

Blindness estimations, projections and service delivery

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This paper has the following sections:

1. Estimated prevalence and incidence
2. Reported cases
3. Projections
4. Causes, interventions and standard treatment protocols
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The scope of estimations applied in items 1–3 contains all States and Union Territories listed as per the Census of India 2001. The causes, interventions and treatment protocols have been limited to those diseases which have been prioritized for the World Health Organization—Vision 2020 Programme for India.

Estimated prevalence and incidence

The prevalence and incidence of blindness refer to the year 2004. The prevalence has been estimated for all the States and Union Territories listed in the Census of India Report, 2001. Incidence has been estimated as the number of new cases in the year 2004 for all the States. State-wise prevalence and incidence data per 1000 population—age-wise, sex-wise and consolidated—are presented in Table 1. The methods of estimation are detailed below.

Methods of estimation

State-wise population projections

The Census of India for the years 1991 and 2001 along with projected population as per the Registrar General¹ were used in the estimation and projection of prevalence and incidence in this paper.

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Estimates of prevalence

The data used in this paper pertain to the 37 districts covered by various surveys,^{2–4} i.e. the 1999–2001 survey conducted by the National Programme for Control of Blindness (NPCB) in 15 States (15 districts), the rapid assessment in the north-eastern States of India, Goa, Haryana, Delhi, Jammu and Kashmir, Jharkand and Uttaranchal, Andhra Pradesh (2 districts), Madhya Pradesh (2 districts), Maharashtra (2 districts), Orissa (2 districts), Rajasthan (2 districts), Tamil Nadu (2 districts) and Uttar Pradesh (2 districts). The prevalence of blindness (visual acuity <6/60) in the general population was estimated for each State (Table A1.1 of Appendix 1). For the Union Territories where prevalence estimates were not available, estimates from the nearest State were used (e.g. Tamil Nadu rates for Pondicherry). For the Andaman and Nicobar Islands, the overall Indian prevalence rate was applied.

Using the estimated population who are blind, the age–sex-wise population was further estimated. As projected population-based data on age- and sex-wise distribution of blindness in the general population were not adequate, the results of the National Survey done in 1986–89 along with some population-based studies conducted in Andhra Pradesh in 2000–2001^{5–8} were used to estimate the same for other States. The age–sex distribution of blindness estimated from the population-based studies is given in Table A1.2 of Appendix 1. This is the best available estimate for India. It was assumed that the age–sex distribution would remain the same over the years and hence was used for the projected population of 2005, 2010 and 2015.

However, the prevalence rate of blindness as per the NPCB surveys in 1986–89 and 2001–02 showed a reduction of 26.2%. This reduction has occurred over a period of 13 years. Based on this, it was assumed that the prevalence rate of blindness would reduce by 2% every year. This assumption was also applied while estimating the prevalence of blindness for the projected years (Table A1.1 of Appendix 1).

Table 1. Estimated prevalence and incidence of blindness (2004)

State/Union Territory	Estimated prevalence per 1000 population (by age)			Estimated prevalence per 1000 population (by sex)		Estimated number of new cases per year (incidence by age)			Estimated number of new cases per year (incidence by sex)		Estimated prevalence per 1000 population	Estimated number of new cases per year
	0–14	15–49	50+	Male	Female	0–14	15–49	50+	Male	Female	All	All
Andaman and Nicobar Islands	0.1	0.5	117.9	9.1	11.8	3	23	832	403	455	10.3	858
Andhra Pradesh	0.1	0.7	89.2	12.4	14.3	453	4,075	146,404	70,938	79,994	13.3	150,932
Arunachal Pradesh	0.2	1.2	209.1	19.3	23.8	8	72	2,574	1,247	1,407	21.4	2,654
Assam	0.3	1.4	236.9	26.1	31.5	165	1,486	53,399	25,874	29,177	28.7	55,050
Bihar	0.1	0.4	55.6	6.6	8.1	438	3,946	141,750	68,683	77,451	7.3	146,134
Chandigarh	0.1	0.4	94.1	8.2	11.0	6	53	1,921	931	1,049	9.5	1,980
Chhattisgarh	0.1	0.8	111.2	13.7	16.6	175	1,571	56,450	27,352	30,844	15.1	58,196
Dadra and Nagar Haveli	0.1	0.5	89.6	8.5	9.4	1	11	411	199	225	8.9	424
Daman and Diu	0.1	0.5	80.8	9.6	10.5	1	8	301	146	164	10.1	310
Delhi	0.1	0.5	102.5	9.5	11.9	96	866	31,129	15,083	17,009	10.6	32,092
Goa	0.1	0.7	98.7	13.6	15.0	11	95	3,430	1,662	1,874	14.3	3,536
Gujarat	0.1	0.5	72.1	9.2	11.0	306	2,757	99,058	47,997	54,125	10.1	102,122
Haryana	0.2	0.9	133.8	15.8	20.0	126	1,134	40,740	19,740	22,260	17.8	42,000
Himachal Pradesh	0.1	0.4	43.7	6.3	6.8	44	393	14,104	6,834	7,706	6.6	14,540
Jammu and Kashmir	0.1	0.9	130.4	14.2	16.1	64	579	20,789	10,073	11,359	15.1	21,432
Jharkhand	0.1	0.7	100.6	11.9	14.7	206	1,857	66,705	32,321	36,447	13.3	68,768
Karnataka	0.2	0.8	107.9	15.5	18.0	328	2,953	106,104	51,411	57,975	16.7	109,386
Kerala	0.1	0.2	27.8	5.0	5.5	200	1,802	64,728	31,363	35,367	5.3	66,730
Lakshadweep	0.04	0.3	43.2	5.0	5.5	0	4	153	74	84	5.3	158
Madhya Pradesh	0.1	0.6	80.1	9.9	12.0	339	3,050	109,577	53,094	59,872	10.9	112,966
Maharashtra	0.1	0.4	57.0	8.2	9.8	569	5,121	183,993	89,151	100,533	8.9	189,684
Manipur	0.1	0.7	105.1	12.3	13.7	17	151	5,428	2,630	2,966	13.0	5,5596
Meghalaya	0.05	0.4	73.4	6.6	7.3	16	146	5,248	2,543	2,867	7.0	5,410
Mizoram	0.1	0.4	70.3	6.8	7.8	6	57	2,058	997	1,1125	7.3	2,122
Nagaland	0.1	0.5	91.1	9.0	10.8	11	102	3,655	1,771	1,997	9.9	3,768
Orissa	0.1	0.6	84.6	12.2	14.2	223	2,003	71,957	34,866	39,316	13.2	74,182
Pondicherry	0.1	0.4	51.3	7.0	7.6	7	67	2,398	1,162	1,310	7.3	2,472
Punjab	0.1	0.5	63.5	8.5	10.6	147	1,325	47,600	23,064	26,008	9.5	49,072
Rajasthan	0.1	0.8	109.5	13.1	16.1	345	3,103	111,480	54,016	6,912	14.6	111,928
Sikkim	0.05	0.3	60.2	5.6	6.7	4	34	1,207	558	659	6.1	1,244
Tamil Nadu	0.1	0.3	38.3	6.8	7.9	383	3,443	123,689	59,932	67,582	7.3	127,514
Tripura	0.1	0.4	56.6	6.8	7.7	25	227	8,152	3,950	4,454	7.2	8,404
Uttar Pradesh	0.1	0.5	66.3	7.9	9.9	1,118	10,060	361,416	175,119	197,475	8.8	372,594
Uttaranchal	0.04	0.3	39.5	4.7	5.9	56	503	18,069	8,755	9,873	5.3	18,628
West Bengal	0.1	0.5	76.2	10.1	12.3	498	4,486	161,177	78,096	88,066	11.2	166,162
All India	0.1	0.6	77.3	10.2	12.2	6,396	57,565	2,068,087	1,002,063	1,129,985	11.2	2,132,048

