

ESTIMATION OF TOTAL FERTILITY RATE AND BIRTH AVERTED DUE TO CONTRACEPTION: REGRESSION APPROACH

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Fertility plays an important role in any demographic transition and total fertility rate (TFR) is one of the basic measurements of fertility. Absences of complete and reliable data, a large number of indirect techniques have been developed to estimate the demographic parameters with incomplete data. Some of these techniques are based on utilizing the data from stable population theory while others are based on the regression technique in which the parameters are estimated through regression equations between the dependent variable which is the TFR and the independent variables which is the socio economic well as demographic variables. The first method is based on the relationship between the Total fertility rate (TFR) and contraceptive prevalence rate for all women. By using this modified estimate of TFR, demographic analysis can easily calculate the birth averted for different regions as well as states also. In fact, provide reasonable estimates of births averted due to contraceptive use by national populations. The variables are CPR that about 51.2 percent variation in TFR can be explained by the first regression approach. The second is based on the relationship between total fertility rate (TFR) and Additive combination of CPR and proportion of currently married females having open birth interval. Using new predictor variable, the improved model explained about 55percent of the variation in TFR. The findings reveal that the values of TFR calculated by the present method are quite close to the observed values of the TFR without involving much computational complexities at different background characteristics. Estimates of births averted and the percent change in births in the absence of contraception, based on the two methods, are fairly consistent.

Keywords: Births averted, total fertility rates, contraception, linear regression and contraceptive prevalence rate.

INTRODUCTION

Fertility is governed by a complex set of biological, socio-economic, political, legal and psychological factors. This is widely affected by different demographic and socioeconomic factors as well as reproductive attitude and behaviour (Bongaarts, 1978). Changes in fertility can be ascertained by studying summary measure of fertility such as Crude Birth Rate (CBR) and Total Fertility Rate (TFR) as well as by birth order distribution and age pattern of fertility. The TFR is interpreted as the average number of children born to a woman during her complete reproductive period (Swamy, 1992). The functioning of the vital registration system is not adequate in coverage and quality both in majority of developing countries (Brass, 1968). In spite of carefully planned and executed, any survey data from developing countries comprise large errors of omission of events, errors in the identification of the appropriate time period in which the events have occurred, and serious errors in the reporting of the age of the mothers due to recall lapse and thus age heaping in the data (Devkota, 2014). These errors affect the fertility measures such as CBR, TFR and so on up to a great extent (Kpedekpo, 1982). Due to these facts researchers develop some appropriate technique which is free from the above mentioned error. To overcome these difficulties the indirect method is useful. The most popular indirect method is regression technique. Using indirect method the TFR is generally estimated through the own-children

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method. Another indirect technique for estimation of TFR is proximate determinants model (Bongaarts & Potter, 1983).

The methods of estimating births averted were described in the literature in the late 1960s and early 1970s (Kelly, 1971). Ross's has explained the rules of thumb which says that 'Five IUDs (intra-uterine devices) inserted this year will prevent one birth next year and another birth each year for at least four more years.' Although rules of thumb is a convenient for obtaining quick estimates, but it over simplify the components needed for more precise calculations (Hobcraft & Little, 1984). Potter have given the method of couple-years of effective contraception, which is sophisticated and relatively comprehensive at the individual level but place heavy demands for data on users and requires the estimation of the length of the birth interval in the absence of contraception. After 1970's some more modification has been done (United Nation, 1983). Brass's used a P/F ratio method for estimating fertility and its advancement has been done. This needs the data on last birth history with the age group of the females. Furthermore stable population method has been used for estimating TFRs (Rele, 1987). It can be estimated a few regression models to provide indirect estimates of fertility levels. The continuous rise of contraceptive use nationally and globally implies that many unintended pregnancies, as well as induced abortions and maternal deaths, are being prevented and used contraceptive prevalence rate (CPR) to predict TFR of any population (Ross, John, Stover, & Adelaja, 2005) using the proposed NPV (Palmore & James, 1978).

DATA AND METHODS

Nepal Demographic Health Survey is monitor and evaluates the success of its family planning and reproductive and child health programs at national level. In demography always face problems due to non-availability of complete and reliable data. Observed values of TFR and CPR and open birth interval for women who are currently married have been taken have been taken from Nepal Demographic and Health Survey report (MoHP, 2012).

