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Summary Vision Screening Data: Israel

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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

NGOs Non-Governmental Organisations

PM Pursuit Movements

PPP Purchasing Power Parity

PPV Positive Predictive Value

PR Pupillary Reflexes

RE Retinal Examination

ROP Retinopathy of Prematurity

RR Red Reflex Testing

SV Stereopsis

VA Visual Acuity

WHO World Health Organisation

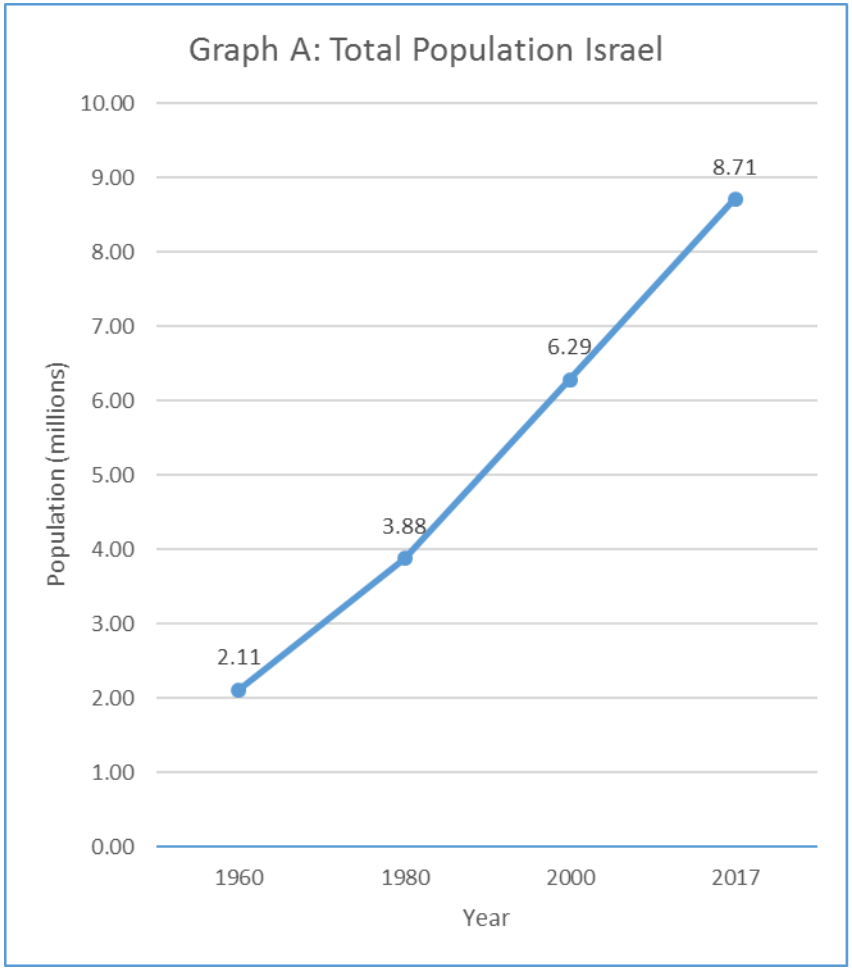
3 Population and Healthcare Overview

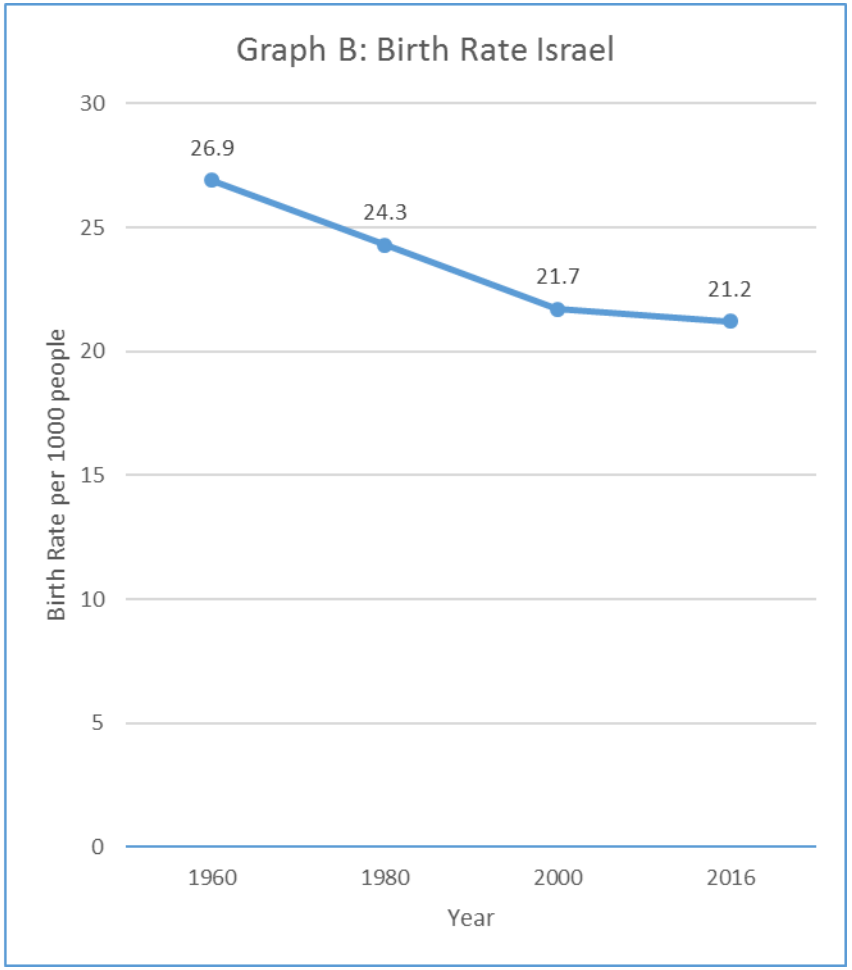
The population of Israel is 8,712,400 (World Bank, 2018a) and birth rate is estimated at 21.2 births/1,000 population in 2016 (World Bank, 2018b). The change in population and birth rate from 1960 to 2017 is shown in Figure 1, graphs A and B respectively.

