Estimation of Fertility Levels and Trends in Nepal

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ABSTRACT

The objectives of this study are to estimate and analyze levels and trends of fertility by indirect methods, to verify the estimated level of fertility from indirect methods by linear regression method and to compare the estimated level of fertility from indirect methods with direct method. The source of data for this study is secondary which is obtained from data files of Nepal Demographic and Health Surveys of the years 2006, 2011 and 2016. Required data to estimate fertility level (TFR) is obtained by using IBM SPSS Statistics 21. Two indirect methods were used in this study i.e. comparing period fertility rates with average parities for a hypothetical cohort and Arriaga method. The data were tabulated manually and estimated by Excel Sheet and MORTPAK. For verification of estimated value on level of fertility (TFR), linear regression was used. Estimation of fertility levels (TFRs) at the national level by indirect methods and linear regression are almost same which show the high accuracy of estimation of fertility by indirect methods at the national level. Similarly, comparison of estimated trend of fertility (TFR) by indirect methods with direct method is almost same at the national level. So, estimation of fertility level (TFR) by indirect methods is found suitable at the national level.

Key Words : Fertility, Estimation, Nepal Demographic and Health Survey, Indirect Methods.

Introduction

Demographic estimation consists of the attempt to measure values of basic demographic parameter such as birth rate, death rate, the level of total fertility, under less than perfect

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conditions. These basic parameters indicate the way in which a population will evolve in terms of size and age structure, over time. The term "indirect" used to qualify some of the techniques used in demographic estimation has its origin in the fact that such techniques produce estimates of a certain parameter on the basis of information that is only indirectly related to its value. The term "indirect" is therefore used to describe any estimation method that depends upon models or uses consistency checks, or indeed uses conventional data in an unconventional way (UN, 1983: 2).

Because of the paucity of the reliable data fertility rates or for that matter any other demographic rates in the context of Nepal have to be estimated using indirect methods of estimation. The basic data for the present estimates comes from population censuses of Nepal, 1991 (CBS, 1993) and 2001. Both censuses contain information on children ever born and births in the last year by age of mothers. These two types of fertility information are suitable to apply the P/F ratio method to estimate fertility. The methods most often used are the Brass method (Brass & Coale, 1968), Palmore's regression method (Palmore, 1978), Gunasekaran and Palmore method (Gunasekaran & Palmore, 1984) and own-children method (Cho et al., 1986). (CBS, 2003: 39-40).

No internationally comparable data on population and its characteristics existed for Nepal prior to the 1952/54. Also, no demographic surveys existed, to provide on vital events before 1960s. A health survey that was conducted in 1966 (Gubhaju, et al., 1978 cited in CBS, 1995: 61-62) provided estimates fertility but there was inherent weakness in the sample design and methodology. More reliable estimates of fertility were available from multi-round demographic sample surveys conducted by Central Bureau of Statistics in 1974-75, 1976 and 1977-78 and the Nepal Fertility Survey of 1976 conducted by WFS (UN, 1980 cited in CBS, 1995: 61-62).

Not only the censuses but also sample surveys such as the Nepal Fertility Survey of 1976, Contraceptive Prevalence Survey of 1981 and many other similar survey suffer from different types of response biases, necessitating use of indirect methods for obtaining demographic estimates (Goldman et al., 1979 cited in CBS, 1995: 62).

The Brass indirect technique has been applied to the data of 1971, 1981 and 1991. Data from 1991 indicates declining fertility levels, so the methods above are not appropriate for computing fertility levels after 1991. Hence Arriaga's method has been applied to calculate fertility levels in 2001 and 2011 (CBS, 2014:118).

Indirect estimates of the TFR calculated using Arriaga's method is approximately 3.25 in 2001, which declines to 2.52 in 2011, a decline of slightly less than one child per woman over a decade. The value of the TFR recorded by the Population and Housing of 2011 at 2.52, is much closer to the value of the TFR obtained by the Demographic and Health Survey of 2011 of 2.6 in 2009 that is during the period 2008 to 2010 (CBS, 2014: 118).