This regression analysis is carried out by ordinary least square (OLS) assumptions. The basic assumption of OLS has been fulfilled since the data are taken from normal population and independent also. The information for the predictor variable is extracted for 13 sub regions of Nepal. Using regression analysis concept, firstly the relationship between TFR and CPR has been established. Line of regression between TFR (Y) and CPR (X) is drawn taking 13 sub regions of Nepal considering NDHS data and its equation is as follows:

$$\text{Estimated TFR} = a + b \times \text{CPR} \quad \text{_____} (1)$$

where,

TFR = Estimated TFR

b= Regression coefficient

CPR = Contraceptive prevalence rate

a= Intercept and can be treated as the extreme point of TFR which indicate the maximum TFR in the absence of CPR.

Again a similar type of regression analysis has been done by taking dependent variable as TFR and independent variable NPV, which are combination of CPR and the proportion of women whose open birth interval. The line of regression is drawn between TFR (Y) and NPV (X) for the 13 sub regions of Nepal with the data of NDHS. Equation for the Regression line is given as:

$$\text{Estimated TFR} = a^1 + b^1 \times \text{NPV} \quad (2)$$

where,

Estimated TFR = Proposed estimated TFR using regression equation

b^1 = Coefficient of regression line for equation

NPV = New predictor variable (additive combination of CPR and proportion of currently married females having open birth interval).

a^1 = Intercept and this can be treated as the extreme point of TFR indicates the maximum TFR rate in the absence of NPV (Mogull, 2004).

The model after considering the NPV gives higher value of R^2 than the previous one where only CPR is taken as predictor variable. Thus, one can say that Model2 explains the data better than Model 1(Singh,2012).

RESULTS

The variables are CPR and TFR utilizing the NDHS data on sub regions of a country. Furthermore, it shows the regression line taking TFR as dependent variable and CPR as independent variable. Through the regression equation it is cleared that if we increase the CPR by one unit the TFR is lowered down by 0.131 units. If CPR is equal to zero then TFR will take the value a, i.e. it will go up to 2.801. The coefficient of determination (R^2) of this regression line is 0.512. This indicates that about 51.2 percent variation in TFR can be explained by this regression line.

Table 1 shows the CPR, TFR (observed) and TFR (estimated) for 13 sub-regions of Nepal. The predicted value of TFR is obtained with the help of linear regression using Model1. Central Hill shows highest use of CPR which is 62.2 percent. After Central Hill, Far-western Terai is at second highest and Central Mountain is at third highest in contraceptive use with CPR 59.4 percent respectively. Eastern Mountain, Western Mountain, Western Mountain, Mid-western Hill, Far-western Hill and Eastern Terai shows CPR lower than whole country which is 49.7 percent. Mid-western Hill and Eastern Terai shows lowest CPR with 41.2 percent.

Table 1: Estimation of total fertility rates using contraceptive prevalence rate

Sub-Regions	CPR	TFR (Obs)	Estimated TFR	% Change
Eastern Mountain	44.4	3.39	2.75	23.2727
Central Mountain	59.4	3.40	2.73	24.5421
Western Mountain	43.1	3.41	2.75	24.0000
Eastern Hill	42.8	2.34	2.75	14.9091
Central Hill	62.2	2.37	2.73	13.1868
Western Hill	42.9	2.41	2.75	12.3636
Mid-western Hill	41.2	3.11	2.75	13.0909
Far-western Hill	41.6	2.78	2.75	1.0909
Eastern Terai	41.2	2.31	2.75	16.0000
Central Terai	50.0	2.32	2.74	15.3285
Western Terai	50.3	2.33	2.74	14.9635
Mid-western Terai	54.2	2.96	2.74	8.0292
Far-western Terai	60.1	2.68	2.73	1.8315
Nepal	49.7	2.6	2.74	5.1094

TFR (Obs): Observed value of TFR.

The simple linear regression analysis has been carried out to find the relationship between TFR and NPV. With the help of 13 sub regions data the estimated value of regression coefficient of this model was obtained as -0.175. From the regression equation it is clear that one unit increase in NPV will give 0.055 units reduction in TFR. This Model2 has coefficient of determination higher than Model1. The value of coefficient of determination (R^2) was observed as 0.550. It implies that about 55 percent of the variation in TFR is explained by NPV.

Table 2 gives the data for CPR, proportion of females whose open birth interval is more than 5 years, contraceptives prevalence rate, TFR (observed) and TFR (estimated) for sub regions using Model2. The estimated TFR is this case more closed than previous estimate of TFR which is given in Table1. Central Hill shows lowest estimated TFR 2.61 and Far western Hill shows highest estimated TFR 3.82. India has estimated value of TFR as 2.88.