Israel has a reported population density of 403 people per square kilometre in 2017 and this has risen from 101 people per square kilometre in 1961 (World Bank, 2018c). In terms of healthcare facilities, the total density of hospitals in 2013 was 0.56 per 100,000 population (WHO, 2016a). Infant mortality in 2017 is estimated at 2.9 deaths/1,000 live births in total (World Bank, 2018d).

The average life expectancy in Israel is estimated at 82.4 years (World Bank, 2018e), with a death rate of 5.1 deaths/1,000 population in 2016 (World Bank, 2018f). Israel has a gross national income per capita (PPP int. $, 2013) of $32,000 (WHO, 2016b) – however, information provided by the country representative states that this is $40,272. The estimated total expenditure on health per capita in 2014) was $2,599 (Intl $) and the total expenditure on health in 2014 as percentage of GDP was 7.8% (WHO, 2016b).

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





Source: Information sourced from World Bank (2018)

4. Vision Screening Commissioning and Guidance

In Israel, vision screening is conducted either regionally or nationally depending on the age group and target condition. All regions provide some type of vision screening, but there are differences between protocols. Funding differs between regions and is provided through charity, health insurance, municipalities and the state.

National vision screening is embedded into a general preventative child healthcare screening system. Decisions on what is provided are made with input from a professional advisory board. In the case of national screening there is also input from public health experts. The vision screening programme is only reviewed when a change is needed; any revisions are decided upon by the Public Health Service within the Israel Ministry of Health, based on discussions and expert opinion. Vision screening was implemented in 1983 and has changed since then; there has been update to the pass/fail criteria.

Nationally organised vision screening consists of:

- In first grade there is nationally organised visual acuity screening.
- Developmental vision screening is nationally organised and funded by the government as general preventive childcare.

Regionally organised screening consists of:

- There are regional initiatives by both non-governmental organisations (NGOs), such as the Lions Club, in collaboration with municipalities, as well as the two large municipalities who run preventive child services to provide vision screening.
- National red reflex screening in neonates is performed in all hospitals and paid for by National Insurance Institute; this pays for all birth related hospitalisations.
- Tel Aviv and Jerusalem municipalities that run preventive child care clinics have vision screening for amblyogenic risk factors in 2-year-old children. These are funded by the municipalities.
- Recently vision screening for amblyogenic risk factors in 2-year-old children that was provided in the Haifa sub-district was discontinued due to a lack of funding; this was originally funded by discretionary governmental funds.
- One health fund (Maccabi) provides ophthalmologic examinations for all 1-year-olds covered by their insurance.
- Two NGOs run photoscreening programs in 20 municipalities. These are funded through a charity.
- The Ministry of Health funds vision screening for first grade children in schools delivered by optometrists.

Orthoptists, ophthalmologists, paediatricians, nurses, lay screeners and optometrists conduct vision screening. For the red reflex screen in the hospital, it is the paediatrician or paediatric resident who does the first and discharge neonatal exam. Public health nurses conduct behavioural screen in Well Child Clinics. Either public health nurses or optometrists conduct visual acuity screening in schools. In the Lions clubs, lay personnel conduct vision screening. It is not known how many there are per million population. Some nurses, optometrists, paediatricians do not screen but could do so with additional training; this is also true for general practitioners (GP) and family doctors. Currently, there is no specific or accredited course that provides training for vision screening professionals.

