	12.6	15.6		
Unemployed, agriculture	3436	1.4	0.3	52.8	12.5	13.7	5.6	13.7		
Decision maker for using contraception									35.7	<0.001
Mainly respondent	287	0.8	1.3	54.9	15.9	13.9	2.2	11.0		
Mainly husband, partner, other	122	5.1	0.0	37.3	14.8	11.3	8.8	22.7		
Joint decision	3130	1.7	0.9	51.2	11.9	13.9	5.8	14.6		

Using the table above, we are going to figure out the distribution of contraceptive methods by users' characteristics. Findings show that overall 1.7 % are women who were using sterilization., sterilization was more used by women aged 35+ years (4.0 %), and was high among women who have ever been in union (1.7 % among those in union and 2.3 % among those out of union). Also; sterilization was more prevalent among women with secondary or higher education (3.4 %), high among women with more 3 or more children (2.6 %) and was high in urban respondents (3.4 %). Sterilization was favored by richest women (3.1 %), employed women (3.7 %) and women whose partners take lead in the decision making for using contraception (5.1 %).

Although used as low as 0.9 %, the IUDs, at the time of the survey were more used by respondents aged 35+ years (1.3 %), by women with at least secondary education (4.6 %) and by urban women (4.1 %).

The injectables, the most prevalent (50.9 %) method of all, are interestingly disproportionate across characteristics where injectable-users are young, non-educated, still in childbearing hood, rural and unemployed/agriculture women. Splitting by age groups, proportions of injectable users were respectively 62.9 % among women aged 15-24 years, 53.7 % among 25-34 years and 42.1 % among those aged 35 plus. In regards to education, injectable users were found to be 52.6 % of women with primary education, 53.7 of women with primary education and low as 32.8 % among those with secondary or higher education. 56.5 % of women with less than 3 children were using injectables compared to 47.3 % of those with 3 or more children. 42.4 % of urban women used the method against 52.3 % of rural residents. In terms of occupation; while 38.1 % of employed women were injectable users, 52.8 were women unemployed or involved in agricultural activities.

The condom and diaphragm as barrier methods, though not frequently used (6.5 %), was more preferred by single women (24 %), by women with secondary or higher education (10.1 %), by urban women (10.2 %) and by employed women (12.6 %).

Overall 13.6 % were pills users and 12.5 % were implants, however, the two methods don't show differences across characteristics.

13.9 % reported using natural methods (combination of LAM, Standard days, Rhythm method, withdrawal and other traditional-folk methods). 20.7 % of women aged 35+ and 17.4 % of women with secondary of higher education reported using natural methods.

The disproportionality in distribution of contraception methods raised curiosity of knowing whether there was not any relationship between users' characteristics and the outcome- "current contraceptive method used". To know more about the relationship that would exist, we used the chi-square test of independence to determine if the association exist between covariates and the outcome. By this test, we reported the chi-squared statistics and associated p-values so as to confirm the existence of the relationship. Note that the higher the chi-squared values are, the stronger the evidence against *Ho* that there is no dependence. Considering the significance level at 5%, a relationship with a p-value less than the significance level would merely evidence a significant association between an explanatory and the outcome variables.

Findings from Table 2 show strong evidence that maternal age ($p = Pr(\chi^2 > 224.5) < 0.001$)); marital status ($p = Pr(\chi^2 > 115.6) < 0.001$)), education ($p = Pr(\chi^2 > 200.4) < 0.001$)), woman's parity ($p = Pr(\chi^2 > 89.8) < 0.001$)), residence ($p = Pr(\chi^2 > 135.1) < 0.001$)) and woman's occupation ($p = Pr(\chi^2 > 172.5) < 0.001$)) are associated with current contraceptive used.

3.4. Multicollinearity screening test:

Table 3: Multicollinearity screening test

	age	**education**	**number of alive children**	**residence**	**occupation**	**Decision maker for using contraception**
age	1					
education	-0.0545	1				
number of alive children	0.603	-0.1289	1			
residence	0.0365	-0.2586	0.076	1		
occupation	0.0029	-0.3057	0.069	0.414	1	
Decision maker for using contraception	-0.0644	0.0464	-0.0792	0.0264	0.0052	1

The purpose of testing for collinearity is to ensure independence between presumed covariates influencing the choice of contraceptives. Two independent variables are collinear if the correlation coefficient ***r*** is greater than **0.5**. The correlation matrix here above summarizes the relationship between correlates of the contraceptive choice. Although almost all covariates are non-collinear in the correlation matrix, maternal age and parity are collinear with ***r =0.6***. However, we'll kept both variables in the multinomial logistic as this occurrence is due to chance.

