

# Examination of the Quality of Sample Registration System Data on Births and Deaths Data in India and Major States

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**Background:** Reliable demographic and health data are a key to track progress of human development in any country. In the absence of a reliable civil registration system in India, the Sample Registration System (SRS), beginning in 1970, has been the only source of information that allows us not only to track Sustainable Development Goals (SDGs) (Under five Mortality Rate (U5MR), Maternal Mortality Rate (MMR) and Infant Mortality Rate (IMR), etc.), but which also provides inputs to calculate the Human Development Index (HDI) and to measure gender gap and immature births and deaths in aged 5+.

**Objective:** Since 2001, there has been no attempt to examine the quality of the Sample Registration System. In this context, the present paper is an attempt to assess the quality of the SRS data for birth and death in India as a whole and for some selected states.

**Method:** Using Bennett and Horiuchi (1981) extended the concept of Preston and Coale proposed a method to estimate completeness of death registration during intercensal period.

**Result:** We found that at the country level, death undercounts for population aged 5+ by the SRS seemed to be around 4.3% for males and 11.3% for females during 2001-10 and results also show that the national level during the decade 1991-2000, 2 percent births (nearly 0.5 million) went unrecorded by the system, while during the decade 2001-2010, 3 percent of the births (0.8 million) went unrecorded by the SRS.

**Conclusion:** There is a need to review the SRS procedure/design of data collection and updating of (ages 5+) deaths and births registration of the sampled population in the dual record of registration.

**Contribution:** This is the first study after 2001, there has been no attempt to examine the quality of the Sample Registration System data.

**Key words:** Fertility, Mortality, Quality of Data, Bennett Horiuchi, Sample Registration System and India

**1. Introduction** The civil registration system (CRS) in India, like in many other countries in the developing world, is grossly incomplete and cannot be used directly for the analysis of fertility and mortality. According to

the 2011 report (Registrar General of India (RGI), 2014), in India 21.8 million births were registered against 26.3 million expected births using birth rate from sample registration system (SRS) and the 2011 population census. If the population in 2011 was adjusted for its net omission rate of 2.298%, the expected births would be 27 million. This indicates that CRS was able to count around 81% of total births in the country; a great improvement indeed compared to what was 10 years back (50%). On the other hand, the CRS counted only around 5.74 million of total deaths (2011) that was expected to be 7.79 million (completeness of only 65%). In case of infant deaths, the system miserably failed as it was able to count only 178,172 against a nearly total of 1,188,000 infant deaths in India (CRS and ORG, 2011). So, looking the status of the CRS in the 1960s, the Sample Registration System (SRS) was launched in the late 1960s and the system has been regularly providing the vital rates since 1970. Two points related to this are noteworthy. First, fertility and mortality were not published until 1981 for West Bengal and Bihar, two states sharing 17% of the Indian total population in 2011, and for smaller states the data quality has been under suspicion due to difficult areas and sample size. Second, during initial years of SRS (or before 1976) the stabilization of the system was very unlikely, and thus there was a greater fluctuation in annual vital rates (Bhat, 2002). After the launch of the SRS in the late 1960s, Registrar General of India (RGI, 1964) conducted two in house comprehensive evaluations for the SRS in 1980-1981 and in 1984-1985 (RGI, 1983, 1988) with undercount rates of around 3% in both births and deaths in 1980-1981 and 1.8% for births and 2.5% for deaths in 1984-1985.

There is, however, no information available by sex which could be indicative of problem while discussing sex-wise improvement in mortality and the sex ratio at birth. This knowledge was never used to adjust the vital rates published by RGI nor to undercount rates as indicated above, probably due to the fact there was no time trend of omission rate available and therefore adjustment would not affect the trend but level will surely be on higher side. The evaluation of SRS data using indirect technique for period 1981-1990 indicated an omission of 5% of death among men and 12% of death among women on average; at the same time births were also under reported by 7% (Bhat, 2002). Such a differential in omission has serious implications if anyone attempts to study gender differential in mortality from SRS vis.-vis. many women empowerment interventions taken by government. In our knowledge, no attempt so far has been made to incorporate such research evidence while analysing gender

differential in mortality. Data for the 1990s and for the first decade of the 21st century have not been put into such a systematic scrutiny nor found out the quality of counts in deaths in the SRS. Thus, it becomes much more important to evaluate of SRS data quality not only in the context of changing sampling areas for each SRS but also in context of changing vital rates. Therefore, the focus of present work is to carry out a systematic evaluation of mortality data from the SRS for the period 1991-2000 and 2001-2010.

In India, the assessment of the mortality level of the population can be done through civil registration, the SRS, and various other sources, but in the absence of good quality civil registration statistics, the SRS has been the most reliable source to estimate the level of mortality.

Preston and Hill (1980) proposed a method that does not require the assumption of stability. This method is adapted for a closed population which relates the size of a cohort at the second census to the size of the same cohort at the first census and to the intercensal deaths occurring to the members of the cohort. They assumed that the relative completeness of death registration is constant across the ages within each source of data and gave the relationship:

