



## Summary Vision Screening Data: Denmark

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## 1. Glossary of Terms: Vision Screening

<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>	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.
<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>	The visual defect you are aiming to detect via the screening programme.
<b>Well, healthy babies</b>	Infants who are <i>not</i> admitted into the NICU or born prematurely (born after a gestation period of less than 37 weeks).



## 2. Abbreviations

<b>ACT</b>	Alternating Cover Test
<b>AR</b>	Autorefraction
<b>AS</b>	Automated Screening
<b>CT</b>	Cover Test
<b>CV</b>	Colour Vision
<b>EI</b>	Eye Inspection
<b>EM</b>	Eye Motility
<b>Fix</b>	Fixation
<b>GDP</b>	Gross Domestic Product
<b>GP</b>	General Practitioner
<b>Hir</b>	Hirschberg test
<b>NICU</b>	Neonatal-intensive care unit
<b>PM</b>	Pursuit Movements
<b>PPP</b>	Purchasing Power Parity
<b>PR</b>	Pupillary Reflexes
<b>RE</b>	Retinal Examination
<b>ROP</b>	Retinopathy of Prematurity
<b>RR</b>	Red Reflex Testing
<b>SV</b>	Stereopsis
<b>VA</b>	Visual Acuity
<b>WHO</b>	World Health Organisation
<b>YHN</b>	Youth Health Nurse



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

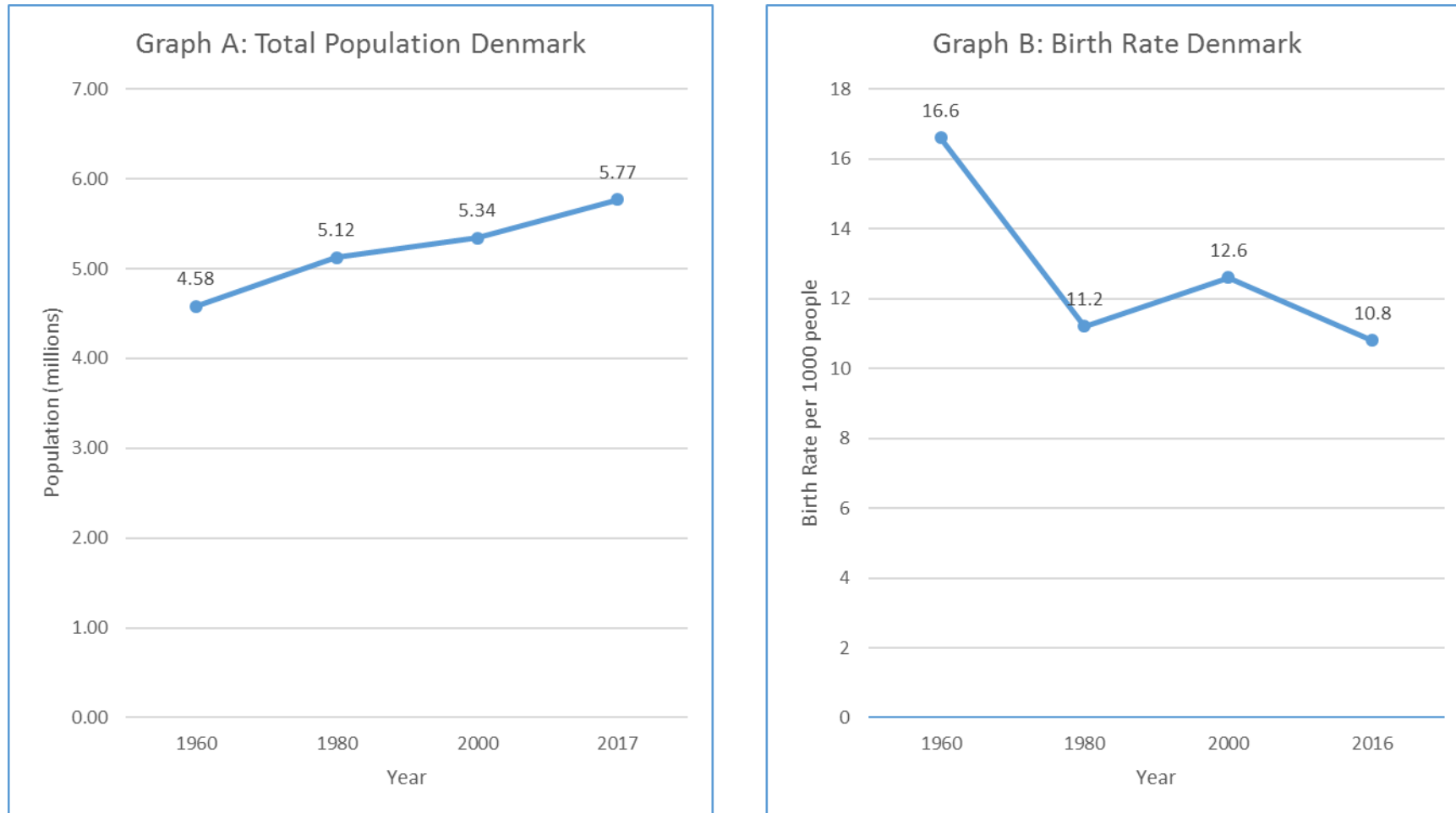
The population of Denmark is 5,769,603 (World Bank, 2018a) and a birth rate estimated at 10.8 births/1,000 population in 2016 (World Bank, 2018b). The change in population and birth rate from 1960 to 2017 is shown in Figure 1, graphs A and B respectively.

