



## Summary Vision Screening Data: China

### Produced as part of Work Package 3

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**28<sup>th</sup> March 2019**

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under Grant Agreement No 733352



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## 1. Glossary of Terms

<b>Abnormal test result</b>	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.”
<b>Attendance rate</b>	<p>The proportion of all those invited for screening that are tested and receive a result:</p> <ul style="list-style-type: none"> <li>Invited for screening includes all those that are offered the screening test.</li> <li>Tested and receive a result could be a “pass” or “referral to diagnostic assessment”.</li> </ul> <p>Attendance rate provides information on the willingness of families to participate in screening.</p>
<b>Compliance with referral (percentage)</b>	<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>
<b>Coverage</b>	<p>The proportion of those eligible for screening that are tested and receive a result:</p> <ul style="list-style-type: none"> <li>Eligible for screening includes those within the population that are covered under the screening or health care programme.</li> <li>Tested and receive a result could be a “pass” or “refer to diagnostic assessment”.</li> </ul> <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>
<b>False negatives</b>	<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>
<b>False positives</b>	The percentage of children with normal vision that are referred from screening to a diagnostic assessment.
<b>Guidelines</b>	Recommendations or instructions provided by an authoritative body on the practice of screening in the country or region.



<b>Vision screening professional</b>	A person qualified to perform vision screening, according to the practice in the country or region.
<b>Inconclusive test result</b>	A test result where a normal “pass” response could not be detected due to poor test conditions or poor cooperation of the child.
<b>Invited for screening</b>	Infants/children and their families who are offered screening.
<b>Outcome of vision screening</b>	An indication of the effectiveness or performance of screening, such as a measurement of coverage rate, referral rate, number of children detected, etc.
<b>Untreated amblyopia</b>	Those children who have not received treatment for amblyopia due to missed screening or missed follow-up appointment.
<b>Persistent amblyopia</b>	Amblyopia that is missed by screening, or present after the child has received treatment.
<b>Positive predictive value</b>	<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>
<b>Prevalence</b>	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.
<b>Programme</b>	An organised system for screening, which could be based nationally, regionally or locally.
<b>Protocol</b>	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.
<b>Quality assurance</b>	A method for checking and ensuring that screening is functioning adequately and meeting set goals and benchmarks.
<b>Referral criteria</b>	A pre-determined cut-off boundary for when a child should be re-tested or seen for a diagnostic assessment.
<b>Risk babies / Babies at-risk</b>	<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>



<b>Sensitivity</b>	<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>
<b>Specificity</b>	<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>
<b>Target condition</b>	<p>The visual defect you are aiming to detect via the screening programme.</p>
<b>Well, healthy babies</b>	<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