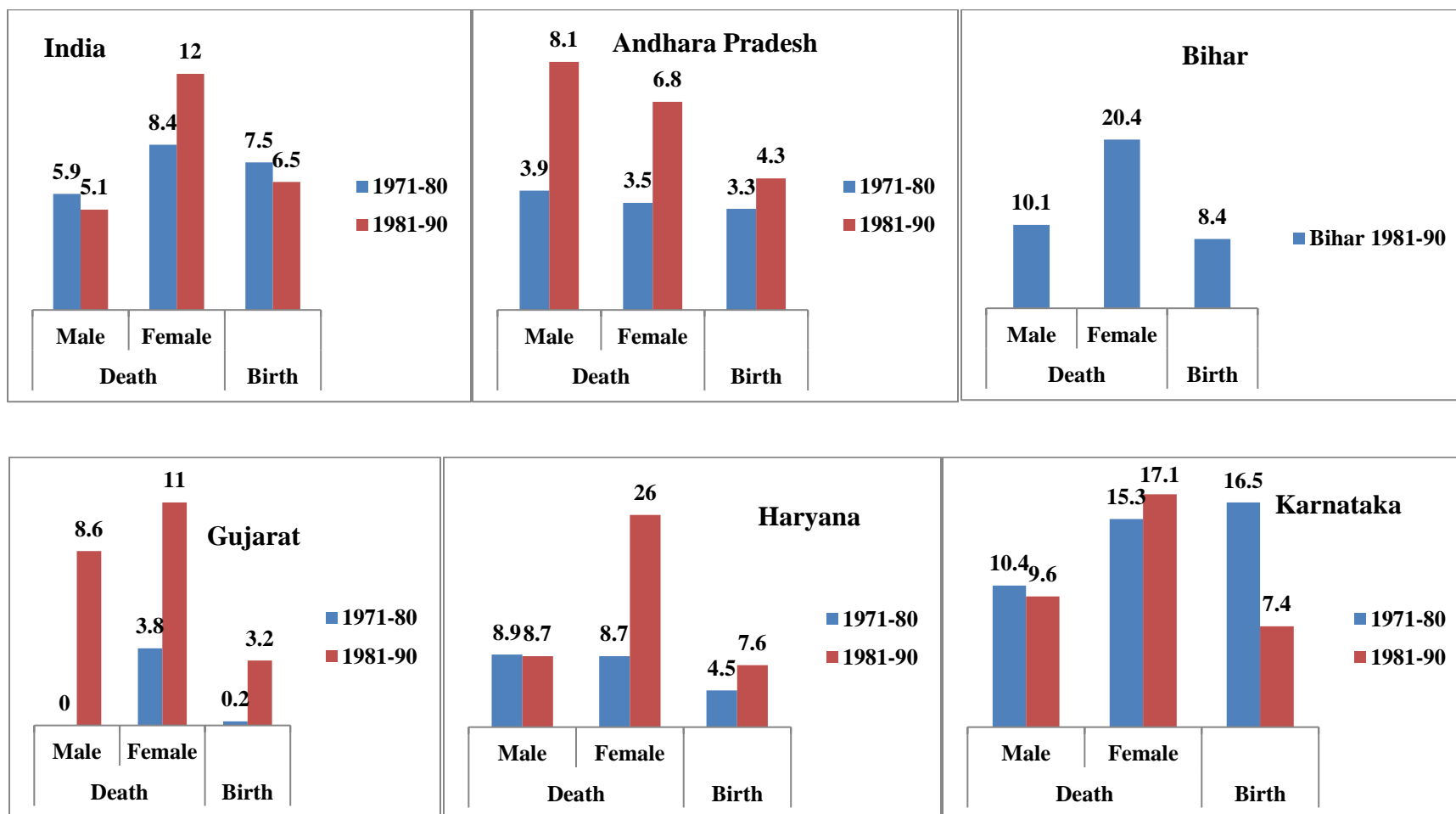
$$N^*(1) / N^*(2) = E (1)/E (2) + E (1)/C *(D^*/N^*(2))$$

