



Summary Vision Screening Data: Netherlands

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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	<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	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	<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	The visual defect you are aiming to detect via the screening programme.
Well, healthy babies	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

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

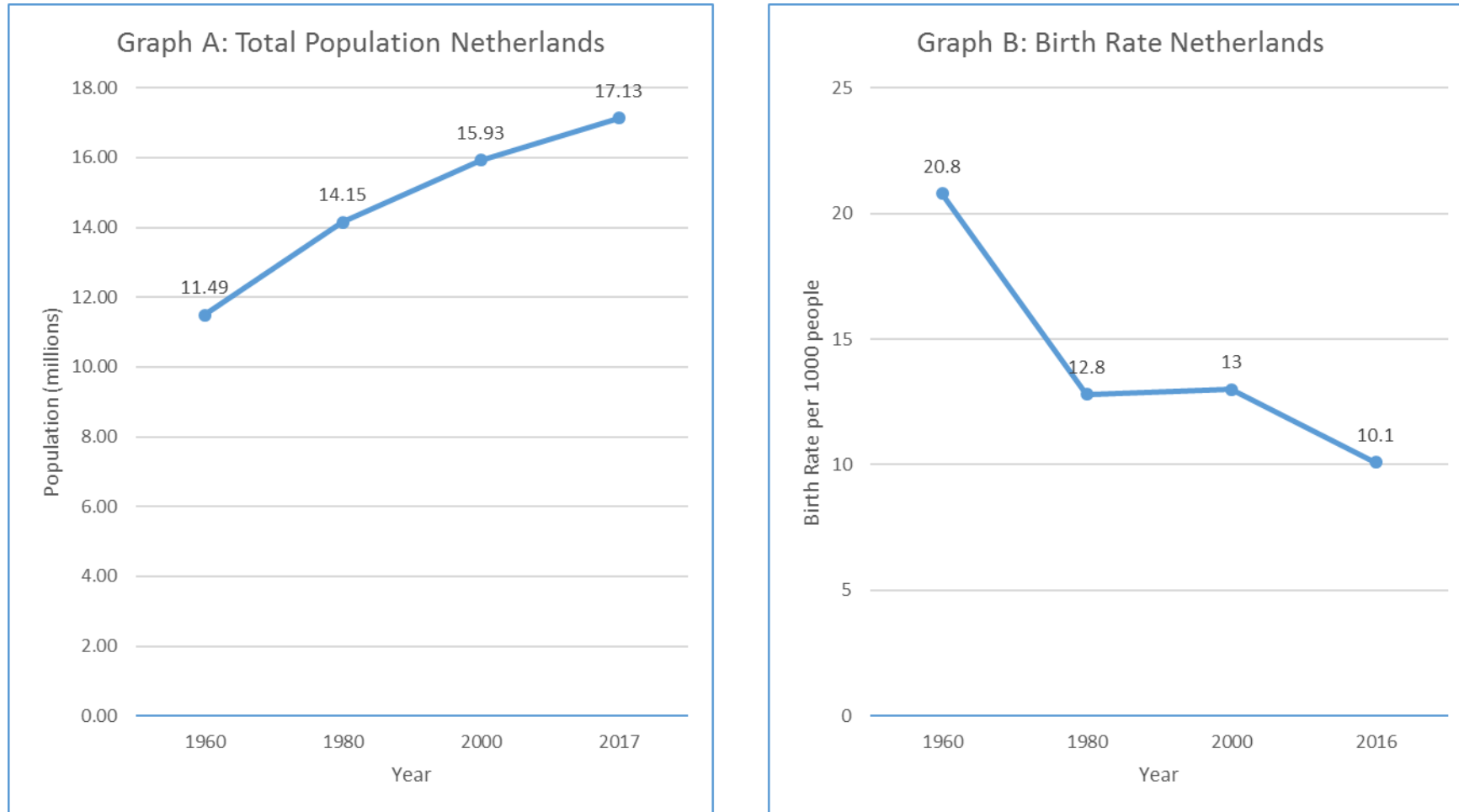
The population of the Netherlands is 17,132,854 (World Bank, 2018a) and birth rate is estimated at 10.1 births/1,000 population in 2016 (World Bank, 2018b). The change in population and birth rate from 1960 to 2017 is shown in Figure 1, graphs A and B respectively.