**AS:** Automated Screening

**BCVA:** Best Corrected Visual Acuity

**CT:** Cover Test

**CV:** Colour Vision

**EI:** Eye Inspection

**EM:** Eye Motility

**GDP:** Gross Domestic Product

**Hir:** Hirschberg test

**NICU:** Neonatal-intensive care unit

**PM:** Pursuit Movements

**PPP:** Purchasing Power Parity

**PR:** Pupillary Reflexes

**RE:** Retinal Examination

**SV:** Stereoacuity

**VA:** Visual Acuity

**WHO:** World Health Organisation



### **3. Population and Healthcare Overview**

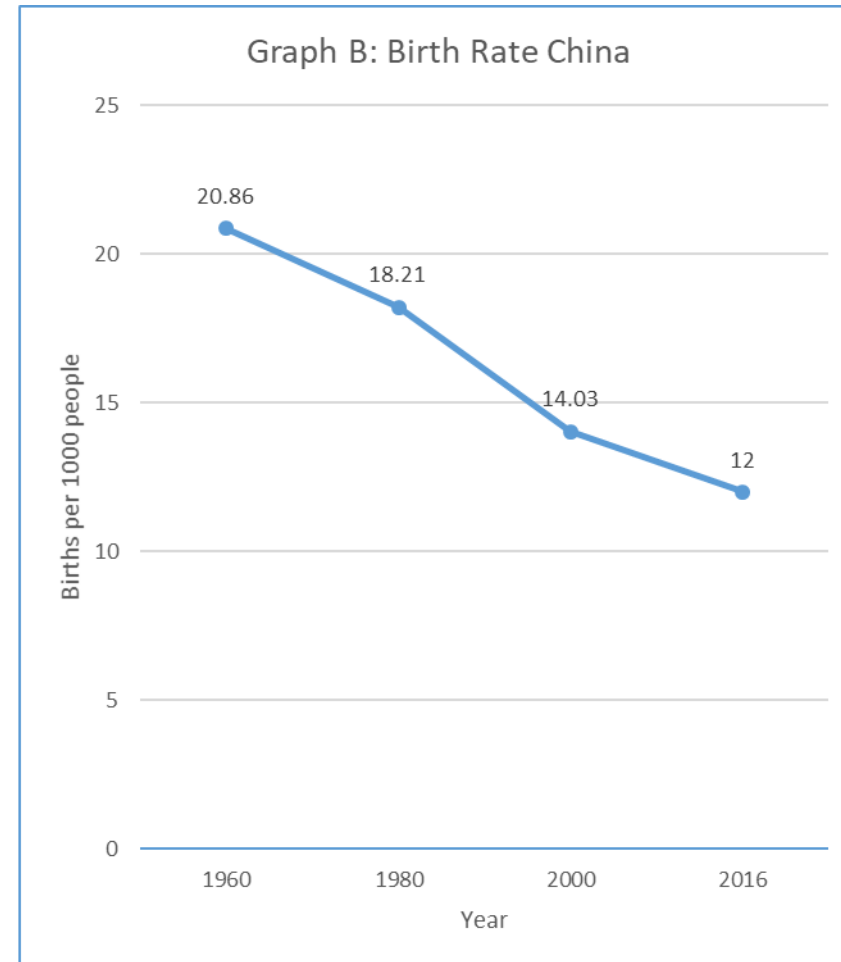
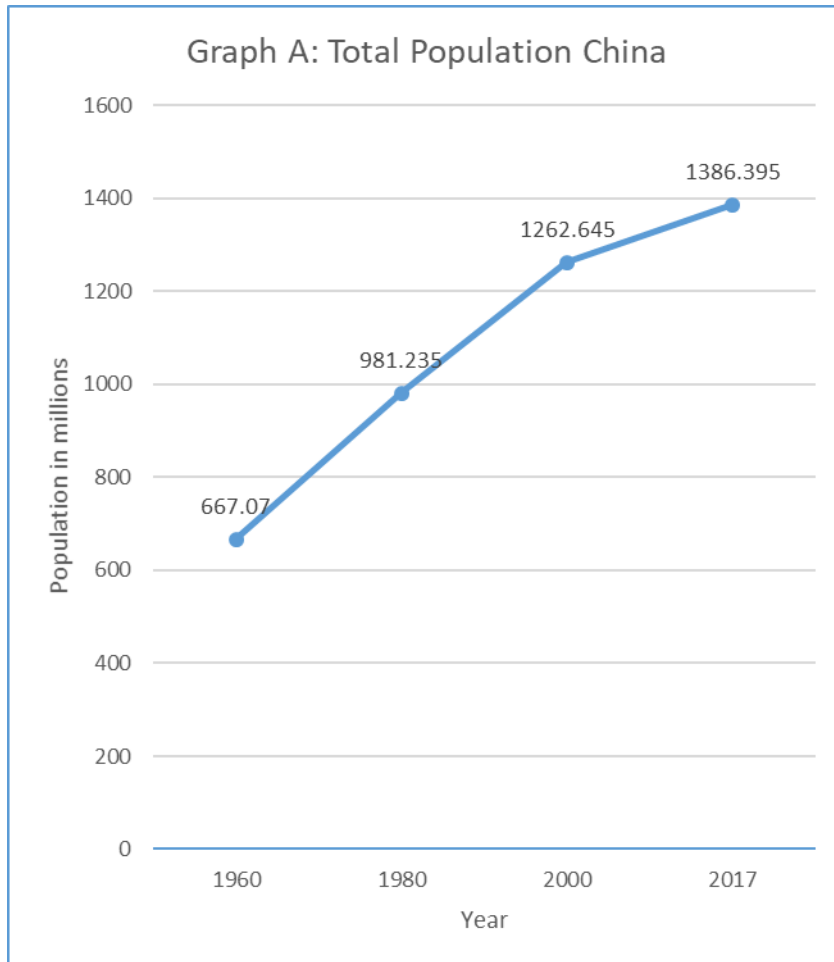
The population of China is estimated as 1386.395 billion (World Bank, 2018a) and birth rate estimated at 12 births/1,000 population in 2016 (World Bank, 2018b). The change in population and birth rate from 1960 to 2017 is shown in Figure 1, graphs A and B respectively.

China had a reported population density of 147.67 people per square kilometre in 2017 and this has risen from 70.34 people per square kilometre in 1961 (World Bank, 2018c). Infant mortality in 2017 was estimated at 8 deaths/1,000 live births in total (World Bank, 2018d).

The average life expectancy in China is estimated at 76.25 years (World Bank, 2018e), with a death rate of 7.3 deaths/1,000 population in 2016 (World Bank, 2018f). China has a gross national income per capita (PPP int. \$, 2013) of \$11,850 (WHO, 2016). The estimated total expenditure on health per capita in 2014 was \$731 (Intl \$) and the total expenditure on health in 2014 as percentage of GDP was 5.5% (WHO, 2016).