Table 2: Estimation of total fertility rates using new predictor variable

Sub-Regions	CPR	NvrC	NPV	TFR(Obs)	Est. TFR	% Changed
Eastern Mountain	44.4	22.6	67.0	3.39	2.76	22.9099
Central Mountain	59.4	21.2	80.6	3.4	2.66	27.9831
Western Mountain	43.1	8.5	51.6	3.41	2.87	18.6883
Eastern Hill	42.8	16.8	59.6	2.34	2.81	16.8253
Central Hill	62.2	24.1	86.3	2.37	2.61	9.3362
Western Hill	42.9	28.5	71.4	2.41	2.73	11.5685
Mid-western Hill	41.2	15.0	56.2	3.11	2.84	9.5558
Far-western Hill	41.6	10.9	52.5	2.78	2.88	3.0127
Eastern Terai	41.2	18.9	60.1	2.31	2.81	17.7826
Central Terai	50.0	16.1	66.1	2.32	2.76	16.0891
Western Terai	50.3	26.2	76.5	2.33	2.69	13.2928
Mid-western Terai	54.2	21.0	75.2	2.96	2.70	9.7553
Far-western Terai	60.1	13.9	74.0	2.68	2.71	0.9559
Nepal	49.7	18.9	68.6	2.6	2.74	5.1106

NvrC: Proportion of females having no births in last 5 years.

TFR (Obs): Observed Value of TFR.

The changes were occurred due to the use of an additive indicator in addition to CPR which is proportion of females whose open birth interval is more than 5 years. Western Hill shows this proportion highest as 28.5 percent and Western Mountain shows this proportion lowest with just 8.5 percent. The different demographic and socio-economic Characteristics also effect of estimated TFR which is discuss Table 3.

Table 3: Estimation of TFR for different demographic and socio-economic characteristics using Model2

Sub-Regions	CPR	NvrC	NPV	TFR(Obs)	Est.TFR	% Changed
Education						
No education	52.8	17.5	70.3	3.7	2.57	44.1790
Primary	47.0	19.3	66.3	2.7	2.52	7.0193
Some secondary	46.1	21.8	67.9	2.1	2.54	17.3309
SLC & above	47.7	23.0	70.7	1.7	2.57	33.8673
Wealth quintile						
Lowest	40.4	14.2	54.6	4.1	3.86	6.1931
Second	46.3	18.0	64.3	3.1	3.11	0.4548
Middle	48.2	20.6	68.8	2.7	2.77	2.4476
Fourth	52.0	20.3	72.3	2.1	2.50	15.9430
Highest	59.6	28.8	88.4	1.5	1.26	19.1522
Residence						
Urban	59.6	27.9	87.5	1.6	1.62	1.2345
Rural	48.2	18.1	66.3	2.8	2.81	0.3558

NvrC: Proportion of females having no births in last 5 years.

TFR (Obs): Observed Value of TFR.

Table 3 represents the CPR, proportion of females having no births in last 5 years, NPV, observed value of TFR and estimated value of TFR and percentage change in the observed and estimated values of TFR according to different demographic and socio-economic background characteristics of a country by application of Model 2. TFR is estimated with the help of NPV for different groups for example wealth index, educational status and place of residence for the country. The difference between lowest and highest wealth index groups with respect to the estimated value of TFR is observed to be about 2 children per women. In case of education differential, no education group have CPR 47.7 percent and another additive indicator in NPV have 23 percent proportion and 10+ education group have CPR 70.7 percent. Thus, estimated values of TFR decrease as education level increase which can be clearly observed in Table 3.

Similarly, the proportion of NPV difference between rural and urban group is 11.2 percent. This indicates that Model2 is quite helpful to get the estimates of TFR at different background characteristics at state level and it is very easy to obtain.

Table 4 represents the NPV, estimated value of TFR, proportion of females having no births in last 5 years in their complete reproductive period prior to survey date, potential TFR in the absence of current contraceptives, percentage decrement (PD) in TFR due to use of contraceptives and number of births averted in last three year among the females who were exposed for 13 sub regions of Nepal by using current contraceptives. Estimated value of TFR is obtained with the help of NPV and potential value of TFR is obtained by taking additive indicator, which is the proportion of females who have not given births in last 5 years till reference date, using NPV in Model-2. Thus, the potential TFR will provide the TFR in the absence of current contraceptive. Maximum 676 births have been reduced by central Terai for sample size of 2,415 currently married females and minimum 60 births with sample size of 229 currently married females have

been averted in eastern Mountain. This analysis shows that large number of births has been averted in the presence of current contraceptives of the country.