Statement of Problem

When data are not accurate or reliable or complete, then the values of demographic parameters estimated using direct techniques will have errors. Thus, because of impossibility of obtaining reasonable estimates of demographic parameters using direct techniques, a set of techniques was developed for indirect estimation.

The principal sources of fertility data in Nepal are intercensal censuses and periodic sample surveys. Since data on vital events available from censuses and surveys are deficient due to error, it is difficult to estimate their levels and patterns by employing direct methods. So, estimates of fertility in this analysis have been derived through indirect methods.

Objectives

- To estimate and analyze the level and trend of fertility by indirect methods.
- To verify the estimated level of fertility from indirect methods by linear regression.
- To compare the estimated level of fertility from indirect methods with that of direct method.

Delimitations

- This study takes only one parameter of fertility variable (TFR) with the exclusion of mortality and migration variables.
- To complete this research, secondary data was used from NDHS data file. So, there was no control over the data collection and processing.
- There are lots of periodic and periodic sample surveys but this study took only 2006, 2011 and 2016 Nepal demographic and health surveys' data file to estimate fertility levels (TFR).

Methodology

Method of Data Collection

Being whole research estimation, it needs to be some specific data on fertility. So, the method of data collection in this study is secondary sources which is obtained from Nepal Demographic and Health Survey, 2006; 2011 and 2016 data file. Required data to estimate fertility level (TFR) is obtained by using IBM SPSS Statistics 21 by using weight 1000000 (compute wgt = v005/1000000., weight by wgt).

Methods to Estimate

A number of indirect methods are currently available to estimate fertility but because of the uncertainties and unavailability of preferred date at the national level, some of the selected indirect techniques can be only used:

- Comparing period fertility rates with average parities for a hypothetical cohort and
- Arriaga method

Required Data for the Selected Methods

- The total number of children ever born classified by five-year age group of mothers taken from two surveys.
- The total number of births during the year preceding the survey classified by five-year age group of mothers.
- The total number of women in each five-year age groups for both surveys.

Estimation Procedure

The collected data for the study was analyzed in line with the objectives of the study. The data were tabulated manually and estimated by Excel Sheet and MORTPAK. The data were analyzed quantitatively. Comparing period fertility rates with average parities for a hypothetical cohort method gives the interval estimates of level of fertility. Verification of estimated value of level of fertility (TFR), linear regression is used. Comparison of estimated level of fertility from indirect method with direct method was also done. Direct method gives level of fertility (TFR) for point estimates whereas indirect method gives level of fertility (TFR) for interval estimate. To make comparable at same point for direct and indirect estimate, linear regression was used for same point projection.

Quality of Data and Descriptive Statistics

This topic is an assessment of the quality of the data collected from Nepal Demographic Health Surveys 2006, 2011, and 2016.

Distribution of Average Number of Children Ever Born and Age Specific Fertility Rate

Table 1 shows average number of children ever born of Nepal for survey year 2006, 2011, 2016 and percentage of difference in 2011-2006 and 2016-2011. The percentage difference of average number of children ever born are decreasing in each age group of women in 2011-2006 whereas percentage difference of average number of children ever born are also decreasing in each age group of women except 15-19 age group of women in 2016-2011.

Table 1: Average number of children ever born of Nepal

Age group	Index (i)	Average number of children ever born			Percentage of Difference[1]	
		2006	**2011**	**2016**	**2011-2006**	**2016-2011**
15-19	1	0.15222	0.13828	0.15243	-9.15780	10.23286
20-24	2	1.21764	1.00628	0.90005	-17.35817	-10.55670
25-29	3	2.40213	2.06404	1.86316	-14.07459	-9.73237
30-34	4	3.24802	2.79242	2.57500	-14.02701	-7.78608
35-39	5	4.08677	3.51643	3.16527	-13.95576	-9.98626
40-44	6	4.60048	4.01626	3.52444	-12.69911	-12.24572
45-49	7	5.26322	4.56727	4.03899	-13.22289	-11.56665

Sources: Nepal Demographic and Health Survey Data Files, 2006, 2011, 2016.

