

District Level Estimates of Fertility from India's 2001 Census

Over the last few decades, both fertility and mortality rates have been falling, but the decline of mortality was strong enough to offset the fall in fertility rates. The 2001 Census, however, gives a clear indication that India is passing through the last phase of fertility transition, moving towards moderate to low fertility. Fertility declines have not, however, been uniform across the country and the differential rates are mainly responsible for the differentials in population growth rates across states and union territories.

CHRISTOPHE Z GUILMOTO, S IRUDAYA RAJAN

On March 1, 2001, India has officially crossed the billion plus figure and the population was enumerated as 1,027,015,247 persons.¹ Over the last 10 years, India added 180,627,359 persons to its population, equivalent to the population of Brazil. This is the highest addition of people since India's independence. However, the annual growth rates which were hovering above 2 per cent for the last 30 to 40 years, have been brought down to below 2 per cent (1.93) during 1991-2001. Moreover, recent figures of vital rates for the late 1990s indicate that this downward trend is likely to accelerate in the future.

The growth rate is the product of birth and mortality rates at the national level. Over the last few decades, both fertility and mortality rates fell, but the decline of mortality was strong enough to offset that of fertility. But the 2001 Census gives a clear indication that India is passing through the last phase of the fertility transition, moving towards moderate to low fertility. As a result, the decline in birth rates is now faster than the parallel decline in mortality rates.

Fertility decline is, however, not uniform across the states and union territories. While 15 states and union territories have registered growth rates below 2 per thousand during the last decade, the remaining states have registered rates that are greater than the national average. High growth rates in some states can also be attributed to internal and international migration rather than fertility and mortality, but the main factor explaining these growth differentials is related to regional fertility levels. Some states are more advanced in their decline in population growth rates. The lowest annual growth rate of less than 0.9 per cent is reported for the southern

state of Kerala, followed by Tamil Nadu (1.06 per cent) and Andhra Pradesh (1.30 per cent).

As of 2001 Census, Indian union was divided into 28 states and seven union territories. The number of districts in India has increased from 466 in 1991 to 593 in 2001, 127 new districts formed during the last 10 years. With this background, the objective of this paper is to provide district level indirect estimates of birth and fertility rates for all districts of India using the population aged 0-6 years as observed in 2001.

Earlier Estimates: An Overview

Prior to the introduction of the Sample Registration System (SRS) in India at the beginning of 1970s, even state level estimates of fertility were also made by indirect techniques using different methodologies by different researchers. For instance, Rele (1987) used two child-woman ratios (number of children aged 0-4 divided by women ages 15-49 and number of children aged 5-9 divided by women ages 20-54) and produced comparable estimates of fertility for major states for the earlier periods. Over the last 30 years, SRS has emerged as the main source of fertility estimates at the state level and various agencies in India and abroad use their estimates for various planning and monitoring purposes. However, due to its sample size problems, SRS has not gone beyond major states and it has extended its estimates to the smaller states only very recently. As a result, we still have no idea of the yearly variations in fertility trends at the district level in India.

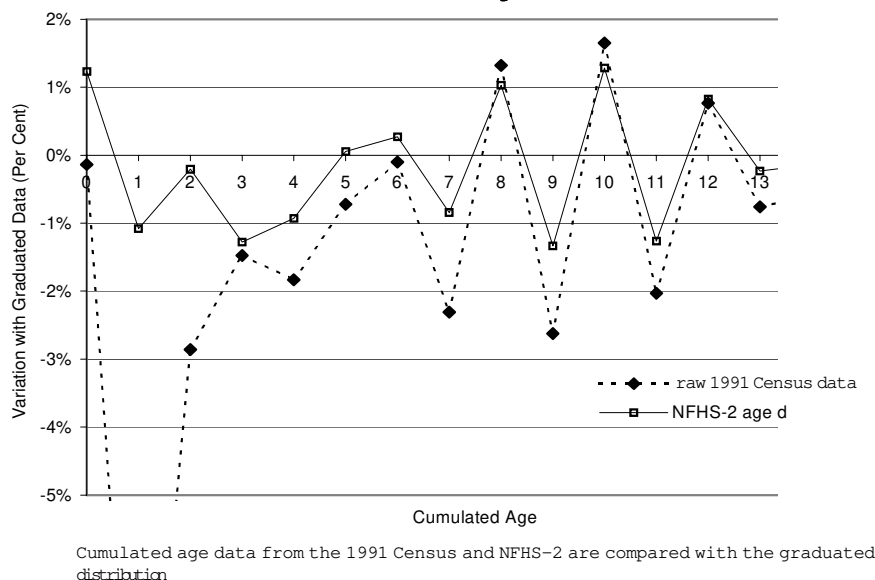
The planning and interventions to reduce the fertility at the district level was hampered due to the unavailability of data.

To fulfil this lacuna, the Census of India 1981, for the first time, canvassed the information on children ever born and surviving among women of different age groups at the district level. The Registrar General of India using the indirect techniques provided the district level estimates of fertility for the first time in the independent India [Registrar General of India 1988; 1989]. Some researchers have utilised the district level information and offered constructive policy suggestions to reduce fertility at the lower level [Kishor 1991; Malhotra, Vanneman and Kishor 1995; Murthi, Guio and Dreze 1995]. The same questions were canvassed in the 1991 Census and the Registrar General published comparable estimates of fertility and mortality at the district level from the two censuses (Registrar General of India 1998), while other independent researchers provided further demographic estimates [Bhat 1996; Irudaya Rajan and Mohanchandran 1998]. The 1991 district level data sets on fertility and mortality also led to few studies in the recent past (For instance, Dreze and Murthi 2001; Guilmoto and Irudaya Rajan, forthcoming).

Moreover, during the last 10 years, under the leadership of International Institute for Population Sciences, Bombay, two large scale National Family Health Surveys were conducted; one in 1992-93 and another in 1998-99 (IIPS 1995; IIPS 2000). Thus they also produced comparable estimates of fertility at the state and union territory level at two points of time. Moreover, Mari Bhat and Zavier (1999) using the raw data of the first NFHS divided the country into 76 zones and computed fertility rates (and other indicators) for these regions.