Denmark has a reported population density of 136.52 people per square kilometre in 2017 and this has risen from 108.84 people per square kilometre in 1961 (World Bank, 2018c). In terms of healthcare facilities, the total density of hospitals in 2013 was 1.01 per 100,000 population (WHO, 2016a). Infant mortality in 2017 is estimated at 3.7 deaths/1,000 live births in total (World Bank, 2018d).

The average life expectancy in Denmark is estimated at 80.7years (World Bank, 2018e), with a death rate 9.2 deaths/1,000 population in 2016 (World Bank, 2018f). Denmark 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 \$4,782 (Intl \$) and the total expenditure on health in 2014 as percentage of GDP was 10.8% (WHO, 2016b).



**Figure 1: Total Population and Birth Rate in Denmark**



Source: Information sourced from World Bank (2018)





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

In Denmark, vision screening is organised nationally, with no regional variation between protocols. Vision screening is embedded into the general preventative child healthcare screening system. The content of this system is decided upon by the Ministry of Health and was commenced and implemented nationally in 1946. The vision screening programme has been changed since its start date, specifically in 1945 vision screening was conducted on children aged 6 years, in 1963 vision screening was also conducted on children aged 4 years and in the most recent revision (2007), vision screening was changed to include children aged 3 years. These revisions are decided upon by the Ministry of Health and are tax-funded.

Under these provisions vision screening is conducted by either a YHN in the child's home, or in school once the child reaches school age, or by the GP at the GP's office. There are approximately 3500 GPs in Denmark, however, doctors devote only 5% of their time to screening, of which, roughly 10% is specific to vision screening. Danish vision screening is conducted with general paediatric screening. This is performed by the GP and the YHN. No other general healthcare professionals see the children regularly. It is possible to add another layer to the screenings, for example, ophthalmic assistants, optometrists and ophthalmologists; however, there are no plans to as the Danish screening system appears to be a cheap and effective method. The training that is undertaken by specialist nurses is practical and embedded within their specialist training, which runs for 1.5 years. GPs do not undertake formalised vision screening training, apart from a course in screening and paediatric examinations, which is undertaken during general training and is comprised of 4 day courses covering screening/ophthalmology/healthy children/sick children; a "pass" is achieved through attending.

The training provided is not regularly updated, monitored, or revalidated. Denmark does not have exam-based training to be a sub-specialist such as a GP. It works with log-books that the doctor fills out during training. Certification is granted as a GP after completing all "logs", this is not recertified later and there is no accreditation for vision testing.