3.5. Determinants of choice of contraceptive methods in Rwanda:

Table 4: Determinants of choice of contraceptive methods relative to "Injectables" in Rwanda

	Sterilization vs. injectables	IUD vs. Injectable	Implants vs. Injectables	Pills vs. Injectables	Barrier vs. injectables	Traditional methods vs. Injectables
	RRR	RRR	RRR	RRR	RRR	RRR
Age group						
15-24	**Ref.**					
25-34	1.4	2.8	2.1**	1.2	1.6	2.0**
35+	12.0*	5.9*	2.3**	1.2	2.3*	4.8***
Education						
No education	**Ref.**					
Primary	1.2	1.0	0.9	1.2	1.5	1.0
Secondary/Higher	2.5*	7.2*	1.8*	2.3***	2.0*	1.8*
Number of children alive						
<3	**Ref.**					
3+	3.5*	0.9	1.5*	1.0	0.9	0.9
Residence						
Urban	**Ref.**					
Rural	0.5*	0.2*	1.0	0.9	0.7	0.9
Occupation						
Employed	**Ref.**					
Unemployed, agriculture	0.4*	0.3**	0.8	1.1	0.4***	0.7*
Decision maker						
Mainly respondent	**Ref.**					
Mainly husband, partner,	14.3**	0.0	1.5	1.2	6.0***	3.2***
Joint decision	3.7	0.7	0.8	1.1	2.8*	1.6*

RRR means "Relative risk-ratio"; **Ref.** means "reference group"; * significant at **0.001<p-value<0.05**; ** significant at **p-value =0.001; *****significant at p-**value<0.001**

3.5.1. Model summary:

In the fitting of the multinomial model, the number of observations has reduced to 3,538 because some predictors have missing values and this leads to list wise deletion of incomplete cases. In this model, we reported the relative risk ratios (RRR) and p-values at a significance of level of 5%. Overall the fitted model is statistically significant with LR chi2 (54) = 464.17, p-value <0.001 compared to the empty model which means that at least one predictor has an effect on the choice of contraceptive methods.

3.5.2.Sterilization vs. Injectables:

Results from Table 4 show that the likelihood to use "sterilization'' relative to "Injectables" increases 12 times high (p=0.028) among women aged 35 or above compared to women aged 15-24 years old; 2.5 times (p=0.049) among women with secondary or higher education compared to women with no formal education; 3.5 times (p=0.040) among women with three or more children against women with less than 3 children; and 14.3 times(p=0.002) among women who report their partner playing the main role in deciding the contraception to use. However, the likelihood to use sterilization over injectables reduces by half among rural residents (Rural women vs. Urban women: RRR=0.5, p=0.041) and among unemployed or women involved in agriculture (Unemployed, agriculture women vs. Employed women: RRR=0.4, p= 0.026).

3.5.3. IUD vs. Injectables:

Relative to injectables, age and education have a positive effect on the use of IUD. Compared to women aged 15-24 years, table 4.3 shows that women aged 35+ are more likely to choose IUD (RRR=5.9, p= 0.037) over injectables; women with secondary or higher education against women without formal education are seven-folds (RRR=7.2, p=0.012) more likely to use IUD over the injectables. Neither less, residence and occupation have a negative effect on the use of IUD relative to injectables where rural women compared to urban inhabitants' women have decreased risk of choice of IUD over injectables (RRR=0.2, p<0.001), and unemployed or women involved in agriculture against employed are less likely to use IUDs (RRR=0.3, p=0.001) over Injectables.

3.5.4. Implants vs. Injectables:

Determinants of choice of implants over injectables, in this study, are age, education and the number of children alive-the descendants of the respondent.

Compared to women aged 15-24 years, middle aged (25-34 years) and elderly women (35 + years) have increased likelihood to choose "Implants" over "Injectables", respectively, by factors (RRR=2.1, p<0.001) and (RRR=2.3, p=0.001). Women with secondary or higher education against those with no formal education are almost twice (RRR=1.8, p=0.004) likely to choose "Implants" over "Injectables". And women with more than 3 children alive compared to women with less than 3 children are more likely to use "Implants" over "Injectables" (RRR=1.5, p=0.006).

3.5.5. Pills vs. Injectables:

While the likelihood of using "Pills" relative to "Injectable" shows no significant difference across many of the users' characteristics, education has made an exception where women with secondary or higher against those without formal education are twice (RRR=2.3, p<0.001) more likely to use "Pills" relative to "Injectables".

3.5.6. Barrier methods vs. Injectables:

Here barrier methods refer to condom or diaphragm in the context of the survey data. Age, education, occupation, and contraception use decision maker are the influential factors of choosing barrier methods over injectables.

From Table 4.3, we read that women aged 35 or above compared to young women aged 15-24 years are more likely to use "Barrier methods" than "Injectables" (RRR=2.3, p=0.007). Unemployed against employed women are less likely to choose for "Barrier methods" (RRR=0.4, p<0.001) than "Injectables". Women whose contraceptive use decision maker is mainly the partner are 6.0(p=0.003) times higher likely to use "Barrier method" relative to "Injectable" than the respondent who are the decision makers at their own. If it is a joint decision, then the likelihood to choose "Barrier" increases 3 times (RRR=2.8, p=0.009).