Estimates of incidence

Incidence rates for blindness are not available and there is only one published study from Raipur district that reported the incidence of age-specific cataract in 1990.⁹ Limburg *et al.* have used these incidence figures, which were adjusted by means of a factor making the age-specific prevalence rates for Raipur at par with those for India in 1996.¹⁰ The important assumption made was that the incidence of cataract blindness would remain constant for the next 16 years. For this report, we used the WHO estimates of incidence of cataract (not cataract blindness) of 2 per 1000 per year (i.e. 0.2%) as the basis for calculating blindness. If it is presumed that half of these persons will have bilateral cataract leading to blindness, the incidence of cataract blindness would be 0.1%. In the absence of a larger cohort study, the best estimate used was 0.2% per year, as cataract accounts for nearly 50% of the cases of blindness.⁷ The major assumptions used in this estimation are as follows:

1. The incidence of blindness would remain the same over the years, similar to what Limburg *et al.*¹⁰ have used in their estimations.
2. The age- and sex-wise breakdown for the incidence of blindness was calculated using similar estimates as for prevalence. The assumption used for the projected population is that the age- and sex-wise proportion of blindness would remain the same over the years.

Reported cases

The reported cases include only one major blindness-related disease (cataract) for the period April 2003 to March 2004. The reported cases per 1000 population have also been estimated using the same data. Due to non-availability of data, the estimations could not be presented age-wise but have been presented sex-wise based on the NPCB survey results. The methods of estimation are detailed below.

Methods of estimation

The lacuna in data on diseases other than blindness due to cataract is the major reason for the non-inclusion of other diseases. Cataract was considered as the major problem as per the national surveys of 1986–89 and 1999–2001^{1,5} and the priority of service delivery was towards this. This has led to a situation where only cataract surgery rates (CSRs) per million population are monitored.

For this estimation, the CSRs (Appendix 2) for every State for the period April 2003 to March 2004 (*Source*: NPCB) were used as a basis to estimate the reported new cases the preceeding year for cataract. The secondary data available include only those cases that were operated. There could have been many patients who were advised cataract surgery and refrained from undergoing surgery,

due to various barriers such as fear, cost, lack of attenders, superstitious beliefs, etc.¹¹ Hence, based on previous experience it was assumed that around 60% had accepted and undergone cataract surgery. This would mean that the reported cases of cataract would also constitute those who did not accept surgery even after advice. Based on this assumption, the reported cases were calculated using the formulae

$$\text{Reported cases (cataract)} = \text{Total cataract surgeries performed} + \text{those who did not accept surgery (surgery acceptance rate: 60\%)}$$

$$\text{Reported cases (cataract) per 1000 population} = \text{Number of reported cases/population} \times 1000$$

The reported cases have been presented per 1000 population in Table 2. However, one of the major limitations is the estimation of the reported cases in terms of age break-up because the CSR refers to the number of cataract surgeries done per million population and the available data are for surgeries performed on people above 50 years of age. This constraints the presentation of the data age-wise. Based on the gender-wise break-up of cataract surgeries as reported in the NPCB 2001–02 for various States, the reported cases have been presented on the basis of gender break-up.

Since there are no data available for other diseases, estimations for these were not made. However, there were some reports available from the sentinel centres in different States but as these reports are hospital based they cannot be taken as the actual reported cases. Moreover, the proportion of eye diseases varies from centre to centre. For example, the proportion of refractive errors among patients attending the sentinel centre varies from 11.80% in Maharashtra (Nagpur) to 53.78% in Gujarat (Surat).

Projections

The estimations of prevalence and incidence calculated for the year 2000 and for the project years 2005, 2010 and 2015 have been combined and presented as 'cases'. Though most eye-related diseases do not cause 'deaths' directly, the number of deaths due to blindness has not been estimated. The estimated 'cases' have been presented in Tables 3a–3f. The methods of estimation are detailed below.

Methods of estimation

There is evidence that the blind in India and Nepal have higher mortality rates than the non-blind. According to the Nepal Blindness Survey, 5-year survival rates of less than 50% have been reported in some areas.¹² A 1992 longitudinal study of a cohort of 1020 people aged 40–64 years in central India with cataract reported a mortality rate that was double that of the normal population.¹³ However, there are no reports on blindness as a cause of death. The probable chance of death due to blindness would be due to accidents.

