



Summary Vision Screening Data: India

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Paolo Mazzone¹, Dr Jill Carlton², Dr Helen Griffiths³

1. Research Assistant, School of Health and Related Research, University of Sheffield, United Kingdom (UK)
2. Senior Research Fellow, School of Health and Related Research, University of Sheffield, United Kingdom (UK)
3. Senior Lecturer, Academic Unit of Ophthalmology and Orthoptics, University of Sheffield, United Kingdom (UK)

Information provided by Zia Chaudhuri - Paediatric Ophthalmologist, Strabismologist, Neuro-Ophthalmology (Lady Hardinge Medical College, University of Delhi, PGIMER, Dr RML Hospital, New Delhi, India)

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1. Glossary of Terms

Abnormal test result	A test result where a normal “pass” response could not be detected under good conditions. The result on screening equipment may indicate “no response,” “fail,” or “refer.”
Attendance rate	<p>The proportion of all those invited for screening that are tested and receive a result:</p> <ul style="list-style-type: none"> • Invited for screening includes all those that are offered the screening test. • Tested and receive a result could be a “pass” or “referral to diagnostic assessment”. <p>Attendance rate provides information on the willingness of families to participate in screening.</p>
Compliance with referral (percentage)	<p>The percentage of those who are referred from screening to a diagnostic assessment that actually attend the diagnostic assessment.</p> <p>Percentage of compliance provides information on the willingness of families to attend the diagnostic assessment after referral from screening.</p>
Coverage	<p>The proportion of those eligible for screening that are tested and receive a result:</p> <ul style="list-style-type: none"> • Eligible for screening includes those within the population that are covered under the screening or health care programme. • Tested and receive a result could be a “pass” or “refer to diagnostic assessment”. <p>Factors such as being offered screening, willingness to participate, missed screening, ability to complete the screen, and ability to document the screening results will influence the coverage.</p>
False negatives	<p>The percentage of children with a visual deficit (defined by the target condition) that receive a result of “pass” during screening.</p> <p>Example: If 100 children with visual deficit are screened, and 1 child passes the screening, the percentage of false negatives is 1%.</p>
False positives	The percentage of children with normal vision that are referred from screening to a diagnostic assessment.
Guidelines	Recommendations or instructions provided by an authoritative body on the practice of screening in the country or region.



Vision screening professional	A person qualified to perform vision screening, according to the practice in the country or region.
Inconclusive test result	A test result where a normal “pass” response could not be detected due to poor test conditions or poor cooperation of the child.
Invited for screening	Infants/children and their families who are offered screening.
Outcome of vision screening	An indication of the effectiveness or performance of screening, such as a measurement of coverage rate, referral rate, number of children detected, etc.
Untreated amblyopia	Those children who have not received treatment for amblyopia due to missed screening or missed follow-up appointment.
Persistent amblyopia	Amblyopia that is missed by screening, or present after the child has received treatment.
Positive predictive value	<p>The percentage of children referred from screening who have a confirmed vision loss.</p> <p>For example, if 100 babies are referred from screening for diagnostic assessment and 10 have normal vision and 90 have a confirmed visual defect, the positive predictive value would be 90%.</p>
Prevalence	The percentage or number of individuals with a specific disease or condition. Prevalence can either be expressed as a percentage or as a number out of 1000 individuals within the same demographic.
Programme	An organised system for screening, which could be based nationally, regionally or locally.
Protocol	Documented procedure or sequence for screening, which could include which tests are performed, when tests are performed, procedures for passing and referring, and so forth.
Quality assurance	A method for checking and ensuring that screening is functioning adequately and meeting set goals and benchmarks.
Referral criteria	A pre-determined cut-off boundary for when a child should be re-tested or seen for a diagnostic assessment.
Risk babies / Babies at-risk	<p>All infants that are considered to be at-risk or have risk-factors for vision defects/ophthalmic pathology according to the screening programme.</p> <p>Two common risk factors are admission to the neonatal-intensive care unit (NICU) or born prematurely. However, other risk factors for visual defects may also be indicated in the screening programme.</p>



Sensitivity	<p>The percentage of children with visual defects that are identified via the screening programme.</p> <p>For example, if 100 babies with visual defects are tested, and 98 of these babies are referred for diagnostic assessment and 2 pass the screening, the sensitivity is 98%.</p>
Specificity	<p>The percentage of children with normal vision that pass the screening.</p> <p>For example, if 100 babies with normal vision are tested, and 10 of these babies are referred for diagnostic assessment and 90 pass the screening, the specificity is 90%.</p>
Target condition	<p>The visual defect you are aiming to detect via the screening programme.</p>
Well, healthy babies	<p>Infants who are <i>not</i> admitted into the NICU or born prematurely (born after a gestation period of less than 37 weeks).</p>