The 1991 Census released for the first time the data on children below six years

Figure 1: Variation in Per Cent between 1991 Graduated Age Data, Raw 1991 Age Data and NFHS-2 Age Data



for computing literacy rates for the population aged 7 and above. Mari Bhat (1996) used the above information and utilising the reverse survival technique produced fertility estimates at the district level for the 1980s and 1990s. We have repeated the same exercise using a slightly modified methodology and estimated the birth rates at the end of 1990s at the district level using the just released 2001 Census results. Fertility estimates are mapped to highlight the regional differentials. The results are also compared with the most recent fertility estimates available from various sources.

Methodology

The method used here is based on the provisional 0-6 population available from the census and follows the “reverse survival technique”, as was done by Mari Bhat for his estimation from the 1991 Census.² The first step consists in the computation of the crude birth rates (births/population), followed by the indirect estimation of the total fertility rates (children per woman). These results correspond to the 1994-2001 period and are centred on the year 1997.

To know the crude birth rates during period 1994-2001, one needs to estimate the number of births and the corresponding population for each district. The computation of the reference population during the 7-year interval is straightforward, using the 2001 population and the intercensal growth rate. However, the

calculation of the number of births is more complex, as it is based on a back-projection of the child population available from the 2001 Census, using district-level estimates of mortality. The technique requires the construction of a life table to project backwards the census population. As district-level mortality estimates are not yet available for the 2001 Census, they are computed by combining the district mortality differentials within each state as estimated in 1991 and the child mortality estimates for states in 1996-98 as derived from the SRS. This reverse-survival method is described in greater detail in the appendix below.

For want of detailed age distribution available for districts, the total fertility rate is then computed from the estimated crude birth rates by using a TFR/CBR ratio. This ratio is estimated for each district through the combination of available demographic data: the district-level age distribution of women in childbearing age from the 1991 Census, and the fertility schedule of each state as provided by the NFHS-2. This procedure is also detailed below in the appendix.

The quality of child mortality and fertility estimates used here has a minor impact on the final results of the reverse-survival method. However, this estimation procedure is directly vulnerable to the level of age misstatement of children below seven. Any inaccuracy in the child population as recorded in the census will have a symmetrical consequence on the birth and fertility estimates. Fortunately, the 0-6 age

segment is probably quite accurately recorded by the census and is not subject to severe age heaping as are the 0-4 and 5-9 age groups. Previous estimates by Bhat that followed a similar methodology with 1991 Census data are quite satisfactory. Moreover, with rapidly improving literacy levels, there is no doubt that the intensity of age misstatement in India is decreasing rapidly and that the quality of census age figures has most probably improved in 2001 compared to the previous censuses.

To examine the quality of the age reporting, we used available single-year data (population from age 0 to 15) from the 1991 Census. We first computed a graduated age distribution by using 3-year moving averages. For example, population aged 7 is replaced by an adjusted distribution, using the average population aged 6 to 8. We then cumulated the observed and the adjusted distribution and we plotted the relative difference between both in Figure 1. We did the same for NFHS-2 age data that are admittedly of better quality. As shown in the figure, there is a gap between both observed and adjusted distributions cumulated by age because of age heaping. This gap may indeed be very important as is the case for the population less than 2. However, the observed census value for the 0-6 population figure is almost identical to that of the graduated population and the gap between both curves is of 0.1 per cent.³ Similarly, the 0-6 population calculated from the NFHS-2 sample deviates from the graduated population by less than 0.3 per cent. While the possibility of regional bias remains, as some isolated regions may have recorded in 2001 unusually high level of age misstatement resulting in under- or over-estimates of the child population, the comparison with graduated and other data is very encouraging. It suggests that age misstatement has a negligible impact on the estimation of the population below seven.

There remains an unknown factor that might disrupt our calculation as some children might have been actually enumerated during the census in district other than that of their parents. For instance, this may occur in urban areas where there is a large floating population of adult migrants: some of these migrants may reside without their children, while migrants' children stay in their parents' native locality, sometimes with their mother. For instance, the examination of the age and sex structure from

previous censuses show a real deficit of adult men in traditional outmigration areas such as Kerala, south Tamil Nadu, eastern Uttar Pradesh and Bihar, and Uttaranchal. In other areas, such as million-plus cities, the proportion of adult men is on the contrary very high. In these cases, the enumerated number of children below 7 may not exactly tally with the actual fertility of the adult population. Fertility may therefore be underestimated in some in-migration areas. While our estimation procedure takes into account the specific age structure of each district when converting CBRs into TFRs, there is simply no way we can assess the actual impact of such a phenomenon on our estimate of the CBR.⁴

The comparable estimates of crude birth rates and total fertility rates from three sources refers to the same period are presented in Table 1. They are: Sample Registration System, the Second National Family Health Survey (NFHS-2) and our indirect estimates based on the number of children below 7. Because of incomplete data, the comparable figures are available only for 21 states and union territories from all the three sources. In terms of both fertility indices, our estimates lie somewhere between NFHS-2 and SRS figures.

NFHS definitely underestimated fertility rates at the all-India level. In this respect, Mari Bhat (2001) indicated that the sharp decline in fertility noted in the survey in Bihar and Rajasthan are largely spurious. They are most probably an outcome of greater exaggeration of young children in the second survey compared to the first survey [Bhat 2001]. Our census based estimates of CBR and TFR are almost identical with SRS in Rajasthan and very close in Bihar. Our total fertility rate of 3.2 for India is very close to the SRS figure of 3.3.

Few more observations can be made from the table using the total fertility rate. In the three new states (Chhattisgarh, Jharkhand and Uttaranchal), we have no estimates either from SRS and NFHS-2 for comparison. While Jharkhand leads with the TFR of 4.1, Uttaranchal and Chhattisgarh share the same value of 3.6. We have also no CBR values for Jammu Kashmir and Nagaland from SRS. Similarly, estimates are not available from NFHS-2 in smaller states and union territories such as Andaman and Nicobar Islands, Chandigarh, Dadra Nagar Haveli, Daman and Diu, Lakshadweep, Pondicherry and Tripura. The SRS seems

also to underestimate the fertility rates for smaller states and union territories. For instance, the recently released National Population Policy document says that the TFR in Nagaland and Delhi are 1.5 and 1.6 whereas the NFHS estimates and ours are much higher [Government of India 2000].