Table 2. Reported cases of cataract

State/Union Territory	Reported cases per 1000 population		Reported new cases last year (April 2003–March 2004)		Reported cases per 1000 population	Reported new cases last year (April 2003–March 2004)
	Male	Female	Male	Female		
Andaman and Nicobar Islands	2.32	2.66	531	624	2.69	1,155
Andhra Pradesh	9.27	9.52	354,473	384,012	9.79	738,485
Arunachal Pradesh	0.76	0.83	524	616	0.86	1,140
Assam	1.51	1.62	21,525	16,913	1.40	38,438
Bihar	2.03	2.23	77,624	68,836	2.00	146,460
Chandigarh	8.45	10.01	4,537	6,014	10.66	10,550
Chhattisgarh	3.41	3.66	51,357	55,637	3.68	106,993
Dadra and Nagar Haveli	NA	NA	NA	NA	NA	NA
Daman and Diu	3.59	3.45	273	347	4.00	620
Delhi	7.74	8.61	65,392	68,061	8.32	133,453
Goa	5.24	5.12	4,581	4,581	5.18	9,162
Gujarat	12.55	13.28	329,438	419,285	14.66	748,723
Haryana	6.59	7.41	73,260	76,250	7.12	149,510
Himachal Pradesh	4.29	4.12	15,286	15,286	4.21	30,572
Jammu and Kashmir	1.48	1.50	7,983	9,371	1.62	17,353
Jharkhand	1.38	1.51	24,781	21,976	1.36	46,757
Karnataka	6.16	6.37	171,348	268,007	8.03	439,355
Kerala	3.56	3.45	58,444	74,383	3.98	132,827
Lakshadweep	NA	NA	NA	NA	NA	NA
Madhya Pradesh	4.67	5.01	136,424	253,359	6.90	389,783
Maharashtra	7.09	7.53	346,374	519,561	9.13	865,935
Manipur	0.37	0.37	516	406	0.33	922
Meghalaya	0.80	0.79	1,073	990	0.76	2,063
Mizoram	1.29	1.31	690	637	1.25	1,327
Nagaland	0.39	0.42	379	336	0.38	715
Orissa	4.25	4.37	79,897	57,856	3.71	137,753
Pondicherry	11.53	11.06	6,978	9,637	13.44	16,615
Punjab	7.41	8.21	95,586	126,707	9.06	222,293
Rajasthan	5.80	6.33	173,902	204,146	6.58	378,048
Sikkim	0.83	0.88	266	156	0.68	422
Tamil Nadu	9.84	10.04	316,855	437,562	11.83	754,417
Tripura	2.96	2.95	6,208	7,288	3.21	13,497
Uttar Pradesh	4.72	5.27	463,636	482,560	5.08	946,197
Uttaranchal	6.17	6.89	30,302	31,539	6.64	61,842
West Bengal	4.83	5.21	208,246	208,246	5.01	416,492
All India	5.68	7.44	3,128,690	3,831,183	6.53	6,959,873

Projection of blindness and cataract surgeries

As cataract is the major cause of blindness, it was assumed that an increase in cataract surgery would reduce the blindness problem as well. Based on the previous years' cataract surgeries performed it was estimated that there was an increase of almost 50% between 1995 and 2000. An increase of 50% is expected every five years in the future. As the projected cases have been estimated till 2015, the projected cataract surgeries were also estimated and both the data have been presented in Fig. 1. The figure is expected to show the huge gap between the need and what is delivered for policy decisions.

Causes, interventions and standard treatment protocols

At the global level, from among the many causes of avoidable blindness, five conditions have been identified as immediate priorities within the framework of Vision 2020. The choice of these conditions is based on the burden of blindness they represent and the feasibility and affordability of interventions to prevent and treat them. These are: cataract, trachoma, onchocerciasis, childhood blindness and refractive errors, and low vision.

In India, during the 'Launch Workshop on Vision 2020: Right to Sight' at Goa between 10 and 13 October 2001, it

Table 3a. Projections for blindness (all combined)

State/Union Territory	Cases			
	2000	2005	2010	2015
Andaman and Nicobar Islands	5,090	5,333	5,367	5,049
Andhra Pradesh	1,243,982	1,136,820	1,029,658	922,496
Arunachal Pradesh	30,105	31,316	31,272	29,079
Assam	867,515	840,357	813,460	768,301
Bihar	676,620	681,538	680,563	673,262
Chandigarh	10,924	11,484	11,608	10,969
Chhattisgarh	499,513	497,753	490,827	477,732
Dadra and Nagar Haveli	2,233	2,331	2,350	2,219
Daman and Diu	1,808	1,883	1,907	1,786
Delhi	188,877	205,873	215,541	210,646
Goa	27,936	28,995	28,885	26,859
Gujarat	623,204	613,365	596,352	569,208
Haryana	422,049	414,186	404,799	387,141
Himachal Pradesh	61,339	62,566	61,316	56,179
Jammu and Kashmir	183,188	183,419	175,750	156,566
Jharkhand	523,929	523,301	517,322	505,523
Karnataka	1,050,047	1,018,527	978,716	920,370
Kerala	248,828	241,323	233,291	220,765
Lakshadweep	548	579	593	567
Madhya Pradesh	727,992	728,311	721,526	706,296
Maharashtra	1,065,169	1,031,427	994,664	942,512
Manipur	40,495	42,192	42,225	39,448
Meghalaya	23,240	24,451	24,745	23,442
Mizoram	9,478	9,993	10,142	9,627
Nagaland	21,404	22,585	22,886	21,682
Orissa	583,801	557,286	528,200	491,487
Pondicherry	11,061	11,644	11,788	11,165
Punjab	289,589	280,956	271,990	257,261
Rajasthan	953,886	951,730	944,279	922,806
Sikkim	4,824	5,083	5,175	4,923
Tamil Nadu	615,062	590,476	563,321	528,223
Tripura	37,268	39,179	39,625	37,486
Uttar Pradesh	1,873,559	1,924,211	1,955,987	1,977,929
Uttaranchal	65,629	68,023	69,902	71,612
West Bengal	1,116,987	1,090,351	1,056,068	1,004,774
All India	14,107,178	13,878,846	13,542,100	12,995,390

Table 3c. Projections for blindness (females)

State/Union Territory	Cases			
	2000	2005	2010	2015
Andaman and Nicobar Islands	2,698	2,826	2,844	2,676
Andhra Pradesh	659,310	602,515	545,719	488,923
Arunachal Pradesh	15,956	16,598	16,574	15,412
Assam	459,783	445,389	431,134	407,200
Bihar	358,608	361,215	360,698	356,829
Chandigarh	5,790	6,087	6,152	5,813
Chhattisgarh	264,742	263,809	260,138	253,198
Dadra and Nagar Haveli	1,183	1,235	1,245	1,176
Daman and Diu	958	998	1,011	946
Delhi	100,105	109,113	114,237	111,643
Goa	14,806	15,367	15,309	14,235
Gujarat	330,298	325,084	316,066	301,680
Haryana	223,686	219,518	214,543	205,185
Himachal Pradesh	32,509	33,160	32,498	29,775
Jammu and Kashmir	97,090	97,212	93,148	82,980
Jharkhand	277,682	277,350	274,181	267,927
Karnataka	556,525	539,819	518,719	487,796
Kerala	131,879	127,901	123,644	117,006