2. Abbreviations

ACT: Alternating Cover Test

AR: Autorefraction

BCVA: Best Corrected Visual Acuity

CT: Cover Test

CV: Colour Vision

EI: Eye Inspection

EM: Eye Motility

Fix: Fixation

GDP: Gross Domestic Product

Hir: Hirschberg

NICU: Neonatal-intensive care unit

PM: Pursuit Movements

PPP: Purchasing Power Parity

PR: Pupillary Reflexes

RE: Retinal Examination

RR: Red Reflex Testing

SV: Stereoacuity

VA: Visual Acuity

WHO: World Health Organisation



3. Population and Healthcare Overview

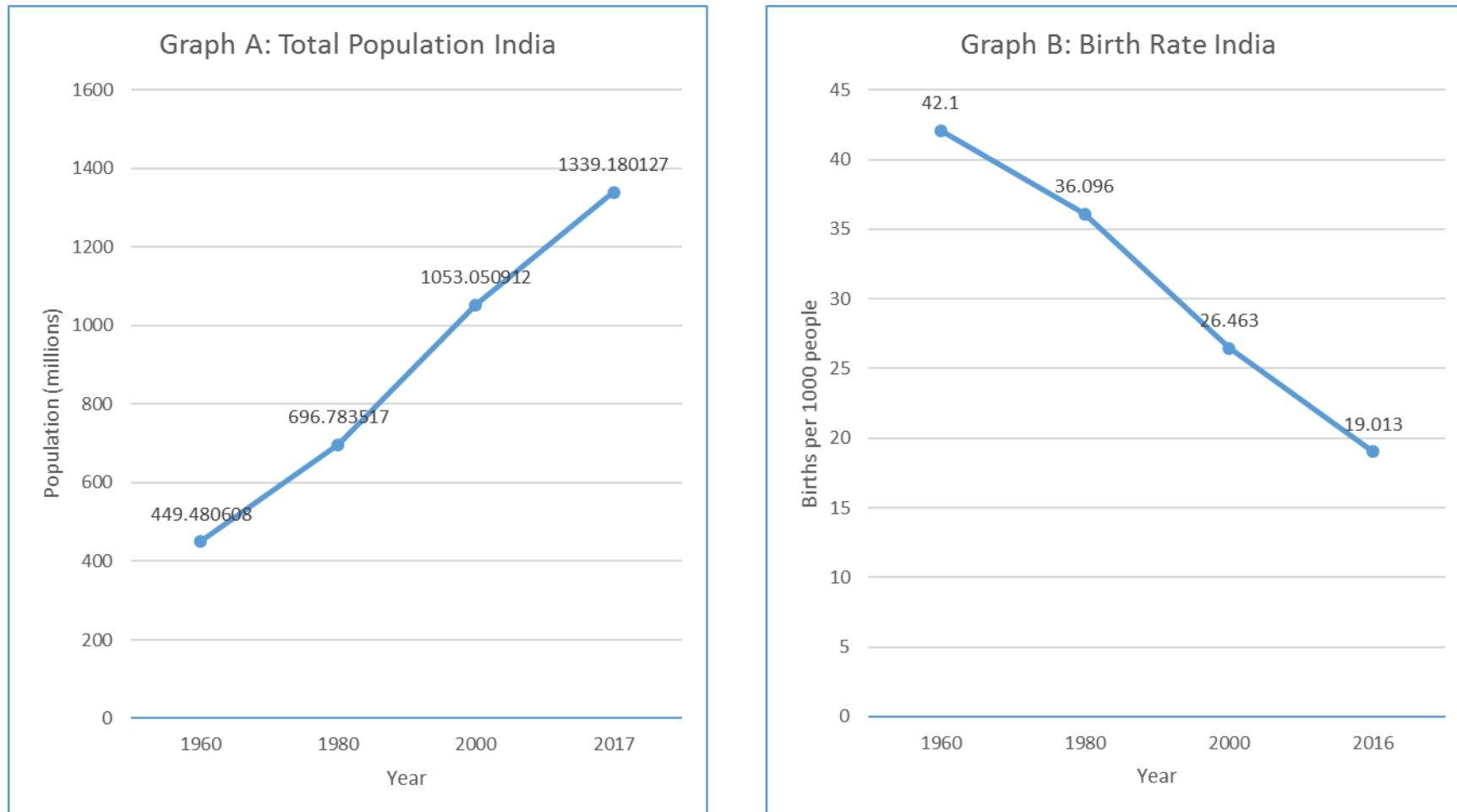
The population of India is estimated as 1.339 billion (World Bank, 2018a) and birth rate is estimated at 19.013 births/1,000 population in 2016 (World Bank, 2018b). The change in population and birth rate from 1960 to 2017 is shown in Figure 1, graphs A and B respectively.

