Estimation and Projection of Fertility, 2001-2031: Province 2, Nepal

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Abstract

Fertility is an essential tool of population growth which can assist to formulate and evaluate policies related to population change. Fertility decline in Nepal has been tested and by with different studies with different figures like demographic health survey and national census data but varies data in provincial level. This study describes the children ever born and the birth before 12 months who were given birth by reproductive (15-49) age group of women. The study has utilized census data from CBS that were conducted in 2001 and 2011. These national household censuses were carried out in 12.5 percent of total household. From census data files 1,063,903 and 1,304,079 number of reproductive age group of women were identified through analysis. The study was carried out adhering to the Arriaga method and changing P/F ratio method. Age sex pyramids and frequency table represent demographic scenario of province two. The TFR values of province 2 exact years 2016, 2021, 2026 and 2031 were obtained by linear interpolation and extrapolation by 2031, it will to reach TFR replacement level.

Key Words: Estimation, projection, census, indirect techniques, province 2

Introduction

Fertility is important demographic variable linked to socio-economic development and health wellbeing population (Bongaarts, 1978). Many research questions explore its actual data needed for estimation to obtain accurate and reliable information in a country (Schmertmann, Cavenaghi, Assunção, & Potter, 2013).The indirect technique for estimation of TFR is proximate determinants model (Bongaarts, 1987). The measurement of fertility indicators, models based on polynomial models, Coale- Demeny function (Coale & Demeny, 1968). The various indirect measures of fertility are parity progression ratio, stable method, and regression techniques that Brass's (Brass, 1996) has suggested a P/F ratio method for estimating fertility by Hobcraft (Hobcraft & Little, 1984). The P/F ratio method for estimating fertility and stable population method (United Nations, 1983) has been used for estimating TFRs (Rele, 1987) which is proposed techniques in this study. Indirect method is very reliable for estimating TFR where data are irregularities (Devkota,

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2018). There are no methods for estimating fertility rates in developing countries over time based on different data sources that assess the uncertainty of the estimates (Alkema et al., 2009).Since most of the less developed countries don't have complete registration of vital statistics, demographic procedures have been divided for an indirect measurement of fertility. In general, the procedures take into account data collected in a census or survey about women by age their children ever born and their children born during the year prior, to census or survey data (Brigitte, 1952). This states that the methods were developed earlier 1940's by Grab Ill (1941) Mortar (1949), Henry (1970) and Arriaga's and Anderson (1975) (Rossi, 1975). This technique devised several years ago (Arriaga, 1983) consists of comparing average numbers of children ever born to obtain a set of age specific fertility rates. Some of these techniques are based on indirect estimation while others are based on the statistical modeling in which the parameters are estimated through modeling (Brass & Coale, 1977).This knowledge gap in fertility data within various researches is fulfilled by estimation and projection of fertility. The demographic health survey 2011 reveals that province 2 has shortest birth interval (30 months) and the total fertility rate (TFR) is 2.3 children per woman highest among the provincial level (Ministry of Health, 2016) and applying the estimation and projection of fertility in Province 2. The aim of this study is to estimate and verify the validity logistic curve function using the projection in province 2.

Data and Methods

Indirect demographic estimation covers a wide variety of procedures many of which solely utilize information obtained from single round surveys (United Nations, 1983). The estimation of vital rates using national registers in developing countries is problematic and NDHS has limited sample size. These censuses suffer from coverage and content errors (Kpedekpo, 1982) used in indirect estimation. Nepal, the proposed analysis has used available on census data set (2001 and 2011) focused on Province 2 in Nepal. This study describes the children ever born and the birth before 12 months who were given birth by reproductive (15-49) age group of women. The main staple of the demography taught and later extended by the UN regional demographic centers and were the subject scores of journal, articles reports; applied Arriaga method and changing P/F ratio for reliable and accurate information in indirect estimation (Schmertmann et al., 2013). Feeney (1996) presented a reinterpretation of P/F adjustment that similar logic (Feeney & Noller, 1996), however, proposed time based on the difference between current age and past and future mean time of cohort childbearing used logistic curve function rather than others mathematical model.