Table 3b. Projections for blindness (males)

State/Union Territory	Cases			
	2000	2005	2010	2015
Andaman and Nicobar Islands	2,392	2,506	2,522	2,373
Andhra Pradesh	584,671	534,305	483,939	433,573
Arunachal Pradesh	14,149	14,719	14,698	13,667
Assam	407,732	394,968	382,326	361,102
Bihar	318,011	320,323	319,865	316,433
Chandigarh	5,134	5,397	5,456	5,155
Chhattisgarh	234,771	233,944	230,689	224,534
Dadra and Nagar Haveli	1,049	1,095	1,104	1,043
Daman and Diu	850	885	896	839
Delhi	88,772	96,760	101,304	99,004
Goa	13,130	13,628	13,576	12,624
Gujarat	292,906	288,282	280,285	267,528
Haryana	198,363	194,667	190,255	181,956
Himachal Pradesh	28,829	29,406	28,819	26,404
Jammu and Kashmir	86,099	86,207	82,603	73,586
Jharkhand	246,247	245,952	243,142	237,596
Karnataka	493,522	478,707	459,996	432,574
Kerala	116,949	113,422	109,647	103,760
Lakshadweep	257	272	279	266
Madhya Pradesh	342,156	342,306	339,117	331,959
Maharashtra	500,630	484,771	467,492	442,981
Manipur	19,033	19,830	19,846	18,541
Meghalaya	10,923	11,492	11,630	11,018
Mizoram	4,455	4,697	4,767	4,525
Nagaland	10,060	10,615	10,756	10,191
Orissa	274,386	261,924	248,254	230,999
Pondicherry	5,199	5,473	5,540	5,248
Punjab	136,107	132,049	127,835	120,913
Rajasthan	448,326	447,313	443,811	433,719
Sikkim	2,267	2,389	2,432	2,314
Tamil Nadu	289,079	277,524	264,761	248,265
Tripura	17,516	18,414	18,624	17,618
Uttar Pradesh	880,573	904,379	919,314	929,627
Uttaranchal	30,846	31,971	32,854	33,658
West Bengal	524,984	512,465	496,352	472,244
All India	6,630,374	6,523,058	6,364,787	6,107,833

Table 3c. (cont.) Projections for blindness (females)

State/Union Territory	Cases			
	2000	2005	2010	2015
Lakshadweep	290	307	314	301
Madhya Pradesh	385,836	386,005	382,409	374,337
Maharashtra	564,540	546,656	527,172	499,531
Manipur	21,463	22,362	22,379	20,908
Meghalaya	12,317	12,959	13,115	12,424
Mizoram	5,023	5,296	5,375	5,102
Nagaland	11,344	11,970	12,129	11,492
Orissa	309,414	295,361	279,946	260,488
Pondicherry	5,862	6,172	6,248	5,917
Punjab	153,482	148,907	144,155	136,348
Rajasthan	505,559	504,417	500,468	489,087
Sikkim	2,557	2,694	2,743	2,609
Tamil Nadu	325,983	312,952	298,560	279,958
Tripura	19,752	20,765	21,001	19,868
Uttar Pradesh	992,986	1,019,832	1,036,673	1,048,303
Uttaranchal	34,783	36,052	37,048	37,954
West Bengal	592,003	577,886	559,716	532,530
All India	7,476,804	7,355,789	7,177,313	6,887,557

Table 3d. Projections for blindness by age (0–14 years)

State/Union Territory	Cases			
	2000	2005	2010	2015
Andaman and Nicobar Islands	15	16	16	15
Andhra Pradesh	3,732	3,410	3,089	2,767
Arunachal Pradesh	90	94	94	87
Assam	2,603	2,521	2,440	2,305
Bihar	2,030	2,045	2,042	2,020
Chandigarh	33	34	35	33
Chhattisgarh	1,499	1,493	1,472	1,433
Dadra and Nagar Haveli	7	7	7	7
Daman and Diu	5	6	6	5
Delhi	567	618	647	632
Goa	84	87	87	81
Gujarat	1,870	1,840	1,789	1,708
Haryana	1,266	1,243	1,214	1,161
Himachal Pradesh	184	188	184	169
Jammu and Kashmir	550	550	527	470
Jharkhand	1,572	1,570	1,552	1,517
Karnataka	3,150	3,056	2,936	2,761
Kerala	746	724	700	662
Lakshadweep	2	2	2	2
Madhya Pradesh	2,184	2,185	2,165	2,119
Maharashtra	3,196	3,094	2,984	2,828
Manipur	121	127	127	118
Meghalaya	70	73	74	70
Mizoram	28	30	30	29
Nagaland	64	68	69	65
Orissa	1,751	1,672	1,585	1,474
Pondicherry	33	35	35	33
Punjab	869	843	816	772
Rajasthan	2,862	2,855	2,833	2,768
Sikkim	14	15	16	15
Tamil Nadu	1,845	1,771	1,690	1,585
Tripura	112	118	119	112
Uttar Pradesh	5,621	5,773	5,868	5,934
Uttaranchal	197	204	210	215
West Bengal	3,351	3,271	3,168	3,014
All India	42,322	41,637	40,626	38,986

Table 3e. Projections for blindness by age (15–49 years)

State/Union Territory	Cases			
	2000	2005	2010	2015
Andaman and Nicobar Islands	137	144	145	136
Andhra Pradesh	33,588	30,694	27,801	24,907
Arunachal Pradesh	813	846	844	785
Assam	23,423	22,690	21,963	20,744
Bihar	18,269	18,402	18,375	18,178
Chandigarh	295	310	313	296
Chhattisgarh	13,487	13,439	13,252	12,899
Dadra and Nagar Haveli	60	63	63	60
Daman and Diu	49	51	51	48
Delhi	5,100	5,559	5,820	5,687
Goa	754	783	780	725
Gujarat	16,827	16,561	16,101	15,369
Haryana	11,395	11,183	10,930	10,453
Himachal Pradesh	1,656	1,689	1,656	1,517
Jammu and Kashmir	4,946	4,952	4,745	4,227
Jharkhand	14,146	14,129	13,968	13,649
Karnataka	28,351	27,500	26,425	24,850
Kerala	6,718	6,516	6,299	5,961
Lakshadweep	15	16	16	15
Madhya Pradesh	19,656	19,664	19,481	19,070
Maharashtra	28,760	27,849	26,856	25,448
Manipur	1,093	1,139	1,140	1,065
Meghalaya	627	660	668	633
Mizoram	256	270	274	260
Nagaland	578	610	618	585
Orissa	15,763	15,047	14,261	13,270
Pondicherry	299	314	318	301
Punjab	7,819	7,586	7,344	6,946
Rajasthan	25,755	25,697	25,496	24,916
Sikkim	130	137	140	133
Tamil Nadu	16,607	15,943	15,210	14,262
Tripura	1,006	1,058	1,070	1,012
Uttar Pradesh	50,586	51,954	52,812	53,404
Uttaranchal	1,772	1,837	1,887	1,934
West Bengal	30,159	29,439	28,514	27,129
All India	380,894	374,729	365,637	350,876

was recommended that diseases that are at the global level should be concentrated on and a few more diseases were also included as the task force felt that these were important problems as far as India is concerned. Thus the diseases that fall under the priority of the India Vision 2020 are:

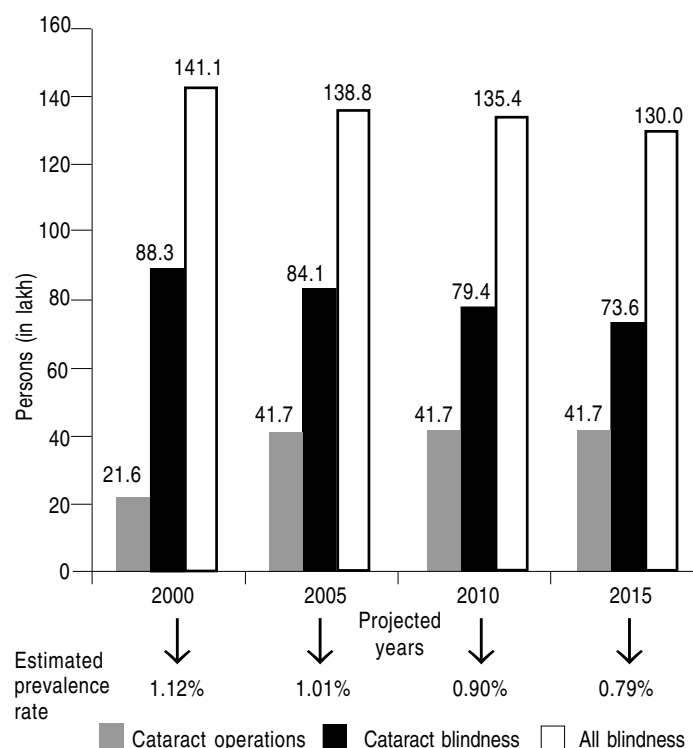
1. Cataract
2. Childhood blindness
3. Refractive errors and low vision

4. Corneal blindness
5. Glaucoma
6. Diabetic retinopathy
7. Trachoma (focal)

In this paper, the causes (Tables 4a–4f), interventions (Tables 5a–5f) and standard treatment protocols (Tables 6a–6f) pertain to diseases that are of priority in the NPCB Vision 2020 National Action Plan.

Table 3f. Projections for blindness by age (50 years and above)

State/Union Territory	Cases			
	2000	2005	2010	2015
Andaman and Nicobar Islands	4,937	5,173	5,206	4,898
Andhra Pradesh	1,206,662	1,102,715	998,768	894,821
Arunachal Pradesh	29,202	30,377	30,334	28,206
Assam	841,490	815,147	789,056	745,252
Bihar	656,321	661,092	660,146	653,064
Chandigarh	10,596	11,139	11,260	10,640
Chhattisgarh	484,527	482,820	476,102	463,400
Dadra and Nagar Haveli	2,166	2,261	2,279	2,152
Daman and Diu	1,754	1,827	1,850	1,732
Delhi	183,211	199,697	209,075	204,327
Goa	27,098	28,125	28,018	26,053
Gujarat	604,508	594,964	578,461	552,131
Haryana	409,388	401,760	392,655	375,527
Himachal Pradesh	59,498	60,689	59,477	54,494
Jammu and Kashmir	177,693	177,916	170,478	151,869
Jharkhand	508,211	507,602	501,803	490,358
Karnataka	1,018,546	987,971	949,354	892,759
Kerala	241,363	234,083	226,292	214,142
Lakshadweep	531	562	575	550
Madhya Pradesh	706,152	706,461	699,880	685,107
Maharashtra	1,033,214	1,000,484	964,824	914,237
Manipur	39,281	40,926	40,958	38,265
Meghalaya	22,543	23,717	24,002	22,739
Mizoram	9,194	9,693	9,838	9,338
Nagaland	20,762	21,908	22,199	21,032
Orissa	566,287	540,567	512,354	476,742
Pondicherry	10,729	11,295	11,434	10,830
Punjab	280,901	272,528	263,830	249,543
Rajasthan	925,269	923,178	915,951	895,121
Sikkim	4,679	4,931	5,020	4,775
Tamil Nadu	596,610	572,761	546,422	512,376
Tripura	36,150	38,004	38,436	36,362
Uttar Pradesh	1,817,353	1,866,484	1,897,308	1,918,591
Uttaranchal	63,660	65,982	67,805	69,464
West Bengal	1,083,477	1,057,641	1,024,386	974,631
All India	13,683,962	13,462,481	13,135,837	12,605,528

**Fig. 1** Projection of blindness cases and cataract surgeries**Table 4a.** Causes of cataract

	Direct (normally clinical)	Indirect (diet, exercise, alcohol)	Distant (sociopolitical, economic, empowerment, gender, literacy, etc.)
Main causes	Senile, inflammation (intraocular), traumatic, metabolic, congenital		
Interaction with other causes	Corticosteroids (systemic and topical), Metallic foreign body, inflammation, intrauterine infections, rubella during pregnancy	Sun exposure, poor nutrition, acute diarrhoea in early life, smoking, alcohol	Poor socioeconomic status, feminine gender, low literacy, older age

Sources: 1. *Quality assurance in cataract surgery, Clinical practice module*. New Delhi: NPCB, Ministry of Health and Family Welfare, Government of India; 2001.
2. Ughade SN, Khanolkar VA. Risk factors for cataract: A case-control study. *Indian J Ophthalmol* 1998;**46**:221-7.

