J. biosoc. Sci. (1986) **18**, 179–196

PROXIMATE DETERMINANTS OF FERTILITY IN THE KATHMANDU VALLEY, NEPAL: AN ANTHROPOLOGICAL CASE STUDY

J. L. ROSS*†, J. BLANGERO*†, M. C. GOLDSTEIN† AND S. SCHULER†

**Division of Medical Genetics, Cleveland Metropolitan General Hospital and †Department of Anthropology, Case Western Reserve University, Cleveland, Ohio, USA*

Summary. This article employs the analytical model of Bongaarts and Potter to compare the proximate determinants of fertility among three populations in Nepal's Kathmandu valley with the following characteristics: (1) high and low caste, (2) urban and urban fringe residence, and (3) users and non-users of contraception. It is shown that while Nepal, as a whole, is firmly entrenched in Phase 1 of the fertility transition, each of the populations studied has begun to experience a demographic transition to different degrees. In fact, greater progress in controlling fertility has been made than previously known.

Introduction

Nepal is a small, independent Hindu kingdom approximately 141,000 km^2 in area situated between the Tibetan autonomous region of China to the north and India to the south, east and west.

It is a predominantly rural country; only 7% of the population reside in urban areas while the remainder live primarily on family owned farms and earn their livelihood from agriculture. In 1984 the GNP per capitum was US$170, with a per annum growth rate in the last 5 years of less than 0·5% (Population Reference Bureau, 1984). The economy of Nepal is one of low productivity and growth, with a poverty of known natural resources, a lack of capital, a labour surplus and a heavy dependence on external aid (Abueva & Upadhyaya, 1975). By virtually any standard, Nepal remains one of the most underdeveloped countries in the world.

The current (1984) population of the country is approximately 16·6 million persons, 43% of whom are under 15 years of age. The crude birth rate is 43/1000, the crude death rate 18/1000 and the infant mortality rate 149/1000 (one of the highest in the world). The current rate of natural increase is 2·5% per annum, resulting in a doubling time of 28 years. By the year 2000 Nepal may have over 23 million persons, by 2020 as many as 33·5 millions (Population Reference Bureau, 1984).

The government of Nepal has become increasingly concerned with the consequences of rapid population growth. The current Five Year Plan gives priority to fertility reduction: 'If the population growth rate, which has already assumed a problem of grave proportion, is not checked in time, the hope of meeting the basic minimum needs of the people will recede further and further away' (National Planning Commission, 1981, p. 13).

Longitudinal data on which to assess the effectiveness of family planning efforts, or even the constituent elements of population dynamics for Nepal as a whole, are severely limited. To date no system for the registration of births and deaths has been established and, while nation-wide censuses were begun in 1911, these have been conducted in a scientific, systematic way only since the 1950s and they still suffer from an underreporting of births and deaths. Their use is further complicated by the fact that boundaries for reporting aggregate data have changed between enumerations.

These limitations are unfortunate because reliable data are essential not only for providing a baseline from which to assess the existing situation and to predict prevailing trends, but also for informed planning and programme evaluation. To overcome these difficulties, two large national surveys have been undertaken. The first was the Nepal Fertility Survey of 1976 (part of the World Fertility Survey: Population Reference Bureau, 1982). The second was the Nepal Contraceptive Prevalence Survey of 1981 (Westinghouse Health Systems, 1983). Each of these was designed to meet the need for up-to-date, reliable information on fertility and contraceptive behaviour.

The results from these two surveys indicate an increase in overall knowledge of at least one modern contraceptive method among all currently married women from 22% in 1976 to 52% in 1981, an increase of more than 100%. Similarly, contraceptive use among these women rose from 3·7 to 8·6%, a positive increase of 132%. Among urban residents overall knowledge of contraceptive methods was 76% in 1981, and 24% of urban women between the ages of 15 and 49 were current users of modern methods, up from the utilization rate of 16% among women reported in 1976. But while there was an increase in the levels of knowledge and contraceptive use between 1976 and 1981, Nepal has made little progress in reducing high fertility and population growth. This is apparently true even in urban areas.

To date, micro-demographic studies of population dynamics in Nepal have been relatively few, generally limited in scope and (with the exception of that by Folmar, 1985) conducted primarily with 'natural fertility' populations (i.e. groups characterized by the absence of contraception and induced abortion) of the mountain and hill regions (e.g. Ross, 1981, 1984; Goldstein, 1976; MacFarlane, 1976; Weitz *et al.*, 1978). In 1981–82 Case Western Reserve University initiated a study (under the direction of M. C. Goldstein) of the determinants of fertility and contraceptive use (including the cost and value of children) in the Kathmandu valley which was designed, in part, to fill this gap in current knowledge.

Method

The project was designed to compare a series of sub-populations with the following characteristics: (1) high and low caste, (2) urban and urban fringe residence, and (3) users and non-users of contraception (Goldstein, Ross & Schuler, 1983, unpublished report).

Two principal research sites were chosen thought to be typical of the neighbourhoods or villages they were assumed to represent, and within those communities households were selected at random for participation in the study. The first was a high caste Hindu (Brahmin and Chetri) urban neighbourhood (Ghatakhola) located in the centre of Kathmandu city. It contained a mixture of low and middle income households. To test its representativeness a second urban neighbourhood in another section of the city (Paknajole) was also surveyed; no significant differences were found and the data from these two sites were combined.

The second research site (Katunje) was a high caste Hindu urban fringe community (i.e. one in which the majority of residents own and farm land but in which a substantial number are employed in non-agricultural pursuits) 12 km south-east of Kathmandu proper and approximately 2·5 km south of Bhaktapur, a second city in the valley.