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



Source: Information sourced from World Bank (2018)





#### **4. Vision Screening Commissioning and Guidance**

Vision screening in China is organised regionally by each district, with the exception of rural areas which do not provide vision screening. There are differences in protocols between each district; this report is based on the vision screening protocol in the region of Jinan, which is the capital of eastern China's Shandong province. Jinan has a population of approximately 5.21 million (Statista, 2019).

Vision screening is funded by the hospital; it is not known how vision screening is funded in other areas but the systems vary. The content of the vision screening programme is decided upon by a professional body of ophthalmologists and orthoptists, or a public health organisation.

Vision screening started in 2008 and was implemented in the Purui eye hospital group in 2012. Recently, vision screening archives have been introduced, which is the only known change to the vision screening programme since it began. There are regional general health screening guidelines that provide information on vision screening.

Vision screening is conducted by paediatric ophthalmologists, ophthalmologists and paediatricians. There are approximately 20 vision screening professionals per million population. General professionals that do not screen, but could do so with additional training have been identified as ophthalmologists.

There is specific training to perform vision screening for screening professionals via local screening training and further secondary education each year. This training lasts 3 months and is regularly updated, monitored or revalidated, however, it is not accredited or certified.

The vision screening programme is reviewed every 1-2 years by the local government according to national government policies. There is no specific funding for these revisions. There are methods imposed by the government to quality monitoring of the programme. Information is collected by a local-national screening system. There has been research conducted concerning the vision screening programme, however, there has been no cost-effectiveness analysis.



## 5. Screening programme

In China, retinopathy of prematurity (preterm babies) 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 up to the age of 3 months are screened by a paediatric ophthalmologist in an eye clinic. The tests conducted at this age include retinal examination at 1 month of age.

### 5.2 Vision screening - Birth to 3 months

Well, healthy babies up to the age of 3 months are screened by either a paediatrician or an ophthalmologist in a hospital or a child healthcare centre. The tests conducted include retinal examination at 1 month of age. Babies are referred after 1-2 abnormal tests or 2-3 inconclusive examinations.

### 5.3 Vision screening - 3 months to 36 months

Infants aged 3 to 36 months of age are screened by either a paediatrician or an ophthalmologist in an eye clinic. The tests conducted at this age include eye inspection, eye motility, Hirschberg test, retinal examination, cover test and alternate cover test at 3 months of age, followed by automated screening (Suresight, Topocon) at 6 months of age. Infants are referred after 2 abnormal tests or 2-3 inconclusive examinations.

### 5.4 Vision screening - 36 months to 7 years.

Children aged from 36 months to 7 years of age are screened by a paediatrician or an ophthalmologist in an eye clinic. The tests conducted at this age include eye inspection, eye motility, Hirschberg test, retinal examination, pursuit movements, pupillary reflexes, cover test, alternate cover test, visual acuity measurement, stereopsis (Titmus), colour vision (colour test book), autorefraction and automated screening (Suresight, Topocon). Visual acuity is measured for the first time at 3 years of age and then repeated every 6 months until 18 years of age. The optotype chart used for visual acuity measurement is a logarithmic eye chart (logMAR, one space, crowded, with a range of 0.1-2.0 decimal). Referral criteria is defined as:

- 3 years of age: visual acuity of less than 0.6 decimal (0.2 logMAR, 6/9.5 Snellen)
- 4 years of age: visual acuity of less than 0.8 (0.1 logMAR, 6/7.5 Snellen)
- 5 years of age and above: visual acuity of less than 1.0 (0.0 logMAR, 6/6 Snellen)

Children are referred after 1 abnormal tests or 2-3 inconclusive examinations.



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

<b>Table 1</b>	<b>Paediatric Ophthalmologist</b>	<b>Ophthalmologist</b>	<b>Paediatrician</b>
Preterm babies	✓	×	×
0 to 3 months	×	✓	✓
3 to 36 months	×	✓	✓
3 to 7 years	×	✓	✓



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

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

Key: ACT: Alternating Cover Test; AR: Autorefracton; AS: Automated Screening; CT: Cover Test; CV: Colour Vision; EI: Eye Inspection; EM: Eye Motility; Hir: Hirschberg test; PM: Pursuit Movements; PR: Pupillary Reflexes; RE: Retinal Examination; SV: Stereoacuity; VA: Visual Acuity



**Table 3:** Location of vision screening for each age group

<b>Table 3</b>	<b>Eye Clinic</b>	<b>Hospital</b>	<b>Child Healthcare Centre</b>
Preterm babies	✓	×	×
0 to 3 months	×	✓	✓
3 to 36 months	✓	×	×
3 to 7 years	✓	×	×