The Arriaga fertility method (1983) estimates fertility levels by comparing two or more sets of average CEB. This method was designed to be useful in cases where the Brass P/F ratio method is not appropriate because the level of fertility has been changing implemented as part of the population analysis system (Tsuya, Bumpass, & Choe, 2000). It express simply,

$f_x = CEB_{x+l} - CEB_{x,}$ where, f_x is the fertility rate for women in age group (x, x+l) and CEBx is the recorded average number of children ever born for women exact age x (Arriaga, 1994).

The Brass changing P/F ratio method characterized as hypothetical inter-survey cohort is logical relationship in this context is that, a cohort of women moves through life, the average parity at each age equals the cumulated ASFRs to that age, provided that the fertility of surviving women is equal to that of women dying during the interval. The method uses two key assumptions: firstly, because of common reporting problems, the Brass approach supposes that parity data (children ever born) are better than fertility data (CEB in a recent reference period) for estimating the overall level of fertility. If reported fertility is low (or high) relative to parity, then parity trumps fertility and TFR is adjusted upwards (or downwards) and secondly, the Brass approach supposes that age specific fertility rates have been constant over the reproductive lifetimes of women contributing data to the sample. If rates are nearly unchanging, then there should be little difference in a cross-sectional survey between age specific parities (P_x) and true cumulative period fertility (Φ_x). However, when fertility levels have been changing rapidly, as clearly states that prior to 2011, then the relationship between Φ_x and P_x becomes more complex (United Nations, 1983). The changing rates make parity based on consistency checks and corrections more difficult to derive (Moultrie & Dorrington, 2008). Where k is selected from consistent Pi, sFi and TFR = 5 × i=17.f*(i). In any case, the best P/F ratio for adjustment will be that for the youngest useable age group, 20-24. In projection by using logistic function mathematical is statistical models that have been used in diffusion processes are often modeled by a logistic function. The logistic function is the sigmoid curve with equation:

$$f(x) = \frac{1}{1 + e^{-x}}$$

Where, e is Euler's number; for values of x in the range of real numbers from $-\infty$ to $+\infty$, the S-curve shown is obtained (Pearl & Reed, 1920). Medium variant is used to project TFR estimation and projection. These data were processed in computer were using SPSS, Mort Pak 4.3 and MS excel programmed.