The low caste untouchable Sarki (leather worker) households included in this study are located in four separate communities. One of these (Sarkigoan) is located just within the ring road which forms the unofficial city limits of Kathmandu, two others are located just outside it, and the fourth is located within the urban fringe community of Katunje. Because there are no large communities of Sarkis the total study population of this caste is considerably smaller than that of the higher caste groups. There are no Sarkis living in the heart of the city proper so there is no clear contrast between urban and urban fringe. While there were differences between the communities of Sarkis, the similarities were striking. For example, all males were engaged in equivalent types of wage labour in urban areas, the majority of households held small plots of land as tenants which were attended primarily by women of the households, and the Sarkis' attitudes and behaviour towards reproduction and contraception were similar. In this paper the Sarkis will be treated as a single population.

This study employed both survey and anthropological methods. The total number of women between the ages of 15 and 49 from each community included in this study is presented in Table 1.

Table 1. Age distribution, all women 15–49 years, Kathmandu valley study

Age (years)	No. of women		
	Urban	Rural	Sarki
15–19	128	89	58
20–24	141	77	40
25–29	135	45	37
30–34	79	42	25
35–39	58	42	33
40–44	51	52	24
45–49	29	33	13
Total	621	380	230

First a pre-tested demographic–reproductive–contraceptive questionnaire was completed for each household by female interviewers, carefully reviewed, and any gaps and internal inconsistencies resolved in subsequent re-visits by the interviewer who discussed the matter in an informal manner with the respondent.

This paper presents the initial findings on the primary proximate determinants of fertility among the three sub-groups studied, i.e. high caste (Brahmin and Chetri) urban residents, high caste urban fringe residents and low caste untouchables (Sarki).

Proximate determinants of fertility

An early model of the proximate determinants of fertility, i.e. biological and behavioural variables which have a direct effect upon it (Davis & Blake, 1956), identified eleven intermediate variables but has not been widely utilized in fertility studies, partly because it does not readily lend itself to quantification. The model developed more recently by Bongaarts (1975, 1976, 1978, 1982) is more useful for it allows quantitative examination of the relationship between the proximate determinants of fertility and aggregate fertility measures.

Bongaarts & Potter (1983) identify seven proximate determinants through which socioeconomic and environmental factors may affect fertility. These proximate determinants are: marriage patterns; use and effectiveness of contraception; prevalence of induced abortion; post-partum infecundability; spontaneous intrauterine mortality; waiting time to conception; onset of permanent sterility.

These variables can be further divided into primary and secondary determinants. Those identified as secondary determinants, i.e. spontaneous intrauterine mortality, waiting time to conception and natural sterility, are relatively constant between populations regardless of where they are located. The primary determinants, i.e. marriage, contraception, abortion and post-partum infecundability, are the principal determinants of fertility. Bongaarts & Potter (1983, p. 87) using data on 41 historical, developed and developing populations, concluded that 96% of the variance in the total fertility rates of these populations could be explained by reference to the four primary proximate determinants.

These determinants are calculated by the following four indices, which can only take values between 0 (complete inhibition of fertility) and 1 (no inhibition).

Index of marriage

The index of marriage, C_m, (i.e. exposure to reproductive risk), would equal 1 if all women at reproductive risk were married and 0 in the total absence of intercourse. It is the weighted (by age-specific marital fertility rates) average of the age-specific proportions of currently married women as follows:

$$C_m = \sum m(a)\,g(a)/\sum g(a)$$

where $m(a)$ = age-specific proportion of currently married women and $g(a)$ = age-specific marital fertility rates.

Table 2 presents the age-specific proportion of females currently married, age-specific marital fertility rates, and age-specific fertility rates for all women

Table 2. Age-specific rates: proportion of women currently married, $m(a)$, marital fertility, $g(a)$, and fertility, AFR(a)

Age (years)	$m(a)$	$g(a)$	AFR(a)
Urban high caste			
15–19	0·219	183·6	40·2
20–24	0·624	274·8	171·5
25–29	0·904	203·3	183·7
30–34	0·911	90·6	82·5
35–39	0·931	28·3	26·4
40–44	0·725	17·9	13·0
45–49	0·759	7·3	5·5
Rural high caste			
15–19	0·393	212·5	83·5
20–24	0·766	314·0	240·5
25–29	0·956	228·2	218·1
30–34	0·902	121·5	109·6
35–39	0·905	59·5	53·8
40–44	0·904	34·2	30·9
45–49	0·909	9·3	8·4
Sarki			
15–19	0·448	219·2	98·2
20–24	0·875	330·6	289·3
25–29	0·919	281·6	258·8
30–34	0·960	195·4	187·6
35–39	0·848	113·4	96·2
40–44	0·667	47·4	31·6
45–49	0·769	7·1	45·4

[AFR(a)] for each of the populations studied. Age-specific fertility rates were calculated from the pregnancy histories provided by currently married women and include the current plus the previous 5-year fertility history.

Age-specific fertility rates were smoothed, using the method of Brass (1960) based on a polynomial graduation function, to reduce error accrued by the effects of age misreporting and stochastic fluctuation due to small sample size. The age-specific fertility rates for each of these three populations are presented in Fig. 1 while age-specific marital fertility rates are presented in Fig. 2.

From these rates the index of marriage was calculated to be 0·649 for the urban high caste, 0·761 for the rural high caste and 0·810 for the Sarkis.