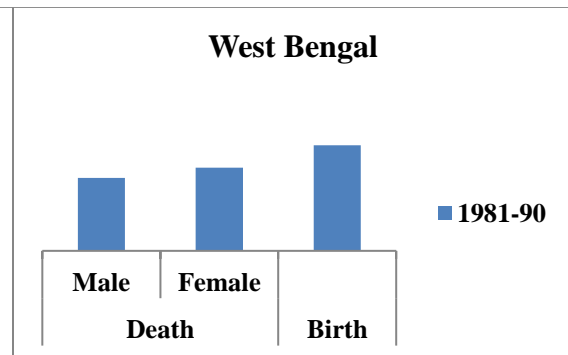
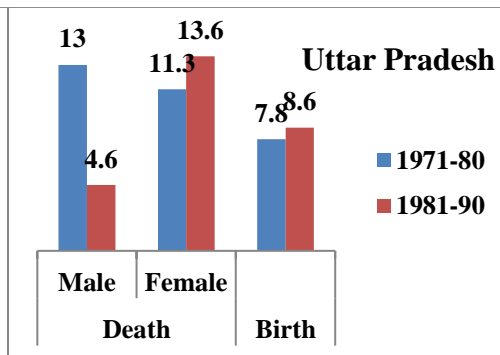
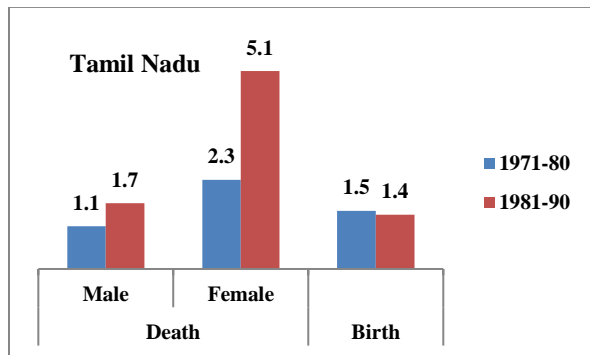
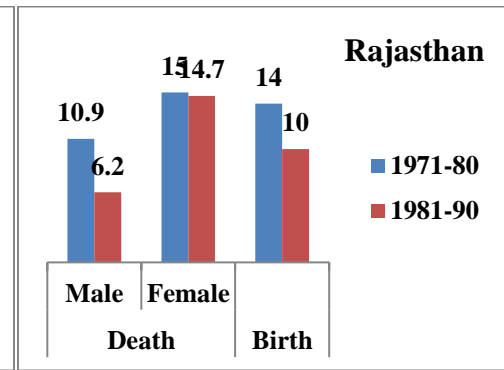
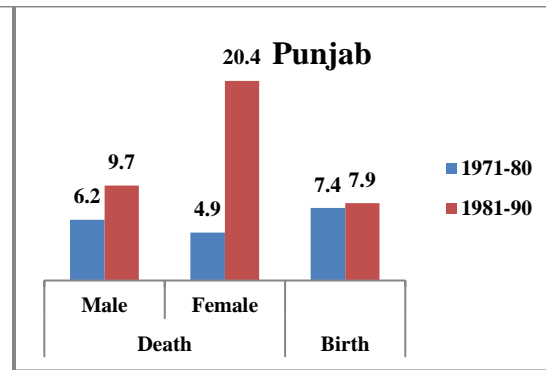
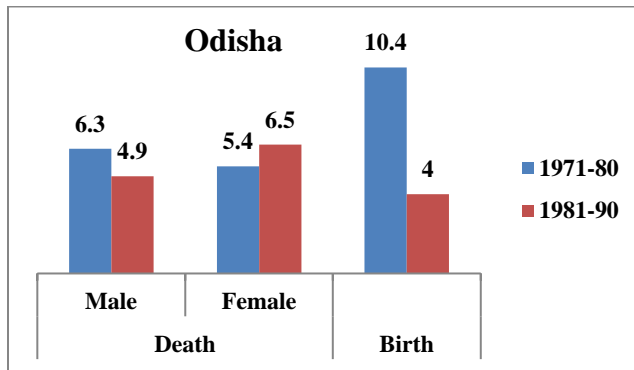
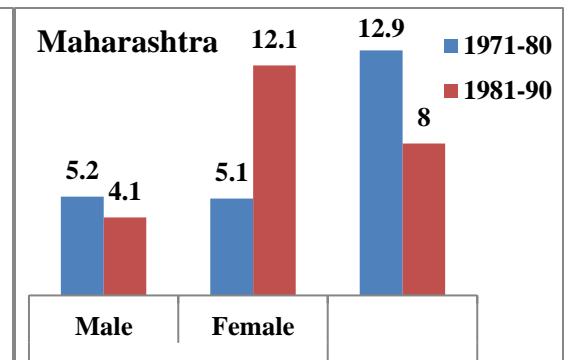
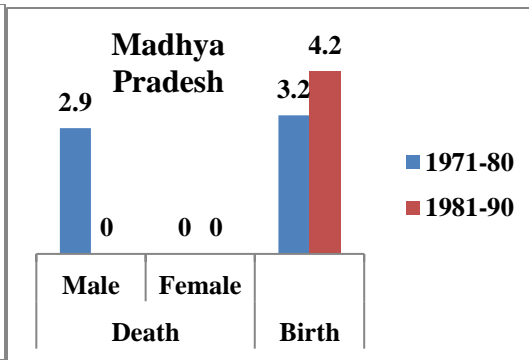
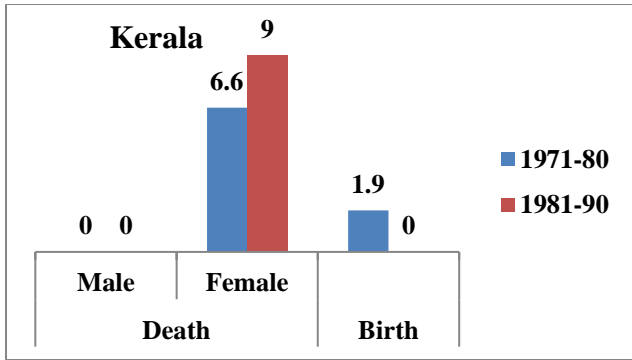
$$\text{And also, } D^* = (D) * (C)$$

Where, N (1) and N (2) are true numbers of the cohort population, N\*(1) and N\*(2) are the reported numbers of members, E (1) and E (2) are the completeness of enumeration at census 1 and census 2 respectively, D\* is the intercensal deaths, and C is the completeness of intercensal death registration. As in the Brass method, the values of E (1)/E (2) and E (1)/C can be estimated by using a simple regression applied to data on different cohorts. The two observed variables are N\*(1)/N\*(2) and D\*/N\*(2). The intercept, E (1)/E (2), is the relative completeness of the two censuses, and the slope, E (1)/C, is the completeness of death registration relative to the first census. One serious problem with this method is its sensitivity to overstatement of age, which tends to distort the estimated relative completeness of death registration.

Pathak and Ram (1981) compared the completeness of death registration in three ASEAN countries – Malaysia, Philippines and Thailand – around the year 1970 in order to study the applicability and suitability of the three systems by using techniques developed by Brass, Preston and Hill, and Martin (Pathak and Ram, 1981). Their study found that the registration system of Malaysia was better than those of the other two countries. Bhat (1995) examined the impact of age misreporting on adult mortality estimates. He found that because of age misreporting, populations in the older age groups were artificially inflated, and that using age distribution with the artificially inflated populations at older ages could produce upward estimates of life expectancy derived from popular techniques of intercensal analysis by about four years for males and by two years for females. He concluded that a simple smoothing of the age distribution would not adequately correct the distortions in data. Bhat (2002) proposed a reformulation of the general growth balance method for estimating census and registration completeness so as to make it applicable even to populations that are affected by migration. He also discussed a new procedure of line fitting that could be useful in countries where data on age distribution of population are available for two points in time either from censuses or from some surveys. Beyond correcting the death rates, the method is useful in inferring the relative completeness of the censuses and in deriving a robust estimate of birth rate under certain conditions (Bhat, 2002). In India, the completeness of the coverage of deaths for population aged 5+ in the SRS was 91% for females and 94% for males during 1971-1980 (Bhat, 2002). During 1981-1990, the corresponding figure was estimated to be 88% for both females and males. Use of the Bennett - Horiuchi method shows that in some states like Andhra Pradesh, Assam, Bihar, Maharashtra, Punjab, Tamil Nadu, and West Bengal, death reporting in the SRS was less than 80% in the period 1990-1997 (Bhat, 2002). During 1971-1997, the completeness of death registration among males was constant at 95%, but in the case of females, it fluctuated from 91% during 1971-1981 to 88% during 1981-1990 to 93% during 1990-1997. The deterioration in the quality of registration was more noticeable in Punjab, Haryana, and Uttar Pradesh in north India, in Andhra Pradesh and Tamil Nadu in south India, and in Maharashtra and Gujarat in west India (Fig. 1). The national level deaths coverage by the SRS was 97% during 1980-1981 and 98% during 1984-1985 (RGI, 1990). In most of the states, during both time periods, the deaths coverage (aged 5+) was more than 95%, but in some states like Rajasthan, Karnataka, and Uttar Pradesh, the coverage was less than 95% (Fig. 1).

