

Fertility Decline in India: Contributions by Uneducated Women Using Contraception

P. AROKIASAMY

India's fertility transition is driven by major fertility declines among women who are illiterate. Consequently, the earlier emphasis on women's education and socio-economic conditions as determinants of fertility decline is shifting to research on the study of reciprocally initiated positive contributions of fertility decline to the improvement of the health of women and children. This analysis indicates that illiterate women and their children are the greatest recipients of the benefits of health and socio-economic advancement. The standardised percentages of women without education who received three antenatal care check-ups and whose children received full immunisation are sharply higher for women with two children and less than for those with more than two children. Child mortality reductions for women of lower parities are steeply higher for uneducated women compared with educated women. These cumulative benefits of low fertility, in effect, have speeded up the health improvement and socio-economic advancement of the states.

Fertility transition in the states is apace since the 1990s. Data from the Sample Registration System (SRS) indicates that the crude birth rate (per 1,000 population) and total fertility rate (TFR) declined from 31 and 4.0, respectively, in 1991 to 24 and 2.6, respectively, in 2004. Eleven states of India have reached the replacement level fertility. Meanwhile, six states have TFR in the range of 2.2-2.5 and the remaining states have a TFR of more than 2.5, with the highest TFR (4.0) in Bihar and Uttar Pradesh (IPS 2007). Based on the conventional framework dealing with socio-economic determinants of fertility, a major body of past literature demonstrated evidence of early and significant fertility reduction among the educated and socio-economically advanced women (United Nations 1973; Caldwell et al 1982; Coale and Watkins 1987; Axinn and Barber 2001; Dreze and Murthi 2001). However, emerging evidence since the 1990s points to the fact that the bulk of fertility decline in India is now occurring among women without education and this transition is being driven in a major way by the increasing contraceptive prevalence rates among the uneducated women (Bhat 2002; McNay et al 2003). Declining fertility, now under way with varying speed in every Indian state, and in most regions of the developing world, is one of the most notable demographic behavioural changes occurring in the world.

A growing volume of recent literature recognises that the fertility reduction among uneducated women in India is a complementary phenomenon to the early phase of fertility decline among educated women (see McNay et al 2003; Arokiasamy et al 2004). The emergence of such a trend in demographic behaviour is consistent with the diffusion school perspective that diffusion of fertility decline progresses faster than socio-economic development, though the two processes are described as complementary to each other (Montgomery and Casterline 1996; Lesthaege and Vanderhoeft 2001). Bongaarts and Watkins (1996) have shown evidence of systematic shift over time in the relationship between development indicators and fertility, where in diffusion process tends to play a greater role in the middle stages of transition.

The momentum in fertility transition among the illiterate women of India through widespread use of contraception is a remarkable demographic behavioural change, aided by rapidly spreading community norms of low demand for children and facilitated by various means of communication and diffusion of ideas. This momentum is critical for taking forward India's fertility transition in view of the fact that close to 60% women are illiterate in Rajasthan and Uttar Pradesh, according to 2001 Census of India, notwithstanding a growing policy thrust to improve literacy rates

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P Arokiasamy (parokiasamy@yahoo.co.uk) is with the Department of Development Studies, International Institute for Population Sciences, Mumbai.

in these poorer states. Consequently, the predominant emphasis of fertility research on development and health indicators as determinants of fertility decline is now steadily and decisively shifting towards the dynamics of fertility decline among uneducated women and its consequences.

A major focus of this shift is on the reciprocally initiated positive contributions of fertility decline among uneducated women. Such contributions through reverse causation include major health improvements for women and children, educational development of children and progress in economic condition of families. This is a critical threshold point of departure from the main thrust of previous studies that dealt with the assessment of the contributions of increasing female education and socio-economic conditions on fertility reduction. In that context, there has been scepticism in the past to recognise a clear process of reverse causation of fertility impact on poverty and family well-being. This, however, was followed by a more balanced argument of mutually reinforcing effect over time between fertility decline and economic performance (IUSSP 1998). Nevertheless, such perceived long-term two-way causations do not predispose the emergence of new evidence on the net positive impact of fertility decline on health and well-being that is now being widely debated and increasingly recognised. More recent studies based on revisionist perspective have confirmed a net negative impact of high population growth on economic growth and poverty reduction, while declining fertility is seen to have spurred economic growth and poverty reduction (Bloom and Williamson 1997; Kelley 2001; Kelley and Schmidt 2001).

The demographic changes in recent decades in the east Asian and Latin American countries point to such clearly recognisable evidence of impact of fertility decline towards acceleration in economic development and health improvements. For instance, the decline in TFR from more than five during 1965-70 to 1.8 children during 1995-2000 in east Asia contributed not only to the global prospects, but the conditions of livelihood and well-being among the east Asian population themselves (United Nations 2001; Knodel 1992). Bloom and Williamson (1997) estimated that demographic factors accounted for about half of east Asia's excess growth of real gross domestic product (GDP) per capita in 1970-90.

Merrick (2002) showed that effects of demographic change on economic growth are useful to explain the past experience of different countries and regions; slow growth in Africa versus the burst of growth in east Asia. Analysing cross-sectional data of 45 developing countries, he demonstrated that had the average country reduced its birth rate by five per 1,000 throughout the 1980s, the average country poverty incidence of 18.9% in the mid-1980s would have been reduced to 12.6% between 1990 and 1995. Merrick concluded that both theory and improved and expanded empirical efforts support the likelihood that high average fertility at the country level hurts the poor, and that their own high fertility can contribute to their children's poverty. Developed countries' experience also suggests such reverse causal effect of fertility decline. Payne (2004) observed that the reduction in total fertility rate from 3.9 in 1960 to 1.4 children in 2000 in Canada had clearly contributed to improvements in women's maternal and reproductive health. The health benefits of low fertility to women and children including child schooling have been widely reported in micro studies as well (Bhat 2002; Schultz 2005).

1 Context and Objectives

The past demographic experience of east Asian countries in 1970-90 is now seen to be closely replicating in the Indian states beginning with the south and moving forward to west, east and other northern states. The emergence of these demographic shifts has concordance with the following long-term policy rationale of fertility control:

- to promote health of women and children
- accelerate poverty reduction
- achieve faster improvement in socio-economic conditions.