India had a reported population density of 450.42 people per square kilometre in 2017 and this has risen from 154.21 people per square kilometre in 1961 (World Bank, 2018c). Infant mortality in 2017 was estimated at 32 deaths/1,000 live births in total (World Bank, 2018d).

The average life expectancy in India is estimated at 68.56 years (World Bank, 2018e), with a death rate of 7.31 deaths/1,000 population in 2016 (World Bank, 2018f). India has a gross national income per capita (PPP int. \$, 2013) of \$5,350 (WHO, 2016). The estimated total expenditure on health per capita in 2014 was \$267 (Intl \$) and the total expenditure on health in 2014 as percentage of GDP was 4.7% (WHO, 2016).



Figure 1: Change in the Total Population and Birth Rate in India between 1960 and 2017



Source: Information sourced from World Bank (2018)



4. Vision Screening Commissioning and Guidance

Vision screening in India is organised both nationally and regionally. Each community health centre provides services to approximately 30,000 people. All regions should provide vision screening, but some may not for logistical reasons; the national programme policy is not always followed due to local variations in infrastructure. Specifically, the distribution of vision screening in India varies. Vision screening is not currently implemented as part of National Health Policy, therefore there are no set guidelines on this. Depending on the institution providing care and the expertise therein, vision screening varies in different regions in the country. It is true that in most cases vision assessment is performed only after the patient presents to an eye care centre with symptoms.

Vision screening is funded by parents, charity, companies, health insurance, councils, municipalities, parent's employers, states, provinces/regions, and the Government of India National Programme of Control of Blindness (set up in 1976). In government funded tertiary care eye institutions, the charges are usually completely paid for by the government, while in private institutions, it is paid for by the parents directly or by third party insurance. Vision screening is embedded into a general preventative child healthcare screening system, the content of which is decided upon by Technical Committees in the Government of India. The vision screening programme commenced in 1976, this was simultaneously introduced across the whole of India.

The vision screening programme has been changed since its implementation; specifically, in 2003, India adopted the goals of VISION 2020. This is a global initiative that aims to eliminate avoidable blindness by the year 2020. VISION 2020 provides guidance, technical and resource support to countries that have formally adopted its agenda. The guidelines for vision screening are set out in the National General Health screening guidelines, which have been continuously reviewed since 2003. Any revisions are decided upon by the Technical Committee of the Government of India and funded dependent upon need, with budgetary allocation made every year. Revisions are documented and submitted to the committee who decide on the need.

It is not known how many vision screening professionals there are, per million population, in India. There are general professionals that do not screen, but could do so with additional training, including ophthalmologists, neonatologists, optometrists, paediatricians and trained health workers. However, there is currently no specific training to perform vision screening.

There are methods of quality monitoring for vision screening imposed by the government, this is conducted through service and performance audits. However, any research conducted using this data is institutional and not available to view. There has been no cost-effectiveness analysis and no other studies on the effectiveness of the vision screening programme in India.



5. Screening programme

In India, retinopathy of prematurity (ROP) and reduced visual acuity are the target conditions screened for by vision screening. The health care professionals delivering vision screening, venue for screening and tests used vary depending on the age of the child as shown in Tables 1, 2 and 3 respectively. Specific details of the screening offered within each age group are described more fully in sections 5.1 to 5.4 below.

5.1 Vision screening - Preterm babies

Preterm babies are screened by a paediatric ophthalmologist in an ophthalmic clinic. The number of screens in this age group is not defined. The tests used include eye inspection, fixation, red reflex testing by 6 weeks of age, eye motility, Hirschberg, retinal examination, pursuit movements and pupillary reflexes by 3 months of age. ROP screening is now a must in all high-risk populations. However, not all children receive this and there is no standardised referral criteria.