**Fig.1 % undercount of births and deaths (5+) by SRS estimated by P. N. Mari Bhat in India and major states, 1971-1980 and 1981-91**





## 2. Data and Method

The SRS data is an initiative of the Office of the Registrar General, India, with the goal of generating reliable and continuous data on demographic indicators. It was introduced as a pilot scheme in some major states in 1964-65 and was made into a full-scale system in 1969-70. The SRS collects data using a dual record system which first enumerates events on a continuous basis and later verifies the same by conducting retrospective half yearly surveys. This is followed by the process of matching of the two records and the subsequent field verification of the unmatched and the partially matched events. We used the % of deaths by age and sex from the SRS, the % of deaths by age and sex used for estimating the number of deaths, and the size of population by age and sex for India and states between the 1991 and 2010 by censuses.

SRS under the guidance of the RGI is the primary and continuous source of data on % of deaths by age and sex. These states are Himachal Pradesh, Punjab, Haryana and Rajasthan (from the north region), Uttar Pradesh and Madhya Pradesh (from the central region), West Bengal, Odisha and Bihar (from the east region), Gujarat and Maharashtra (from the west region), and Andhra Pradesh, Karnataka, Kerala and Tamil Nadu (from the south region) and Assam (from north east region). These states covered nearly 90 percent of all India's population in the 2011 census. The Office of the Registrar General and Census Commissioner has been conducting the census every ten years since 1881, the latest having been conducted in 2011. We used information on population by age and sex for latest three censuses (i.e., in 1991, 2001, and 2011) in this study. For the birth registration using SRS Statistical Report 1991-2011, CBR and CDR from SRS 1996 and 2006.

### Method

Brass (1975) used the concept of balancing equation to figure out the relationship between age distribution of deaths and population. In the absence of migration and under the assumption of population stability, it was logically argued that the proportion of population at exact age  $x$  to total population above age  $x$  would equal growth rate ( $r$ ) plus ratio of death above age  $x$  to population above age  $x$ . However, it has been argued that this method makes strong assumptions, particularly of population stability and, therefore, it may not work when the population under study is unstable. Preston and Hill (1980) proposed another method that does not require the

assumption of stability, but which does not take migration treatment into consideration either. Interpretation of completeness of death registration above age 5 or so was linked to relative quality of enumeration of two censuses being used. However, Preston *et al.*, (1980) proposed another method based on the assumption of stable population and the logical concept of stationary population. In stationary population, we know that all the deaths above age x are the same as survival at age x as all those who are at the survival age would die in the remaining years of their life.

After the emergence of the generalized population model (Coale *et al.*, 1981), treatment of relations in various population parameters underwent a drastic change. In mathematical demography, this model has been demonstrated to be useful not only in the estimation of vital rates using census data (Coale *et al.*, 1981), but also for understanding population momentum and distance to stability. Using this model, Bennett and Horiuchi (1981) extended the concept of Preston and Coale and proposed a method to estimate completeness of death registration during intercensal period. These methods were used to estimate completeness of the CRS in India and in some of the Asian countries (Pathak and Ram, 1981). Bhat (2002) reformulated the general growth balance method incorporating migration to estimate the completeness of count of deaths. In the present research work, we have used the Bennett and Horiuchi method. Results were obtained using the latest version of MORTPAK using data for India and for some selected states for the periods 1991-2000 and 2001-2010. Migration data are still not available for the 2011 census; therefore, it was not possible to use the Synthetic Extinct Generations (SEG) method for adult completeness for India and the states.

### **Estimation of Completeness of Birth registration by balancing equation**

$r = \text{Birth rate} - \text{Death rate}$ ,

where r is Growth rate

$$CDR^{\text{adjusted}} = k * CDR^{\text{SRS}}$$

K = correction factor for death under registration by SRS at the same time for same population.

$$CBR^{\text{estimated}} = r + CDR^{\text{adjusted}}$$

$$\text{Completeness of Birth registration by SRS} = CBR^{\text{SRS}} / CBR^{\text{estimated}}$$



## **Implementation of procedures for estimation of intercensal deaths**

**(1):** Population by sex given by the Census of India for the census years 1991, 2001, and 2011 was used to estimate the total population of India and the major states for each intercensal year using the Newton Forward Linear Interpolation methods. This procedure gave the population for the periods of 1991-2000 and 2001-10. For estimating the SRS completeness of death registration during the census period 1991-2010, the population of each year, that is, 1992, 1993, ... 2010 was estimated using the Newton Forward Interpolation methods and census population 1991, 2001, and 2011.

**(2):** Age distribution of population by five-year age groups and by sex was taken from the SRS for the respective years and the population by age and sex was estimated for each year.

**(3):** Distribution of deaths by five-year age groups and by sex was taken from the SRS, and the estimated population of the corresponding year was used to estimate absolute number of deaths by age and sex.

**(4):** Total number of deaths for all years from 1991, 1992, 1993... to 2000 and from 2001, 2002, 2003... to 2010 were added to estimate total intercensal deaths by age and sex.

**(5):** finally, we have estimated the deaths completeness and then adjust the death rate (CDR). Then we applied the balancing equation to estimate the birth rate (crude birth rate). Lastly, we have taken crude birth rate (CBR) from the SRS and compare it to estimated crude birth rate (CBR) for India and major states.