Table 4b. Causes of refractive errors and low vision

	Direct (normally clinical)	Indirect (diet, exercise, alcohol)	Distant (sociopolitical, economic, empowerment, gender, literacy, etc.)
Main causes	Hypermetropia, myopia, astigmatism, presbyopia	Axial length of eyeball, curvature of cornea, refractive index of lens, trauma, surgery	Non-utilization of spectacles associated with lower level of education, living in rural areas, cost
Interaction with other causes	Diabetes, cataract		

Sources: 1. *Quality assurance in refraction, Clinical practice module*. New Delhi: NPCB, Ministry of Health and Family Welfare, Government of India; 2001.
2. Dandona R, Dandona L, Kovai V, Giridhar P, *et al*. Population-based study of spectacles use in southern India. *Indian J Ophthalmol* 2002;50:145–55.

Table 4c. Causes of corneal blindness

	Direct (normally clinical)	Indirect (diet, exercise, alcohol)	Distant (sociopolitical, economic, empowerment, gender, literacy, etc.)
Main causes	Trachoma (infection by <i>Chlamydia trachomatis</i>)	Poor hygiene	Poverty, poor sanitation, feminine gender, rural areas, illiteracy, low socioeconomic status
	Ocular trauma and corneal ulceration	Traditional medication, work environment, war and social unrest	
	Xerophthalmia	Measles infection, malnourishment, vitamin A deficiency, traditional eye medication	
	Ophthalmia neonatorum	Herpes simplex virus, trachoma, gonococcal infection, traditional eye medication	

Source: Whitcher JP, Srinivasan M, Upadhyay MP. Corneal blindness: A global perspective. *Bull World Health Organ* 2001;79:214–21.

Table 4d. Causes of glaucoma

	Direct (normally clinical)	Indirect (diet, exercise, alcohol)	Distant (sociopolitical, economic, empowerment, gender, literacy, etc.)
Main causes	Primary open-angle (intraocular pressure change, susceptibility of optic nerve head), primary angle-closure (intraocular pressure change, shallow anterior chamber angle)	Myopia, hyperopia, cataract, diabetes, thyroid dysfunction	Age, race, family history

Source: *Quality assurance in management of glaucoma (primary open-angle and angle-closure), Clinical practice module*. New Delhi: NPCB, Ministry of Health and Family Welfare, Government of India; 2001

Table 4e. Causes of diabetic retinopathy

	Direct (normally clinical)	Indirect (diet, exercise, alcohol)	Distant (sociopolitical, economic, empowerment, gender, literacy, etc.)
Main causes	Duration of diabetes, lack of control of blood sugar	Hypertension, hyperlipidaemia, renal and cardiac problems, smoking and alcohol, family history	Age, ethnicity, increased life expectancy, food habits, urbanization, lifestyle changes, improved socioeconomic conditions

Source: *Manual on diabetic retinopathy*. New Delhi: RP Centre, NPCB, Ministry of Health and Family Welfare, Government of India; 2001

Table 4f. Causes of childhood blindness

	Direct (normally clinical)	Indirect (diet, exercise, alcohol)	Distant (sociopolitical, economic, empowerment, gender, literacy, etc.)
Main causes	Corneal scar, cataract, glaucoma, optic atrophy	Premature birth, measles, congenital rubella syndrome, vitamin A deficiency, ophthalmia neonatorum	Traditional eye medication

Source: Gilbert C, Foster A. Childhood blindness in the context of Vision 2020—the right to sight. *Bull World Health Organ* 2001;79:227–32.

Table 5a. Interventions for cataract

Disease/condition	Medical intervention	Non-medical intervention (exercise, nutrition, others)
Senile	IOL microsurgery	Nil
Inflammation	Corticosteroids (oral and topical) and cycloplegics (topical), IOL microsurgery	Nil
Traumatic	IOL microsurgery	Protective glasses for at-risk workers
Metabolic	IOL microsurgery	Good metabolic control
Congenital	Rubella vaccination in mothers, IOL microsurgery, spectacles and review at appropriate intervals to prevent amblyopia	Nil

Source: *Quality assurance in cataract surgery, Clinical practice module*. New Delhi: NPCB, Ministry of Health and Family Welfare, Government of India; 2001.

Table 5b. Interventions for refractive errors and low vision

Disease/condition	Medical intervention	Non-medical intervention (exercise, nutrition, others)
Hypermetropia		
Myopia	Spectacle correction, contact lens, refractive surgery,	
Astigmatism	low-vision aids for low-vision patients, ocular physiotherapy	Nil
Presbyopia		

Sources: 1. *Quality assurance in refraction, Clinical practice module*. New Delhi: NPCB, Ministry of Health and Family Welfare, Government of India; 2001.
2. Dandona R, Dandona L, Kovai V, Giridhar P, *et al*. Population-based study of spectacles use in southern India. *Indian J Ophthalmol* 2002;**50**:145–55.

Table 5c. Interventions for corneal blindness

Disease/condition	Medical intervention	Non-medical intervention (exercise, nutrition, others)
Trachoma	Azithromycin 20 mg (single dose), surgery for trichiasis	Facial cleanliness, improvement in environmental conditions
Ocular trauma and corneal ulceration	Antibiotics, corneal wound closure, keratoplasty or corneal transplant	Protective eye wear
Xerophthalmia	Vitamin A supplementation	Dietary fortification, nutritional education
Ophthalmia neonatorum	Prevention of sexually transmitted disease, antenatal screening of pregnant women, ocular prophylaxis at birth	Nil

Source: Whitcher JP, Srinivasan M, Upadhyay MP. Corneal blindness—a global perspective. *Bull World Health Organ* 2001;**79**:214–21.

Table 5d. Interventions for glaucoma

Disease/condition	Medical intervention	Non-medical intervention (exercise, nutrition, others)
Primary open-angle	Medical therapy, laser trabeculoplasty, trabeculectomy	Nil
Primary angle-closure	Medical therapy, laser iridotomy, trabeculectomy	Nil

Source: *Quality assurance in management of glaucoma (primary open-angle and angle-closure), Clinical practice module*. New Delhi: NPCB, Ministry of Health and Family Welfare, Government of India; 2001.

Table 5e. Interventions for diabetic retinopathy

Disease/condition	Medical intervention	Non-medical intervention (exercise, nutrition, others)
NPDR	Early detection by periodic check-up, laser treatment,	Control of diabetes mellitus, regular exercise,
PDR (laser)	vitrectomy surgery and low-vision aids	proper food intake
PDR (surgery)		

NPDR: non-proliferative diabetic retinopathy; PDR: proliferative diabetic retinopathy

Source: *Manual on diabetic retinopathy*. New Delhi: RP Centre, NPCB, Ministry of Health and Family Welfare, Government of India; 2001.