The main arguments of well-known social and economic change theories of fertility have been that the perceived positive health, social and economic benefits as a result of quantity-quality trade-off concerning number of children motivate parents to reduce fertility (Davis 1963; Blake 1989; Becker 1981). In the Indian context, women adopting sterilisation at a relatively young age of 25-30 may realise a longer period of unencumbered activity in the household and community, but transformation of opportunities for social and economic progress has not been empirically analysed (Schultz 2005).

The dynamics of recent demographic changes and economic progress in India clearly point to the need for a more comprehensive and systematic measurement of the potential benefits of reverse causation of fertility reduction in general, and among uneducated women, in particular. Though this has been a subject of concern in recent literature, efforts towards such an assessment have been constrained by the challenges of data analysis in order to establish causal impact of fertility decline in terms of returns in social, economic and health improvement (Birdsall et al 2001). We argue that improved quantitative methods with time series and micro level data provide a potential for credible prediction of low fertility contributions. Two specific types of assessments are possible. First, cross-sectional panel macro data can be effectively used to measure and disaggregate evidence of fertility impact on performance in economic and social indicators. Second, household level data from nationally representative demographic and health surveys are valuable for measuring health impact and social benefits of low fertility.

Set to this context, the twofold objectives of this analysis are: (a) assess systematic linkages between levels of fertility reduction and the health and development improvements amongst the states of India; (b) compare women and children's health and quality of life indicators for women using contraception (sterilised women) with two and less than two children and those with more than two children.

This analysis seeks to explore both macro and micro level evidence of the health and development outcomes of fertility decline for the following key women and child health indicators. At the macro level, empirical evidence is investigated if Indian states with greater fertility reduction have achieved higher rates of economic growth, faster reduction in poverty and infant mortality, and faster rates of increase in literacy and women's work participation.

At the micro level, low fertility impact has been studied with evidence of whether "low fertility among uneducated sterilised women" compared with those with high fertility, contributed to an improvement in the health of women – maternal healthcare coverage; rise in utilisation of healthcare services for their

children – immunisation coverage; greater reduction in neonatal, infant and child mortality; increase in school attendance rate of children.

Based on this perspective, this paper demonstrates a significant volume of evidence; that in India, the reverse causation of fertility reduction among illiterate women adopting contraception has contributed immensely to the improvement of health of women and children and in raising the standards of socio-economic conditions of their families.

2 Methodology

Data from the census, SRS, Centre for Monitoring Indian Economy (CMIE) are used for macro (state) level analysis. Data from three rounds of National Family Health Survey (NFHS-1992-93, 1998-99, 2005-06) are used in trend and decomposition analysis of fertility decline and contraceptive use. Data from NFHS-2 are used to assess evidence on the micro (household) level impact of fertility decline on key women and child health indicators.

We use decomposition procedures and econometric multivariate panel data regression analyses to assess the macro level impact fertility decline on key health and development indicators. Multivariate logistic regression models are estimated to compare differences in critical women and child health indicators between low and high fertility families.

2.1 Decomposition Analysis

To obtain contributions of fertility reductions by illiterate and literate women and by changes in educational composition of women for major states and India, the total fertility rates for the three rounds of NFHS conducted in 1992-93, 1998-99 and 2005-06 are decomposed by women's education. The decomposition method proposed by Kitagawa (1955) and modified by Bhat (2002) is used. The following formula is used:

$$F_b - F_a = \sum_{i=1}^k F_{b,i} C_{b,i} - \sum_{i=1}^k F_{a,i} C_{a,i}$$

$$= \frac{(F_{b,1} - F_{a,1})(C_{b,1} + C_{a,1})}{2} + \sum_{i=2}^k (F_{b,i} - F_{a,i}) \frac{(C_{b,i} + C_{a,i})}{2} + \sum_{i=1}^k (C_{b,i} - C_{a,i}) \frac{(F_{b,i} + F_{a,i})}{2}$$

where $C_{a,i}$ and $C_{b,i}$ refer to proportion of women of educational class i at time a and time b , respectively.

The three additive terms on the right-hand side of the equation give, respectively, the contributions of the above-mentioned three components of overall change in total fertility (with $i=1$ denoting the category of illiterate women). It may be noted that by using the average values of the two points of time as weights to the category-specific differences, the above decomposition formula neatly distributes the overall change into three components, without leaving anything for the residual category of "interaction" effects.

2.2 Panel Data Regression

A panel data regression differs from regular time-series or cross-section regression because of double subscript on its variables (Baltagi 2001). The panel regression is represented by the equation:

$$y_{it} = \alpha + X_{it}\beta + u_{it} \quad i = 1, \dots, N; t = 1, \dots, T$$

with i denoting population and t denoting time. The i subscript, therefore, denotes the cross-sectional dimension, whereas t

denotes the time-series dimension. α is a scalar, β is $K \times 1$, X_{it} is the l -th observation on K explanatory variables and u_{it} is the error component.

where, $u_{it} = \mu_i + v_{it}$

μ_i denotes the unobservable individual specific effect and V_{it} denotes the remainder disturbance.

Three models of panel data regression have been estimated for predicting the percentage of population below poverty line (BPL), infant mortality rate and female work participation rate with their respective set of predictors. Pooled observations of cross-section data across states of India over three time periods of 1981, 1991 and 2001 – the period of major fertility decline in most states – have been used. The predictors included in the models are TFR and relevant covariates such as female literacy rate, per capita state domestic product (SDP), percentage of males employed in non-agricultural sector, percentage of urban population and sex ratio and period dummy variables for 1981-91 and 1991-2001. Variables infant mortality rate, percentage of population below poverty line (BPL) and female work participation rate are used as co-predictors in models in which they are not used as dependent variables. The theoretical basis of retaining these predictors in the panel regression models is discussed in results sections.