The Netherlands has a reported population density of 509 people per square kilometre in 2017 and this has risen from 345 people per square kilometre in 1961 (World Bank, 2018c). In terms of healthcare facilities, the total density of hospitals in 2013 was 0.76 per 100,000 population (WHO, 2016a). Infant mortality in 2017 is estimated at 3.3 deaths/1,000 live births in total (World Bank, 2018d).

The average life expectancy in the Netherlands is estimated at 81.5 years (World Bank, 2018e), with a death rate of 8.7 deaths/1,000 population in 2016 (World Bank, 2018f). The Netherlands has a gross national income per capita (PPP int. \$, 2013) of \$43,000 (WHO, 2016b). The estimated total expenditure on health per capita in 2014 was \$5,202 (Intl \$) and the total expenditure on health in 2014 as percentage of GDP was 10.2% (WHO, 2016b).



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



Source: Information sourced from World Bank (2018)



4 Vision Screening Commissioning and Guidance

In the Netherlands, vision screening is organised nationally by 28 Youth Healthcare regions. All children in the Netherlands are offered the same package via the Basic Youth Healthcare (Basic JGZ) package. The Youth Doctors and Youth Nurses offer all care in the Netherlands to all children. However, flexibility in implementation is permitted, vision screeners are free to decide, together with the parent, whether certain elements are not carried out, or carried out in any other way. Local initiatives to omit vision screening are allowed. All regions do however provide vision screening and in general there are no differences. Vision screening is funded by the municipalities and it is embedded into a general preventative child healthcare screening system.

The vision screening programme started regionally between 1965 and 1975, was implemented nationally between 1987 and 1989. The vision screening programme has been changed since its implementation; specifically, in 1987 the first non-binding guideline was published, the first national guideline was released in 2002 and a revision was implemented in 2010. This is currently under revision (2018). The NCJ (Netherlands Center for Youth (child) Healthcare) called for a revision of the guidelines after consulting the Ministry of Health, Welfare and Sport, they provide financial support by means of The Netherlands Organisation for Health Research and Development (ZonMw). There is no regular update. Although review has taken place, there have been no significant changes since 1987 when the addition of visual acuity measurement at 7 years was introduced.

There are no methods for quality monitoring imposed by the government. However, it is carried out by the implementation process included in the development and continuing education, as a regulation for Youth Healthcare Doctors. There may be differences from region to region, but they will all follow and adhere to the guidelines as suggested by their associations. There has been research on the vision screening programme carried out in the Netherlands (Sloot et al., 2017; Sloot et al., 2015; Groenewoud et al. 2010). There has been no cost-effectiveness analysis in the Netherlands.

Vision screening is conducted by Youth Nurses and Youth Doctors within approximately 1400 centres. General professionals identified, that do not screen, but could do so with additional training include orthoptists, optometrists and general practitioners (GP). There is no specific training to perform vision screening. It is incorporated in the general medical training or Youth Doctor training (2 years) and the post-bachelor nursing degree (1 year part-time). The Youth Doctor degree has mandatory re-registration and the Nursing degree has voluntary re-registration. In a period of 5 years, the Youth Doctor must have worked as a doctor for 2,080 hours. Work experience only counts if it meets the requirements of the medical assessment framework. Additionally, the doctor needs to participate in a continuing education programme. Both Youth Doctor and Nursing degrees are accredited.