Table 5f. Interventions for childhood blindness

Disease/condition	Medical intervention	Non-medical intervention (exercise, nutrition, others)
Corneal scar Cataract Glaucoma Optic atrophy	Refer to the respective interventions table	School vision screening, ROP screening, health and nutritional education to parents, fortification of food, vitamin A supplementation, promotion of primary eye care

Source: Gilbert C, Foster A. Childhood blindness in the context of Vision 2020—the right to sight. *Bull World Health Organ* 2001;**79**:227–32.

Table 6a. Standard treatment protocols for cataract

Condition	Personnel (units of time and type)	Tests (by type)	Drugs (dosage, type and time)	Inpatient stay
Senile Inflammation Traumatic Metabolic Congenital	Ophthalmologist trained in microsurgery, paramedical staff (time: 1/2 hour) + Anaesthetist	Slit-lamp examination, intraocular tension, nasolacrimal duct examination, BP, urine sugar, keratometry, A-scan	Preoperative: Eye drops (antibiotic and cycloplegic), xylocaine injection Postoperative: Eye drops (antibiotic, steroids and cycloplegic), paracetamol tablets	Routine: 2 days

Source: *Quality assurance in cataract surgery, Clinical practice module*. New Delhi: NPCB, Ministry of Health and Family Welfare, Government of India; 2001.

Table 6b. Standard treatment protocols for refractive errors and low vision

Condition	Personnel (units of time and type)	Tests (by type)	Drugs (dosage, type and time)	Inpatient stay
Hypermetropia Myopia Astigmatism Presbyopia	Ophthalmologist trained in low-vision aids, refractionist or optometrists, paramedical staff (time: 1/2 hour)	Visual acuity measurement, pinhole visual acuity, verification of existing glasses, retinoscopy, subjective refraction, interpupillary distance measurement	Eye drops (cycloplegic, atropine 1%, homatropine 2%, cyclopentolate 1%, tropicamide 1%)	Nil

Source: 1. *Quality assurance in refraction, Clinical practice module*. New Delhi: NPCB, Ministry of Health and Family Welfare, Government of India; 2001.
2. Dandona R, Dandona L, Kovai V, Giridhar P, et al. Population-based study of spectacles use in southern India. *Indian J Ophthalmol* 2002;**50**:145–55.

Table 6c. Standard treatment protocols for corneal blindness

Condition	Personnel (units of time and type)	Tests (by type)	Drugs (dosage, type and time)	Inpatient stay
Trachoma Ocular trauma and corneal ulceration Xerophthalmia Ophthalmia neonatorum	Ophthalmologist trained in corneal diseases, paramedical staff (time: 1 hour)	Slit-lamp examination, intraocular tension, nasolacrimal duct examination, BP, urine sugar, posterior segment evaluation	Preoperative: Eye drops (antibiotic and cycloplegic), xylocaine injection Postoperative: Eye drops (antibiotic, steroids and cycloplegic), paracetamol tablets	5–7 days

Source: Whitcher JP, Srinivasan M, Upadhyay MP. Corneal blindness—a global perspective. *Bull World Health Organ* 2001;**79**:214–21.

Table 6d. Standard treatment protocols for glaucoma

Condition	Personnel (units of time and type)	Tests (by type)	Drugs (dosage, type and time)	Inpatient stay
Primary open-angle Primary angle-closure	Ophthalmologist trained in diagnosis and treatment of glaucoma, paramedical staff (time: 1/2 hour)	Slit-lamp examination, intraocular tension, gonioscopy, field test	Eye drops (beta-blockers, miotics), tablets (carbonic anhydrase inhibitors), prostaglandin analogue, alpha-1 receptor agonist	Nil except in case of surgery (2 days)

Source: *Quality assurance in management of glaucoma (primary open-angle and angle-closure), Clinical practice module*. New Delhi: NPCB, Ministry of Health and Family Welfare, Government of India; 2001.

Table 6e. Standard treatment protocols for diabetic retinopathy

Condition	Personnel (units of time and type)	Tests (by type)	Drugs (dosage, type and time)	Inpatient stay
NPDR PDR (laser) PDR (surgery)	Ophthalmologist trained in retinal diseases, indirect ophthalmoscopy and laser photocoagulation, paramedical staff (time: 1/2 hour)	Slit-lamp examination, intraocular tension, indirect ophthalmoscopy, FFA, gonioscopy, field test	Eye drops (cycloplegic), paracetamol tablets Preoperative: Cycloplegic eye drops, xylocaine injection Postoperative: Eye drops (antibiotic and cycloplegic), paracetamol tablets	Nil except in case of surgery (3–5 days)

NPDR: non-proliferative diabetic retinopathy; PDR: proliferative diabetic retinopathy; FFA: fundus fluorescein angiogram

Source: *Manual on diabetic retinopathy*. New Delhi: RP Centre, NPCB, Ministry of Health and Family Welfare, Government of India; 2001

Table 6f. Standard treatment protocols for childhood blindness

Condition	Personnel (units of time and type)	Tests (by type)	Drugs (dosage, type and time)	Inpatient stay
Corneal scar Cataract Glaucoma Optic atrophy	Ophthalmologist trained in paediatric eye care and surgery, anaesthetist for surgeries, paramedical staff (time: refer to the respective condition)	Slit-lamp examination, examination under general anaesthesia	Refer to the respective condition	Refer to the respective condition

Source: Gilbert C, Foster A. Childhood blindness in the context of Vision 2020—the right to sight. *Bull World Health Organ* 2001;**79**:227–32.