Our census estimates are identical to SRS in two states (Assam and Rajasthan) and two union territories. The difference in TFR was just 0.1 children between the SRS and our estimates in the following states and union territories: Bihar, Dadra Nagar Haveli, Karnataka, Kerala, Lakshadweep, Madhya Pradesh, Maharashtra, Tamil Nadu and West Bengal. In a few areas (Andhra Pradesh, Chandigarh, Manipur and Orissa), the difference is just 0.2 children. In two-thirds of states and union territories, our estimates are very close indeed to those from the SRS. Our estimates are closer to the NFHS-2 only in Andhra Pradesh and Goa.

Data and Mapping

The detailed district level estimates are provided in a separate table as an appendix to this paper (Table A-1). In this paper, we have not attempted a systematic statistical analysis, as we first wanted to share our estimates with potential users. However, data have been plotted on a map of India to stress the particular shapes of fertility decline in the country.⁵ The map shown in Figure 2 uses the new administrative boundaries of the 2001 Census. Total fertility rates have been reclassified into five value groups, starting from districts with a TFR less than 2 children per woman up to districts with TFR higher than 5.

Below-replacement values are mostly found in contiguous areas of Tamil Nadu, Kerala and south Karnataka. Other pockets with the lowest fertility levels can be observed in the Krishna River Delta and around Goa. Some further isolated districts that may not be visible in the map

Table 1: Estimates of Total Fertility Rate for States in 1995–2001, various Sources

Estimates Reference Period	Crude Birth Rate			Total Fertility Rate		
	Census 1994–2001	NFHS-2 1995–99	SRS 1996–98	Census 1994–2001	NFHS-2 1995–99	SRS 1996–98
<i>India</i>	25.9	24.8	27.1	3.16	2.85	3.3
Andaman and Nicobar	20.1	–	18.3	2.32	–	1.9
Andhra Pradesh	20.4	21.4	22.6	2.31	2.25	2.5
Arunachal Pradesh	29.9	22.6	21.9	3.92	2.52	2.8
Assam	27	21.8	27.9	3.19	2.31	3.2
Bihar	33.4	28.1	31.6	4.54	3.49	4.4
Chandigarh	20.1	–	18.1	2.25	–	2.1
Chhattisgarh	28.6	*	*	3.6	*	*
Dadra Nagar and Haveli	31.8	–	30.4	3.61	–	3.5
Daman and Diu	21.7	–	22.7	2.48	–	2.5
Delhi	23.4	21.3	20.7	2.62	2.40	1.6
Goa	15.9	16.6	14.3	1.79	1.77	1.5
Gujarat	22.6	24.3	25.6	2.57	2.72	3
Haryana	25.9	23.1	28.2	3.22	2.88	3.4
Himachal Pradesh	20.5	19.9	22.7	2.39	2.14	2.7
Jammu and Kashmir	24.5	23.1	–	2.98	2.71	–
Jharkhand	29.9	*	*	4.07	*	*
Karnataka	20.9	20.4	22.6	2.4	2.13	2.5
Kerala	17.1	18.8	18.1	1.7	1.96	1.8
Lakshadweep	22.6	–	23.1	2.69	–	2.8
Madhya Pradesh	30.7	26.7	31.6	3.86	3.31	4
Maharashtra	21.7	23	23	2.56	2.52	2.7
Manipur	21.0	25.8	19.4	2.59	3.04	2.4
Meghalaya	33.6	35.7	29.9	4.45	4.57	4.0
Mizoram	27.3	25.7	15.3	3.36	2.89	–
Nagaland	24.1	30.4	–	3.16	3.77	1.5
Orissa	23.6	22.1	26.4	2.82	2.46	3
Pondicherry	18.1	–	18.2	1.82	–	1.8
Punjab	20.1	19.1	23.2	2.42	2.21	2.7
Rajasthan	32.1	29.9	32	4.22	3.78	4.2
Sikkim	23.7	24.5	20.2	3.03	2.75	2.5
Tamil Nadu	17.2	21.4	19.2	1.85	2.19	2
Tripura	21.2	–	18.1	2.48	–	2.1
Uttar Pradesh	31.4	31.1	33.3	4.36	3.99	4.8
Uttaranchal	26.1	*	*	3.63	*	*
West Bengal	22.5	20.8	22.2	2.62	2.29	2.5

Notes: * separate data for new states (Chhattisgarh, Jharkhand and Uttaranchal) are not available from the NFHS-2 and SRS.

– SRS and NFHS-2 data not available.

Sources: SRS data are compiled from various reports of the Sample Registration System.

NFHS data are compiled from NFHS-2 India report.