### **3. Results**

The results using the Bennett and Horiuchi (1981) method for estimating completeness of death count (age 5+) in the SRS in India are presented in Table 1 for the periods 1991-2000 and 2001-2010. At the outset, it is pointed out that there may be an undercount in relation to the quality of respective census 1991, 2001 and 2011. It may be observed from Table 1 that among males, during 1991-2000, nearly 7.5% of (ages 5+) deaths were missed in the SRS at the all-India level, whereas only 2.1 % of female (ages 5+) deaths were missed. During 2001-2010, 4% of male (ages 5+) deaths, and 11% of female (ages 5+) deaths were missed.

At the state level, there was an unexpectedly huge variation not only across states but also within the states during the two decades. Based on these estimates, we may conclude the following:

- 1) Maharashtra and Punjab seem to have had full coverage of (ages 5+) deaths.
- 2) The states of Andhra Pradesh, Gujarat, Karnataka, Madhya Pradesh, Odisha, and Tamil Nadu indicate an invariably high undercount during 1991-00 but almost 100% coverage during 2001-10.
- 3) States like Assam, Bihar, Haryana, Himachal Pradesh, Kerala, Rajasthan, Uttar Pradesh, and West Bengal show a moderately high undercount of (ages 5+) deaths in both the decades.

Table 1 also shows the completeness of birth registration for India and some major states. At the national level, results show that during the decade 1991-2000, 2 % births (nearly 0.5 million) were missed by the system, and during the decade 2001-2010, 3 % births (0.8 million) were omitted by it. It may be noted that in Bihar, Tamil Nadu, and Himachal Pradesh, more than 5% of births were missed during 1991-2000. In Uttar Pradesh, the omission was nearly 4% during the decade 2001-2010, while in the rest of the states, birth completeness was more than 96% in the same time period. Rajasthan and Bihar had fewer birth registrations compared to the rest of the states during the decade 1991-2000. During 2001-2010, completeness of birth reporting improved. At 95 % and 96 % respectively, Rajasthan and Bihar too performed better than in the previous decade of birth registration. The national level coverage of birth completeness by balancing equation is 98 % for the decade 1991-2001 and 97 % for 2001-2010. The analysis of the SRS data for the states of Tamil Nadu, Bihar, and Himachal Pradesh indicates a deterioration in the completeness of (ages 5+) birth reporting as compared to the national level and as well as other states over time.

#### **4. Discussion**

Since the 1970s, demographic parameters like fertility and mortality have been provided by the SRS, considered to be the most reliable source. From time to time, demographers have used indirect methods to examine the reliability of the SRS in terms of coverage of deaths and births. However, for the last one or two decades, such an exercise has not been undertaken. In the absence of a reliable civil registration system (CRS) in India, the sample registration system (SRS) has been providing fertility and mortality indicators since 1970. The SRS has

undoubtedly helped us to understand the demographic transition in the country in the last four or five decades, but when we get very clinical time series data (defying the principle of sample estimates), it raises questions. In any case, it is worthwhile to have internal auditing of the data collected through any system.

Indirect methods for estimating population parameters in the absence of reliable data have contributed to our understanding of demography in developing countries. Nevertheless, these methods rely on certain assumptions and also require data in a certain format. As seen in the analysis method provides undercount only for above age 5 or 10. There is no way to get the completeness of count for deaths below age 5. It has been observed (CRS and ORG, 2010) that under civil registration, deaths below age 5, especially those below age 1, are grossly undercounted. This may not be true in the case of SRS as local enumerators used in this system are better trained and less dependent on informers unlike in CRS. There is also a strong supervisory check by independent teams, which helps minimise the undercount of death below age 5. In view of this argument, it may be fairly good to assume the extent of undercount for below age 5 to be similar to what has been estimated for deaths above age 5. With few exceptions, the analysis clearly indicates a comparatively larger undercount of female deaths. In other words, female mortality is underestimated (i.e.  $e_0^0$ ) is overestimated in the SRS; more so in the recent times. Such a situation leads us to believe that whatever gains for females have been observed in terms either of U5MR or  $e_0^0$  may not be true. This is especially true for some of the states. In order to understand the dynamics of the quality of data from the SRS, an in-depth analysis of unit level data is essential. The Registrar General of India must regularly get its data analysed; not just for internal consistency, but also for its validity vis-à-vis census age distribution. Migration data is one of the serious concerns as far as the application of indirect methods at the state level is concerned. There is scope to develop model age distribution of net migration and test its validity under a variety of conditions/ situations.

In the absence of a reliable civil registration system in India, the Sample Registration System (SRS) provides estimates of vital events, but this has some limitations as shown by various studies. The analysis in this paper indicates a huge undercount of deaths from all causes among females compared to males. SRS counting/coverage appear to have deteriorated over time. This puts a huge question mark on the creditability of the SRS especially with regard to the gender gap in mortality. It may be concluded that there is a need to review the SRS

procedure/design of data collection and updating of (ages 5+) deaths registration of the sampled population in the dual record of registration. Doing so will give better and more reliable estimates of (ages 5+) deaths at the national and state levels by gender and update some mortality indicators like Infant Mortality Rate (IMR), Under Five Mortality Rates (U5MR) and  $e_0^0$ . Regarding the fertility indicator adjusting for the undercount to get an idea what would be the difference. It is very difficult at this level but for some fertility indicator like CBR will increase 6% and 5% where birth undercount is 6% and 5% respectively same things will apply for TFR also.