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Appendix 1

Table A1.1 Estimated and projected prevalence rates of blindness

State/Union Territory	Estimated prevalence (Visual acuity < 6/60) in the general population (%)					
	2000	2002	2004	2005	2010	2015
Andaman and Nicobar Islands ¹	1.12	1.10	1.03	1.01	0.90	0.79
Andhra Pradesh	1.45	1.42	1.33	1.31	1.16	1.02
Arunachal Pradesh	2.33	2.28	2.14	2.10	1.87	1.64
Assam	3.11	3.05	2.87	2.81	2.50	2.20
Bihar	0.80	0.78	0.73	0.72	0.64	0.56
Chandigarh ²	1.03	1.01	0.95	0.93	0.83	0.73
Chhattisgarh	1.64	1.61	1.51	1.48	1.32	1.16
Dadra and Nagar Haveli ³	0.97	0.95	0.89	0.87	0.78	0.68
Daman and Diu ⁴	1.09	1.07	1.01	0.98	0.88	0.77
Delhi	1.15	1.13	1.06	1.04	0.93	0.81
Goa	1.55	1.52	1.43	1.40	1.25	1.09
Gujarat	1.09	1.07	1.01	0.98	0.88	0.77
Haryana	1.93	1.89	1.78	1.74	1.55	1.36
Himachal Pradesh	0.71	0.70	0.66	0.64	0.57	0.50
Jammu and Kashmir	1.64	1.61	1.51	1.48	1.32	1.16
Jharkhand	1.44	1.41	1.33	1.30	1.16	1.02
Karnataka	1.82	1.78	1.67	1.64	1.46	1.28
Kerala	0.57	0.56	0.53	0.52	0.46	0.40
Lakshadweep ⁵	0.57	0.56	0.53	0.52	0.46	0.40
Madhya Pradesh	1.18	1.16	1.09	1.07	0.95	0.84
Maharashtra	0.97	0.95	0.89	0.87	0.78	0.68
Manipur	1.41	1.38	1.30	1.27	1.13	0.99
Meghalaya	0.75	0.74	0.70	0.68	0.61	0.53
Mizoram	0.80	0.78	0.73	0.72	0.64	0.56
Nagaland	1.07	1.05	0.99	0.97	0.86	0.76
Orissa	1.43	1.40	1.32	1.29	1.15	1.01
Pondicherry ⁶	0.80	0.78	0.73	0.72	0.64	0.56
Punjab	1.03	1.01	0.95	0.93	0.83	0.73
Rajasthan	1.58	1.55	1.46	1.43	1.27	1.12
Sikkim	0.66	0.65	0.61	0.60	0.53	0.47
Tamil Nadu	0.80	0.78	0.73	0.72	0.64	0.56
Tripura	0.79	0.77	0.72	0.71	0.63	0.55
Uttar Pradesh	0.96	0.94	0.88	0.86	0.77	0.68
Uttaranchal	0.57	0.56	0.53	0.52	0.46	0.40
West Bengal	1.21	1.19	1.12	1.09	0.98	0.86
India	1.12	1.10	1.03	1.01	0.90	0.79

Note: 1. Andaman and Nicobar Islands (All-India prevalence %)

2. Chandigarh (Punjab prevalence %)

3. Dadra and Nagar Haveli (Maharashtra prevalence %)

4. Daman and Diu (Gujarat prevalence %)

5. Lakshadweep (Kerala prevalence %)

6. Pondicherry (Tamil Nadu prevalence %)

Table A1.2 Age- and sex-specific proportion of blindness prevalence

Age group (years)	Males (%)	Females (%)
0–14	0.10	0.20
15–59	1.30	1.40
60+	45.60	51.40
Total	47.00	53.00

Source: National Blindness Survey (1986–1989)⁵ and Andhra Pradesh Eye Diseases Study (APEDS)^{6–8}

Appendix 2

Number of cataract surgeries performed between April 2003 and March 2004

State/Union Territory	Census population 2001	Growth rate	Estimated population 2003	Total cataract operations performed	Cataract surgery rate (per 1,000,000 population)	IOL operations performed	% IOL
Andaman and Nicobar	356,265	2.39	373,294	693	1,856	657	94.8
Andhra Pradesh	75,727,541	1.30	77,696,457	443,091	5,703	409,808	92.5
Arunachal Pradesh	1,091,117	2.33	1,141,963	684	599	608	88.9
Assam	26,638,407	1.73	27,560,096	23,063	837	11,509	49.9
Bihar	82,878,796	2.50	87,022,736	87,876	1,010	30,757	35.0
Chandigarh	900,914	3.39	961,996	6,330	6,580	5,850	92.4
Chhattisgarh	20,795,956	1.66	21,486,382	64,196	2,988	53,574	83.5
Dadra and Nagar Haveli	220,451	4.65	240,953	0	NA	0	NA
Daman and Diu	158,059	4.42	172,031	372	2,162	298	80.1
Delhi	13,782,976	3.81	14,833,239	80,072	5,398	76,229	95.2
Goa	1,343,998	1.39	1,381,361	5,497	3,979	0	NA
Gujarat	50,596,992	2.03	52,651,230	449,234	8,532	426,772	95.0
Haryana	21,082,989	2.47	22,124,489	89,706	4,055	62,902	70.1
Himachal Pradesh	6,077,248	1.62	6,274,151	18,343	2,924	13,917	75.9
Jammu and Kashmir	10,069,917	2.55	10,583,483	10,412	984	0	NA
Jharkhand	26,909,428	2.09	28,034,242	28,054	1,001	8,416	30.0
Karnataka	52,733,958	1.59	54,410,898	263,613	4,845	243,657	92.4
Kerala	31,838,619	0.90	32,411,714	79,696	2,459	74,619	93.6
Lakshadweep	60,595	1.59	62,522	0	NA	0	NA
Madhya Pradesh	60,385,118	2.18	63,017,909	233,870	3,711	197,176	84.3
Maharashtra	96,752,247	2.04	100,699,739	519,561	5,160	484,558	93.3
Manipur	2,388,634	2.63	2,514,276	553	220	517	93.5
Meghalaya	2,306,069	2.62	2,426,907	1,238	510	1,214	98.1
Mizoram	891,058	2.56	936,680	796	850	687	86.3
Nagaland	1,988,636	4.97	2,186,306	429	196	326	76.0
Orissa	36,706,920	1.48	37,793,445	82,652	2,187	78,590	95.1
Pondicherry	973,829	1.87	1,010,250	9,969	9,868	9,888	99.2
Punjab	24,289,296	1.80	25,163,711	133,376	5,300	75,722	56.8
Rajasthan	56,473,122	2.49	59,285,483	226,829	3,826	143,560	63.3
Sikkim	540,493	2.85	571,301	253	443	0	NA
Tamil Nadu	62,110,839	1.06	63,427,589	452,650	7,136	439,194	97.0
Tripura	3,191,168	1.46	3,284,350	8,098	2,466	5,858	72.3
Uttar Pradesh	166,052,859	2.30	173,691,291	567,718	3,269	322,861	56.9
Uttaranchal	8,479,562	1.76	8,778,043	37,105	4,227	31,317	84.4
West Bengal	80,221,171	1.64	82,852,425	249,895	3,016	233,057	93.3
Total	1,027,015,247	1.93	1,067,062,942	4,175,924	3,913	3,444,098	82.5

Source: National Programme for Control of Blindness