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Summary Vision Screening Data: Sweden

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Contents

1 Glossary of Terms: Vision Screening

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	The proportion of all those invited for screening that are tested and receive a result: • 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". Attendance rate provides information on the willingness of families to participate in screening.
Compliance with referral (percentage)	The percentage of those who are referred from screening to a diagnostic assessment that actually attend the diagnostic assessment. Percentage of compliance provides information on the willingness of families to attend the diagnostic assessment after referral from screening.
Coverage	The proportion of those eligible for screening that are tested and receive a result: • 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". 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.
False negatives	The percentage of children with a visual deficit (defined by the target condition) that receive a result of "pass" during screening. Example: If 100 children with visual deficit are screened, and 1 child passes the screening, the percentage of false negatives is 1%.

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	The percentage of children referred from screening who have a confirmed vision loss. 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%.
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	All infants that are considered to be at-risk or have risk-factors for vision defects/ophthalmic pathology according to the screening programme.

	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.
Sensitivity	The percentage of children with visual defects that are identified via the screening programme. 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%.
Specificity	The percentage of children with normal vision that pass the screening. 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%.
Target condition	The visual defect you are aiming to detect via the screening programme.
Well, healthy babies	Infants who are *not* admitted into the NICU or born prematurely (born after a gestation period of less than 37 weeks).