Table A-1: Estimates of Birth Rate and Total Fertility Rate for District in 2001

Districts	Crude BirthRate	Total Fertility Rate	Districts	Crude BirthRate	Total Fertility Rate	Districts	Crude BirthRate	Total Fertility Rate
INDIA	25.9	3.2	Begusarai	34.0	4.8	South Goa	16.6	1.8
Andaman and Nicobar Islands	20.1	2.3	Bhagalpur	31.9	4.5	Gujarat	22.6	2.6
Andamans	20.3	2.3	Bhojpur	30.1	4.2	Ahmadabad	20.5	2.3
Nicobars	19.1	2.2	Buxa	31.7	4.4	Anreli	21.1	2.5
Andhra Pradesh	20.4	2.3	Darbhangha	33.1	4.5	Anand	21.7	2.4
Adilabad	23.5	2.7	Gaya	33.2	4.4	Banas Kantha	31.3	3.9
Anantapur	20.6	2.4	Gopalganj	31.9	4.4	Bharuch	22.3	2.5
Chittoor	19.6	2.2	Jamui	32.8	4.5	Bhavnagar	25.3	3.0
Cuddapah	19.8	2.3	Jehanabad	32.0	4.1	Dohad	34.2	4.3
East Godavari	18.6	2.1	Kaimur (Bhabua)	34.4	4.8	Gandhinagar	22.1	2.4
Guntur	17.7	1.9	Katihar	38.2	5.3	Jamnagar	21.7	2.4
Hyderabad	18.6	1.9	Khagaria	35.7	5.1	Junagadh	23.1	2.6
Karimnagar	19.9	2.2	Kishanganj	39.0	5.3	Kachchh	0.0	0.0
Khammam	21.0	2.3	Lakhisarai	33.8	4.7	Kheda	23.1	2.6
Krishna	18.0	1.9	Madhepura	36.7	4.8	Mahesana	22.4	2.5
Kurnool	24.5	3.0	Madhubani	33.3	4.3	Narmada	24.6	2.8
Mahbubnagar	24.8	3.1	Munger	29.0	4.0	Navsari	17.9	2.0
Medak	23.3	2.9	Muzaffarpur	32.7	4.6	Panch Mahals	27.7	3.5
Nalgonda	21.7	2.6	Nalanda	31.2	4.2	Patan	26.1	3.1
Nellore	18.5	2.0	Nawada	33.3	4.3	Porbandar	21.8	2.5
Nizamabad	21.9	2.5	Pashchim Champaran	35.7	5.0	Rajkot	16.9	1.9
Prakasam	19.2	2.3	Patna	28.4	3.9	Sabar Kantha	25.1	2.9
Rangareddi	22.5	2.6	Purba Champaran	34.8	4.9	Surat	23.2	2.5
Srikakulam	20.6	2.4	Purnia	37.6	5.0	Surendranagar	27.6	3.4
Visakhapatnam	19.6	2.2	Rohtas	32.1	4.5	The Dangs	32.8	3.8
Vizianagaram	20.7	2.5	Saharsa	35.5	4.6	Vadodara	21.3	2.4
Warangal	21.7	2.5	Samastipur	34.8	4.9	Valsad	22.7	2.5
West Godavari	18.0	2.0	Saran	32.6	4.7	Baranya	25.9	3.2
Arunachal Pradesh	29.9	3.9	Sheikhpura	34.3	4.7	Ambala	20.9	2.4
Changlang	32.4	4.4	Sheohar	35.8	5.1	Bhiwani	25.5	3.3
Dibang Valley	29.3	3.9	Sitamarhi	36.3	5.1	Faridabad	29.9	3.7
East Kameng	34.1	4.4	Siwan	32.9	4.6	Fatehabad	26.3	3.2
East Siang	27.6	3.7	Supaul	36.2	4.7	Gurgaon	35.2	4.5
Idhit	31.6	4.2	Vaishali	31.9	4.6	Hisar	25.3	3.1
Lower Subansiri	28.7	3.4	Chandigarh	20.1	2.2	Uhajjar	24.3	3.1
Papum Pare	29.9	3.5	Chandigarh	20.1	2.2	Jind	26.0	3.3
Tawang	30.2	3.8	Chhattisgarh	28.6	3.6	Kaithal	25.1	3.1
Tirap	31.9	4.4	Bastar	29.3	3.5	Karnal	24.0	3.0
Upper Siang	29.5	4.0	Bilaspur	28.3	3.6	Kurukshetra	23.0	2.7
Upper Subansiri	31.0	4.1	Dantewada	30.2	3.6	Mahendragarh	25.5	3.3
West Kameng	27.3	3.4	Dhamtari	27.5	3.3	Panchkula	24.1	2.8
West Siang	26.1	3.8	Durg	25.1	2.9	Panipat	27.5	3.5
Assam	27.0	3.2	Janjgir-Champa	28.0	3.5	Rewari	25.0	3.1
Barpeta	30.8	3.8	Jashpur	27.0	3.3	Rohtak	23.5	3.0
Bongaigaon	29.4	3.5	Kanker	27.0	3.2	Sirsa	24.7	2.9
Cachar	25.3	3.1	Kawardha	30.9	3.8	Sonipat	24.4	3.1
Darrang	29.1	3.4	Korba	28.0	3.5	Yamunanagar	22.7	2.8
Dhemaji	27.7	3.5	Koriya	27.4	3.4	Himachal Pradesh	20.5	2.4
Dhubri	35.2	4.3	Mahasamund	25.4	3.1	Bilaspur	19.7	2.3
Dibrugarh	22.0	2.4	Raigarh	26.3	3.2	Chamba	24.2	2.9
Goalpara	32.0	3.9	Raipur	28.4	3.4	Hamirpur	18.8	2.2
Golaghat	23.3	2.7	Rajnandgaon	28.1	3.3	Kangra	18.8	2.2
Hailakand	30.2	3.8	Surguja	31.5	3.9	Kinnaur	0.0	0.0
Jorhat	19.4	2.2	Dadra and Nagar Haveli	31.8	3.6	Kullu	22.4	2.6
Kamrup	22.1	2.6	Dadra and Nagar Haveli	31.8	3.6	Lahul and Spiti	17.1	2.0
Karbi Anglong	29.6	3.7	Daman and Diu	21.7	2.5	Mandi	21.0	2.4
Karimganj	29.0	3.6	Daman	19.9	2.3	Shimla	18.9	2.2
Kokrajhar	29.3	3.3	Diu	25.9	2.9	Simaur	24.4	3.1
Lakhimpur	27.4	3.3	Delhi	23.4	2.6	Solan	22.1	2.5
Marigaon	31.8	3.9	Central	17.2	1.9	Una	21.1	2.5
Nagaon	29.9	3.6	East	22.6	2.5	Jammu and Kashmir	24.5	3.0
Nalbari	23.0	2.7	New Delhi	17.1	1.9	Anantnag	25.0	3.1
North Cachar Hills	26.4	3.1	North	18.8	2.1	Badgam	25.8	3.2
Sibsagar	21.6	2.4	North East	28.1	3.2	Baramula	26.4	3.3
Sonitpur	25.6	3.0	North West	25.2	2.8	Doda	29.1	3.7
Tinsukia	25.1	2.9	South	24.2	2.7	Jammu	21.3	2.7
Bihar	33.4	4.5	South West	24.0	2.7	Kargil	26.7	3.4
Araria	36.2	4.9	West	21.3	2.4	Kathua	24.9	3.1
Aurangabad	32.3	4.3	Goa	15.9	1.8	Kupwara	30.4	3.8
Banka	33.8	4.8	North Goa	15.4	1.7	Leh (Ladakh)	10.6	1.3

(Contd)

Table A-1: Estimates of Birth Rate and Total Fertility Rate for District in 2001 (Contd)