There are no specific methods for quality monitoring for vision screening imposed by the government and information is not systematically collected. The general practitioner (GP) and the Youth Health Nurse (YHN) have separate recordings. The GP keeps individual data in patient records and are not publically available. In most places the YHN's collaborate in the municipality so data is available for all YHNs in the municipality. There have been studies concerning the effectiveness of the vision screening programme in Denmark (Nørregaard et al, 2010; Høeg et al., 2015; Torp-Pedersen et al., 2017). There has been no cost-effectiveness analysis of this programme, but Nørregaard et al. (2010) provides a cost-benefit analysis compared to the British system.



## 5 Screening programme

Reduced vision, strabismus and amblyopia are target conditions screened for in Denmark. 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 seen in hospital for retinal examination if born before 32 weeks or if they weigh below 1500g. No specific vision screening exists, they follow the same vision screening provided to babies born at full term: The YHN makes an appointment 1 week after birth. Within the first 3 months, the child is seen at least 2 times, but if needed this can be more. Testing includes eye inspection, fixation, and observation for manifest strabismus. The GP sees the child at 5 weeks conducting the same tests.

### 5.2 Vision screening - Birth to 3 months

Well, healthy babies up to the age of 3 months are screened in the same way as preterm babies, conducted at the home of the parent or private clinics. Well, healthy babies are screened by a nurse at 2 to 3 weeks of age, by a GP at 5 weeks of age and again by a YHN at 8 weeks of age. There are no standardised criteria regarding the number of abnormal or inconclusive test results which necessitate a baby to be referred for further examination, this is individually decided by the YHN or GP.

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

Vision screening is conducted by a YHN, at home at 8 months of age and by a GP in clinics at 5 months and 1 year. There are no new tests introduced at this age' the same tests are provided as for preterm or well, healthy babies.

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

GPs conduct vision screening at age 2, 3, 4 and 5 years. A YHN performs vision screening in school at ages 6 to 7 years. Retinal examination and visual acuity measurement are performed and these are conducted at the GPs office, in the child's home (YHN) and in local schools (YHN). Visual acuity is measured for the first time at 3 years of age, this is conducted by a GP. This is done using, in the majority of cases using the Osterberg picture chart, which is an old version of the Snellen linear optotype chart; it is not validated or standardised and is said to be used because of tradition and because of a lack of funding for logMAR based tests. The Snellen letters chart is also used in some schools. Visual acuity measurement is repeated at ages 4, 5, 6, and again over the age of 7 years by either a GP or a YHN - with referral criteria of worse than 6/9 Snellen in one or both eyes (0.2 logMAR, 0.63 decimal).

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The number of abnormal test results or inconclusive tests necessitating referral for further diagnostic examination is not known.



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

<b>Table 1</b>	<b>Youth Health Nurse</b>	<b>GP</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

<b>Table 2.</b>	<b>Retinal Exam</b>	<b>Eye Inspection</b>	<b>Fixation</b>	<b>Cover test</b>	<b>Visual Acuity</b>
Preterm babies	✓	✓	✓	✓	✗
0 to 3 months	✓	✓	✓	✓	✗
3 to 36 months	✓	✓	✓	✓	✗
3 to 7 years	✓	✗	✗	✗	✓



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

<b>Table 3.</b>	<b>Hospital</b>	<b>Private clinic</b>	<b>Home</b>	<b>School</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. No automated vision screening is used in Denmark.



## **7 Provision for Visually Impaired**

In Denmark, there is one school for blind or severely visually impaired children. Within this school, there are three departments; one for normal curriculum students and the other two comprise of children who have more than one disability. The school has room for up to 40 children in youth education. The policy is to integrate these children into public schools and as such, there is specialist support for these children who attend regular mainstream primary school. Specifically, visual aid therapists follow the visually impaired children, costing approximately 80 Euros per hour. This special support is dependent upon the child, there is not a fixed number of hours that a child can receive aid.