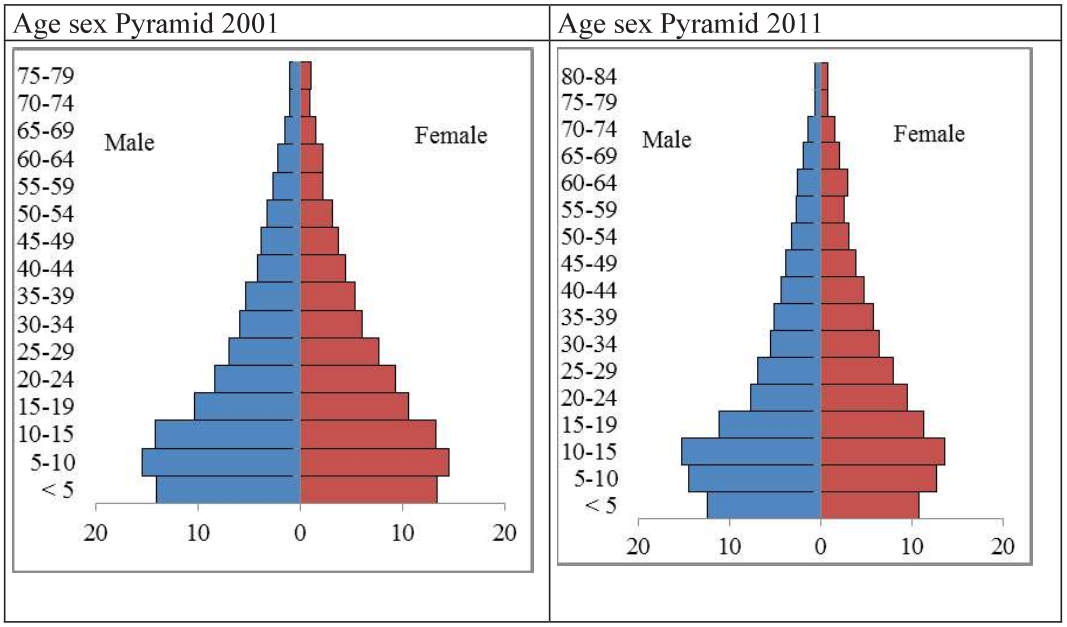
Results

This study has attempted to estimate fertility change by applying latest indirect techniques of fertility estimation at province 2, from 2001 and 2011 census data. The fertility estimates which are based on children ever born, last year birth according to reproductive age group of women.

Household Population by Age and Sex

The demographic processes are influenced by the age and sex structure. The demographic factors and the demographic processes have a very close link. However, the significance of age and sex extends far beyond demography. In traditional societies, the division of labor is nearly exclusively based on age and sex. The age-sex pyramids of household population clearly represents the population structure of specific time frame. The age-sex pyramid of province 2 for census 2001 and 2011 are presented in Figure 3.1.

Figure 3.1: Age sex pyramid 2001 in province 2



Source: Census dataset, 2001 and 2011.

Age-sex structure analysis of 2001, province 2 (Figure 3.1) has the highest proportion of the population in the age group 5-9 followed by the 0-4 age group. The population of the 0-4 is lower than 5-9 age groups. The data clearly indicate declining fertility and mortality. On the other hand, 2011 census shows that the highest proportion of the population is in the age group 5-9 followed by the 10-14 age groups. The population of the 0-4 age group is lower than subsequent (5-9 and 10-14) group. In 2001 and 2011 data were smoothed by Arriga method. The Figure 3.1 shows that aging index increases from 14.98 to 19.47 accordingly. This means there was significant increase in life expectancy and decrease in sex ratio at reproductive age group. The child dependency ratio has decreased from 76 to 71, working ratio has increased from 53 to 54, ageing dependency ratio has increased from 11 to 14, child dependency ratio has decreased from 76 to 71, child- aged ratio has decreased from 87 to 85, sex ratio has decreased from 107 to 101 and women ratio has

decreased from 0.573 to 0.455 during census 2001 to 2011. The sex ratio of the study population shows that male population with the age group between 15 to 40 years has declined sharply in comparison to other age groups. It might be the effect of absentee population. The demographic parameters represent the general idea about the child, adults, working age, reproductive age, and schooling age and so on. It is important to study fertility and effect of migration.

Estimation of fertility Arriaga method in province 2

The Arriaga fertility method estimates fertility levels by comparing two or more sets of average CEB in province 2. These estimates are used to adjust observed fertility patterns in a manner similar to the changing Brass P/F ratio method. The method was implemented as part of the population analysis system in two dates (Bumpass & Tsuya, 2003). This study has utilized the Arriaga approach for both theoretically and through simulations. It's a modern statistical take on a traditional deterministic population estimating method. As in the majority of developing countries, information from vital statistics is incomplete in Nepal. The contrary to the Brass technique, which assumes constant fertility, the hypothesis implicit in Arriaga's method is that the average number of children born per woman varies linearly in the time interval under consideration. The evidence of Nepal indicates that fertility is declining hence Arriaga's technique should be applicable to determine the validity of this tendency in province 2. In the case of intermediate surveys, the averages between the values of the preceding and following years are taken to determine the fertility. This study has based on CEB according to reproductive age group of women in province 2 (2001 and 2011 censuses).