Whilst there is information available on where and what programmes are implemented, there is no information regarding referral rates or outcomes. There are no methods for quality monitoring imposed by the government. There has been research conducted concerning the vision screening programme in Israel, specifically by Eibschitz-Tsimhoni et al. (2000) which was an evaluation of 1 to 2-year old vision screening for amblyogenic risk factors and Ore et al. (2009) which was an evaluation of the reliability of the E-chart as used with Israeli school children. There has been no cost-effectiveness analysis.

5. Screening programme

The target conditions screened for by vision screening include cataract and other opacities at birth, reduced strabismus, visual acuity caused by either amblyopia or refractive error. The health care professionals delivering vision screening, venue for screening and tests used vary depending on the age of the child. 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 before discharge by an ophthalmologist in a neonatal intensive care unit (NICU) in a hospital. Preterm infants treated in NICU undergo an ROP exam. Criteria are less than 32 gestational weeks or less than 1500 grams birth weight, and they are examined at 6 weeks of age.

5.2 Vision screening - Birth to 3 months

Well, healthy babies up to the age of 3 months are screened by a paediatrician or a nurse in a hospital or a child healthcare centre. The tests conducted at this age include eye inspection, fixation, red reflex testing (paediatrician), eye motility and pursuit movement. Eye inspection and red reflex are conducted at the neonatal exam following birth. A developmental exam is conducted by nurses in well child clinics, this includes: fixation at 1 and 2 months of age, horizontal pursuit movements at 2 months. After one abnormal or one inconclusive test result babies are referred to an ophthalmologist if there is no red reflex or no fixation.

5.3 Vision screening - 3 months to 36 months

Children aged 3 to 36 months are screened by either an orthoptist or an optometrist in a child healthcare centre, nursery or kindergarten. The tests conducted include eye inspection, fixation, Hirschberg test and pursuit movements. After one abnormal or one inconclusive test result children are referred to an ophthalmologist if there is evidence of strabismus, or no following of a moving target.

5.4 Vision screening - 36 months to 7 years

Children aged between 36 months and 7 years are screened four times by a nurse, lay screener or an optometrist in a nursery, kindergarten, or school. The tests conducted at this age include visual acuity (VA), cover/uncover (in two municipalities) and automated screening (PlusOptix). Automated screening is conducted in some nursery schools (currently in 20 municipalities) and kindergartens by lay screeners. In one small programme it is performed by optometrists. School VA is performed by the school nurses or optometrists depending upon the provider and the geographic area. It is measured for the first time at 3 years of age, then repeated at ages 4 years, 6 years and 7 years. The optotype charts used to measure

visual acuity include Numbers and Tumbling E at child healthcare centres, and Snellen numbers in schools. These charts are Snellen based, linear format.

Referral criteria at age 3 years are:

- VA less than 6/9 or 2-lines difference
- presence of strabismus

Referral criteria at age 4 years is:

- VA less than 6/12.5 or 2-lines difference

Referral criteria at age 6 are:

- VA of less than 6/9 or 2-lines difference
- presence of strabismus

Referral criteria at age 7 years is:

- visual acuity less than 6/7.5 or 2-lines difference

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

Table 1	Paediatrician	Ophthalmologist	Nurse	Orthoptist	Optometrist	Layscreener
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	**RE**	**EI**	**RR** *Paediatrician*	**EM**	**Fix**	**Hir**	**CT** *2 regions*	**PM**	**VA**	**AS** *20 regions*
Preterm babies	✓	×	×	×	×	×	×	×	×	×
0 to 3 months	×	✓	✓	✓	✓	×	×	×	×	×
3 to 36 months	×	✓	×	×	✓	✓	×	✓	×	×
3 to 7 years	×	×	×	×	×	×	✓	×	✓	✓

Key: *RE: Retinal examination; EI: Eye inspection; RR: Red reflex testing; EM: Eye motility; Fix: Fixation; Hir: Hirschberg, CT: Cover/uncover test; PM: Pursuit movements; VA: Visual acuity; AS: Automated screening*

Table 3: Location of vision screening for each age group

Table 3	**Hospital**	**Child healthcare centre**	**Nursery**	**Kindergarten**	**School**
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.

PlusOptix is used in Israel, the cost of these devices is approximately $10,000 (approximately 8700 Euros, 19/11/2018). The maintenance costs per year and the number of years before the device is scheduled to be replaced are not known.

A total of 20 municipalities are using automated screening. These are used to test children aged between 3-5 years of age in nursery schools. These are used as stand-alone tests, and are used on all children within these areas. Referral criteria are stated as:

- PlusOptix:
    - Hypermetropia of 3 Dioptres and above
    - Anisometropia of 0.75 Dioptres or above
    - Astigmatism of 1.5 Dioptres or above

There is no comparative data between areas that use automated screening and areas that do not.