## **8 Diagnostic Outcomes**

### *8.1 Prevalence/Diagnosis*

There is no data available relating to the prevalence of treated, untreated, or persistent amblyopia by the age of 7 years. Prevalence of treated or untreated amblyopia by the age of 20 years is reported to be 1.44%; this evidence was taken from a Danish rural study with criteria of best corrected visual acuity (BCVA) of less than 20/40 (Høeg et al, 2016). The prevalence of strabismus is detailed as 2.56% at age 7 years, evidenced in a PhD dissertation by Torp-Pedersen (2017) which was based on Danish National Health records. There is no data available about the incidence (observed cases) of the four types of amblyopia (strabismic, refractive, combined-mechanism and deprivation).

### *8.2 Coverage*

Children are invited to vision screening by health nurses, however, an appointment can be made to see a GP. The percentage of children who are invited for vision screening is approximately 90 to 100%, this includes children who are invited through YHN appointments made with parents for home visits and through the school. The GP does not invite children for vision screening, parents have to make their own appointments for their children. The percentage of compliance with referral after an abnormal screening test result is not known as there are no data available, the percentage of compliance is estimated to be 80 to 90%.

The coverage and attendance rates for vision screening, before the age of 7 is not known, however, before the age of 10 it is estimated at 90 to 100%. The percentage of infants treated for congenital eye disorder in the total population of Denmark is less than 1%, the source of this data is not publicly available. It is an estimate based on the number of referred babies to a tertiary clinic in the Northern Jutland region, where there are approximately 50 children under the age of 1 years are referred per year. Approximately 75% of these suffer from a congenital eye disease. This is from a population of 6000 babies born in the region every year.

### *8.3 Screening evaluation*

The percentage of false negative referrals, after vision screening is estimated at less than 10%, the percentage of false positive referrals after vision screening is also estimated at less than 10%, however there is no source for this estimate. The positive predictive value of a refer result after vision screening, the sensitivity of vision screening and the specificity of vision screening in Denmark is unknown.

### *8.4 Treatment success*

After referral from screening, Ophthalmologists are the only professionals that prescribe glasses for children under the age of 10 years. Other treatment options include patching,



penalisation with glasses, atropine, cataract surgery or treatment of any other condition that might cause a child to have lower than expected vision. For this reason, the children are referred directly to ophthalmologists, so they do not have several stops on their way to a diagnosis and treatment. All eligible children are offered treatment.

The percentage of children treated for strabismus and amblyopia after being screened before the age of 7 years, is 8 to 10% (Torp-Pedersen, 2017). Data specific to strabismus and amblyopia separately are not available publicly without applying for permission. There is no centrally registered documentation detailing who has received screened, with most being conducted in private ophthalmologist clinics. These professionals do not send data to databases and as such, it is not possible to review these children.



## 9 Costs of vision screening in children

### 9.1 Cost of vision screening

In Denmark, vision screening is free of charge for parents, with no penalty for those parents who do not attend with their child. Vision screening is conducted as part of general screening, however, it is not obligatory. GPs devote around 5% of their time to general screening and it is approximated that 10% of this time is dedicated to vision screening. The salary range is 42,900 Euros (Specialist nurse) to 130,000 Euros (GP) per year, however, it is difficult to determine the salary costs per hour for vision screening. No information is provided about the cost to train the professionals that perform vision screening. Nørregaard et al. (2010) estimate the cost of screening to be 200 DKR (23.80 Euros\*) per screened child at the GP - this covers examinations at 5 weeks, 5 months, 1 year, 2 years, 3 years, 4 years and 5 years of age. This includes, but not is not exclusively, time for vision screening. This is the best available data in Denmark, as the vision screening is part of a larger package and the total screening costs per year and per child per year are not available.

### 9.2 Cost of treatment for amblyopia

It is not possible to estimate the cost of treatment and follow-up of typical patients with refractive amblyopia and strabismic amblyopia. This is due to a large price range and because of the difference in treatment options. For instance, glasses for hyperopia can be treated with two visits to the Ophthalmologist, whereas cataract surgery requires years of frequent follow-ups. There are no data available regarding this.

### 9.3 Cost of Treatment for strabismus

There is no data regarding the estimated costs of strabismus surgery.

### 9.4 Cost of treatment for cataract

There is no data regarding the estimated costs of cataract surgery, including follow up of deprivation amblyopia.

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- Currency conversion as of 04/12/2018

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