Table 3.1: Estimation of fertility Arriaga method in province 2

Age	Conventional ASFR	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj. factors	Adj. Fertility f*
15-19	0.111	0.111	0.032	0.032	3.451	0.089
20-24	0.187	0.298	0.093	0.125	2.788	0.259
25-29	0.153	0.451	0.080	0.205	2.204	0.223
30-34	0.071	0.522	0.052	0.257	2.030	0.145
35-39	0.016	0.538	0.031	0.288	1.870	0.086
40-44	0.005	0.543	0.017	0.305	1.778	0.047
45-49	0.002	0.544	0.010	0.315	1.729	0.028
TFR						**4.391**

Source: Census dataset, 2001 and 2011.

Table 3.1 is based on age specified data of reproductive age span of women in province 2 (2001 census); the adjusted values are estimated on the basis of cumulative ASFR and

cumulative ASFR pattern. The adjusting value for age group was found in decreasing trends with increasing age group. Here, adjusting factor of P2/F2 values (2.788) has resulted adjusted ASFR for all age group and the adjusted TFR value was 4.391 in December 2000. The mean age of childbearing was 28.26 years. The TFR value was higher than national census value (4.1) (Central Bureau of Statistics, 2003)

Table 3.2: Estimation of ASFR based on 2011 census by using Arriaga method

Age	Conventional ASFR	Cum. ASFR	ASFR Pattern	Cumulative ASFR pattern	Adj. factors	Adj. Fertility f*
15-19	0.071	0.071	0.021	0.021	3.397	0.051
20-24	0.185	0.256	0.086	0.106	2.408	0.207
25-29	0.136	0.392	0.071	0.177	2.211	0.171
30-34	0.074	0.466	0.041	0.218	2.138	0.099
35-39	0.019	0.485	0.023	0.241	2.016	0.055
40-44	0.003	0.488	0.011	0.252	1.938	0.026
45-49	0.001	0.489	0.005	0.257	1.906	0.012
TFR						**3.106**

Source: Census dataset, 2001 and 2011.

Table 3.2 is based on age specified data of reproductive age span of women in province 2 (2011 census); the adjusted values are estimated on the basis of cumulative ASFR and cumulative ASFR pattern. The adjusting value for age group was found in decreasing trends with increasing the age group. Here, adjusting factor of P2/F2 values (2.408) has resulted adjusted ASFR for all age group and the adjusted TFR value was 3.106 in December 2011. The mean age of childbearing was 27.72 years. The TFR value was higher than national census value (2.6) (Central Bureau of Statistics, 2014).

Estimation of fertility for hypothetical inter- survey cohort

This study has been based on province 2 in Nepal. The indirect method of demographic assement aviable to date are frequently insufficient to predict levels. The hypothetical cohort based measurements is used to reduce the impacts of trends and estimate period levels in province 2. If fertility rate has changed over time, cumulative period fertility rates will not equal to lifetime fertility and an adjustment factor determined on the basis of comparison will reflect not only proable data mistake but also the impacts of chances over time. If age-specific fertility rates for the period's end points aren't accessible, a set of rates corresponding to the period's mid-point could be utilized instead. In hypothetical inter-survey cohort method two dates of number of CEB and number of birth before 12 months according to reproductive age groups of women are also taken. The data of censuses 2001 and 2011 were used for the calculation of changing P/F ratio in province 2.

Table 3.3a: Estimation of ASFR based on P/F hypothetical inter survey cohort

Age	2001P(i)	2011P(i)	ΔP(i)	P(i,s)	2001 f(i)	2011 f(i)
15-19	0.233	0.111	0.111	0.111	0.032	0.021
20-24	1.140	0.924	0.924	0.924	0.093	0.086
25-29	2.167	1.886	1.653	1.764	0.080	0.071
30-34	2.892	2.560	1.420	2.343	0.052	0.041
35-39	3.233	2.939	0.772	2.536	0.031	0.023
40-44	3.401	3.106	0.214	2.557	0.018	0.011
45-49	3.371	3.109	-0.124	2.412	0.010	0.005
TFR						

Source: Census dataset, 2001 and 2011.