Index of contraception

The index of contraception, C_c, would equal 1 in the absence of contraception (e.g. natural fertility populations) and 0 if all women at reproductive risk employed completely effective contraception. This index takes into account both the

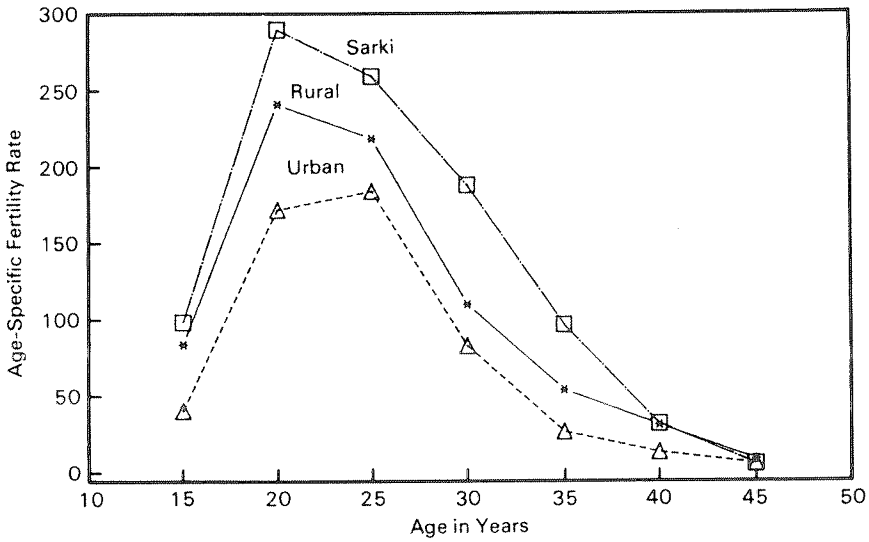

Fig. 1. Age-specific fertility rates in the sample populations

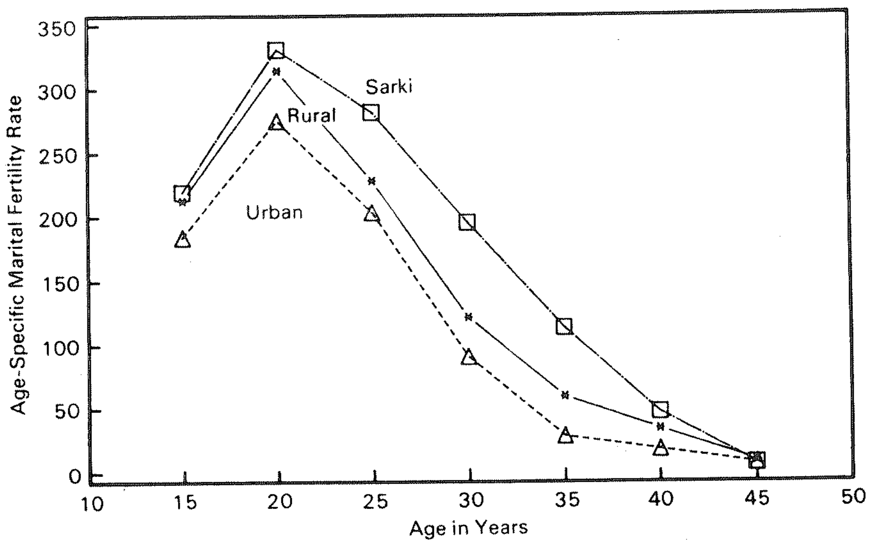

Fig. 2. Age-specific marital fertility rates in the sample populations.

prevalence and use-effectiveness of contraceptive practices employed by those at reproductive risk and is calculated by:

$$C_c = 1 - 1{\cdot}08 \times u \times e$$

where u = proportion of women at reproductive risk currently using contraception (includes abstinence, male methods and sterilizations) and e = average use-effectiveness of contraception.

The overall prevalence of contraceptive use (u) among currently married women (i.e. women assumed to be at risk) for each of the groups studied (Table 3) is 0·509 among urban high caste residents, 0·368 among rural high caste residents and 0·311 among Sarkis.

Table 3. Patterns of contraceptive use, currently married women

Age (years)	Urban		Rural		Sarki	
	N	% users	*N*	% users	*N*	% users
15–19	25	8 (0)*	34	3 (0)	17	6 (0)
20–24	81	35 (11)	57	21 (58)	25	12 (67)
25–29	113	57 (50)	41	34 (71)	26	31 (75)
30–34	70	74 (71)	36	56 (80)	21	48 (50)
35–39	53	57 (73)	36	58 (71)	25	40 (70)
40–44	34	56 (84)	46	61 (89)	13	54 (57)
45–49	21	33 (100)	30	23 (57)	8	38 (67)
All women 15–49	397	51 (58)	280	37 (75)	135	31 (62)

* % of users sterilized in parentheses.

Bongaarts & Potter (1983, p 84) employed adjusted method-specific use-effectiveness values in their calculation of e in the index of contraception (Table 4) but did not include injectable contraceptives, i.e. depo-provera, which was available to the populations studied in the Kathmandu valley. McDaniel, Gray & Pardthaisong (1984) examined the effectiveness of depo-provera injection as a contraceptive method in Thailand. They obtained a Pearl pregnancy rate of 0·14 per 100 years (i.e. 0·14% of women exposed for a year experienced contraceptive failure). Following Bongaarts & Potter (1983), this rate was converted into an estimate of contraceptive use-effectiveness. First, the 1-year failure rate was approximated by:

$$F = 0{\cdot}01P/(1 + 0{\cdot}005P)$$

where P = Pearl pregnancy rate.