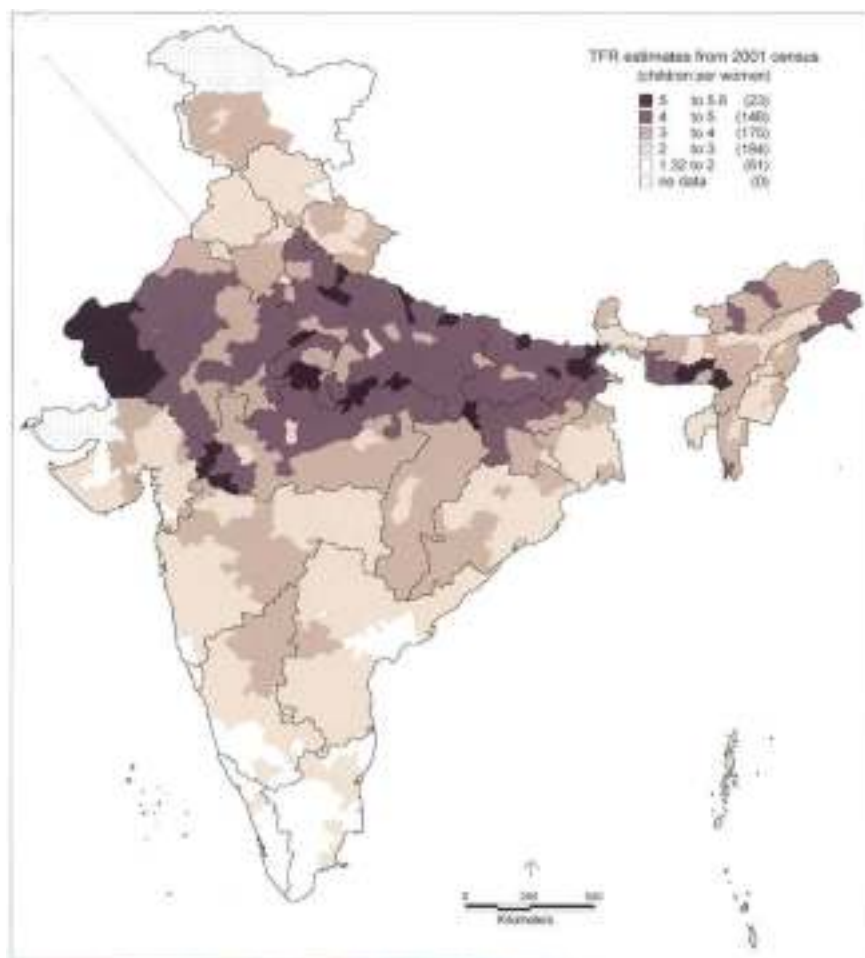
Districts	Crude BirthRate	Total Fertility Rate	Districts	Crude BirthRate	Total Fertility Rate	Districts	Crude BirthRate	Total Fertility Rate
Pulwama	20.8	2.6	Balaghat	25.2	3.1	Pune	20.6	2.3
Punch	30.3	3.8	Barwani	39.6	5.1	Raigarh	21.8	2.3
Rajauri	28.0	3.5	Betul	29.6	3.9	Ratnagiri	20.5	2.1
Srinagar	17.5	2.2	Bhind	29.5	4.0	Sangli	19.4	2.3
Udhampur	27.7	3.5	Bhopal	26.6	3.0	Satara	19.2	2.3
Jharkhand	29.9	4.1	Chhatarpur	36.0	5.0	Sindhudurg	17.4	1.8
Bokaro	25.8	3.5	Chhindwara	27.3	3.5	Solapur	22.2	2.7
Chatra	34.1	4.6	Damoh	31.4	4.0	Thane	23.4	2.6
Deoghar	33.2	4.5	Datia	29.8	4.0	Wardha	19.2	2.3
Dhanbad	24.4	3.4	Dewas	30.1	3.8	Washim	24.3	3.0
Dumka	28.6	3.6	Dhar	33.0	4.1	Yavatmal	23.7	2.9
Garhwa	37.7	5.3	Dindori	27.2	3.2	Manipur	21.0	2.6
Giridih	35.8	4.7	East Nimar	30.4	3.9	Bishnupur	20.4	2.5
Godda	31.5	4.2	Guna	35.2	4.6	Chandel	23.0	2.8
Gumla	30.7	4.0	Gwalior	25.6	3.3	Churachandpur	20.5	2.5
Hazaribagh	30.0	4.1	Harda	31.6	4.2	Imphal East	20.7	2.6
Kodarma	33.1	4.5	Hoshangabad	27.9	3.7	Imphal West	18.3	2.2
Lohardaga	32.9	4.6	Indore	24.7	2.9	Senapati	19.3	2.2
Pakaur	35.0	4.4	Jabalpur	24.2	2.9	Tamenglong	22.0	2.8
Palamu	34.7	4.9	Jhabua	41.6	5.4	Thoubal	25.8	3.3
Pashchimi Singhbhum	28.3	3.5	Katni	30.4	3.6	Ukhrul	23.0	3.1
Purbi Singhbhum	22.1	2.7	Mandla	28.8	3.4	Meghalaya	33.6	4.5
Ranchi	26.4	3.5	Mandsaur	28.4	3.5	East Garo Hills	34.2	4.4
Sahibganj	35.5	4.5	Morena	31.6	4.2	East Khasi Hills	27.7	3.6
Karnataka	20.9	2.4	Narsimhapur	27.4	3.5	JaintiaHills	38.0	5.4
Bagalkot	25.1	3.1	Neemuch	27.1	3.3	Ri Bhoi	41.2	5.4
Bangalore	18.7	1.9	Panna	35.7	4.7	South Garo Hills	36.2	4.6
Bangalore Rural	17.9	2.2	Raisen	33.5	4.5	West Garo Hills	32.1	4.1
Belgaum	22.8	2.7	Rajgarh	32.8	4.2	West Khasi Hills	38.6	5.5
Bellary	25.1	3.1	Ratlam	30.6	3.7	Mizoram	27.3	3.4
Bidar	25.1	3.4	Rewa	34.0	4.4	Aizawl	24.4	3.0
Biapur	24.4	3.0	Sagar	31.9	4.2	Champhai	28.7	3.5
Chamarajanagar	17.9	2.0	Satna	33.6	4.3	Kolasib	27.7	3.4