2.3 Multivariate Logistic Regression

The NFHS provides data on maternal healthcare utilisation, body mass index (BMI), anaemia and reproductive morbidity and on child health and nutrition indicators: these include height, weight, anaemia, healthcare utilisation and child survival. We analyse key women and child health indicators between educated and uneducated women at sterilisation that critically bring out low fertility impact. Multivariate logistic regression models are estimated using NFHS-2 (1998-99) data set for assessing micro (household) level impact of fertility decline on selected women and child health indicators. These indicators are antenatal care (ANC) coverage (at least three checks-ups) to represent women's health and child healthcare utilisation (all vaccinations coverage) and child survival (neonatal, infant and child mortality) represent child health, besides children of 6-14 years attending school. The data for children born in the last three years prior to the survey are used for the analysis of ANC and immunisation. Data on children born in the last five years are used for child mortality analysis. Comparative analyses are performed between sterilised women with two and less than two children and those sterilised women with greater than two children and between educated and uneducated women with these selected women and child health indicators as dependent variable.

The logistic regression coefficients are converted into adjusted probabilities through the following steps:

Step 1: By using regression coefficient and mean values of independent variables, the probability is computed as:

$$P_o = \exp(Z) / \{1 + \exp(Z)\}, P_1 = 1 - P_o$$

where, Z is the estimated value of response variable for all categories of each variable.

Step 2: The probability P is multiplied by 100 to obtain the percentage values.

When calculating adjusted percentages for categories of a given predictor variable, other related predictor variables such as women's age, religion, caste, place of residence and standard of living index are held constant at their mean values. The tables consisting of adjusted probabilities in percentages are presented.

2.4 Cox Proportional Hazard Model

Proportional hazard model is applied to estimate neonatal, post-neonatal and child mortality rates by parity and women's education controlling for interrelated covariates. Proportional hazard model is a multivariate extension of the life table, combining the regression model with cohort life table analysis. The estimated hazard coefficients for categories of women's parity by women's education controlling for covariates are then converted into adjusted neonatal, post-neonatal and child mortality rates using Multiple Classification Analysis (MCA).

3 Decomposition of Fertility Reduction

The statewide trends in TFR by levels of women's education among NFHS-1, NFHS-2 and NFHS-3 shows a greater amount of fertility reduction among the illiterate women compared with women having high school education and above (Table 1).

The magnitude of overall TFR reduction vis-à-vis TFR reduction among illiterate women over the period of three rounds of NFHS surveys shows that the main contribution to the overall fertility decline in majority of the Indian states comes from illiterate women. The states that make major contributions include Bihar, Haryana, Himachal Pradesh, Punjab, Jammu and Kashmir,

Madhya Pradesh, Uttar Pradesh, Assam, West Bengal, Andhra Pradesh and Karnataka.

Decomposition results of TFR reduction by women's education demonstrate further evidence that 40-64% of fertility reduction between NFHS-1 and NFHS-2 is contributed by illiterate women in Bihar, Haryana, Himachal Pradesh, Madhya Pradesh, Uttar Pradesh, West Bengal and Karnataka. The corresponding contribution of fertility reduction by educated women is a low of 10% in Bihar and a high of 40% in Himachal Pradesh. In addition to the above seven states, fertility reduction between NFHS-1 and NFHS-3 for the state of Andhra Pradesh is seen through major contribution of illiterate women. In Kerala, Tamil Nadu, Maharashtra, Gujarat and Orissa, the difference in TFR by education has narrowed down due to sustained decline in TFR contributed by uneducated women in the 1980s and 1990s. Change in educational composition of women is the next largest contributor to changes in TFR. The fertility reduction among educated women accounts for the lowest amount of changes in overall TFR. Only 13% and 29% of the changes in TFR between NFHS-1 and NFHS-2, NFHS-1 and NFHS-3 are explained by fertility decline among educated women. Similar decomposition analysis by Bhat (2002) based on census data showed that 65% of India's fertility decline during the 1990s was due to the fall in fertility among illiterate women.

The reduction in TFR in the Indian states is mainly because of emerging behavioural change among the uneducated women. The three rounds of NFHS surveys demonstrate further evidence of illiterate women making a massive contribution to the rise in overall contraceptive prevalence rate (Table 2, p 59). For instance,

current use of contraception among all currently married women rose from 41% in 1992-93, to 48% in 1998-99 and 56% in 2005-06. The corresponding rise in contraceptive use rate among currently married illiterate women is from 34% in 1992-92, to 43% in 1998-99 and 52% in 2005-06. The contraceptive prevalence rose more steeply among illiterate women compared with all currently married women and educated women during the three successive rounds of NFHS. For instance, in 1992-93, the contraceptive prevalence rate among illiterate women (67%) rose higher than the contraceptive prevalence rate for all women (64%) only in one state, Kerala. Six years later in 1998-99, the contraceptive prevalence rate among illiterate women rose greater than that of all women in five more states Haryana, Himachal Pradesh, Punjab, Maharashtra and Karnataka cutting across all regions of the country, besides Kerala. By 2005-06 with the addition of four more states, Orissa, Gujarat, Andhra Pradesh and Tamil Nadu, 10 out of 17 major

Table 1: Trends in Total Fertility Rate and Decomposition of Fertility Change by Education of Women in India, NFHS-1, NFHS-2 and NFHS-3

States	Percentage Contribution of Change in TFR by Education between										
	Total Fertility Rate		Change in TFR between			NFHS-1 (1992-93) & NFHS-2 (1998-99)			NFHS-1 (1992-93) & NFHS-3 (2005-06)		
	NFHS-1 1992-93	NFHS-2 1998-99	NFHS-3 2005-06	NFHS-1 and 2	NFHS-1 and 3	Illiterate Women	Literate Women	Change in Educational Composition of Women	Illiterate Women	Literate Women	Change in Educational Composition of Women
North											
Bihar ¹	4	3.49	4	0.51	-	41	10	49	1	0	99
Haryana	3.99	2.88	2.69	0.88	1.3	64	24	12	83	47	-30
Himachal Pradesh	2.97	2.14	1.94	0.83	1.03	43	40	17	48	55	-3
Jammu and Kashmir ²	3.13	2.71	2.38	0.42	0.75	24	18	58	28	47	25
Madhya Pradesh	3.9	3.31	3.12	0.59	0.78	47	12	41	53	25	22
Punjab	2.92	2.21	1.99	0.71	0.93	37	34	29	43	50	7
Rajasthan	3.63	3.78	3.21	0.42	0.42	21	21	58	21	21	58
Uttar Pradesh ¹	4.82	3.99	3.82	0.83	1	68	23	17	74	26	0
East											
Orissa	2.92	2.46	2.37	0.46	0.55	23	16	54	4	51	45
West Bengal	2.92	2.29	2.27	0.63	0.65	47	13	37	38	27	35
West											
Gujarat	2.99	2.72	2.42	0.27	0.57	14	13	73	11	46	43
Maharashtra	2.86	2.52	2.11	0.34	0.75	21	13	66	32	43	25
South											
Andhra Pradesh	2.59	2.25	1.79	0.34	0.8	34	-	66	62	18	20
Karnataka	2.85	2.13	2.08	0.72	0.77	56	16	28	64	13	23
Kerala	2	1.96	1.93	0.04	0.07	0.1	4	96	-12	19	93
Tamil Nadu	2.48	2.19	1.8	0.29	0.68	22	7	71	27	41	32
India	3.39	2.85	2.68	0.54	0.71	41	13	46	42	29	29