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**Table 1. New level and trend of undercount of (ages 5+) births and deaths registration by SRS in India and major states in 1971-80, 1981-90, 1991-2000 and 2001-10**

Country/States	Time	% Undercount Deaths (ages 5+)		% Undercount Births (ages 5+)
		Male	Female	
All India	1971-80a	5.9	8.4	7.5
	1981-90b	5.1	12.0	6.5
	1991-00c	7.5	2.1	1.6
	2001-10d	4.3	11.3	2.7
Andhra Pradesh	1971-80a	3.9	3.5	3.3
	1981-90b	8.1	6.8	4.3
	1991-00c	19.8	15.1	7.2
	2001-10d	3.1	0.6	0.7
Assam	1971-80a	***	***	NA
	1981-90b	***	***	13.9
	1991-00c	17.0	10.3	5.2
	2001-10d	4.1	8.4	2.3
Bihar	1971-80a	***	***	NA
	1981-90b	10.1	20.4	8.4
	1991-00c	10.3	23.9	6.2
	2001-10d	8.4	19.0	4.2
Gujarat	1971-80a	0.0	3.8	0.2
	1981-90b	8.6	11.0	3.2
	1991-00c	11.5	7.5	3.0
	2001-10d	0.0	0.0	0.0
Haryana	1971-80a	8.9	8.7	4.5
	1981-90b	8.7	26.0	7.6
	1991-00c	4.5	3.7	0.0
	2001-10d	9.8	18.9	4.4
Himachal Pradesh	1971-80a	8.7	3.1	9.7
	1981-90b	3.5	5.8	0.0
	1991-00c	3.0	25.0	5.4
	2001-10d	0.0	6.2	1.1
Karnataka	1971-80a	10.4	15.3	16.5
	1981-90b	9.6	17.1	7.4
	1991-00c	11.8	10.4	4.0
	2001-10d	0.0	0.0	0.0
Kerala	1971-80a	0.0	6.6	1.9
	1981-90b	0.0	9.0	0.0
	1991-00c	0.6	10.1	1.9
	2001-10d	7.3	16.4	5.7
Madhya Pradesh	1971-80a	2.9	0.0	3.2

	<b>1981-90b</b>	0.0	0.0	4.2
	<b>1991-00c</b>	10.6	1.5	2.2
	<b>2001-10d</b>	0.0	0.0	0.0
<b>Maharashtra</b>	<b>1971-80a</b>	5.2	5.1	12.9
	<b>1981-90b</b>	4.1	12.1	8.0
	<b>1991-00c</b>	0.0	0.0	0.0
	<b>2001-10d</b>	0.0	0.0	0.0
<b>Odisha</b>	<b>1971-80a</b>	6.3	5.4	10.4
	<b>1981-90b</b>	4.9	6.5	4.0
	<b>1991-00c</b>	6.4	4.1	2.2
	<b>2001-10d</b>	0.0	0.0	0.0
<b>Punjab</b>	<b>1971-80a</b>	6.2	4.9	7.4
	<b>1981-90b</b>	9.7	20.4	7.9
	<b>1991-00c</b>	2.1	0.0	0.3
	<b>2001-10d</b>	0.3	0.0	0.1
<b>Rajasthan</b>	<b>1971-80a</b>	10.9	15.0	14.0
	<b>1981-90b</b>	6.2	14.7	10.0
	<b>1991-00c</b>	13.0	0.0	1.9
	<b>2001-10d</b>	11.0	17.0	3.5
<b>Tamil Nadu</b>	<b>1971-80a</b>	1.1	2.3	1.5
	<b>1981-90b</b>	1.7	5.1	1.4
	<b>1991-00c</b>	24.7	20.1	10.6
	<b>2001-10d</b>	0.0	0.0	0.6
<b>Uttar Pradesh</b>	<b>1971-80a</b>	13.0	11.3	7.8
	<b>1981-90b</b>	4.6	13.6	8.6
	<b>1991-00c</b>	16.0	7.0	3.8
	<b>2001-10d</b>	7.8	17.6	3.7
<b>West Bengal</b>	<b>1971-80a</b>	***	***	NA
	<b>1981-90b</b>	7.1	8.1	10.3
	<b>1991-00c</b>	14.5	0.6	2.7
	<b>2001-10d</b>	2.5	7.7	1.8

a and b Bhat, P.N. Mari (2002), Completeness of India's Sample Registration System: An Assessment Using the General Growth Balance Method", Population Studies, Vol. 56, No. 2, pp. 119-134 (Table 4 (page 126) and Table 6 (Page 130).

c and d estimated by authors by Bennett Horiuchi method

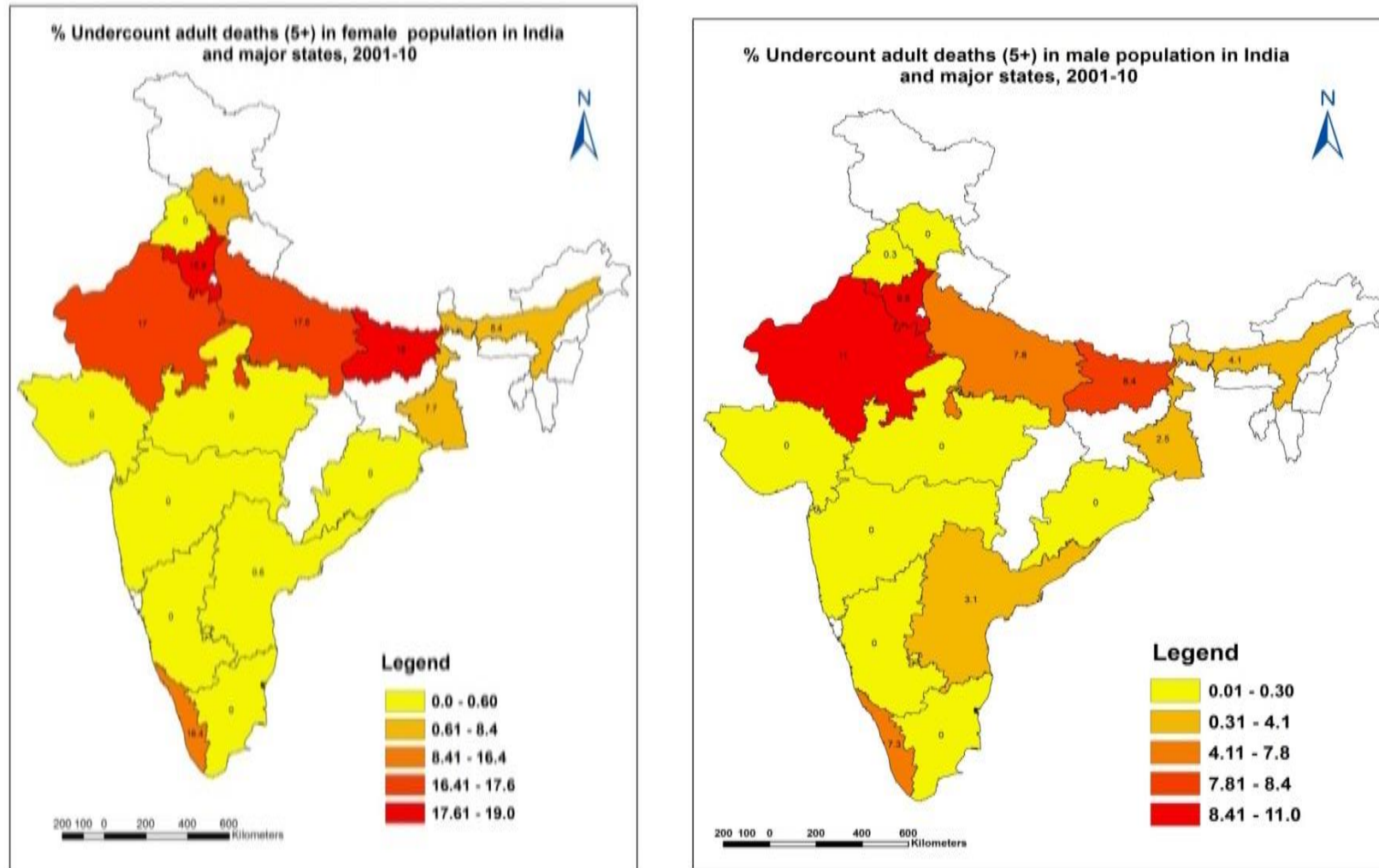
These states cover nearly 90 % of all India's population in the respective census