Chikmagalur	18.3	1.9	Sehore	34.3	4.6	Lawngtlai	34.1	4.2
Chitradurga	20.4	2.3	Seoni	27.8	3.4	Lunglei	28.1	3.5
Dakshina Kannada	17.6	1.7	Shahdol	29.3	3.6	Mamit	26.9	3.3
Davanagere	20.7	2.4	Shajapur	31.5	4.1	Saiha	32.4	4.0
Dharwad	21.1	2.5	Sheopur	34.5	4.6	Serchhip	27.1	3.3
Gadag	22.0	2.6	Shivpuri	36.1	5.1	Nagaland	24.1	3.2
Gulbarga	26.7	3.5	Sidhi	36.5	4.7	Dimapur	25.8	3.3
Hassan	17.6	1.9	Tikamgarh	33.8	4.5	Kohima	23.6	3.0
Haveri	21.8	2.6	Ujjain	28.0	3.5	Mokokchung	16.4	2.0
Kodagu	19.2	2.0	Umaria	32.6	4.0	Mon	25.1	3.4
Kolar	20.5	2.5	Vidisha	34.0	4.5	Phek	29.0	3.8
Koppal	27.4	3.4	West Nimar	33.3	4.3	Tuensang	24.2	3.4
Mandya	16.9	1.9	Maharashtra	21.7	2.6	Wokha	23.9	3.2
Mysore	18.9	2.1	Ahmadnagar	21.8	2.7	Zunheboto	26.9	3.5
Raichur	26.5	3.3	Akola	22.3	2.7	Orissa	23.6	2.8
Shimoga	19.5	2.0	Amravati	21.2	2.5	Anugul	23.4	2.9
Tumkur	18.3	2.2	Aurangabad	24.1	3.1	Balangir	22.9	2.8
Udupi	15.0	1.5	Bhandara	20.7	2.4	Baleshwar	25.2	2.9
Uttara Kannada	19.7	2.2	Bid	23.5	3.2	Bargarh	20.6	2.5
Kerala	17.1	1.7	Buldana	23.5	3.0	Baudh	27.4	3.2
Alappuzha	15.2	1.5	Chandrapur	20.9	2.4	Bhadrak	24.8	2.9
Ernakulam	15.7	1.5	Dhule	22.5	2.7	Cuttack	19.6	2.4
Idukki	17.0	1.6	Gadchiroli	25.8	2.9	Debagarh	25.5	3.1
Kannur	16.6	1.7	Gondiya	21.8	2.5	Dhenkanal	21.8	2.7
Kasaragod	18.9	1.9	Hingoli	26.1	3.4	Gajapati	27.6	3.3
Kollam	16.2	1.6	Jalgaon	21.7	2.7	Ganjam	24.0	2.9
Kottayam	15.6	1.6	Jalna	24.6	3.2	Jagatsinghapur	18.8	2.3
Kozhikode	17.4	1.7	Kolhapur	19.3	2.3	Jajapur	21.8	2.6
Malappuram	22.4	2.4	Iatur	24.1	3.1	Jharsuguda	21.1	2.6
Palakkad	17.3	1.8	Mumbai	14.6	1.6	Kalahandi	26.8	3.2
Pathanamthitta	14.5	1.5	Mumbai (Suburban)	18.2	2.0	Kandhamal	30.8	3.6
Thiruvananthapuram	16.4	1.6	Nagpur	20.2	2.2	Kendrapara	21.8	2.6
Thrissur	16.1	1.6	Nanded	25.5	3.3	Kendujhar	25.3	3.0
Wayanad	19.5	2.0	Nandurbar	27.0	3.3	Khordha	20.3	2.4
Lakshadweep	22.6	2.7	Nashik	25.0	3.1	Koraput	27.3	3.1
Lakshadweep	22.6	2.7	Osmanabad	23.2	3.0	Malkangiri	28.8	3.3
Madhya Pradesh	30.7	3.9	Parbhani	25.2	3.3	Mayurbhanj	26.0	3.0