7. Provision for Visually Impaired

In Israel, there are four special kindergartens and three special schools for blind or severely visually impaired children. It is not known exactly how many children attend these schools. The costs per child for these schools are not available. There is special support for visually impaired children who attend regular mainstream primary school, the Ministry of Health subsidises rehabilitative devices: telescopic and microscope glasses, contact lenses and scleral lenses for children who cannot benefit from regular prescription glasses. The subsidy consists of 75% of the cost of the devices (parents who are below a certain income are not required to pay); children who gain 3 lines of vision beyond the visual acuity achieved with regular prescription lenses are eligible for this benefit. There are also special supplementary teachers for support in mainstream school.

8. Knowledge of existing screening programme

8.1 Prevalence/Diagnosis

There is no data available concerning the prevalence of treated or untreated amblyopia at the age of 7 years. However, a study by Morad et al. (2007) found that at 16 years of age it is 0.98% irrespective of whether or not the individual had been screened or not. This study also found that in a sample of 260,186 Israelis, the prevalence of:

- Anisometropia ≥ 1 D sphere and/or cylinder = 17,226 (6.3%)
- Strabismus = 2,321 (0.89%)
- Strabismus and anisometropia = 442 (0.16%)
- Bilateral myopia ≥7 D = 1,706 (0.65%)
- Bilateral hyperopia ≥4 D = 440 (0.17%)
- Bilateral astigmatism ≥2 D = 2,156 (0.83%)
- Cataract 233 (0.09%)
- Ptosis 125 (0.05%)

The prevalence of strabismus was similarly reported as 0.6% at age 17 years (Shapira et al., 2016). These results are based on a population of 107,608 young adults born between 1971 and 1994 from a computerised database of the northern recruitment centre of Israel.

8.2 Coverage

All neonates born in a hospital are screened. In the first year of life 95% of infants attend preventative child clinics and receive behavioural visual screening. Approximately 50% of the children invited to the visual screening for toddlers (questionnaires, cover/uncover test, rapid manual retinoscopy) in the cities of Tel Aviv and Jerusalem attend. Public health nurses send invitation letters, appointments can also be self-initiated. In summary coverage rates are:

- At birth - Red reflex in hospital: approximately 99%
- First year of life - Behavioural vision screen in preventive care clinics: approximately 95%
- Age 3 to 5 years - VA screen: reported to be very low, no actual data available.
- First grade (6 years of age) - Visual acuity screen: 97%

In a 2014 audit of national data from hospital neonatal discharge records, it was found that at discharge after birth:

- 0.16/1000 live births - congenital cataract
- 0.02/1000 live births - congenital glaucoma
- 0.01/1000 live births – anophthalmia

8.3 Screening evaluation

There is no data available concerning the percentage of false positive, false negative, the positive predictive value (PPV), sensitivity or specificity of screening in Israel. Professional estimates are 1/150 (0.67%) false negatives, 1/150 (0.67%) false positives and 70% PPV for first grade age children.

8.4 Treatment success

There is no information available concerning the percentage of children treated for strabismus or amblyopia before the age of 7 years, or the percentage of compliance with a referral after an abnormal screening test result. However, as with neonatal hearing screening, abnormal red reflex is noted in the neonatal discharge along with the referral and the result of the screening, this is a routine part of the admission questions to preventative care clinics.

The number of patients treated for congenital cataract or strabismus each year is not known.

Ophthalmologists are the only professionals that provide glasses for children under the age of 7 years. Other treatment options include patching, penalisation with glasses, atropine and cataract surgery. All are offered treatment , and the National Health Insurance covers the cost all treatment. However, there are issues of compliance, and to a less degree accessibility in terms of the lengthy waiting times for ophthalmologists in certain rural areas.

9. Costs of vision screening in children

9.1 Cost of vision screening

No data is available cornering the salary per year for each professional for vision screening, the costs to train vision screening professionals, the total screening costs per year for vision screening, or the total costs per child per year for vision screening.

9.2 Cost of treatment for amblyopia

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

- 6 clinic visits at 50 Euros each =300 Euros
- Glasses = 150 Euros
- Strabismus surgery = 1000 Euros

9.3 Cost of Treatment for strabismus

The estimated costs for strabismus surgery including follow-up:

- Surgery = 1000 Euro
- 6 Visits = 300 Euro

9.4 Cost of treatment for cataract

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

- 20 visits = 1000 Euros
- Glasses = 250 Euros (bifocal)
- Surgery = 1500 Euro
- Contact lenses = 1000 Euro

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