Here 0.0 means 100% counting of (ages 5+) births and deaths in SRS

and \*\*\* means NA

## Maps

Fig 2. Show the % undercount of (ages 5+) deaths in male and female population in India and major states in 2001-10

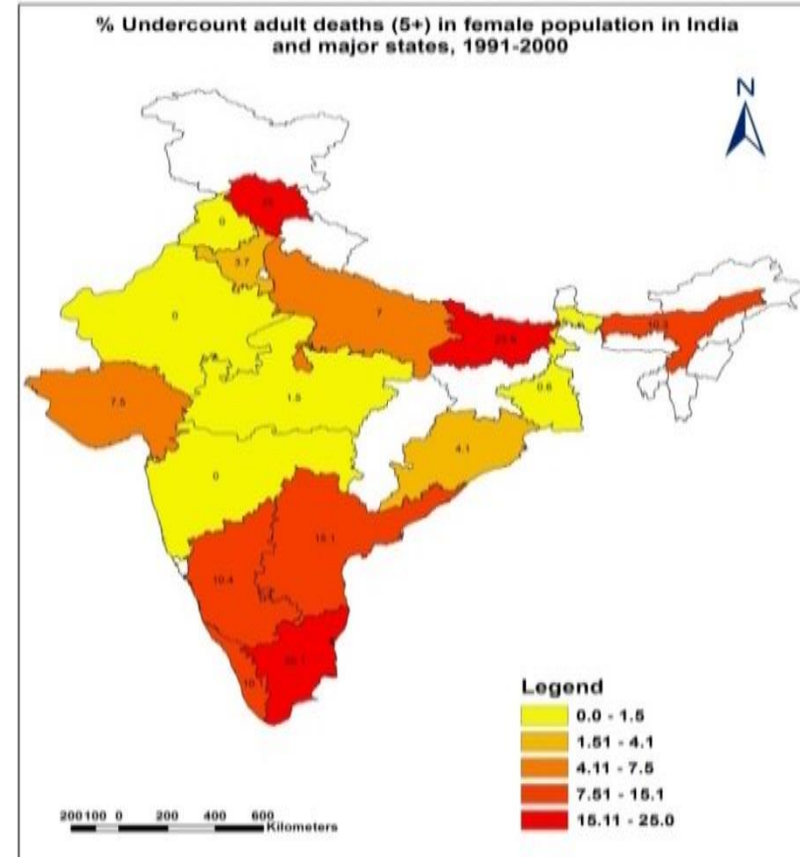
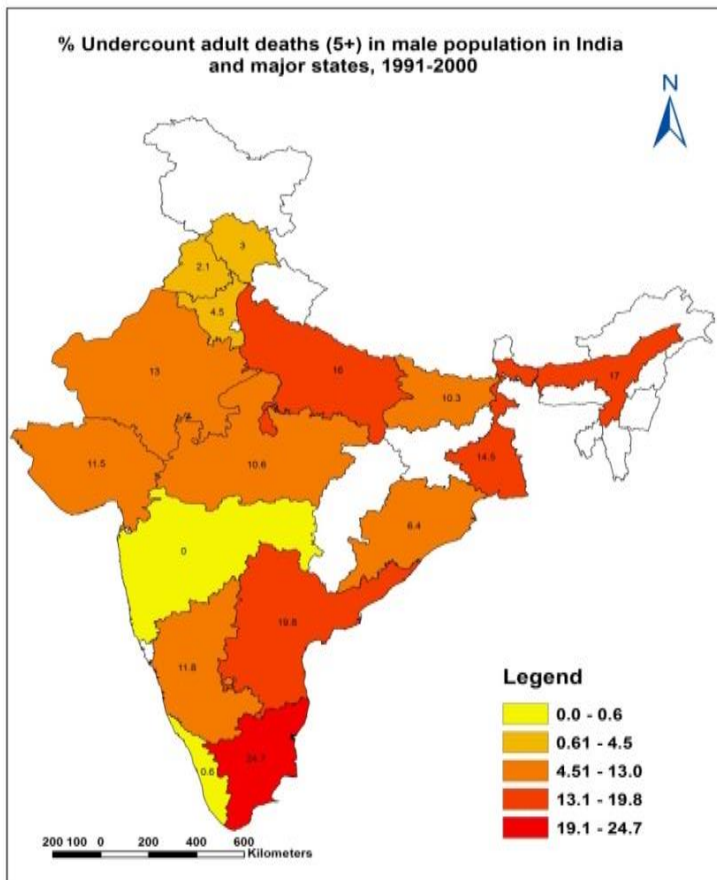