5.2 Vision screening - Birth to 3 months

Well, healthy babies are screened by either a paediatrician, ophthalmologist, orthoptist or youth doctor in either a hospital, child healthcare centre or a private clinic. The number of screens in this age group is not defined. The tests conducted at this age include eye inspection, fixation and red reflex testing by 6 weeks of age, followed by eye motility, Hirschberg, retinal examination, pursuit movements and pupillary reflexes by 3 months of age. The ophthalmologist or orthoptist is responsible for all vision screening; the paediatrician or youth doctor will only perform a fundus red reflex examination to diagnose a white pupil. Referral for further examination is necessary after 3 inconclusive tests or 3 abnormal test results – however, it is not stated what the referral criteria are at this age.

5.3 Vision screening - 3 months to 36 months

Children aged between 3 and 36 months of age are screened by either a paediatric ophthalmologist, optometrist, or an orthoptist in hospital clinics. The number of screens in this age group is not defined. The tests conducted at this age include eye inspection, fixation, red reflex testing, eye motility, Hirschberg, retinal examination, pursuit movements, pupillary reflexes, cover test, alternating cover test, visual acuity measurement, stereopsis, colour vision and autorefractometry. Subsequently, an assessment of visual acuity, stereopsis, ocular motility and alignment, colour vision and refraction (retinoscopy) are conducted by 3 years of age. All tests done by paediatric ophthalmologist, optometrist, or orthoptist. Optometrists and orthoptists conduct the refraction, ocular motility and misalignment evaluation, the paediatric ophthalmologist will overview all findings. Referral for further examination is necessary after 3 inconclusive tests or 3 abnormal test results; however, it is not stated what the referral criteria are at this age. There is no standardised referral criteria.



Visual acuity is measured for the first time at 1-year of age, this is repeated at 2-years of age and then in one year intervals. There is no specific age when this is stopped. Visual acuity is measured by ophthalmologists, optometrists and orthoptists. The same optotype charts are used by each professional at all ages as follows: Grating acuity (Lea symbols) in very young or developmentally delayed children; Alphabets (Sloan letters) and HOTV charts in older children. These charts are logMAR based, not crowded, with a range of 0.05-2.0 decimal and 6/12 (Snellen).

5.4 Vision screening - 36 months to 7 years

Children aged from 36 months to 7 years are screened by an ophthalmologist, orthoptist, or optometrist in a hospital clinic. The number of screens in this age group is not defined. The tests conducted at this age include eye inspection, fixation, red reflex testing, eye motility, Hirschberg, retinal examination, pursuit movements, pupillary reflexes, cover test, alternating cover test, visual acuity measurement, stereopsis, colour vision and auto-refraction. Optometrists and orthoptists conduct the refraction, ocular motility and misalignment evaluation, the paediatric ophthalmologist will overview all findings. Referral for further examination is necessary after 3 inconclusive tests or 3 abnormal test results. However, there are no specific guidelines on referral. It is not clear when the visual acuity measurement is conducted between the age of 36 months and 7 years, but usually, at the age of 5 years there is a school vision test with a recommended follow-up every year; however, there are no guidelines on this. This screening is conducted by either school health workers, optometrists, or ophthalmologists who are sent for school vision screening, or trained teachers who are taught to evaluate Snellen's charts. Visual acuity is measured by ophthalmologists, optometrists and orthoptists. The same optotype charts are used by each professional at all ages; this includes: Grating acuity (Lea symbols) in developmentally delayed children; Alphabets and HOTV charts in older children. These charts are logMAR, not crowded, with a range of 0.05-2.0 decimal. Referral criteria is not defined, but the cut off at each age is a visual acuity of 6/12 Snellen (0.3logMAR).



Table 1: Healthcare professionals who conduct vision screening in each age group

Table 1	Paediatrician	Ophthalmologist	Orthoptist	Optometrist	Youth Doctor	Teacher
Preterm babies	x	✓	x	x	x	x
0 to 3 months	✓	✓	✓	✓	✓	x
3 to 36 months	✓	✓	✓	x	x	x
3 to 7 years	✓	✓	✓	x	x	✓



Table 2: Vision screening tests used in vision screening for each age group

Table 2	EI	RR	Fix	EM	Hir	RE	PM	PR	CT	ACT	AR	VA	SV	CV
Preterm babies	✓	✓	✓	✓	✓	✓	✓	✓	x	x	x	x	x	x
0 to 3 months	✓	✓	✓	✓	✓	✓	✓	✓	x	x	x	x	x	x
3 to 36 months	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
3 to 7 years	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓



Table 3: Location of vision screening for each age group

Table 3	Ophthalmic Clinic	Hospital	Child Healthcare Centre	Private Clinic	School
Preterm babies	✓	x	x	x	x
0 to 3 months	x	✓	x	x	x
3 to 36 months	x	✓	x	x	x
3 to 7 years	x	✓	x	x	✓



6. Automated Screening

Automated vision screening is achieved using handheld, portable devices designed to detect presence of refractive error in infants from 6 months of age. It provides objective results and is used to detect amblyopic risk factors. This differs from other methods used to screen children for amblyopia which focus on detection of the actual condition and the resulting visual loss. Automated screening is conducted in some place using PlusOptix. However, there is no common database or comparative data on any of this. No further information is available.



7. Provision for Visually Impaired

It is not known how many schools there are for blind or severely visually impaired children in India or the costs per child. There is special support for visually impaired children who attend mainstream primary schools, this is provided through low vision services that are financed by the Government and charities. However, it is not known what this support might be.



8. Knowledge of existing screening programme

8.1 Prevalence/Diagnosis

The prevalence of treated or untreated amblyopia by the age of 7 years in India is reported by Ganekal et al in 2013 as 1.1%. This was a population based, cross-sectional study on a total of 4,020 school children aged between 5 and 15 years in Southern India. The prevalence of persistent amblyopia by the age of 7 years is not known. The prevalence of strabismus is reported as 6.9% (Saxena et al., 2016). This is based on cover test results collected from 1,950 children with a mean age of 16 years \pm 14 years. Amblyopia was also reported in this study as 2% with a diagnosis of unilateral amblyopia given as: a difference in best corrected visual acuity of two lines or more between the two eyes in the absence of any organic cause and best corrected visual acuity in the worse eye being $<20/30$ (Snellen) and bilateral amblyopia defined as: bilateral decreased best corrected visual acuity $<20/30$ (Snellen) in the presence of bilateral isometropia (hyperopia ≥ 4.00 D, myopia ≥ 6.00 D, astigmatism ≥ 2.50 D) (Saxena et al., 2016). The incidence of the four types of amblyopia (strabismic, refractive, combined mechanism and deprivation) are not available.

8.2 Coverage

All children are invited for vision screening and this is conducted by the Government of India scheme through ICDS (Ministry of Women and Child Development) sending out an invitation. However, there is no policy for inviting children for vision screening. Once a child has been registered for vision screening, it is emphasised to the parents that they must follow up at least once a year for vision assessment or earlier if there were complaints of visual impairment. There is no data on coverage or attendance. There is no registration or documentation with referral after an abnormal screening test result, and therefore, there is no data on compliance to referral.

8.3 Screening evaluation

There is no available data concerning the percentage of false negatives and false positives from vision screening. No information has been provided concerning the positive predictive value of a refer result, the sensitivity of vision screening and the specificity of vision screening.

8.4 Treatment success

The percentage of children treated for congenital disorders in the total population is reported as 61 to 69.9 per 1,000 births. There is no specific data for individual types of congenital eye disorders (Sharma, 2013). There is no data available concerning the percentage of children treated for strabismus or amblyopia. The distribution of the four types of amblyopia is reported by Menon et al. (2005) in a hospital based study of 683 patients with average age of at presentation of 7.97 ± 6.18 years; with 11.8% presenting above the age of 20 years. The findings were as follows:



- Strabismic amblyopia: 39.4%
- Refractive amblyopia (ametropic and anisometropic): 34.4%
- Combined mechanism amblyopia: 18.1%
- Sensory deprivation amblyopia: 8.1%

Glasses are prescribed for children under the age of 7 years by an ophthalmologist, optometrist, or an orthoptist. Other treatment options include patching, penalisation, atropine, cataract surgery. Not all children are treated due to both capacity problems and payment problems. Some children may never come to an established healthcare centre.



9. Costs of vision screening in children

9.1 Cost of vision screening

The costs of vision screening are not known.

9.2 Cost of treatment for amblyopia

The costs of treatment for amblyopia are not known.

9.3 Cost of Treatment for strabismus

The costs of treatment for strabismus are not known.

9.4 Cost of treatment for cataract

The costs for congenital cataract surgery, including follow-up of deprivation amblyopia, is not known.



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