Table 4. Method-specific use-effectiveness values, e(m)

Method	Use-effectiveness
Sterilization	1·00
Injection	0·99
IUD	0·95
Pill	0·90
Other	0·70

An index of contraceptive use-effectiveness was then obtained from:

$$e(m) = 1 - F/[12\, f_n\, (1 - 0{\cdot}5\, F)]$$

where f_n is an estimate of average natural fecundability (assumed to be approximately equal to 0·14).

These two equations estimate the use-effectiveness of depo-provera injection to be 0·99. This is in accordance with results obtained in a WHO multi-national clinical trial of injectable contraceptives (WHO, 1983).

Average use-effectiveness (e) is estimated as the weighted average of the method-specific use-effectiveness levels, with the weights equal to the proportion of women employing a specific method, and is calculated as follows:

$$e = \sum e(m)\, u(m)/u$$

where $e(m)$ = method-specific use-effectiveness, $u(m)$ = proportion women using specific method and u = proportion currently using contraception.

The values of $u(m)$ for each of the populations (Table 5) give average use effectiveness (e) of 0·906 for the urban high caste, 0·957 for the rural high caste, and 0·977 for the Sarkis. The resulting index of contraception (C_c) for urban high castes is 0·502, for rural high castes 0·620, and for the Sarkis 0·672.

Table 5. Proportion of women using specific contraceptive method, $u(m)$

Method	Urban	Rural	Sarki
Sterilization	0·295	0·275	0·193
Injection	0·013	0·007	0·074
IUD	0·018	0·011	0·007
Pill	0·040	0·036	0·022
Other	0·144	0·039	0·015

Index of induced abortion

The index of induced abortion, C_a, would equal 1 in the absence of induced abortion and 0 if all pregnancies were interrupted by induced abortion. This index is calculated as follows:

$$C_a = \text{TFR}/(\text{TFR} + 0{\cdot}4 \times (1 + u) \times \text{TA})$$

where TFR = an estimate of the total fertility rate, TA = total abortion rate, equal to the average number of induced abortions per woman at the end of the reproductive period if induced abortion rates remain at prevailing levels throughout the reproductive period, and u = proportion women using contraception.

The incidence of induced abortion (TA) was difficult to establish. From a series of in-depth interviews about reproductive and contraceptive decision-making it became apparent that, even though induced abortion is illegal in Nepal, a number of women had attempted this procedure at one time or another (Goldstein *et al.*, 1983, unpublished report). However, the quality of the data did not permit a valid estimate of TA, so, the index of induced abortion is taken to be 1·0 in each of the three populations.

Index of post-partum infecundability

The index of post-partum infecundability, C_i, would equal 1 in the absence of post-partum amenorrhoea (and post-partum abstinence) and 0 if the duration of post-partum infecundability were to continue indefinitely. An estimate of the index of post-partum infecundability is calculated as follows:

$$C_i = 20/(18{\cdot}5 + i)$$

where i = average duration of post-partum infecundability caused by breast-feeding (lactational amenorrhoea) and/or post-partum abstinence.

The numerator approximates the average birth interval in months in the absence of post-partum infecundability while the denominator estimates the average birth interval in the presence of post-partum infecundability. In practice, i is obtained from the mean duration of breast-feeding using an empirically derived non-linear regression (Bongaarts & Potter, 1983, p. 25). However, lacking information on breast-feeding practices, i was calculated from the observed average birth interval, subtracting the constant 18·5 in the denominator, giving the values 17·9 months for the urban high caste, 19·6 for the rural high caste and 19·1 for the Sarkis. The resulting indices of infecundability are 0·550, 0·524 and 0·531 for the three groups, respectively.

The indices of the proximate determinants are summarized in Table 6. To analyse from these indices the relationship between the proximate determinants and general fertility rates requires an estimate of the total fecundity rate (TF), an approximation of the maximum number of children a woman could be expected to bear during her lifetime, which takes into consideration the three secondary proximate determinants of fertility. Bongaarts & Potter estimated that, in the absence of the primary proximate determinants, the average birth interval is approximately 20 months in duration, the average fecund interval the 25 years between 15 and 40 years of age and, from extensive empirical data, that the TF is

Table 6. Proximate determinants of fertility, Kathmandu valley

Index	Urban	Rural	Sarki
Marriage (C_m)	0·649	0·761	0·810
Contraception (C_c)	0·502	0·620	0·672
Abortion (C_a)	1·000	1·000	1·000
Infecundability (C_i)	0·550	0·524	0·531

15·3 children on the average. Employing this TF estimate the remaining general fertility rates can be calculated as follows:

Total natural marital fertility rate (TN). This represents fertility levels obtained when the effects of post-partum infecundability (C_i) are taken into consideration and is calculated by:

$$TN = 15{\cdot}3 \times C_i$$

Total marital fertility rate (TM). This represents the fertility levels obtained when the effects of contraception and abortion are added to the TN and is calculated by:

$$TM = 15{\cdot}3 \times C_c \times C_a \times C_i$$

Total fertility rate (TFR). This represents actual observed fertility level in a population which includes the cumulative effects of all the proximate determinants and is calculated by:

$$TFR = 15{\cdot}3 \times C_m \times C_c \times C_a \times C_i$$

These predicted fertility rates for each of the populations in the Kathmandu study, as well as the observed TM and TFR for each group, are summarized in Table 7. It is evident that there is a high degree of concordance between the model predicted values and those actually observed. This level of agreement provides support, albeit indirect, for confidence in the internal consistency of estimates for the proximate determinants of fertility. Additional support for this conclusion is provided by a calculation of the exact estimate of TF (Bongaarts & Potter, 1983, p. 98). If an error was made in the calculation of one of the primary proximate determinants or the TFR, the exact estimate of the TF would fall outside the normal range of 13–17. The exact TF for high caste urban residents was calculated to be 14·6, for rural 15·1 and for the Sarkis 16·7, all well within the normal range.