Table 3.3b: Estimation of ASFR based on P/F hypothetical inter survey cohort

Age	f(i)	Φ (i)	F(i)	K	f+	f*(i)
15-19	0.027	0.132	0.040	2.789	0.034	0.089
20-24	0.089	0.578	0.351	2.631	0.091	0.239
25-29	0.076	0.955	0.778	2.269	0.072	0.191
30-34	0.047	1.188	1.081	2.168	0.044	0.116
35-39	0.027	1.321	1.257	2.017	0.026	0.067
40-44	0.014	1.393	1.348	1.896	0.014	0.036
45-49	0.007	1.429	1.418	1.701	0.006	0.015
TFR						**3.759**

Source: Census dataset, 2001 and 2011.

In this study, the changing reported average parities P (i, s) were calculated from the reported average parities of 2001 and 2011 censuses. The period ASFR f(i) was obtained from ASFR datasheet of 2001 and 2011 censuses. It was based on medium variant estimation, follows changing reported parities methods with help of manual X procedure in P (i, s)/F (i) ratios applied in province 2. The adjustment factor (K) for registered births and its reciprocal (1 /K) for the estimation of the completeness of birth registration, with inter-censual birth rate was estimated by summing total births registered during the years 2001-2011 in Nepal. The unadjusted ASFR was multiplied with K. The adjusted value 2.631 was estimated based on data in 2001 and 2011 censuses (Table 3.3a and 3.3b). Finally adjusted TFR value of province 2 was 3.75 in December 2005. The TFR value was higher than the national value (3.1) (Ministry of Health, 2006).

Projection of fertility in province 2 (reference date 2010)

Fertility estimate Arriaga method and changing P/F ratio methods was used which is suitable for declining fertility and mortality rate. The estimation of province 2 TFR in December 2010 was verified by using logistic curve function on the basis of December 2000 and December 2005 data. The TFR values were estimated by using Arriaga's and changing P/F methods. A trend extrapolation model refers specifically to a fairly simplistic model that uses the historical growth pattern to project the future growth pattern. The observation incorporates that during the demographic transition, fertility first changes slowly and it accelerates then finally decelerates.

The demographic scenario of province 2 reflects the phase of demographic transition. In province 2 adjusted TFR value was 4.391 in December 2000 and 3.759 in December 2005. The estimate of TFR obtained in December 2010 was 3.106. The estimation curve shows decreasing trend (slope = -0.130) and intercept 260.44. The parameter and TFR was obtained from the same value and hence the logistic curve method was validated. So, similar method can be applied to project the TFR of reference date December 2015, 2020, 2025 and 2030.

Projection of fertility in province 2 (reference date 2031)

Population growth rates are normally determined from historical data and then employed in certain mathematical formulas to forecast the population's likely future size. Population predictions are required for development planning and should, without a doubt, be as precise as possible in province 2. The estimates will be accurate if data used are accurate and assumptions involved in the projections held true in reality. As a result, data must be adequately reviewed and adjusted for mistakes before being used for projection, with logistic curve being the most likely assumption.

The age specific fertility rate is an extension of the general fertility rate that calculates fertility rates for each 5-year age cohort of women, starting with the 15 to 19 age group and continuing through the 40 to 44 age group. Almost all projection approaches extrapolate previous or current trends into the future to some extent. The estimated TFR values of December 2000, 2005 and 2010 by using logistic function has projected the TFR value up to December 2030. The same slope was used for future projection. The model was used spreadsheet TFRLGSTNew.xls interpolates and extrapolates of TFR in province 2.

Finally, 2015, 2020, 2025 and 2030 data were used to interpolate point estimation with medium variant in province 2. Fertility decline has been a primary determinant of population ageing and projected levels of fertility have important implications on the age structure of future populations, including on the pace of population ageing. In these basis trends of TFR values projected (Table 3.4).