5 Screening programme

The target conditions screened for in the Netherlands are retinopathy of prematurity (ROP) in premature infants, congenital cataract/ other congenital ocular abnormalities in all newborn infants and amblyopia in childhood. 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

ROP screening is performed on preterm babies born before 32 weeks and/or birth weight of less than 1500 grams. These babies also receive a fundus examination by an ophthalmologist. If these tests are positive, a further examination is conducted by an ophthalmologist as required. If the tests are negative (no ROP), tests conducted include eye inspection, fixation, red reflex testing, eye motility, Hirschberg test, retinal examination, pursuit movements (monocular and binocular), pupillary reflexes and cover test (near with fixation), all performed by either a nurse, specialist nurse, or Youth Doctor. These tests are conducted in a hospital and referral is determined by evidence of ROP, no or abnormal fixation at 1 month of age and no or abnormal fixation or pursuit at 2 months of age.

5.2 Vision screening - Birth to 3 months

Well, healthy babies up to the age of 3 months are screened by doctor in a child healthcare centre. Tests are conducted at 1-2 months of age and include eye inspection, fixation, red reflex testing, eye motility, Hirschberg test, pursuit movements (monocular and binocular), pupillary reflexes and near fixation cover test. Referral is needed after two abnormal or two inconclusive test results. Criteria that determine referral are absence of red reflex, no or abnormal fixation at 1 month of age and no or abnormal pursuit at 2 months of age.

5.3 Vision screening - 3 months to 36 months

Children aged between 3 to 36 months are screened by a specialist nurse or a Youth Doctor in a child healthcare centre. Screening is conducted at:

- 3-4 months: eye inspection, pupillary reflexes and red reflex testing
- 6-9 months: eye inspection, pupillary reflexes, Bruckner and near cover test , eye motility and pursuit movements (monocular and binocular)
- 14-24 months: eye inspection, pupillary reflexes, Bruckner and near cover test, eye motility and pursuit movements (monocular and binocular)

Further criteria that determine referral for further diagnostic examination are failure to fixing fix on own hands at 3 months. Referral is needed after two abnormal or two inconclusive test results..



5.4 Vision screening - 36 months to 7 years

Children aged between 36 months up to 7 years of age are screened by a specialist nurse, Youth Doctor, or a practice assistant in a child healthcare centre. The test conducted at this age include:

- 3-Years of age: Visual acuity (VA) (Specialist nurse; nurse practitioner; child healthcare doctor). Further assessments can be conducted on indication of abnormality. These include eye inspection, pupillary reflexes, Bruckner and near cover test, eye motility and binocular pursuit movements (Child healthcare doctor; nurse practitioner)
- 3.9-Years of age: VA (Specialist nurse; nurse practitioner; child healthcare doctor). Further assessments can be conducted on indication of abnormality. These include eye inspection, pupillary reflexes, Bruckner and near cover test, eye motility and binocular pursuit movements (Child healthcare doctor; nurse practitioner)
- 5 to 6-Years of age: VA (practice assistant; specialist nurse; nurse practitioner; child healthcare doctor). Further assessments can be conducted on indication of abnormality. These include eye inspection, pupillary reflexes, Bruckner and near cover test, eye motility and binocular pursuit movements (Child healthcare doctor; nurse practitioner)

VA is measured using the Amsterdam picture chart at ages 3 to 3.9 years of age. The optotypes charts are based on the Snellen principle and are used at 5-metre test distance with optotype sizes of 30, 20, 15, 10, 6 and 5.