[1]Note: Percentage of difference is calculated by average number of children ever born from the survey year 2006, 2011 and 2016. It is illustrated by one example which is given as: (0.13828-0.15222)/0.15222*100 = -9.15780.

Table 2: Age specific fertility rate of Nepal

Age group	Index (i)	Age specific fertility rate			Percentage of difference[1]	
		2006	**2011**	**2016**	**2011-2006**	**2016-2011**
15-19	1	0.07826	0.06829	0.07369	-12.73959	7.90745
20-24	2	0.22034	0.19859	0.18281	-9.87111	-7.94602
25-29	3	0.15644	0.14336	0.13966	-8.36103	-2.58092
30-34	4	0.08873	0.07622	0.06231	-14.09895	-18.24980
35-39	5	0.05259	0.03945	0.02669	-24.98574	-32.34474
40-44	6	0.01450	0.01021	0.00660	-29.58621	-35.35749
45-49	7	0.00110	0.00638	0.00095	480.00000	-85.10972

Sources: Nepal Demographic and Health Survey Data Files, 2006; 2011; 2016

[1]Note: Percentage of difference is calculated by age specific fertility rate from the survey year 2006, 2011 and 2016. It is illustrated by one example which is given as: (0.06829-0.07826)/ 0.07826*100 = -12.73959.

Table 2 shows the age specific fertility rate for survey year 2006, 20011, 2016 and percentage of difference in 2011-2006 and 2016-2011. The percentage difference of age specific fertility rate is decreasing in each age group of women except 45-49 in 2011-2006 whereas percentage difference of age specific fertility rate is also decreasing in each age group of women except 15-19 age group of women in 2016-2011.

Total Fertility Rate in Nepal

Table 3: Trend of total fertility rate of Nepal

Survey Year	Nepal
2006	3.1
2011	2.6
2016	2.3

Sources: MOHP et al., 2007: 63; MOHP et al., 2012: 76; MOH et al., 2017: 95.

According to Nepal Demographic Health surveys of 2006; 2011 and 2016, level of fertility is 3.1, 2.6 and 2.3 respectively by direct methods, it means there is also decreasing trend of fertility levels in 2006 to 2011 whereas increasing trend of fertility levels in 2011 to 2016.

Level and Trends of Fertility in Nepal

Trend Analysis of Findings Based on Survey Data

Table 4 shows the estimated values of TFR for the year 2006-2011 and 2011-2016 are 2.80822 and 2.69019 which clears that the declining trend in the level of fertility. Comparing period fertility rates with average parities for a hypothetical cohort gives the interval estimate for the period 2006-2011 and 2011-2016.

Table 4: Trend of fertility level (TFR) of Nepal by comparing period fertility rates with average parities for a hypothetical cohort

S. No.	Period	Estimated TFR
1.	2006-2011	2. 80822
2.	2011-2016	2. 69019

Sources: Nepal Demographic and Health Survey Data Files, 2006, 2011, 2016.

Table 5 shows the level of fertility (TFR) of Nepal by Arriaga method based on three survey dates (NDHS, 2006, 2011, 2016). Table 5 shows the level of fertility (TFR) for the year 2006.5 (November) and 2010.5 (September), 2011.5 (September) and 2015.5 (March) are 2.7597 and 2.3026, 3.1400 and 2.6590 respectively which clearly shows the declining trend in the level of fertility between surveys but increasing trend of fertility recent surveys years.

Table 5: Trend of fertility level (TFR) of Nepal by Arriaga method

S. No.	Period	Estimated TFR
1.	2006.5 (November)	2.7597
2.	2010.5 (September)	2.3026
3.	2011.5 (September)	3.1400
4.	2015.5 (March)	2.6590

Sources: Nepal Demographic and Health Survey Data Files, 2006, 2011, 2016.

Verification of the Estimated Level of Fertility from Indirect Methods by Linear Regression Method.