¹ Figures for NFHS-1 and 2 refer to undivided Bihar (includes Jharkhand), Madhya Pradesh (includes Chhattisgarh) and Uttar Pradesh (includes Uttarakhand).

² Figures for NFHS-1 refer to only Jammu region of Jammu and Kashmir.

Source: IIPS 1995, IIPS 2000 and 2007.

Table 2: Trends in Percentage of Current Users of Contraceptive Methods among Currently Married Women, NFHS-1, NFHS-2 and NFHS-3

State	Illiterate Women			Total (all Women)		
	NFHS-1 1992-93	NFHS2 1998-99	NFHS-3 2005-06	NFHS-1 1992-93	NFHS2 1998-99	NFHS-3 2005-06
North						
Bihar ¹	17.6	20.5	29	23.1	24.5	34.1
Haryana	47.8	63.4	66.4	49.7	62.4	63.4
Himachal Pradesh	5.8	73.5	81.3	58.4	67.7	72.6
Jammu and Kashmir ²	45.7	46.2	49	49.4	49.1	52.6
Madhya Pradesh ¹	33.6	41.5	55.9	36.5	44.3	55.9
Punjab	56.7	67.9	66.4	58.7	66.7	63.3
Rajasthan	29.2	37.2	44.1	31.8	40.3	47.2
Uttar Pradesh ¹	15.5	24	39.7	19.8	28.1	43.6
East						
Assam	32.1	39.5	51.2	42.8	43.3	56.5
Orissa	33.8	45.2	66.4	36.3	46.8	63.3
West Bengal	49.1	62.2	70.2	57.4	66.6	71.5
West						
Gujarat	46.3	56.8	67.1	49.3	59	66.6
Maharashtra	54.1	62.5	72.8	53.7	60.9	66.9
South						
Andhra Pradesh	43.5	58.8	70.5	47	59.6	67.7
Karnataka	45.5	58.7	69.7	49.1	58.3	63.6
Kerala	66.7	74	72.6	63.3	63.7	68.6
Tamil Nadu	47.5	51.8	67.9	49.8	52.1	61.4
India	33.9	42.9	52.1	40.6	48.2	56.3

¹ Figures for NFHS-1 and 2 refer to undivided Bihar (includes Jharkhand), Madhya Pradesh (includes Chhattisgarh) and Uttar Pradesh (includes Uttarakhand).

² Figures for NFHS-1 refer to only Jammu region of Jammu and Kashmir.

Source: IIPS 1995, 2000 and 2006.

states reached higher contraceptive prevalence rate among illiterate women compared with contraceptive prevalence rate for all women in the age group 15-49 years in the state. The contraceptive prevalence rate among illiterate women range from 64-81% compared with 61-73% among all women in these 10 states.

The trend in the above 10 states further suggests that the contraceptive prevalence rate among uneducated women is likely to surpass that of educated women in the remaining states within the next few years. In almost all the states, TFR reductions are seen with a concomitant increase in contraceptive prevalence rate among illiterate women compared with educated women. Such a major shift in demographic behaviour clearly suggests that uneducated women perceive contraceptive use and fertility limitation as means to realise growing parental aspirations of good quality education, better health of children and overall well-being of families. Results presented below provide ample evidence of potential positive health and development contributions of fertility decline both at the macro and micro level and; both short-term and long-term gains are found.

4 Macro Impact of Fertility Decline

Figures 1, 2 and 3 (p 60) display charts with macro level comparison of trends in TFRs vis-à-vis health and development indicators for major states of India. The data presented in these charts show that states with significant fertility reduction during the respective decades of 1970s, 1980s and 1990s have also correspondingly experienced remarkable progress in poverty and infant mortality reduction, literacy rate, per capita sdp growth, human development index in the following 5-10 year lag period. For instance, rapid decline of fertility during the last three decades in the four

south Indian states of Kerala, Tamil Nadu, Karnataka and Andhra Pradesh is seen to have resulted in pronounced improvements in all of the five health and development indicators in the succeeding lag period. Evidence of striking reduction in poverty and infant mortality, rise in per capita sdp, and female literacy is seen in all the four states in correspondence with the preceding periods of fertility reduction. Among the four states, Kerala leads in all the indicators followed by Tamil Nadu, Karnataka and

Figure 1: Trends in Fertility Decline, Poverty Reduction and Gains in Literacy (1971-2001)