Table 7. Model predicted fertility rates, Kathmandu valley

Fertility rate	Urban	Rural	Sarki
Natural (TN)	8·41	8·02	8·13
Marital (TM)	4·23 (4·03)*	4·97 (4·91)	5·46 (5·97)
Total (TFR)	2·74 (2·61)	3·78 (3·72)	4·42 (4·84)

* Observed rates in parentheses.

Model application

Calculation of the proximate determinants and their relationship to measures of aggregate fertility allows an analysis of their relative contribution to any change in the TFR in a given population over time, or between populations at a given time. For the proportional change in the TFR can be broken into its constituent elements from the four primary proximate determinants, i.e. C_m, C_c, C_a, C_i (Bongaarts &

Potter, 1983, p. 106). Briefly stated, the difference in the TFR between two populations is equivalent to the sum of the proportional changes in fertility attributable to the differential effects of the proximate determinants.

In Table 8 the difference of 1·1 births (29·8%) in the TFR between the urban high caste (TFR = 2·6) and rural high caste (TFR = 3·7) is broken down into the relative contribution of each of the proximate determinants. In this instance an increase of 0·55 live births (49·3% of the absolute difference) from urban to rural is attributable to differential proportions of women married, i.e. a greater proportion of rural high caste women are married ($C_m = 0{\cdot}761$ versus urban $C_m = 0{\cdot}649$), especially in the younger age cohorts 15–24 years. Similarly, an increase of 0·71 live births (63·6% of the observed absolute difference) is attributable to contraceptive practices. In other words, even though contraceptive use-effectiveness was higher in the rural population ($e = 0{\cdot}957$) than the urban ($e = 0{\cdot}906$) this is offset by a greater prevalence of contraceptive use among urban dwellers ($u = 0{\cdot}502$) than in high caste rural residents ($u = 0{\cdot}368$). On the other hand, there is a decline of 0·18 live births in the TFR between the urban and rural populations because of a shorter duration of post-partum infecundability in the urban population (17·88 versus 19·64 months). This slight differential is offset by the effects of the other proximate determinants, however. Taken together the remaining (secondary) proximate determinants account for an additional increase of 0·12 live births (10·5% of the difference) while the residual interaction factor is equivalent to a decline of 0·08 live births (7·3% of the difference). The interaction component is simply the sum of the second and higher order products of factors (Bongaarts & Potter, 1983, p. 107).

The difference (1·11 births) in the TFR between rural high castes (TFR = 3·7) and Sarkis (TFR = 4·8) can be accounted for by an increase of 0·24 live births (21·5% of the difference) attributable to differentials in proportions of women married ($C_m = 0{\cdot}810$ versus rural $C_m = 0{\cdot}761$), an increase of 0·31 live births (28% of the difference) to contraceptive practices ($e = 0{\cdot}977$, $u = 0{\cdot}311$ versus

Table 8. Decomposition of differences in total fertility rates between populations, Kathmandu valley

	Urban versus rural	Rural versus Sarki	Urban versus Sarki
Absolute difference (live births)	1·11	1·11	2·22
Difference due to:			
Proportion women married	+0·55	+0·24	+0·65
Contraceptive practices	+0·71	+0·31	+0·88
Induced abortion	0·00	0·00	0·00
Post-partum infecundability	−0·18	+0·05	−0·09
Other proximate determinants	+0·12	+0·42	+0·39
Interaction effect	−0·08	+0·10	+0·40

rural $e = 0{\cdot}957$, $u = 0{\cdot}368$), an increase of 0·05 live births (4·4% of the difference) to the duration of post-partum infecundability, an increase of 0·42 live births (37·4% of the difference) to the remaining proximate determinants and, lastly, an increase of 0·10 live births (8·7% of the difference) to the effects of interaction.

The contrast among these populations is especially dramatic when the decomposition of the differences in the TFRs (2·22 births) between urban high castes (TFR = 2·6) and Sarkis (TFR = 4·8) is examined. The observed TFR among Sarkis is 85·1% higher than for urban high castes. This is attributable to an increase of 0·65 live births (29·1% of the difference) due to the proportion of women married, an additional 0·88 live births (39·7% of the difference) is due to contraceptive practices, and while there is a decrease of 0·09 live births attributable to post-partum infecundability, the remaining proximate determinants account for an increase of 0·39 live births (17·4% of the difference) and interaction effects for another 0·40 additional live births (17·8% of the difference).

One of the many populations for which World Fertility Survey data were available and utilized by Bongaarts & Potter (1983, p. 88) in a test of their model was Nepal. These data permit a comparison of the differences in the TFR for all Nepal (WFS) and the three populations of this study. This decomposition is summarized in Table 9.