## 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.

In China, automated screening is conducted using Suresight and Topocon. These devices cost between 20,000-30,000 Chinese Yuan (2,643.30 Euros\*) with maintenance costs of 20 Chinese Yuan (2.64 Euros\*) per year. The devices need replacing every 5 years. These devices are only used in large 3<sup>rd</sup> grade hospitals – it is not known how many there are in China. The age at which these tests are conducted has not been specified. However, it is known that some areas do screen with autorefractors and some do not – there is no comparative data between these areas. Other tests are conducted alongside this, such as a visual acuity measurement. It is only used on children who have decreased visual acuity and the referral criteria is both visual acuity and autorefraction must be abnormal. If a child passes the visual acuity test, but fails the automated screening, it is necessary to conduct the visual acuity measurement again and refer if this is abnormal.

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\* Currency conversions as of 28.03.2019



## **7. Provision for Visually Impaired**

It is estimated that there are 400 schools for blind or severely visually impaired children in China. The costs per child for these schools is estimated at 2,000 Chinese Yuan (264.33 Euros\*). There is support for visually impaired children that attend regular primary school through the disabled persons' federation, this includes visual aids.

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\* *Currency conversion as of 28.03.2019*



## **8. Knowledge of existing screening programme**

### *8.1 Prevalence/Diagnosis*

The prevalence of treated or untreated amblyopia is estimated at 2.5% by the age of 7 years. The prevalence of persistent amblyopia is estimated at 0.5% by the age of 7 years. The prevalence of strabismus is estimated at 2% by 6 years of age. The incidence of the four types of amblyopia is estimated at 20% strabismic, 60% refractive, 15% combined-mechanism and 5% deprivation.

### *8.2 Coverage*

Invitations for general preventative child healthcare screening are sent by vision professionals or ophthalmologists, of which, approximately 60-70% of children at kindergarten age (3-5 years) are invited – the remaining 30-40% are not invited due to attending private kindergartens. All school aged children (6 years of age) are invited for vision screening by school doctors. The coverage and attendance of any kind of vision screening, before the age of 7 years is estimated at 60-70%. For visual acuity measurements, specifically, the attendance rate is estimated at 60-80%.

### *8.3 Screening evaluation*

The percentage of false negatives is estimated at 20%. The percentage of false positives is estimated at 20%. The positive predictive value of a refer result after vision screening is estimated at 80-90%. The sensitivity and specificity of vision screening are both estimated at 80%.

### *8.4 Treatment success*

The percentage of infants treated for congenital eye disorders is estimated 0.01% of the total population. The percentage of children treated for strabismus, after being screened before the age of 7 years is estimated at 30% - this rises to 30-50% of the total population before the age of 7 years. The percentage of children treated for amblyopia, after being screened before the age of 7 years, is estimated at 40% - this rises to 50% of the total population before the age of 7 years. It is not known how many patients are treated for congenital cataract, amblyopia and strabismus, per year by an orthoptist and/or an ophthalmologist. Ophthalmologists or optometrists prescribe glasses for children under the age of 7 years. Other treatment options include patching, penalisation with glasses, atropine and cataract surgery. There is no registration or documentation of noncompliance with referral after an abnormal screening test result.





## 9. Costs of vision screening in children

### 9.1 Cost of vision screening

The salary costs, per year, for vision screening professionals is estimated at \$10,000 (8,806.95 Euros\*). The salary costs, per hour, for vision screening professionals is estimated at \$5 (4.40 Euros\*). The cost to train general preventative child healthcare screening professionals, between leaving secondary education to qualification, is estimated at \$1,000 (880.70 Euros\*).

The total screening costs per year for vision screening is estimated at \$100,000 (88069.50 Euros\*). The total costs, per child per year, for vision screening nationally is estimated at 50 Chinese Yuan (6.61 Euros\*).

### 9.2 Cost of treatment for amblyopia

The estimated costs for treatment of typical patients, with refractive amblyopia and strabismic amblyopia including follow up are:

- Refractive amblyopia - \$1,000 (881.16 Euros\*) – inclusive of 5 visits.
- Strabismic amblyopia - \$3,000 (2,643.47 Euros\*) including surgery – inclusive of 10 visits.

### 9.3 Cost of Treatment for strabismus

The estimated costs for congenital cataract surgery including follow up of deprivation amblyopia is \$10,000 (8,811.55 Euros\*), including surgery and more than 20 visits.

### 9.4 Cost of treatment for cataract.

The estimated costs for strabismus surgery including follow up are \$20,000 (17,623.10 Euros\*).

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\* Currency conversions as of 21.02.2019



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