Table 4: Estimation of total number of births averted from current contraception

Sub-Regions	NPV	Est. TFR	NvrC	Pot. TFR	PD	Birth	Female	Birth averted
Eastern Mountain	67.0	2.76	22.6	7.28	62.11	97	229	60
Central Mountain	80.6	2.66	21.2	7.27	63.46	98	258	62
Western Mountain	51.6	2.87	8.5	7.14	59.76	217	319	130
Eastern Hill	59.6	2.81	16.8	7.23	61.09	405	956	247
Central Hill	86.3	2.61	24.1	7.30	64.19	471	1563	302
Western Hill	71.4	2.73	28.5	7.34	62.87	592	1513	372
Mid-western Hill	56.2	2.84	15.0	7.21	60.63	372	649	226
Far-western Hill	52.5	2.87	10.9	7.17	60.02	243	409	146
Eastern Terai	60.1	2.81	18.9	7.25	61.25	736	1873	451
Central Terai	66.1	2.76	16.1	7.22	61.71	1095	2415	676
Western Terai	76.5	2.69	26.2	7.32	63.29	400	1147	253
Mid-western Terai	75.2	2.70	21.0	7.27	62.90	295	668	186
Far-western Terai	74.0	2.71	13.9	7.20	62.42	249	676	155
Nepal	68.6	2.81	18.9	7.25	61.24	5,270	12,675	3,266

Est. TFR: Estimated value of TFR using Model2

NvrC: Proportion of females having no births in last 5 years

Pot. TFR: Potential total fertility in the absence of contraceptives

PD: Percentage decrement in TFR due to contraceptive use

DISCUSSIONS

This estimation is very crucial, critical and important. It has discussed knowledge of the dependent variable and associated independent variable(s) which should explain the data in better way and to have reliable results. It is worthwhile to be noted that in this method the dependent and independent variable(s) should be highly correlated. There are so many predictor variable(s) for estimating the TFR. Mauldin and Ross have used CPR to predict TFR of any population (Jain, 1997).

Applying TFR method proposed by Liu and others (2015), a wide variation in births averted at the global level has been found in different countries. The estimation of births averted not only provides approximation of the number of births prevented by using contraception, it also show that the significant impact of contraceptive use on reducing fertility level. It can conclude that though contraception is fully effective method and use of contraception is more but it is not properly practiced then the effect of the method for birth aversion cannot be satisfied and thereby the target of reducing fertility level cannot achieve in the way it can be expected.

There was a linear decrease in TFR needs for increase contraception. The predicted value of TFR is obtained with the help of linear regression was using. This method was using all Indian states show percentage use of CPR which changed 28 percent. The study of TFR done in contraception, India also showed the similar result with variation at (51.1%). This type of study was using in Eritrea highest variation was found in Wealth quintile compared to education groups. In Ethiopia, in the year 2000, similar trend of linear regression method has used. In a study done in 5 Latin American countries (Brazil, Columbia, Dom Republic, Ecuador and Peru) has used similar result of linear regression approach to estimation of fertility (Anand, 2014). In a study in 5 Latin American countries a similar result was found in all the countries with rural areas having high

fertility changed than urban areas Brazil (11.6% vs. 23.6%), Columbia (13.2% vs. 21.8%), Dominic Republic (17.6% vs. 21.8%), Ecuador (19.6% vs. 21.8%) and Peru (19.3% vs. 46.3%). In Kenya also there was lower education and higher education women who are exposed to family planning messages has variation ($R^2=0.723$) (Ojakka, 2014).

Finally in a nutshell there are so many methods discussed in the introductory section, the availability of the data is one of the important problem of these methods. The same model can be used to estimates TFRs up to the different demographic dividend of sub-division of the country also.

CONCLUSION

This result was described as gap between increasing desire to control fertility and ability to do so and then eventual decrease as more women use contraception. The use of current contraception is a reduction of 3266 births in all over Nepal among the total 12675 females considered who are exposed to the risk of conception. Nepal is taking about 61.24 percent decrement in TFR due to the use of contraception. Highest decrement in TFR (64.2%) is shown by Central Hill and lowest decrement in TFR (59.7%) is Western Mountain. It also includes the recent study of number of births averted due to the contraceptive use at regional level.

In fact, provide reasonable estimates of births averted due to contraceptive use by national populations. The variables are CPR that about 51.2 percent variation in TFR can be explained by the first regression approach. Using new predictor variable, the improved model explained about 55percent of the variation in TFR. Estimates of births averted and the percent change in births in the absence of contraception, based on the two methods, are fairly consistent.

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