(Contd)

Table A-1: Estimates of Birth Rate and Total Fertility Rate for District in 2001 (Contd)

Districts	Crude Birth Rate	Total Fertility Rate	Districts	Crude Birth Rate	Total Fertility Rate	Districts	Crude Birth Rate	Total Fertility Rate
Nabarangapur	30.0	3.4	Ariyalur	19.2	2.1	Jalaun	27.0	3.7
Nayagarh	20.9	2.5	Chennai	13.5	1.3	Jaunpur	32.1	4.3
Nuapada	25.9	3.0	Coimbatore	16.4	1.7	Jhansi	26.2	3.4
Puri	20.2	2.4	Cuddalore	18.7	2.1	Jyotiba Phule Nagar	34.1	4.9
Rayagada	28.5	3.3	Dharmapuri	20.9	2.6	Kannauj	30.7	4.4
Sambalpur	21.2	2.6	Dindigul	17.0	1.8	Kanpur Dehat	29.0	4.2
Sonapur	22.7	2.8	Erode	14.7	1.6	Kanpur Nagar	20.7	2.6
Sundargarh	22.8	2.7	Kancheepuram	17.7	1.9	Kaushambi	34.7	4.8
Pondicherry	18.1	1.8	Kanniyakumari	15.4	1.6	Kheri	32.8	4.7
Karaikal	18.8	1.9	Karur	16.3	1.8	Kushinagar	33.7	4.7
Mahe	16.4	1.5	Madurai	16.9	1.8	Lalitpur	36.1	4.9
Pondicherry	17.9	1.8	Nagapattinam	17.9	1.9	Lucknow	24.2	3.1
Yanam	23.6	2.5	Namakkal	15.3	1.7	Maharajganj	36.2	5.0
Punjab	20.1	2.4	Perambalur	18.2	2.0	Mahoba	32.3	4.5
Amritsar	21.3	2.7	Pudukkottai	19.0	2.0	Mainpuri	31.1	4.4
Bathinda	19.6	2.4	Ramanathapuram	18.6	2.1	Mathura	32.0	4.6
Faridkot	19.5	2.4	Salem	17.4	1.9	Mau	33.8	4.6
Fatehgarh Sahib	19.2	2.3	Sivaganga	16.8	1.9	Meerut	27.7	3.9
Firozpur	23.3	2.8	Thanjavur	17.1	1.8	Mirzapur	33.5	4.7
Gurdaspur	20.6	2.4	The Nilgiris	16.3	1.6	Moradabad	34.5	5.0
Hoshiarpur	19.2	2.3	Theni	16.7	1.8	Muzaffarnagar	31.9	4.4
Jalandhar	17.8	2.1	Thiruvallur	18.4	1.9	Pilibhit	33.9	4.9
Kapurthala	18.9	2.2	Thiruvannamalai	17.7	2.1	Pratapgarh	31.5	4.2
Ludhiana	19.1	2.3	Toothukudi	17.2	1.8	Rae Bareilly	31.6	4.3
Mansa	21.9	2.7	Vellore	18.6	1.9	Rampur	35.5	5.1
Moga	19.5	2.4	Viluppuram	18.9	2.1	Saharanpur	29.5	4.0
Muktsar	20.8	2.6	Virudhunagar	18.0	1.9	Sant Kabir Nagar	34.4	4.9
Nawanshahr	18.3	2.2	Tripura	21.2	2.5	Sant Ravidas Nagar	32.6	4.4
Patiala	19.6	2.3	Dhalai	24.0	2.8	Shahjahanpur	33.7	4.8
Rupnagar	20.0	2.4	North Tripura	23.4	2.8	Shravasti	34.0	4.8
Sangrur	20.6	2.5	South Tripura	21.8	2.6	Siddharthnagar	36.1	5.1
Rajasthan	32.1	4.2	West Tripura	19.6	2.3	Sitapur	33.0	4.7
Ajmer	29.1	3.7	Uttar Pradesh	31.4	4.4	Sonbhadra	35.3	4.8
Alwar	33.2	4.5	Agra	28.3	3.8	Sultanpur	32.3	4.4
Banswara	38.0	4.8	Aligarh	30.7	4.5	Unnao	29.5	4.1
Baran	31.3	4.0	Allahabad	30.2	4.2	Varanasi	30.1	4.1
Barmer	40.0	5.7	Ambedkar Nagar	31.5	4.2	Uttaranchal	26.1	3.6
Bharatpur	34.8	4.9	Auraiya	30.0	4.1	Almora	23.5	3.0
Bhilwara	31.3	4.0	Azamgarh	33.1	4.5	Bageshwar	25.7	3.3
Bikaner	32.8	4.4	Baghpat	27.5	3.9	Chamoli	23.7	3.0
Bundi	30.9	4.0	Bahraich	36.0	5.2	Champawat	29.1	3.8
Chittaurgarh	30.0	3.8	Ballia	28.4	3.8	Dehradun	20.9	2.6
Churu	32.4	4.2	Balrampur	34.2	4.9	Garhwal	21.6	2.8
Dausa	34.4	4.6	Banda	32.4	4.6	Hardwar	29.6	4.1
Dhaulpur	39.6	5.7	Barabanki	33.1	4.7	Nainital	25.0	3.3
Dungarpur	37.3	4.5	Bareilly	34.1	4.9	Pithoragarh	24.5	3.1
Ganganagar	27.1	3.4	Basti	32.4	4.7	Rudrapur	24.9	3.2
Hanumangarh	27.2	3.4	Bijnor	33.0	4.6	Tehri Garhwal	26.0	3.2
Jaipur	29.6	3.8	Budaun	37.7	5.5	Udham Singh Nagar	29.6	3.9
Jaisalmer	39.7	5.8	Bulandshahar	29.8	4.4	Uttarkashi	28.5	3.6
Jalor	37.3	5.2	Chandauli	32.7	4.5	West Bengal	22.5	2.6
Jhalawar	30.5	4.0	Chitrakoot	36.5	5.2	Bankura	22.2	2.6
Jhunjhun	28.2	3.8	Deoria	31.1	4.4	Bardhaman	20.0	2.3
Jodhpur	32.9	4.4	Etah	34.1	4.9	Birbhum	26.1	3.0
Karauli	35.9	4.9	Etawah	29.5	4.0	Dakshin Dinajpur	26.9	3.3
Kota	27.1	3.5	Faizabad	29.6	4.0	Darjiling	19.6	2.1
Nagaur	32.3	4.2	Farrukhabad	29.8	4.3	Haora	18.0	2.1
Pali	32.2	4.4	Fatehpur	31.8	4.5	Hugli	18.1	2.0
Rajsamand	31.3	3.9	Firozabad	34.1	4.8	Jalpaiguri	24.9	2.8
Sawai Madhopur	31.7	4.4	Gautam Buddha Nagar	31.1	4.4	Koch Bihar	25.5	3.0
Sikar	29.5	3.9	Ghaziabad	28.7	3.9	Kolkata	11.8	1.4
Sirchi	35.3	4.7	Ghaziipur	31.8	4.3	Maldah	33.0	4.0
Tonk	32.1	4.2	Gonda	33.1	4.7	Medinipur	22.6	2.6
Udaipur	32.7	4.1	Gorakhpur	29.9	4.3	Murshidabad	29.3	3.5
Sikkim	23.7	3.0	Hamirpur	30.0	4.2	Nadia	21.1	2.4
East	20.6	2.5	Hardoi	33.8	4.8	North Twenty Four Parganas	18.8	2.1
North	25.5	3.4	Hathras	30.6	4.4	Puruliya	24.9	3.1
South	26.4	3.4				South Twenty Four Parganas	24.7	3.0
West	26.5	3.5				Uttar Dinajpur	35.1	4.3
Tamil Nadu	17.2	1.8						

Figure 2: Map of District Classified by Fertility Level Estimated from the 2001 Census



correspond mainly to the largest metropolises such as Bangalore, Delhi, Hyderabad, Kolkata and Mumbai. The area where fertility is lower than 3 children per woman is much larger, as it covers almost entirely the southern and coastal states, along with Punjab, Himachal Pradesh, Tripura and Manipur. As our estimates pertain to the 1995-2001 period and fertility decline remains rapid, it can be assumed that all these states will have reached the replacement level in a few years from now.

High-fertility areas (districts with more than 5 children per woman) are still widespread in north India, but they reflect a more fragmented picture. Three of these districts are found in west Rajasthan, but the other ones tend to be scattered away in several states such as Uttar Pradesh, Bihar, Madhya Pradesh, Jharkhand and Meghalaya. These districts are part of a larger so-called Bimaru zone where fertility remains very high (above 4 children per woman), but obviously the rhythm of fertility decline is fast reshaping the re-

gional demographic landscape. As a result, the districts with highest fertility levels appear like islands in a sea of change.