3.5.7. Traditional methods vs. Injectables:

Significant predicators of choice of traditional methods over injectables are woman's age, education, occupation and decision maker.

Middle (25-34 years) and elderly (35+ years) women compared to women aged 15-24 years are more likely to go for "traditional methods" than "injectables", by respective relative risk ratios (RRR =2.0, p=0.001 and RRR=4.8, p<0.001). Those with secondary education or higher are for "Natural methods" 1.8 (p= 0.003) times higher than those with no formal education relative to "Injectable". While unemployed women or women involved in agriculture have a reduced risk (RRR=0.7, p=0.035) of using "traditional methods" over injectables; women are more likely to go for "traditional methods" if there's partner approval (RRR=3.2, p<0.001) or joint decision (RRR=1.6, p<0.025) than if the decision is for herself.

IV. CONCLUSION AND RECOMMENDATIONS

4.1. Conclusion:

Rwanda, in the effort to reduce poverty and improve population health, has considered the use of contraception a priority. This led to a positive change in contraceptive prevalence that rose from 4 percent in 2000 to 29 percent in 2010. Modern contraceptive prevail (25 percent) over traditional methods (4 percent) among users [6].

Findings from this study show that, of the 3,917 women contraceptive users included in the analysis, overall 86 percent use any modern method (51 percent use injectables, followed by pills 13.6 percent and implants 12.6 percent, etc.) and 14 percent use traditional-folk methods. This is consistent with other researchers findings despite the availability of a wide range of contraceptive methods, heterogeneity has marked the method-mix in Rwanda [5].

The choice of one contraceptive method over another does not occur by chance among users. To better understand the differentials, a multinomial logistic regression model was used with "Injectables" being the model base outcome as it's the highest preferred method.

Findings from this study have shown that age, education, number of children alive, residence and approval of FP have significant association with the choice of contraceptive methods in Rwanda.

Compared to women aged 15-24 years, women aged 35 or above are more likely to choose sterilization (RRR=12.0, p=0.028), IUD (RRR=5.9, p=0.037), implants (RRR=2.3, p=0.001), barrier methods (RRR=2.3, p=0.007), and traditional methods (RRR=4.8, p<0.001) over "Injectables". This is consistent with other studies where in Ethiopia sterilization is six-fold high among women aged 35 plus (OR: 6.2[1.3-30.4]) compared to younger women 15-24 years [18].

Education has been found to be one of the vital predicative factors where, compared to women with no formal education, women with secondary or higher education are more likely to choose Sterilization (RRR=2.5, p=0.049), IUD (RRR=7.2, p=0.012), implants (RRR=1.8, p=0.004), pills (RRR=2.3, p<0.001), barrier method (RRR=2.0, p=0.027) and traditional methods (RRR=1.8, p=0.003) over Injectables. In accordance with a study on woman's education, empowerment, and contraceptive use in Sub-Sahara ; education of a woman has much influence on the choice of contraception to use, particularly the choice of more effective method [19].

Compared to urban women, rural residents have low risk of choosing sterilization (RRR=0.5, p=0.041), IUD (RRR=0.2, p<0.001) over Injectables. These findings are consistent with a study in Kenya that showed urban residents to be more users of permanent and long-term methods than rural counterparts [20].

The woman's parity has an impact on which contraceptive to choose. Consistently with Kahraman findings [21], our study results show that women with more than 3 children compared to those with less children are likely to choose sterilization (RRR=3.5, p=0.040), and implants (RRR=1.5, p=0.006) over injectables.

In regards to the occupation, unemployed women or women involved in informal agriculture have a reduced risk of choosing sterilization (RRR=0.4, p=0.026), IUD (RRR=0.3, p=0.001), and barrier methods (RRR=0.4, p<0.001) over injectables compared to formally employed women.

As far as couples are concerned, partner approval for FP is much influential on the method to use. In this study, compared to respondent's decision, husband's approval has a significant effect on the choice of sterilization (RRR=14.3, p=0.002) and barrier methods (RRR=6.0, p<0.001) over "Injectables".

4.2. Recommendations:

Based on the study findings, we recommend the following:

1. Continue efforts in family planning education focusing more on rural, non-educated and unemployed women or women involved in informal agricultural activities.
2. For cost effectiveness, supply of contraceptive methods need to take into account demanders' characteristics.
3. Raise awareness of the reproductive health and available contraceptive methods to rural, non-educated and unemployed women in order to increase the uptake.
4. Increase spousal involvement in family planning to increase the uptake and compliance of contraception in Rwanda.
5. As for future research recommendations, due to time constraints this study did not cover all determinants of choice of contraceptive methods in Rwanda, it was limited only to RDHS 2010 data set. Thus further studies would explore deeply all other factors not covered by the current study and deeply understand the dynamics of choice of contraception within our highly selective population.

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