1

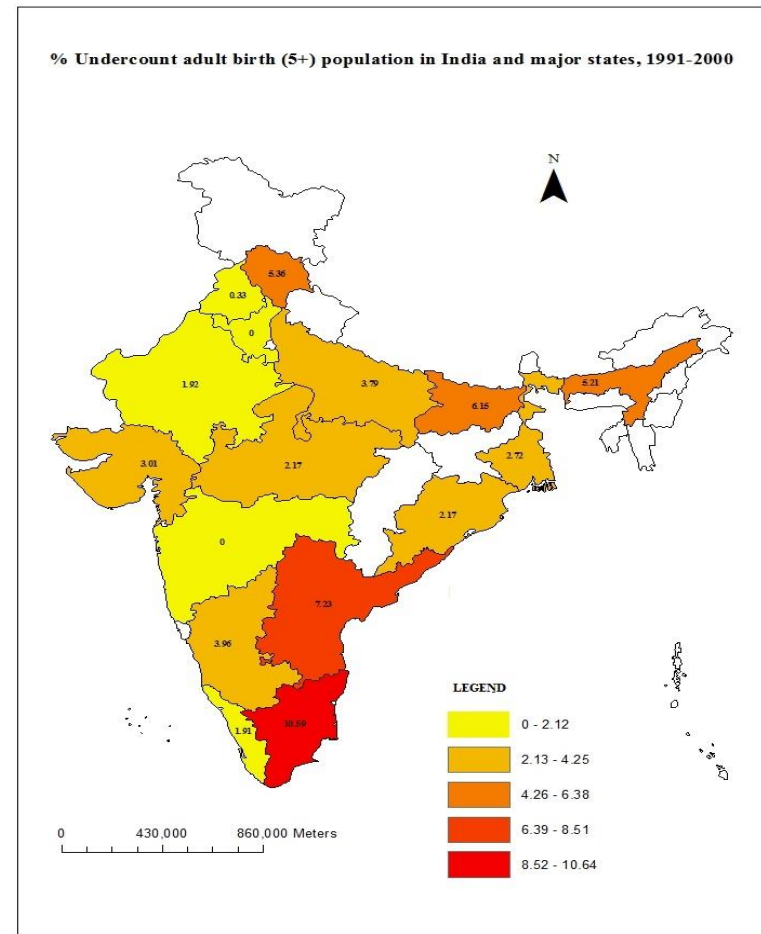
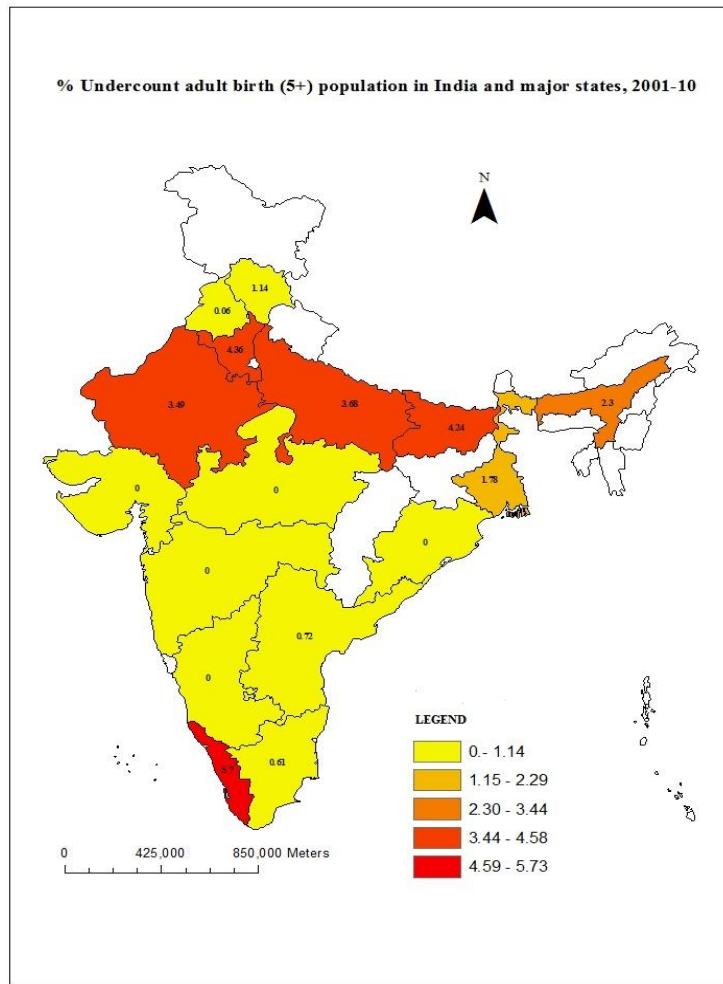
<sup>1</sup>In this study we have taken only 16 major states i.e. Andhra Pradesh, Assam, Bihar, Gujarat, Rajasthan, Haryana, Punjab, Himachal Pradesh, Tamil Nadu, KERALA, Uttar Pradesh, West Bengal, Madhya Pradesh, Maharashtra, Karnataka, Odisha. The states which are blank have not been considered in this study because SRS don't give data for these states.



Show the % undercount of (ages 5+) deaths in male and female population in India and major states in 1991-2000



**Fig.3 Show the % undercount of (ages 5+) births in population in India and major states in 1991-2000 and 2001-10**



<sup>2</sup>In this study we have taken only 16 major states i.e. Andhra Pradesh, Assam, Bihar, Gujarat, Rajasthan, Haryana, Punjab, Himachal Pradesh, Tamil Nadu, KERALA, Uttar Pradesh, West Bengal, Madhya Pradesh, Maharashtra, Karnataka, Odisha. The states which are blank have not been considered in this study because SRS don't give data on these states.