2 Abbreviations

ACT Alternating Cover Test

AR Autorefraction

AS Automated Screening

CT Cover Test

CV Colour Vision

EI Eye Inspection

EM Eye Motility

Fix Fixation

GDP Gross Domestic Product

GP General Practitioner

Hir Hirschberg

NICU Neonatal-intensive care unit

PM Pursuit Movements

PPP Purchasing Power Parity

PR Pupillary Reflexes

RE Retinal Examination

ROP Retinopathy of Prematurity

RR Red Reflex Testing

SV Stereopsis

VA Visual Acuity

WHO World Health Organisation

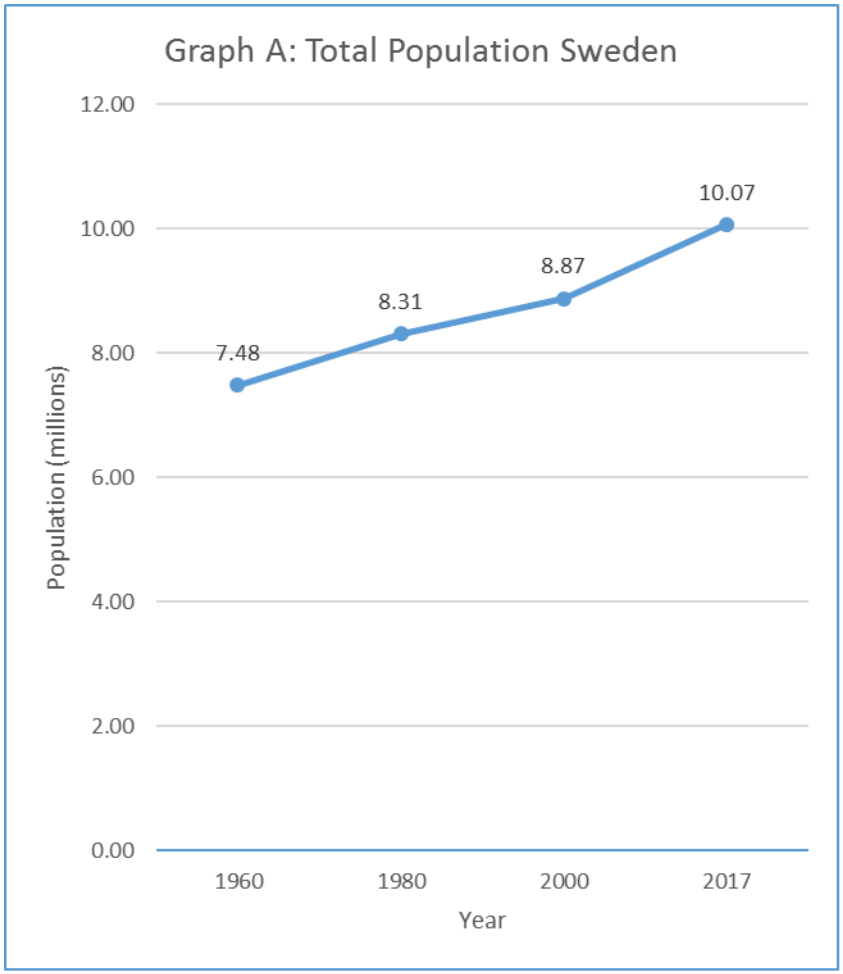
3 Population and Healthcare Overview

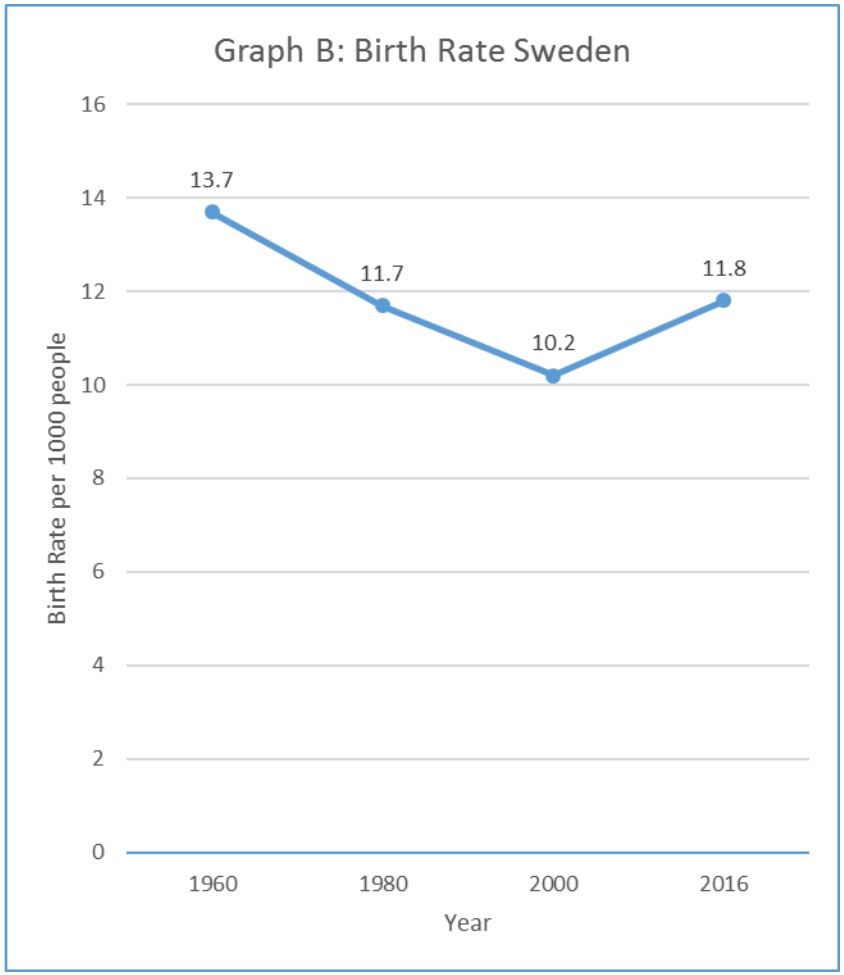
The population of Sweden is 10,067,744 (World Bank, 2018a) and birth rate is estimated at 11.8 births/1,000 population in 2016 (World Bank, 2018b). The change in population and birth rate from 1960 to 2017 is shown in Figure 1, graphs A and B respectively.

Sweden has a reported population density of 25 people per square kilometre in 2017 and this has risen from 18 people per square kilometre in 1961 (World Bank, 2018c). Infant mortality in 2017 is estimated at 2.3 deaths/1,000 live births in total (World Bank, 2018d).

The average life expectancy in Sweden is estimated at 82.2 years (World Bank, 2018e), with a death rate 9.2 deaths/1,000 population in 2016 (World Bank, 2018f). Sweden has a gross national income per capita (PPP int. $, 2013) of $44,000 (WHO, 2016b). The estimated total expenditure on health per capita in 2014 was $5,219 (Intl $) and the total expenditure on health in 2014 as percentage of GDP was 11.9% (WHO, 2016b).