Table 6 shows the trend of fertility level (TFR) of Nepal based on three surveys date (NDHS, 2006; NDHS, 2011 and NDHS, 2016). These data are used for the calculation of linear regression where period (X) is taken as independent variable whereas TFR (Y) is taken as dependent variable.

Table 6: Trend of fertility level (TFR) of Nepal

S. No.	Indirect Methods	Period (X)	TFR (Y)
1.	Arriaga method	2006.92	2.75974
2.	Comparing period fertility rates with average parities for a hypothetical cohort.	2008.75	2.80822
3.	Arriaga method	2010.75	2.30256
4.	Arriaga method	2011.75	3.13997
5.	Comparing period fertility rates with average parities for a hypothetical cohort.	2013.83	2.69019
6.	Arriaga method	2015.25	2.65905

Sources: Nepal Demographic and Health Survey Data Files, 2006, 2011, 2016.

Regression Line

$Y = a + b X$

$Y = 0.29280 + 0.00122 \times 2015.25 = 2.74604.$

$\therefore$ According to linear regression, Level of fertility (TFR) in 2015.25 is 2.74604.

Table 7 shows the level of fertility (TFR) by indirect method (Arriaga method) and linear regression. Fertility level (TFR) is 2.65905 and 2.74604 in 2015.25 by indirect method (Arriga method) and linear regression respectively which is almost same and shows the high accuracy of estimation of fertility by indirect methods.

Table 7: Level of fertility (TFR) by indirect method (Arriaga Method) and linear regression

S. No.	Year	Fertility Level (TFR)	
		Indirect Method (Arriaga Method)	Linear Regression
1.	2015.25	2.65905	2.74604

Comparison of the Estimated Level of Fertility from Indirect Method with Direct Method

Table 8 shows comparison of the estimated level of fertility of Nepal from indirect method (comparing period fertility rates with average parities for a hypothetical cohort) with direct method. Both indirect and direct methods show the same decreasing trend of fertility level (TFR).

Table 8: Comparison of the estimated level of fertility of Nepal from indirect method (comparing period fertility rates with average parities for a hypothetical cohort) with direct method.

S. No.	Period	Fertility Level (TFR)	
		Indirect method[1]	**Direct method[2]**
1	2006.42	2.9	3.1
2	2011.25	2.8	2.6
3	2016.75	2.6	2.3

Sources: [1]Nepal Demographic and Health Survey Data Files, 2006, 2011, 2016.
[2]MOHP et al., 2007: 63; MOHP et al., 2012: 76; MOH et al., 2017: 95.

Table 9 shows comparison of the estimated level of fertility of Nepal from indirect methods (Arriaga method) with direct method. Direct method shows the decreasing trend of fertility level (TFR) whereas indirect method shows the constant level of fertility (TFR).

Table 9: Comparison of the estimated level of fertility of Nepal from indirect methods (Arriaga method) with direct method.

S. No.	Period	Fertility Level (TFR)	
		Indirect method[1]	**Direct method[2]**
1	2006.42	2.7	3.1
2	2011.25	2.7	2.6
3	2016.75	2.7	2.3

Sources: [1]Nepal Demographic and Health Survey Data Files, 2006, 2011, 2016.
[2]MOHP et al., 2007: 63; MOHP et al., 2012: 76; MOH et al., 2017: 95.

Summary of the Findings

The trend of fertility (TFR) for the year 2006-2011 and 2011-2016 are 2.80822 and 2.69019 respectively by the application of comparing period fertility rates with average parities for a hypothetical cohort which clears that the declining trend in the level of fertility.

Application of Arriaga method gives the trend of fertility (TFR) are 2.7597 and 2.3026, 3.1400 and 2.6590 for the year 2006.5 (November) and 2011.5 (September), 2011.5 (September) and 2015.5 (March) respectively which clearly shows the declining trend in the level of fertility between surveys but increasing trend of fertility recent surveys years.