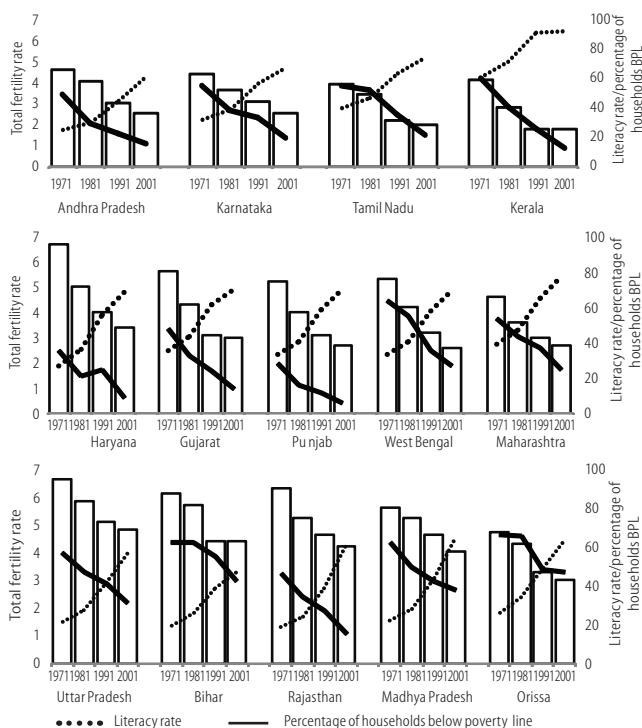
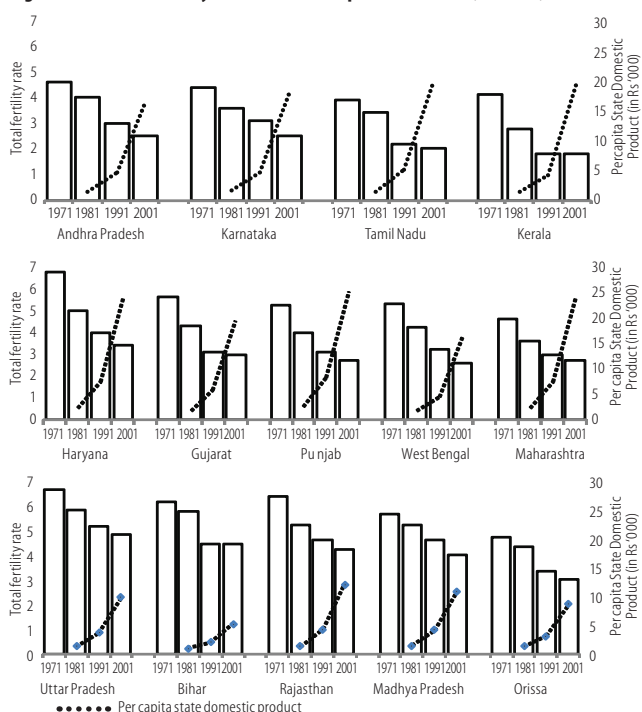


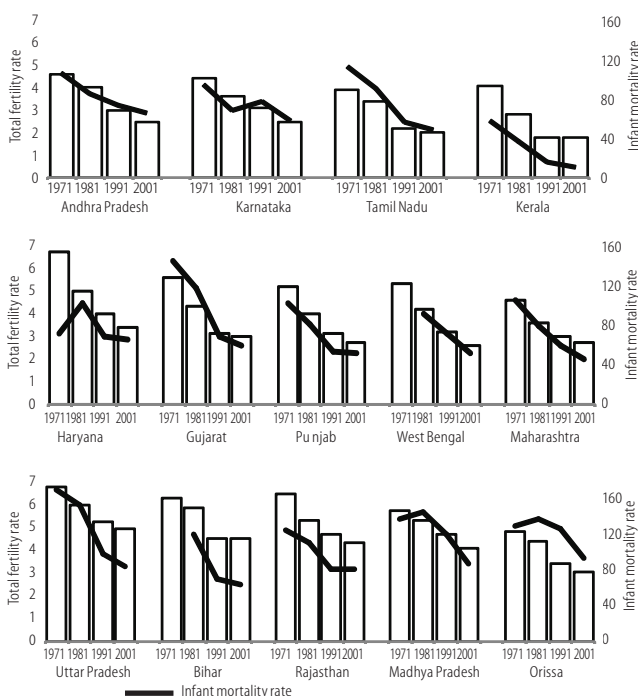
Figure 2: Trends in Fertility Decline and Per Capita SDP Growth (1971-2001)



Andhra Pradesh. The states in the next stage of demographic transition such as Maharashtra, Gujarat, Punjab, Haryana and West Bengal follow closely the south Indian states with continuing fertility decline during 1971-2001. The concomitant progress in literacy and reduction in poverty and infant mortality has been substantial in all these five states. The rise in per capita GDP in Haryana, Punjab and Maharashtra exceeded that of south Indian states for the recent decade of 1991-2001.

Haryana and Punjab are ahead in poverty reduction with less than 10% of BPL households in 2001. In contrast, the pace of fertility decline has been very slow in the states of Uttar Pradesh, Bihar, Rajasthan and Madhya Pradesh during the three decades of 1971-2001. The trends show a modest decline of TFR from about six children in 1971 to four to five children in 1991 but stagnating

Figure 3: Trends in Fertility Decline and Infant Mortality Reduction SDP (1971-2001)



around four children during 1991-2001. With persistent high fertility, these states have been stagnating with meagre improvements in health and development indicators.

From a comparative perspective, the states in south, west and east regions have had some advantage of higher literacy rate and lower infant mortality in the initial phase of 1971-81 and 1981-91 than the states in the north region. However, almost all the states had very meagre per capita GDP in the early 1980s. The real take-off point was the acceleration in per capita GDP growth in the south, west and eastern states during 1990-91 to 2000-01, following sharp fertility declines in the 1980s and early 1990s. The historic economic reform initiatives in the 1990s coincided with this shift in demographic advantage. In contrast, the four northern states stagnated in both fertility decline and per capita GDP growth. The rise in literacy rate and reduction in poverty and infant mortality also accelerated in the south, west and eastern states with faster fertility decline but stagnated in the northern states with slower fertility decline.

It may be argued that these broad associations between fertility decline and health and human development indicators, however, cannot be taken to provide a confirmation of evidence of strong and clear one-way reverse causal impact of fertility decline. The causal direction needs to be further examined given the possibility of two-way causation that fertility decline is not only a possible cause of more rapid economic growth and social progress, but could be an outcome of the later as well (IUSSP 1998). Measuring explicit reverse causation effect of fertility decline on health and development, therefore as stated earlier, entails a more careful analysis of evidence of such gross associations.