Table 3.4: Projected TFR values in province 2

Year	TFR Values
December 2000	4.39
December 2005	3.76
December 2010	3.11
December 2015	2.62
December 2020	2.34
December 2025	2.19
December 2030	2.10

These dates based on census 2001 and 2011 can be obtained by linear interpolation. In fact, this research used point estimation with medium variant interpolation. TFR values were estimated December 2000 and 2010 by using Arriaga method and December 2005 by using hypothetical inter survey cohort. The obtained values were verified and valid by using logistic curve. The projected province 2 TFR of December 2015, 2020, 2025 and 2030 were obtained 2.62, 2.34, 2.19 and 2.10 respectively (Table 3.4). However, exact date of projected TFR using linear interpolation are 2016, 2021, 2026 and 2031 respectively. The TFR value was lower than the national value in all estimated dates. In province 2 will be same as the replacement level in 2031.

Discussion

It is very crucial, critical and important that 156 countries and areas around the world, the estimated number of births that the estimates of the approximately 230 million, which is more than the estimated 129 million births that actually 81 percent variants (Liu, 2015). This study shows that the province 2 has high fertility rate to compare national level TFR (4.125) in December 2001 (Central Bureau of Statistics, 2003). Similarly, province 2 has high fertility rate in comparison of national TFR (3.1) in December 2005 (Ministry of Health, 2006). In December 2010 shows that province 2 has high fertility in compare to national TFR (2.6) (Central Bureau of Statistics, 2014). A significant numbers of women say that they do not want another child but are not using any method of contraception (Casterline, 1989). Reducing unmet need and serving current users of contraceptive scan help in reducing unintended pregnancies that lead to abortions and unwanted births both of which are unacceptably high in many countries (Becker, 1999). Nepal is among the poorest countries in the world and the quality of its demographic data is no different either. Data that is meager and defective limits understanding of population dynamics in the country. The controversy arising from fertility estimates in many developing countries is mainly due to the poor data quality. For instance, fertility decline in Nepal has been tested and tried with different studies coming up with contradictory conclusions national census data. The demographic landscape of the SAARC region has seen unprecedented changes over the last 100 years. The population growth rate accelerated and India (which accounts for

three-fourths of the region population) doubled its population between 1961 and 1991 and crossed one billion marks in 2001. India, Pakistan and Bangladesh are respectively the second, seventh and ninth most populous countries of the world. The highest fertility rate (TFR) 5.4 in Afghanistan and lowest fertility rate (TFR) 2.1 which reached the replacement level in Sri Lanka world population data and NDHS give same TFR 2.6 in Nepal which is medium change of fertility in SAARC countrieswich is resemale indirect estimates of the TFR calculated using Arraiga's method in 2001 and 2011. The TFR is approximately 4.1 in 2001, which declines to 2.6 in 2011, a decline of slightly less than one child per woman over a decade (Central Bureau of Statistics, 2014). The value of the TFR recorded by the population and housing census 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 (Devkota, 2014). The TFR in Nepal is 2.3 children per woman (Ministry of Health, 2016).

Conclusions

This study has presented substantial defectiveness in Nepal's fertility data, hence the usefulness of indirect estimation of the total fertility rate using province 2 in Nepal. This research has main strength of study of point estimation of fertility by Arriaga's method and changing P/F ratio method in province 2 is justified which is a new contributing study in Nepal. The changing P/F ratio, the Arriaga's methods were quite powerful in indirectly estimating fertility levels. If the degree of data errors is enormous, then the techniques can also be sources of errors themselves (Feeney & Noller, 1996). This study used point estimation with medium variant interpolation. TFR values were estimated from December 2000 and 2010 data by using Arriaga method and December 2005 by using hypothetical inter survey cohort. The obtained values were verified and valid by using logistic curve. The projected national level TFR of December 2015, 2020, 2025 and 2030 were obtained 2.62, 2.34, 2.19 and 2.10 respectively. The TFR values are near to reach national TFR replacement level. At last using linear interpolation project of the TFR exact dates were 2016, 2021, 2026 and 2031 respectively.

References

Alkema, L., Raftery, A., Gerland, P., Clark, S., Pelletier, F., & Buettner, T. (2009). *Probabilistic projections of the total fertility rate.* Paper presented at the Proceedings of the 2009 Annual Meeting of the International Union for the Scientific Study of Population, Marrakech, Morocco. http://iussp2009. princeton. edu/abstractViewer. aspx.