Children aged 5 and 7 years have visual acuity measured with the Landolt C which are linear logMAR charts (at 5 metres) with optotype sizes of 0.1, 0.12, 0.15, 0.2, 0.25, 0.3, 0.4, 0.5, 0.65, 0.8, and 1.0. Referral is needed after two abnormal, or two inconclusive test results. Criteria that determine referral for further diagnostic examination are detailed as:

- 3 years of age – VA of less than 5/6 Snellen (0.8 decimal, 0.1 logMAR) in one or both eyes
- 3.9 years of age – VA with Landolt C of worse than 0.5 decimal (0.3 logMAR, 6/12 Snellen equivalent) in both eyes
- 5 years of age – VA with Landolt C of worse than 0.8 decimal (0.1 logMAR, 6/7.5 Snellen equivalent) in both eyes (not allowing >0.1 line of intraocular difference)



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

Table 1	Youth doctor	Ophthalmologist	Nurse	Specialist nurse	Doctor	Practice assistant
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	ROP	Eye inspection	Fixation	Red reflex	Eye motility	Hirschberg	Retinal examination	Pursuit movements	Pupillary reflexes	Cover test	Visual acuity
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	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 screening is conducted in the Netherlands.



7 Provision for Visually Impaired

The Netherlands has 10 schools for blind or severely visually impaired children. It was estimated that in 2012, 750 children (aged 3-20 years) attended these schools. The costs per child include funding of 15,700 Euros plus basic funding of 6,100 Euros, totalling 21,800 Euros per child; basic funding is the amount paid for every child for education and the rest of the funding is added due to the special needs. There is support for visually impaired children that attend regular mainstream primary school, including digital instruments and there is also additional funding of up to 15,200 Euros per child for visual impairment needs, covered by the Ministry of Education.



8 Knowledge of existing screening programme

8.1 Prevalence/Diagnosis

A 7-year birth cohort study of 4,624 children was started in 1996/1997 in Rotterdam (Groenewoud, 2010), this investigated the detection and causes of amblyopia. The findings were as follows:

- The prevalence of treated or untreated amblyopia between birth and 6 years was 3.4%
- The prevalence of persistent amblyopia at >7 years of age was 0.78%
- The prevalence of strabismus at age 6 was 1.6% and at age 7 was 1.8%
- Of 102 children diagnosed with amblyopia, the incidence of the four types were 42 refractive, 32 combined mechanism, 19 strabismus, 7 deprivation, 2 unknown.

A paper written in 2018, which is currently only available at abstract (Klaver et al., 2015), investigated the prevalence of ocular conditions found in 6,690 children in Rotterdam at age of 6 years and found:

- Eye injury (Foreign body) 0.3%
- Nasolacrimal duct obstruction 0.8%
- Congenital ocular toxoplasmosis 0.2%
- Orbital cellulitis 0.1%
- Congenital ptosis 0.7%
- Psychogenic amblyopia 0.1%
- Retinopathy of prematurity (ROP) 0.2%
- Retinoblastoma 0.1%
- Congenital cataract 0.4%
- Dominant optic atrophy 0.1%
- Conjunctivitis 0.6%
- Coloboma of iris and choroid (including macula) 0.1%
- Hordeolum 0.2%
- Optic nerve head drusen 0.1%
- Shaken baby retinopathy 0.1%
- Myopic degeneration 0.2%
- Subnormal visual acuity 0.8%
- Chalazion 0.3%
- Eye strain 0.1%
- Transient subnormal visual acuity 0.2%
- Migraine 0.1%
- Susceptible for developing a retinopathy 0.2%
- Marfan syndrome with lens luxation 0.1%
- Capillary hemangioma 0.1%



- Optic nerve disorders 0.1%
- Infantile nystagmus syndrome 0.2%
- Congenital blepharophimosis syndrome (BPES) 0.1%
- Congenital fibrosis of the extraocular muscles (CFEOM) 0.1%
- Uveitis 0.1%

8.2 Coverage

All children are invited for vision screening and attendance to visual screening is estimated at:

- 1st screening- 100%
- 2nd screening - 99.5%
- 3rd screening - 94%
- 4th screening - 89.1%
- 5th screening - 84.1%

Attendance to VA measurement is estimated at:

- 1st screening - 90%
- 2nd screening - 89.1%
- 3rd screening - 84.1%

8.3 Screening evaluation

There is no national registration or documentation of noncompliance with referral after an abnormal screening test result. Groenewoud et al. (2010) found that:

- The percentage of compliance with referral after an abnormal screening test result was 73.62%, with 26.38% not attending referral for diagnostic assessment.
- The percentage of false negatives was 0.91%
- The percentage of false positive was 0.91%
- The positive predictive value was 91%

The diagnosis of amblyopia was made when the children were age 7-years, at the final examination of the study, 2964 children attended that extra screen, 27 of which had a false negative screen result but were diagnosed with amblyopia in this extra screen.

de Koning et al. (2013) investigated the effectiveness of screening for amblyopia and other eye disorders in a prospective 7-year birth cohort study (n=4,624) using the same dataset as the previously mentioned Groenewoud (2010) study. They report:

- The sensitivity of the Dutch vision screening programme was 73% at age 7 years



- The specificity of the Dutch vision screening programme was 83% at age 7 years

It is estimated, based on the data from Groenewoud (2010) that within the 200,000 newborn in Netherlands per year, there was approximately 6,000 (3%) new amblyopia cases, 4,000 (2%) new strabismus cases and 120 (0.06%) new congenital cataract cases.

8.4 Treatment success

The number of children treated for strabismus and amblyopia was also determined by Groenewoud et al. (2010) as follows:

- The percentage of children treated for strabismus, after being screened before the age of 7 years is 0.0145%
- The percentage of all children treated for strabismus is 1.69%
- The percentage of children treated for amblyopia, after being screened before the age of 7 years is 2.46%
- The percentage of all children treated for amblyopia is 3.37%
- The distribution of strabismic, refractive, combined-mechanism and deprivation amblyopia are:
 - strabismic amblyopia 22%
 - refractive amblyopia 34%
 - combined-mechanism amblyopia 34%
 - deprivation amblyopia 7%
 - unknown 3%



9 Costs of vision screening in children

9.1 Cost of vision screening

The maximum salary costs per year for vision screening professionals is 44,000 Euros and 93 Euros per hour. The cost to train a nurse is estimated at between 10,000 and 18,000 Euros and for a doctor this rises to between 40,000 and 60,000 Euros. The total screening costs per year and per child per year for vision screening is not known. The total annual cost of all screening:

- 433 million Euros annual costs (323 million from municipalities and 110 million from vaccination programmes)
- Total screening cost for all screening (not just vision) is 108 Euros, per year, per child

9.2 Cost of treatment for amblyopia

All treatments are covered by health insurance; the local municipality, who receive a municipality fund from the national government, pays child healthcare centres. However, glasses will cost the parents between 100 and 600 Euros per pair, unless the prescription rises above 6 dioptre spheres and the actual cost to parents will depend on the individual's health insurance. Special regulations are in place concerning any hyperopic correction in case of accommodative esotropia. Specifically, the treating orthoptists states in a letter to the insurance company that this child has accommodative esotropia or congenital cataracts, after that, the insurance company pays for the glasses/contact lenses.

9.3 Cost of Treatment for strabismus

The estimated costs for strabismus surgery, including follow-up:

- Average total of 2,045 Euros
- Ophthalmologist (1 year) costs: 700 Euros
- Orthoptist (2 years) costs (10 visits): 800 Euros

9.4 Cost of treatment for cataract

The estimated costs for congenital cataract surgery, including follow up of deprivation amblyopia:

- Surgery and visits round surgery: 635-2,146 Euros.
- Glasses (6 pairs during 10 years) 6 pairs at 500 Euros each: Total cost = 3,000 Euros
- Visits 2x per year ophthalmologist at 700 Euros over 10 years: Total cost = 7,000 Euros
- Visits 6x per year over first 5 years orthoptist: 30 visits at 80 Euros: Total cost = 2,400 Euros
- Visits 2x per year over second 5 years orthoptist: 10 visits at 80 Euros: Total cost = 800 Euros

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