Fertility level (TFR) is 2.65905 and 2.74604 in 2015.25 by indirect method (Arriaga method) and linear regression respectively which is almost same and shows the high accuracy of estimation of fertility by indirect methods.

Comparison of the estimated level of fertility of Nepal from indirect methods (comparing period fertility rates with average parities for a hypothetical cohort) with direct method shows the same decreasing trend of fertility level (TFR).

Comparison of the estimated level of fertility of Nepal from indirect method (Arriaga method) with direct method shows the decreasing trend of fertility level (TFR) whereas indirect method shows the constant level of fertility (TFR).

Conclusions

According to Nepal Demographic Health surveys of 2006, 2011 and 2016, the level of fertility (TFR) by direct methods is in decreasing trend in 2006 to 2011 whereas increasing trend in 2011 to 2016. Similarly, application of indirect methods for the same date gives the decreasing trend of fertility levels in 2006 to 2011 whereas increasing trend of fertility levels in 2011 to 2016. Given the supporting evidence for changing fertility levels in Nepal, the hypothetical inter-survey method and Arriaga's method are appropriate to estimate recent fertility levels because of the changing fertility assumption. Estimation of fertility level (TFR) at the national level by indirect methods and linear regression is almost same which show the high accuracy of estimation of fertility by indirect methods at the national level.

Acknowledgement

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Annexes

Annex 1 : No of women, no. of children ever born, no. of live birth during one year preceding the survey, the average number of children ever born and age-specific fertility rates for the year 2006 of Nepal

Age Group	Index	NDHS 2006				
		W(i)	CEB(i)	B(i)	P(i)	f(i)
15-19	1	2436.55054	370.88805	190.69297	0.15222	0.07826
20-24	2	1994.57942	2428.68375	439.49209	1.21764	0.22034
25-29	3	1773.36147	4259.85140	277.42439	2.40213	0.15644
30-34	4	1336.28243	4340.26997	118.56455	3.24802	0.08873
35-39	5	1219.59064	4984.18651	64.13675	4.08677	0.05259
40-44	6	1121.00593	5157.16011	16.25116	4.60048	0.01450
45-49	7	911.63002	4798.10731	0.99942	5.26322	0.00110

Source: Nepal Demographic and Health Survey Data File, 2006

Annex 2 : No of women, no. of children ever born, no. of live birth during one year preceding the survey, the average number of children ever born and age-specific fertility rates for the year 2011 of Nepal

Age Group	Index	NDHS 2011				
		W(i)	CEB(i)	B(i)	P(i)	f(i)
15-19	1	2753.05001	380.68185	187.99597	0.13828	0.06829
20-24	2	2297.42408	2311.86261	456.24774	1.00628	0.19859
25-29	3	2101.02093	4336.58365	301.19865	2.06404	0.14336
30-34	4	1733.78342	4841.44488	132.14214	2.79242	0.07622
35-39	5	1557.17887	5475.70726	61.42416	3.51643	0.03945
40-44	6	1284.54300	5159.05761	13.11224	4.01626	0.01021
45-49	7	947.00013	4325.20346	6.04363	4.56727	0.00638

Source: Nepal Demographic and Health Survey Data File, 2011

Annex 3 : No of women, no. of children ever born, no. of live birth during one year preceding the survey, the average number of children ever born and age-specific fertility rates for the year 2016 of Nepal

Age Group	Index	NDHS 2016				
		W(i)	CEB(i)	B(i)	P(i)	f(i)
15-19	1	2598.36960	396.06485	191.46208	0.15243	0.07369
20-24	2	2250.72425	2025.77178	411.46502	0.90005	0.18281
25-29	3	2134.53096	3976.97173	298.10677	1.86316	0.13966
30-34	4	1806.13492	4650.79289	112.54867	2.57500	0.06231
35-39	5	1571.73662	4974.97255	41.94594	3.16527	0.02669
40-44	6	1387.96083	4891.78881	9.16242	3.52444	0.00660
45-49	7	1112.54268	4493.55071	1.05145	4.03899	0.00095

Source: Nepal Demographic and Health Survey Data File, 2016