Arriaga, E. E. (1983). *Estimating fertility from data on children ever born, by age of mother*: US Department of Commerce, Bureau of the Census.

Arriaga, E. E. (1994). *Bureau of the Census, USAID a Vol. I.* : Bureau of the Census, USAID and UNFPA.

Becker, H. S. (1999). Notes on the concept of commitment. *American journal of Sociology, 66*(1), 32-40.

Bongaarts, J. (1978). A framework for analyzing the proximate determinants of fertility. *Population development review*, 105-132.

Bongaarts, J. (1987). The proximate determinants of exceptionally high fertility. *Population Development Review*, 133-139.

Brass, W. (1996). *Demographic data analysis in less developed countries: 1946–1996* (Vol. 50).

Brass, W., & Coale, A. J. (1977). Methods of analysis and estimation. In *Mathematical Demography* (pp. 307-313): Springer.

Brigitte, L. (1952). Methods of Using Census Statistics for the calculation of life tables and other demographic measures (with applications to the Population of Brazil). In: Oxford University Press.

Casterline, J. (1989). *The state, social stratification and fertility transition.* Paper presented at the International Population Conference, New Delhi.

Central Bureau of Statistics. (2003). *Population Monograph of Nepal*. Kathmandu, Nepal: Central Bureau of Statistics.

Central Bureau of Statistics. (2014). *Population Monograph of Nepal*. Kathmandu, Nepal: National Planning Commission Secretariat.

Coale, A. J., & Demeny, P. (1968). Methods of evaluating basic demographic measures from limited and defective data.

Devkota, B.M.(2018). Estimation of Fertility due to Contraception in Nepal. Journal of Business and Social Sciences Research (JBSSR), Vol. 3, No. 2, pp. 137-150, BSSR/AIM, 2018, ISSN: 2542-2812, e-ISSN: 2631-2433.

Devkota, B.M.(2014). *Projection of Fertility Levels and Trends in Nepal (2011-2021).* Unpublished M Phil dissertation submitted to Central department of Population Studies (CDPS), TU. Kathmandu: Nepal.

Feeney, J. A., & Noller, P. (1996). *Adult attachment* (Vol. 14): Sage.

Hobcraft, J., & Little, R. J. (1984). Fertility exposure analysis: A new method for assessing the contribution of proximate determinants to fertility differentials. *Population Studies, 38*(1), 21-45.

Kpedekpo, G. M. (1982). Essentials of demographic analysis for Africa.

Liu, A. M. (2015). *Research methods for construction*: John Wiley & Sons.

Ministry of Health. (2006). Nepal Demographic and Health Survey 2016. In. Kathmandu, Nepal and Calverton,: New ERA and ORC Macro, DHS+, Maryland, USA.

Ministry of Health. (2016). Nepal Demographic and Health Survey 2016. In. Kathmandu, Nepal and Calverton,: New ERA and ORC Macro, DHS+, Maryland, USA.

Moultrie, T. A., & Dorrington, R. R. (2008). Sources of error and bias in methods of fertility estimation contingent on the P/F ratio in a time of declining fertility and rising mortality. *Demographic Research, 19*, 1635-1662.

Pearl, R., & Reed, L. J. (1920). On the rate of growth of the population of the United States since 1790 and its mathematical representation. *Proceedings of the National Academy of Sciences of the United States of America, 6*(6), 275.

Rele, J. R. (1987). Fertility levels and trends in India, 1951-81. *Population Development Review*, 513-530.

Rossi, F. (1975). Un modello di simulazione per lo studio del ciclo di vita della famiglia. 35-94.

Schmertmann, C. P., Cavenaghi, S. M., Assunção, R. M., & Potter, J. E. (2013). Bayes plus Brass: estimating total fertility for many small areas from sparse census data. *Population studies, 67*(3), 255-273.

United Nations. (1983). *Indirect techniques for demographic estimation* (Vol. 81): New York: United Nations.