Table 9. Decomposition of differences in total fertility rates between all Nepal (WFS), and three populations, Kathmandu valley

	Urban versus WFS	Rural versus WFS	Sarki versus WFS
Absolute difference (live births)	3·76	2·65	1·53
Difference due to:			
Proportion women married	+0·82	+0·45	+0·25
Contraceptive practices	+2·49	+2·16	+2·22
Induced abortion	0·00	0·00	0·00
Post-partum infecundability	0·00	+0·18	+0·17
Other proximate determinants	−0·13	−0·29	−0·83
Interaction effect	+0·58	+0·15	−0·28

The absolute difference between the TFR for all Nepal (WFS: TFR = 6 ·37) and Sarkis is 1·53 live births (31·7%), a difference of 2·65 live births when compared with rural high castes (71·0%) and a difference of 3·76 live births (143·7%) when compared with urban high caste residents. The most significant proximate determinant contributing to this differential is the prevalence of contraceptive practices, which accounts for more than two live births in each case (urban = 2·49 live births, 66·2% of difference; rural = 2·16 live births, 81·8% of difference; Sarkis = 2·22 live births, 144·7% of difference). The second most important contributing factor is differential proportions married, accounting for 0·82 live births when compared to urban residents (21·8% of the observed difference), 0·45 live births when compared to rural residents (16·9% of difference) and 0·25 live births (16·6% of difference) when compared to Sarkis.

Discussion

Bongaarts & Potter (1983, pp. 103–106) utilized empirical data from a number of populations to construct a four-phase model of the transition in fertility from currently developing countries to levels observed in contemporary developed countries. Phase 1 is characterized by an observed TFR over 6·0, in Phase 2 the TFR ranges between 4·5 and 6·0, in Phase 3 from 3·0 to 4·5 and in Phase 4 the TFR is less than 3·0. Phase 1 populations approximate natural fertility while those in Phase 4 have generally completed the fertility transition.

The proximate determinants of fertility and predicted aggregate fertility rates for each phase of this synthetic fertility transition are summarized in Table 10. The changes in fertility levels from Phase 1 to Phase 4 generally indicate that the transition from natural to controlled fertility is characterized by declines in the proportions of women married and the duration of post-partum infecundability, and a substantial increase in the prevalence and effectiveness of contraceptive practices.

Table 10. Estimates of the proximate determinants and aggregate fertility rates in different phases of a synthetic fertility transition*

	Phase of fertility transition			
	I	II	III	IV
Index				
Marriage, C_m	0·780	0·627	0·551	0·550
Contraception, C_c	0·912	0·682	0·630	0·301
Induced abortion, C_a	1·000	1·000	0·961	0·887
Post-partum infecundability, C_i	0·649	0·780	0·763	0·930
Fertility rate				
Total, TFR	7·03	5·03	3·88	2·06
Marital, TM	9·08	8·08	7·05	3·80
Natural, TN	9·93	11·93	11·67	14·23

* Source: Bongaarts & Potter, 1983, p. 105.

It is evident from Table 10 that Nepal as a whole is firmly entrenched in Phase 1 of the fertility transition. Indices of the proximate determinants calculated from WFS data (Bongaarts & Potter, 1983, p. 90) are as follows: $C_m = 0{\cdot}852$, $C_c = 0{\cdot}980$, $C_a = 1{\cdot}0$, $C_i = 0{\cdot}550$ and model TFR = 7·02. Nevertheless, data from the three populations in the Kathmandu valley reported here clearly indicate that each case has begun to experience a demographic transition to different degrees. The indices of proximate determinants and the predicted fertility rates (Table 6 and Table 7) indicate that the Sarkis have experienced the least change when compared to all of Nepal; and although their indices of marriage and infecundability, as well as TN, place them in Phase 1 of the fertility transition, this is offset by the index of contraception. As a result the Sarkis in this study fall between Phase 2 and Phase 3 as indicated by the TFR. The rural high castes most closely approximate a population in Phase 3 while urban high castes included in this study are approaching Phase 4, i.e. one most commonly associated with controlled fertility in developed countries.

The results of this detailed analysis clearly indicate the heterogeneity in reproductive and contraceptive behaviour which can be found in Nepal (i.e. from natural to controlled fertility). In fact, greater progress in controlling fertility has been made among the populations studied than previously known. The prevalence of contraceptive practices, for example, greatly exceeds that reported for urban populations in general by either the WFS or the CPS. It is evident that for these three populations in the Kathmandu valley the fertility transition is well under way. Unfortunately, it is also evident from national aggregate fertility rates that this degree of controlled fertility is the exception and not the rule in the country.

This analysis of the proximate determinants of fertility also provides insight into the prospects for continued fertility decline among these populations. For example, generally the fertility transition is characterized by a shortening of the period of breast-feeding, resulting in a decrease in the period of infecundability and thus enhancing the potential for an increase in fertility. Among each of the populations studied prolonged breast-feeding is still the norm, thereby maximizing the period of lactational amenorrhoea and its fertility-inhibiting effect. While a future decline in the practice of breast-feeding is not certain (and is generally offset by an increase in contraceptive practices), it may be anticipated and efforts in support of breast-feeding may be appropriate.

The two most important contributing proximate determinants in the fertility transition are a decrease in the proportion of women married and an increase in the prevalence and effectiveness of contraceptive practices. In regard to the first, each of the three populations studied is characterized by a decline in the proportion of women married when compared to all of Nepal. Nevertheless, there remains a strong cultural emphasis on the marriage of women before or soon after first menses (between 20 and 40% of all women 15–19 years of age were married; by the age of 24 years between 60 and 90% of all women were married). Clearly, any efforts to increase the age at marriage among women in Nepal are to be encouraged, but given the prevailing cultural attitudes an immediate or pervasive change cannot be realistically expected. As a consequence the index of marriage and its relative effect on aggregate fertility can be expected to be relatively constant in the future.