5 Panel Data Regression Analysis

In assessing macro level evidence of the impact of fertility decline on health and development trends, the literature points to possible constraints of a perfect econometric model that allows for direct causation of socio-economic determinants on fertility and reverse causal effect of fertility on health and development. We use panel data regression model, an improvised econometric procedure, on pooled observations of cross-sectional data across 14 major states of India over three time periods of 1981, 1991 and 2001 to estimate fertility impact on three selected health and development indicators. Panel data regression has the advantage of less collinearity among the variables, more efficiency with degrees of freedom and measuring the effects that are easily not detectable in pure cross-section or time-series data (Baltagi 2001). Panel data sets are considered more dynamic as they provide time-trend data over cross-sections. Panel data regression involves two methods of estimation – fixed and random effects. In the fixed effects model, the effects of predictor variables are estimated using ordinary least squares method. The method suffers from greater loss of degrees of freedom and time invariant variables are not allowed. In the case of random effects model, the predictor variables effects are estimated using generalised least square method and Hausman's test is used to test the statistical significance. The random effects model is more helpful to capture the temporal effects of predictors including possible lagged effects during specific time periods.

Both fixed and random effects models are estimated for three different dependent variables, (1) percentage of BPL population, (2) infant mortality rate, and (3) female work participation rate. Each of the three models considers six common predictors that comprise TFR, female literacy rate, sex ratio, percentage of male in non-agricultural sector, percentage of urban population, and period dummy variables for 1981-91 and 1991-2001 (Table 3, p 61). In accordance with the reverse causation theoretical framework, the TFR represents the principal predictor variable for each of the models predicting respectively, poverty, infant mortality and female work participation rate. The other covariates included in the model are female literacy rate as a well known determinant of all the above three factors and sex ratio as a measure of gender inequality. Variables like percentage of male workers in non-agricultural sector and percentage of urban population in the models represent economic progress and urbanisation. The period dummy variable is crucial to explain the temporal effects of the changes in the predictors during the period including possibly

Table 3: Panel Data Regression Analysis of Fertility Impact on Poverty, Infant Mortality and Female Work Participation Rate with State-wise Pooled Cross-Sectional Data of 1981, 1991 and 2001

Predictor Variables	Dependent Variable					
	Percentage of Households Below Poverty Line		Infant Mortality Rate		Female Work Participation Rate	
	Fixed Effects	Random Effects	Fixed Effects	Random Effects	Fixed Effects	Random Effects
Total fertility rate	0.164	0.247*	0.423*	0.303**	-0.662*	-0.527*
Infant mortality rate	-0.006	0.007*	–	–	0.008	0.006
Sex ratio	-0.002	0.004	0.003	-0.002	-0.004	-0.001
Female literacy rate	0.001	-0.005	-0.027**	0.005	-0.006	-0.017
Per capita SDP	–	–	-0.458*	0.263	-0.876*	-0.691*
Female work participation rate	-0.012	0.002	0.020*	0.021	–	–
Percentage of male in non-agricultural sector	-0.003*	-0.012*	-0.007	-0.013*	0.015	0.015
Percentage of urban population	-0.026	-0.011	-0.026	-0.008	-0.018	0.030
Period dummy 1981-91	-0.158	-0.079	-0.720**	-0.427*	0.724	0.728*
Period dummy 1991-2001	-0.469	-0.354*	-1.602**	-0.771*	1.172	1.750**
Constant	2.632*	0.382	1.908	3.156	14.823*	10.705*
R square						
Within	0.89	0.86	0.90	0.88	0.60	0.57
Between	0.07	0.34	0.08	0.56	0.04	0.19
Overall	0.16	0.52	0.25	0.60	0.16	0.29
Wald Chi ²		135.1***		143.53**		26.89**
F-value	20.96**		21.03***		3.88**	
Significance of Chi ² (Hausman's test)						
Number of observations	42	42	42	42	42	42

* p<0.10; ** p<0.05 *** p<0.001

the lagged effects. Apart from the above factors, the model for poverty includes infant mortality as a health-related predictor and female work participation rate to represent women's economic condition. Per capita SDP and female work participation rate are additional predictor variables for the model for infant mortality and per capita SDP and infant mortality rate are relevant additional predictors for the model on female work participation rate. The estimates of fixed and random effects of predictors of panel regression models for poverty, infant mortality and female work participation rate are presented in Table 3.

The estimates of both fixed and random effects models together establish evidences of fertility impact on poverty, infant mortality and female work participation. Controlling for other relevant socio-economic covariates, the random effects model shows that fertility decline during the last three decades has had a significant contribution to the reduction in poverty and infant mortality and a rise in women's economic participation. This evidence of reverse causal impact of fertility decline on three of the health and development factors is more credible, when it is viewed from the context of findings from a previous study that "poverty exerts no significant influence on fertility" based on district-level panel data of India for 1981 and 1991 (Drèze and Murthi 2001). Presumably, this vice versa reverse causation effect of fertility decline on poverty reduction possibly predisposes an expected positive effect of poverty on fertility between mid to final stages of fertility transition as this being the case with many Indian states. Variable percentage of males employed in non-agricultural sector, as a measure of industrial economic development also reveals modest contribution to poverty reduction.

The substantial random effect of period dummy variable 1991-2001 suggests an independent temporal effect, a reflection of the greater impact of fertility decline and other co-predictors on poverty reduction during this period.

Aside from fertility impact, the evidence of significant negative effect of female literacy and per capita SDP on infant mortality from the fixed effects model confirms that they continue to mediate as important socio-economic determinants of child health improvement at the macro level. The negative associations between per capita SDP and female work participation rate suggest that states with higher and growing per capita SDP are not necessarily resulting in higher female work participation rate. The lack of significant association between level of urbanisation and reduction in poverty, infant mortality and rise in female work participation rate, points to the fact that trends in rural areas determine the net association between the dependent factor and the explanatory variables. Variable sex ratio of the population which represents gender inequality norms shows very little association with any of three dependent factors. The period dummy variables for 1981-91 and 1991-2001 reveal strong effects on infant mortality and female work participation rate in both fixed and random effects models. In particular, the period effects for 1991-2001 suggest a significant reduction in infant mortality and a rise in female work participation rate that might represent the temporal effects of the combined improvements in healthcare, the predictor variables, besides fertility decline.