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





Source: Information sourced from World Bank (2018)

4 Vision Screening Commissioning and Guidance

Vision screening in Sweden is organised regionally in all twenty regions. All regions deliver vision screening, but operate using different referral criterion. Vision screening is funded by each region and is embedded into a general preventative child healthcare screening system.

The information provided for this report is based upon the service provision in Sahlgrenska Akademin in region of Gothenburg.

The vision screening programme began in 1968 and was implemented across Sweden in 1973. There have been the following changes since its implementation:

- The referral criteria which once stated that the nurse should refer 4-year old children with visual acuity less than 0.8 decimal (0.1 logMAR, 6/7.5 Snellen) in each eye, and 5-year old children with visual acuity less than 1.0 decimal (0.0 logMAR, 6/6 Snellen) in each eye. These referral criteria have been withdrawn.
- The vision charts used in each area. Gothenburg and surrounding areas (with about 1.5 million inhabitants) continue to use HOTV-charts but in some parts of Sweden Lea symbols charts are used.

There are regional general health screening guidelines which include vision screening. There is no defined review process of the vision screening programmes, therefore they are not regularly reviewed or changed. There are no methods for quality monitoring imposed by the government.

In Sweden, vision screening is conducted by ophthalmologists, paediatricians, general practitioners (GP) or specialist nurses in either a school, hospital or child healthcare centres depending on the age group. It is not known how many vision screening professionals there are for every million people and no general professionals have been identified that do not screen, but could do so with additional training. There is no specific training currently available to perform vision screening in Sweden.

There has been research carried out concerning the vision screening programme in Sweden, including the clinical effectiveness of the vision screening programme, Gyllencreutz et al., 2018; Hard, 2007; Hard et al., 2002; Kvarnström & Jakobsson, 2005; Kvarnström et al., 1998. There has been no cost-effectiveness analysis.

5 Screening programme

Amblyopia is the target condition screened for in Sweden. 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, born 36 weeks gestational age or earlier, are screened by either an ophthalmologist within a hospital, if they are. The vision screening tests utilised for preterm babies include only retinal examination.

5.2 Vision screening - Birth to 3 months

Well, healthy babies aged up to 3 months are screened by either a paediatrician or GP in hospital or a child healthcare centre. The vision screening tests utilised include eye inspection, fixation, red reflex testing and pupillary reflexes. Red reflex testing and eye inspection are carried out at birth. At the age of 4-6 weeks, red reflex testing is repeated along with pupillary reflexes, eye inspection and fixation. Babies are immediately referred to an ophthalmologist for further examination if disease is suspected, such as cataract or retinoblastoma.

5.3 Vision screening - 3 months to 36 months

Babies aged 3 to 36 months are screened three times by a GP or a specialist nurse in a child healthcare centre. This is carried out at 6 months, 10 to 12 months, and 18 months of age. The vision screening tests utilised at these ages are eye inspection, fixation, eye motility and Hirschberg test. Referral for further diagnostic examination is made to an ophthalmologist after a maximum of two inconclusive or abnormal screening test results. Whether it is one or two screening tests administered before referral is determined based on the clinical judgement of the specialist nurse conducting the screening.

5.4 Vision screening - 36 months to 7 years

Children aged 36 months to 7 years are screened twice by a specialist nurse. At the age of 4 years, vision screening is carried out in child healthcare centres. At the age of 6 to 7 years, vision screening is carried out in schools. The vision screening test utilised is a visual acuity measurement, this is conducted for the first time at 4 years of age (a re-test is conducted at 5 years of age if the result at 4 years is not acceptable) and then once more at the age of 6 to 7 years. The optotype charts used to measure visual acuity include Lea Symbols (LH), Konstantin Moutakis (KM) and HOTV, all of which are linear, crowded charts with a range of 0.1 to 1.0 (decimal). At 4 and 5 years of age, HOTV or LH are recommended in the national guidelines. The referral criteria is decided regionally, and there are no national guidelines for screening school children. In the Gothenburg region, KM-chart is recommended but some

schools in the region still use old E-charts. Referral for further diagnostic examination is made to an ophthalmologist after a maximum of two inconclusive or two abnormal screening test results. Whether it is one or two screenings is determined based on the clinical judgement of the specialist nurse conducting the screening.