Some districts that are otherwise completely surrounded by high-fertility areas are exhibiting now signs of rapid fertility decline as can be seen for Delhi, Kanpur, Gwalior or Indore among others. These are districts characterised by high levels of urbanisation and non-agricultural workforce. Interestingly, there seems to be very limited diffusion from these districts to neighbouring, rural areas where fertility levels remain high. It remains to be seen in the coming years whether the profound demographic change in these cities is able to spread further and accelerate the pace of fertility decline in the north.

Appendix

This appendix summarises the most important hypotheses of our estimation of fertility from the 2001 Census provisional data.

The number of births in 1994-2001 is deduced by applying a survival ratio to the population aged 0-6 years recorded during the census. This survival ratio is based on the state-level mortality rates of children aged 0-4 as given by the SRS and is converted into a survival rate by using model life tables (South Model from the Coale and Demeny life tables).⁶ Though the NFHS-2 also offered a set of recent mortality estimates for most states in India (such as infant and child mortality rates), we found it safer to retain the SRS average figure for 1996-98 that is based on much larger sample than the NFHS-2.⁷ When data were missing such as for Mizoram and Jammu and Kashmir, the all-India average has been used.

The state-level survival ratio has then been modified to account for district variations within states. For want of a more recent source, we employed a previously computed set of child mortality estimates at the district level based on the 1991 Census data (Irudaya Rajan and Mohachandran 1998). The figures used here are taken from the averaged estimates of district mortality up to age 2 and 3. When a district in 1991 was supposed to have a mortality level that is higher by 15 per cent than the state average, the same 15 per cent variation was applied to the SRS state estimates for 1996-98 to compute the specific district mortality level.

Though the computation of district-level child survival may seem very indirect, it is worth stressing that estimation errors would have little impact on the final survival ratio. Thus, although the coefficient of variation of child mortality estimates for all districts was as high as 44 per cent in 1991, an underestimation of mortality corresponding to this standard deviation would only result in a relative overestimation of district survival of 3.6 per cent. This is so because of the small level of child mortality and the corresponding higher level of child survival. Using SRS figures, the lowest probability to survive from birth to the 0-6 age group is of 88 per cent in Madhya Pradesh as against almost 99 per cent in Kerala.

Fertility estimates

The reverse survival method provides reasonably good estimates of the crude birth rates in districts. However, this rate is significantly influenced by the specific age and sex structure of regions: in places where women of childbearing age

are more numerous, the birth rate should be higher *ceteris paribus*. Therefore, demographers usually compute the total fertility rates that are independent of the specific demographic composition of the population.

Because of the various sex and age distributions of each district, it is not appropriate to apply the relationship between the CBR and the TFR as observed from other sources (SRS, NFHS-2) to derive TFR levels from our estimated CBR values. As the detailed age structure from the 2001 Census may not be available before two years or more, we have once again to rely on an indirect estimation procedure. As done before, we apply the most recent estimates for states and correct them for direct variations as obtained in the 1991 Census.

Here, we use the fertility schedule (number of births per woman in quinquennial age group) derived from the NFHS-2 for 1995-99 and the corresponding TFR value.⁸ To correct for the specific demographic structure of districts, this state-level fertility schedule is then applied to the age distribution obtained during the 1991 Census. For each district, we get a TFR value (identical within each state) as well as a hypothetical CBR resulting from its specific age and sex structure in 1991. Within a given state, variations in the resulting crude birth rates obtained from a single fertility schedule can be sizeable. For example, in Andhra Pradesh, the same average age schedule of fertility would lead to a crude birth rate in Hyderabad district—a district whose age and sex structure is significantly skewed by immigration processes—that is 10 per cent lower than in other districts. Using these age distributions from 1991 and the recent NFHS-2 fertility pattern, we get therefore distinct TFR/CBR ratios for all districts. These ratios are finally applied to our previously estimated CBR to compute the corresponding TFR value.⁹

Missing data and Changing Boundaries

A recurrent problem is related to missing data and changing boundaries. When absolute data are missing, as for the areas not covered by the censuses in 1991 (Jammu and Kashmir) and in 2001 (Kinnaur and Kutch districts), no estimate is possible. However, when only other indicators are missing, such as the fertility schedule for some states, other data from adjacent areas

(or the All-India average) can be used as we explain above.

Regarding boundary changes, numerous changes have been introduced in the administrative map of Indian districts and states. Data from the previous corresponding districts are systematically applied to the 127 new districts of the 2001 Census. When a new district is, however, formed out of several different districts, as is the case for 16 districts in 2001, the average of values taken from its district components in 1991 is used to compute the corresponding district value for 2001. This technique has been used, inter alia, when computing the mortality differentials and the CBR-TFR ratio. ■

Notes

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- 1 Results are presented and discussed in Banthia (2001) and Dyson (2001).
- 2 The estimation and mapping procedure have been carried out by Christophe Z. Guilmoto. Thanks to my colleagues S. Vingadassamy, Amuda and Allapitchai for their help with the data base and the district map. More maps and details on estimation are available on www.demographie.net/sifp.
- 3 The same exercise carried out with different state population from the 1991 Census shows the gap to be generally inferior to 1 per cent, which is a very moderate deviation.
- 4 This possibility might admittedly be limited by the de jure aspect of census enumeration in India.
- 5 See also Guilmoto (2000) for maps of fertility in India in 1981 and 1991. See also Guilmoto and Rajan (forthcoming).
- 6 Coale and Demeny. The choice of a specific mortality pattern for the life table used (west or south pattern, south Asian pattern, etc) has almost no impact on the conversion of death rates into survival ratios.
- 7 The total sample size of the SRS in 1997 was of 59.7 lakhs people, a sample that is twelve times larger than that of the NFHS-2. However, the use of NFHS-2 figures would result only in minor differences in the final fertility estimates.
- 8 The NFHS-2 data have been selected, as there are available for a larger number of states than the SRS. For missing states, the all-India average has been used, except for Chandigarh and Pondicherry for which we used respectively the data from Punjab and Tamil Nadu.
- 9 The more straightforward technique used by Mari Bhat to infer TFRs from CBRs in 1991 is not applicable to the 2001 data as it is based on the 1981 figures. See Mari Bhat (1996).

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