The single most significant proximate determinant of fertility is the prevalence and effectiveness of contraception. The relationships between predicted TFR, contraceptive prevalence, and contraceptive use-effectiveness for each of the populations studied are represented in Fig. 3 (urban high castes), Fig. 4 (rural high

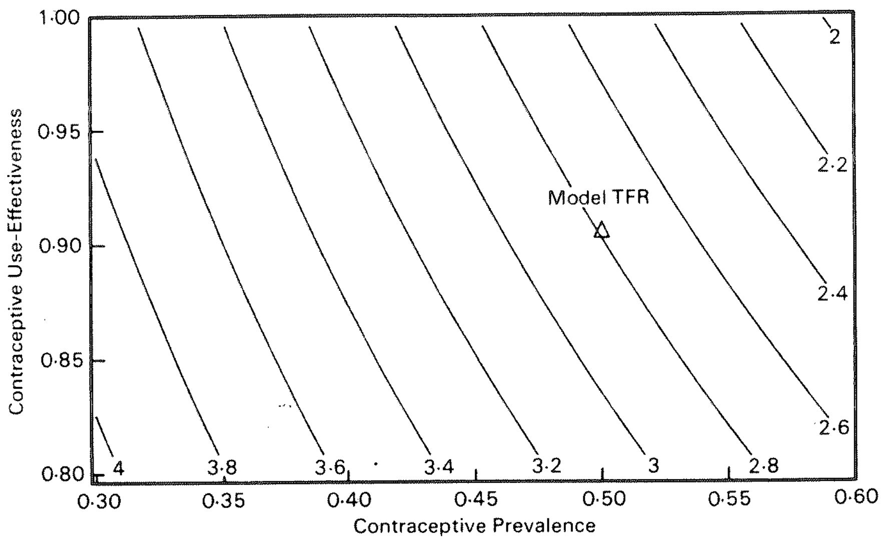

Fig. 3. Contour plot of the relationship between TFR and contraceptive prevalence and use-effectiveness for the urban high caste.

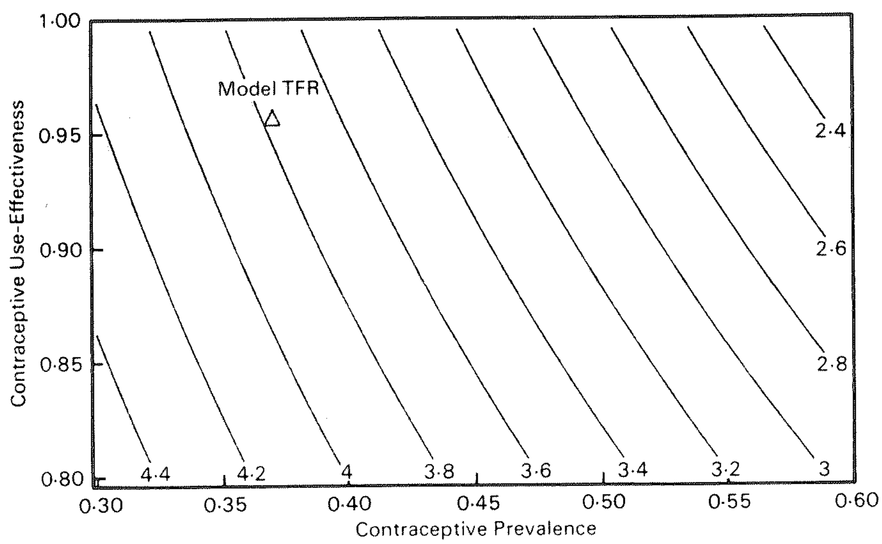

Fig. 4. Contour plot of the relationship between TFR and contraceptive prevalence and use-effectiveness for the rural high caste.

castes) and Fig. 5 (Sarki). These contours identify the levels of use-effectiveness and contraceptive prevalence that would have to be attained in order to reach a desired TFR. It is apparent from these figures that the relative use-effectiveness of methods currently employed is high, i.e. given available technology there remains little to be gained in the choice of contraceptive method. Gains in the reduction of

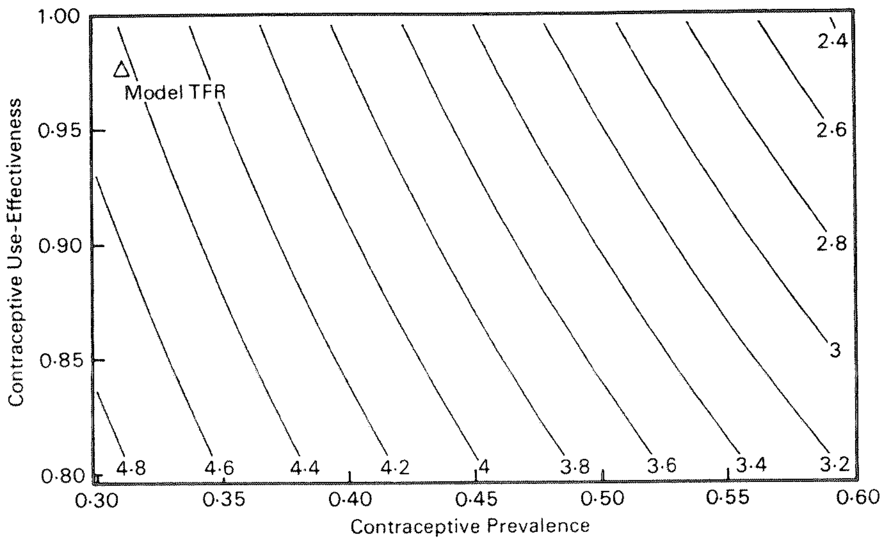

Fig. 5. Contour plot of the relationship between TFR and contraceptive prevalence and use-effectiveness for the Sarkis.

fertility, then, will have to be made from an increase in contraceptive use. The different proportions of contraceptive users (given current levels of efficacy) required to attain a reduction in the average number of births from 0·25 to a level of zero population growth in each community is presented in Table 11.