6 Household Level Impact

In this section, we present micro level evidence of low fertility impact on selected women and child health indicators and child schooling based on logistic regression analysis of NFHS-2 data. Adjusted percentage of women receiving three ANC check-ups, children receiving full immunisation, levels of neonatal, post-neonatal and child mortality and children aged 6-14 years attending school are compared between educated and uneducated women further categorised by parities of women at sterilisation. We limit our analysis to the sample of sterilised women in order to measure evidence of causal impact of fertility decline in a more exclusive form. Because the net fertility impact cannot be clearly established for women not using contraception and those using temporary methods of contraception as they are likely to have additional children. In the analysis of ANC and immunisation coverage, states with same level of health services coverage have been grouped together to carry out analysis with sufficient number of cases for categories of variables by women's education and parity.

The following results on key women and child health indicators reveal that low fertility among uneducated sterilised women leads to significant improvements in the health of women and children and greater school enrolment among children.

6.1 ANC and Immunisation

Table 4 (p 62) presents the adjusted percentage of sterilised women who received three ANC check-ups by women's parity and education. Among both educated and uneducated categories, the adjusted percentage of sterilised women who received a minimum

Table 4: Adjusted Percentage of Women Who Received at Least Three Antenatal Check-ups by Women's Education and Parity at Sterilisation (NFHS 1998-99)

States	Uneducated Women		Educated Women	
	Parity 2 and Less	Parity 3 and More	Parity 2 and Less	Parity 3 and More
Andhra Pradesh and Karnataka	78.8	64.9	96.6	86.2
Goa, Tamil Nadu and Kerala	92.6	81.8	97.5	94.6
Gujarat and Maharashtra	61.9	51.4	83.3	78.8
Delhi, Haryana and Punjab Himachal Pradesh and Jammu and Kashmir	55.3	30.1	67.5	56.4
Bihar, Uttar Pradesh, Rajasthan and Madhya Pradesh	20.7	14.2	56.5	33.7
Assam, Orissa and West Bengal	55.4	52.8	76.9	58.7
India	59.2	36.4	87.1	68.3

Adjusted percentages are calculated from logistic regression coefficients for categories of a given predictor variable, other variables are held constant at their mean values. The control variables include age of women, caste, religion, standard of living index and residence.

Table 5: Adjusted Percentage of Children Fully Immunised by Women's Education and Parity at Sterilisation (NFHS 1998-99)

States	Uneducated Women		Educated Women	
	Parity 2 and Less	Parity 3 and More	Parity 2 and Less	Parity 3 and More
Andhra Pradesh and Karnataka	51.8	39.6	70.3	56.6
Goa, Tamil Nadu and Kerala	90.8	75	82.8	78.3
Gujarat and Maharashtra	47.5	55.3	74.3	63.8
Delhi, Haryana and Punjab Himachal Pradesh and Jammu and Kashmir	56.6	53.2	82.8	75.1
Bihar, Uttar Pradesh, Rajasthan and Madhya Pradesh	15.8	10.3	24.8	33.6
Assam, Orissa and West Bengal	41	33	81	44.6
India	48.3	34.4	72.8	55.6

The adjusted percentages are calculated from logistic regression coefficients. When calculating adjusted percentages for categories of a given predictor variable, variables are held constant at their mean values. The control variables include age of women, caste, religion, standard of living index and residence.

of three ANC checks-ups is higher for women with two and less than two parities compared to those with greater than two parities amongst most states. For all India sample of sterilised uneducated women, the ANC coverage for women with two and less parities is 59% compared with 36% for women three parities.

For sterilised educated women the ANC coverage is 87% for low parity women and 68% for high parity women.

Table 6: Adjusted Neonatal, Post Neonatal and Child Mortality Rates by Mother's Education and Parity at Sterilisation, (NFHS 1998-99)

States	Neonatal Mortality (0-28 Days)				Post Neonatal Mortality (1-11 Months)				Child Mortality (12-47 Months)			
	Uneducated Women		Educated Women		Uneducated Women		Educated Women		Uneducated Women		Educated Women	
	Parity 2 and Less	Parity 3 and More	Parity 2 and Less	Parity 3 and More	Parity 2 and Less	Parity 3 and More	Parity 2 and Less	Parity 3 and More	Parity 2 and Less	Parity 3 and More	Parity 2 and Less	Parity 3 and More
Andhra Pradesh	21	71	10	28	6	23	18	94	13	38	10	35
Bihar	5	41	11	28	6	9	18	37	3	21	3	22
Gujarat	21	62	15	40	—	—	16	71	13	41	8	38
Haryana	5	41	8	24	4	21	8	51	7	30	6	23
Karnataka	19	55	9	29	7	18	16	52	11	37	11	24
Kerala	14	76	10	12	1	14	10	47	3	45	3	13
Madhya Pradesh	15	79	17	45	9	30	8	71	9	37	4	39
Maharashtra	19	57	5	37	5	16	14	74	8	34	4	19
Orissa	33	76	9	30	5	15	14	64	13	51	5	31
Punjab	12	59	11	18	8	15	—	20	—	—	11	34
Rajasthan	16	59	12	39	11	28	11	64	7	37	6	43
Tamil Nadu	21	70	9	29	9	30	16	81	8	39	7	39
West Bengal	15	55	8	32	6	17	16	52	9	26	5	36
Uttar Pradesh	13	71	12	39	4	23	16	62	8	42	—	—
India	18	64	11	35	6	21	14	63	9	36	6	31

The adjusted neonatal, post neonatal and child mortality rates have been calculated by converting the coefficients of cox proportional hazard model. When calculating adjusted child mortality rates for categories of a given predictor variable, other variables are held constant at their mean values. The control variables include age of women, caste, religion, standard of living index and residence. — shows insufficient number of cases.

The difference in coverage of three ANC check-ups (in percentage points) between low and high parity women is substantially greater for uneducated women compared with educated women in most states, where ANC coverage is moderate to low. The net low parity impact on ANC coverage is steeply higher in north and north central states of Bihar, Haryana, Punjab and Jammu and Kashmir. In high ANC coverage states of Kerala, Tamil Nadu and Karnataka the differences are expectedly marginal due to highly equitable access to, and narrowing differentials in ANC by parity and education. The low parity effect on ANC coverage is also substantial among educated sterilised women in most of the states. In sum, the low fertility impact in raising ANC coverage is almost same as education impact on ANC coverage.