The referral criteria is:

- At 4 years using HOTV = < 0.8 decimal (0.1 logMAR, 6/7.5 Snellen) in each eye. But if the child has VA of 0.65 decimal (0.2 logMAR, 6/9.5 Snellen) in one or both eyes they are retested at 5 years before referral.
- At 6-7 years using KM = < 0.8 decimal (0.1 logMAR, 6/7.5 Snellen) in both eyes.

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

Table 1	**Paediatrician**	**Specialist nurse**	**Ophthalmologist**	**GP**
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	Eye inspection	Fixation	Red reflex testing	Eye motility	Hirschberg	Retinal examination	Pupillary reflexes	Visual acuity measurement
Preterm babies	×	×	×	×	×	✓	×	×
0 to 3 months	✓	✓	✓	✓	×	×	✓	×
3 to 36 months	×	×	✓	✓	×	×	×	×
3 to 7 years	×	×	×	×	×	×	×	✓

Table 3: Location of vision screening for each age group

Table 3	**Hospital**	**School**	**Child Healthcare Centre**
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 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. No automated vision screening is conducted in Sweden.

7 Provision for Visually Impaired

In Sweden, there is one school for blind or severely visually impaired children. There is special support for visually impaired children who attend mainstream primary school, but it is not clear what this support is. The costs per child are not known.

8 Knowledge of existing screening programme

8.1 Prevalence/Diagnosis

The prevalence of amblyopia was found to be 0.7% in a sample of 143 children aged 4-15 years of age (Grönlund et al., 2006). The prevalence of untreated and persistent amblyopia by the age of 7 years, is estimated as 0.2% (Grönlund et al., 2006) The prevalence of strabismus is estimated at 3.5% (Grönlund et al., 2006) There is no available data concerning the incidence of the four types of amblyopia (strabismic, refractive, combined mechanism and deprivation).

8.2 Coverage

All children are invited for vision screening; this is sent out in the form of a letter by the child healthcare centres. The coverage for all vision screening programmes before the age of 7 years is estimated at 99%. At the Institute of Neuroscience and Physiology Sahlgrenska Akademin in Gothenburg, all referrals are registered and if the child does not attend the examination, the parents are contacted until the child gets an examination. This intervention has created 100% compliance, although this procedure and uptake may differ within the country.

8.3 Screening evaluation

Data has been provided from the study by Kvarnström et al (1998) which found false positive referral across 5 regions in Sweden to average 29.0% and false negatives to average 5.7% (N= 3,126). The sensitivity of vision screening is determined based on age:

- 4 years of age: Sensitivity - 86.2%; Specificity - 97.7%
- 5.5 years of age: Sensitivity - 88.6%; Specificity - 98.6%
- 4 and 5.5. years of age: Sensitivity - 91.4%; Specificity - 96.9%
- 6-years of age: Sensitivity - 97.8%; Specificity - 99.4%

8.4 Treatment success

All eligible children are offered treatment. There is no data available concerning the percentage of infants treated for congenital eye disorders, or strabismus. It is not known how many patients are treated for congenital cataract, amblyopia and strabismus per year by orthoptists and/or ophthalmologists.

9 Costs of vision screening in children

9.1 Cost of vision screening

The salary costs per year and per hour for vision screening professionals cannot be calculated. There is no available data regarding how much it costs to train the general preventative child healthcare screening professionals between leaving secondary education to qualification. It is not known what the total screening costs per year for vision screening are in Sweden. It is not known what the total costs per child per year for vision screening are nationally or regionally.

9.2 Cost of treatment for amblyopia

It is not known what the estimated screening costs are for treatment of typical patients with refractive amblyopia and strabismic amblyopia, including follow-up.

9.3 Cost of Treatment for strabismus

It is not known what the estimated costs or strabismus surgery are, including follow-up.

9.4 Cost of treatment for cataract

It is not known what the estimated costs for congenital cataract surgery, including follow-up of deprivation amblyopia.

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