Among these populations efforts should be directed towards increasing and retaining the number of acceptors and in reducing the desired family size of those at reproductive risk, i.e. having women accept contraception and use it effectively after the birth of fewer children. It should also be noted that among countries with the lowest rates of population growth (or those which have made the most progress

Table 11. Rates of contraceptive use required to attain target reduction in TFR

	Contraceptive use		
Birth reduction	Urban	Rural	Sarki
0·25	0·558	0·409	0·338
0·50	0·607	0·449	0·364
0·75	0·656	0·489	0·391
1·00	0·706	0·529	0·418
Zero population growth	0·629	0·645	0·734
Current use	0·509	0·368	0·311

in reducing the rate of growth) induced abortion is generally available. This study found that there was an acceptance of and demand for such procedures among a substantial number of women. An appreciation of the potential fertility inhibiting effect of induced abortion can be gained by substituting the index of abortion (C_a = 0·887) obtained from the Phase 4 fertility transition stage in Table 10 into the basic proximate determinant model. Given the observed estimates of C_m, C_c, and C_i, induced abortion at this level would reduce the TFR by 0·31 births in the urban population, 0·43 births in the rural population, and 0·50 births in the Sarki population.

Conclusion

This study of the proximate determinants among three populations in the Kathmandu valley clearly documents the substantial heterogeneity with regard to fertility that is encountered in Nepal. The extent and nature of the heterogeneity within the country remains largely unknown and awaits further inquiry. On the other hand, there is evidence that progress has been made and a fertility transition is at hand among some groups in Nepal. This is a cause for cautious optimism, and a great deal remains to be learned from these populations with respect to reproductive and contraceptive decision-making which will be of import in the design, initiation and evaluation of subsequent family planning efforts.

This study has demonstrated the utility and value of the conceptual and analytical model proposed by Bongaarts & Potter. A great deal of difficulty is encountered in interpreting the available micro-demographic literature on population dynamics because of the relatively idiosyncratic manner in which much of it is collected and reported. This analytical model has the potential to place researchers from disparate disciplines on common ground.

Acknowledgments

Funding for this study was provided by the National Institute of Child Health and Human Development, Center for Population Research (HD 13827-02) and a supplementary grant from the Population Council (CP82.7A). We would like to express our appreciation to the government of Nepal, the Nepal Population Commission and the Center for Nepal and Asian Studies, Tribhuvan University, for their assistance.

References

ABUEVA, J. & UPADHYAYA, C. (Eds) (1975) *Population and Development in Nepal.* Tribhuvan University, Kathmandu.

BONGAARTS, J. (1975) A method for the estimation of fecundability. *Demography,* **12**, 645.

BONGAARTS, J. (1976) Intermediate fertility variables and marital fertility rates. *Popul. Stud.* **30**, 227.

BONGAARTS, J. (1978) A framework for analysing the proximate determinants of fertility. *Popul. Dev. Rev.* **4**, 105.

BONGAARTS, J. (1982) The fertility inhibiting effects of the intermediate fertility variables. *Stud. Fam. Plann.* **13**. 179.

BONGAARTS, J. & POTTER, R. (1983) *Fertility, Biology and Behaviour: An Analysis of the Proximate Determinants.* Academic Press, New York.

BRASS, W. (1960) The graduation of fertility distributions by polynomial functions. *Popul. Stud.* **14**, 148.

DAVIS, K. & BLAKE, J. (1956) Social structure and fertility: an analytical framework. *Econ. Dev. cult. Change*, **43**, 211.

FOLMAR, S.J. (1985) *Fertility and the Economic Value of Children in the Pokhara Valley, Nepal.* PhD thesis, Case Western Reserve University, Cleveland, Ohio.

GOLDSTEIN, M.C. (1976) Fraternal polyandry and fertility in a high Himalayan valley in northwest Nepal. *Hum. Ecol.* **4**, 223.

MACFARLANE, A. (1976) *Resources and Population: A Study of the Gurungs of Nepal.* Cambridge University Press, Cambridge.

MCDANIEL, F., GRAY, R. & PARDTHAISONG, J. (1984) Method failure pregnancy rates with depoprovera and a local substitute. *Lancet*, **i**, 1293.

NATIONAL PLANNING COMMISSION (1981) *The Sixth Plan.* Kathmandu, Nepal.

POPULATION REFERENCE BUREAU (1982) *The World Fertility Survey: Charting Global Childbearing.* Washington, DC.

POPULATION REFERENCE BUREAU (1984) *World Population Data Sheet.* Washington, DC.

ROSS, J.L. (1981) *Hindu and Tibetan Reproduction and Fertility in Northwestern Nepal: A Study of Population. Ecology and Economics.* PhD thesis, Case Western Reserve University, Cleveland, Ohio.

ROSS, J.L. (1984) Culture and fertility in the Nepal Himalayas: a test of a hypothesis. *Hum. Ecol.* **12**, 163.

WEITZ, C., PAWSON, I., WEITZ, M., LANG, S. & LANG, A. (1978) Cultural factors affecting the demographic structure of a high altitude Nepalese population. *Social. Biol.* **25**, 179.

WESTINGHOUSE HEALTH SYSTEMS (1983) *Nepal Contraceptive Prevalence Survey Report 1981.* Kathmandu, Nepal.

WHO (1983) Multinational clinical trial of long-acting injectable contraceptives: final report. *Contraception*, **28**, 1.

Received 14th March 1985