Evidence of similar differences by women's parity and education are demonstrated with respect to percentage of children fully immunised almost consistently in states of all regions (Table 5). The percentage of children fully immunised is consistently higher among low parity sterilised women than the high parity sterilised women regardless of their educational status in all the states.

6.2 Child Mortality

Table 6 compares low parity effect on reduction of neonatal, post-neonatal and child mortality between educated and uneducated women. First, women's education shows a strong effect on child mortality but this effect is greater for women with two and less than two parities consistently across all the states. Second, the low parity effect on reduction on neonatal, post-neonatal and child mortality emerges to be two to three times higher than education effect on child mortality reduction. For instance, for the total India sample of sterilised women, neonatal mortality is nearly twice higher for uneducated women than educated women. Compared with this, among uneducated sterilised women, neonatal mortality is more than three times higher (64) for women with three and more parities compared with women

of two and less parities (18). Among the educated sterilised women also, neonatal mortality is similarly three times higher for women of high parity than low parity. More striking is the result that child mortality in all stages is lower for uneducated sterilised women with low parity than educated sterilised women of high parity.

Clearly, in every state, the net positive returns of low fertility on child mortality reduction are the largest than returns in other health indicators such as coverage in antenatal care and immunisation.

6.3 Child Schooling

Low fertility in general, and among uneducated women in particular, in the Indian states have been reported to result in both quantitative and qualitative improvement in child schooling

Table 7: Percentage of Children Attending School (6-14 Years) by Mother's Education and Parity at Sterilisation, NFHS (1998-99)

States	Uneducated Women		Educated Women	
	Parity 2 and Less	Parity 3 and More	Parity 2 and Less	Parity 3 and More
Andhra Pradesh	85.2	72.5	97.8	92.9
Bihar	82.9	65.8	90.5	92.6
Gujarat	65.9	67.7	99.2	91.5
Haryana	91.3	86.6	100	97.4
Himachal Pradesh	97.5	96.5	99.2	98.7
Jammu and Kashmir	94.4	87	100	99.4
Karnataka	82.4	75.7	98.7	95
Kerala	82.4	91.2	99.6	98.3
Madhya Pradesh	81.3	74.3	100	93.3
Maharashtra	86.1	85.9	99	96.5
Orissa	83.6	74.8	96	97
Punjab	83.3	82.4	100	95.4
Rajasthan	87.1	79.7	100	94.7
Tamil Nadu	95.2	87.7	98.6	94.8
West Bengal	83.1	73.3	92.9	90.2
Uttar Pradesh	96.7	80	97.3	94.7
India	87.3	79.3	98.4	95.6

The adjusted percentages are calculated from logistic regression coefficients. When calculating adjusted percentages for categories of a given predictor variable, other variables are held constant at their mean value. The control variables include age of women, caste, religion, standard of living index and residence.

(Bhat 2002; Retnakumar and Arokiasamy 2006). Low fertility choice among uneducated women and the consequent positive benefits in child schooling is theorised as an outcome of quantity-quality trade-off on number of children. Results presented in Table 7 reveal that the percentage of children aged 6-14 attending school is greater for both educated and uneducated women with lower parities (two and less) compared with women of higher parities (three and more). In particular, the difference in overall school attendance rate for India between women with low and high parities is steeper for uneducated women (87% and 79%) compared with educated women (98% and 96%).

For educated women with lower parities of two and less, the school attendance rate range between 98 and 100% in most states except in Bihar (91%), West Bengal (93%) and Uttar Pradesh (97%). For educated women with higher parities, the school attendance rate ranged from 90-95% in half of the states and between 96 and 99% among the rest of the states. In contrast, the school attendance rate among children of uneducated women drops to an average of 79% for women with high parities but rises sharply to 87% among women of low parities. The impact of low fertility among uneducated on child schooling is certainly substantial.

7 Conclusions

In this analysis, we explored and presented evidence of fertility decline among illiterate women in India and its positive contributions to progress in health and development conditions.

First, fertility decline among uneducated has been a major driving force for the recent acceleration in fertility transition in India. Between 1992-93 and 2005-06, more than two-fifths of reduction in TFR was contributed by illiterate women with the remaining proportion equally contributed by literate women and changes in educational composition of women. Concomitantly, the increase in contraceptive prevalence rate among uneducated women has been larger and faster among uneducated than educated women. We suggest that the choice of low fertility among uneducated is guided by *quantity-quality trade-off* and maximisation of benefits of health and well-being for women and children.

Second, as proposed, this remarkable demographic behaviour change has conclusively contributed to the overall health and development of the states with significant direct health benefits for uneducated women and their children. Macro level trend analysis of the link among fertility, health and development indicators firstly shows the evidence of what economists have often

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referred to as the potential *reinforcing effects* between demographic change and economic growth. However, we have tried to untangle such complementary effects to shed insights on one way causation effects with estimates from macro level panel data regression models. The results illustrate modest positive impact of fertility decline on poverty and infant mortality reduction, and a rise in female work participation rate. The larger fertility change among uneducated women has been a greatly influential factor in raising average economic and health conditions of the states.

Third, we establish more convincing evidence of causal impact of low fertility with potential health benefits for women and their children based on micro data from the national family health surveys. The adjusted percentage of women receiving ANC and their children receiving full immunisation is significantly higher for uneducated sterilised women with two and less number of children compared with uneducated sterilised women with three and more number of children. Similar differences are found in

children attending school and with the largest differences emerging in infant and child mortality. In several states, the adjusted levels of healthcare utilisation for women and their children are substantially higher for uneducated women of less parities than even educated women but with higher parities.

We also found evidence of greater gains in household economic condition, rates of female work participation and improved nutritional status for sterilised women with lower parities (results are not presented for constraints of page length). Cumulatively, fertility decline among uneducated women in addition to health benefits to them and their children has also been a major stimulus in raising average macro level health and development conditions. Net returns of low fertility in general, and among vast majority of uneducated women, in particular, to progress in health and development conditions in India are almost what educational improvement has done for progress in human development and demographic transition.

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