



Summary Vision Screening Data: Macedonia

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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
AS	Automated Screening
BT	Bagolini Test
CT	Cover Test
CV	Colour Vision
EI	Eye Inspection
EM	Eye Motility
Fix	Fixation
GDP	Gross Domestic Product
GP	General Practitioner
Hir	Hirschberg test
NICU	Neonatal-intensive care unit
PCT	Prism Cover Test
PM	Pursuit Movements
PPP	Purchasing Power Parity
PR	Pupillary Reflexes
RE	Retinal Examination
Ret	Retinoscopy
ROP	Retinopathy of Prematurity
RR	Red Reflex Testing
USAID	United States Agency for International Development
VA	Visual Acuity
WHO	World Health Organisation
WT	Worth Test



3 Population and Healthcare Overview

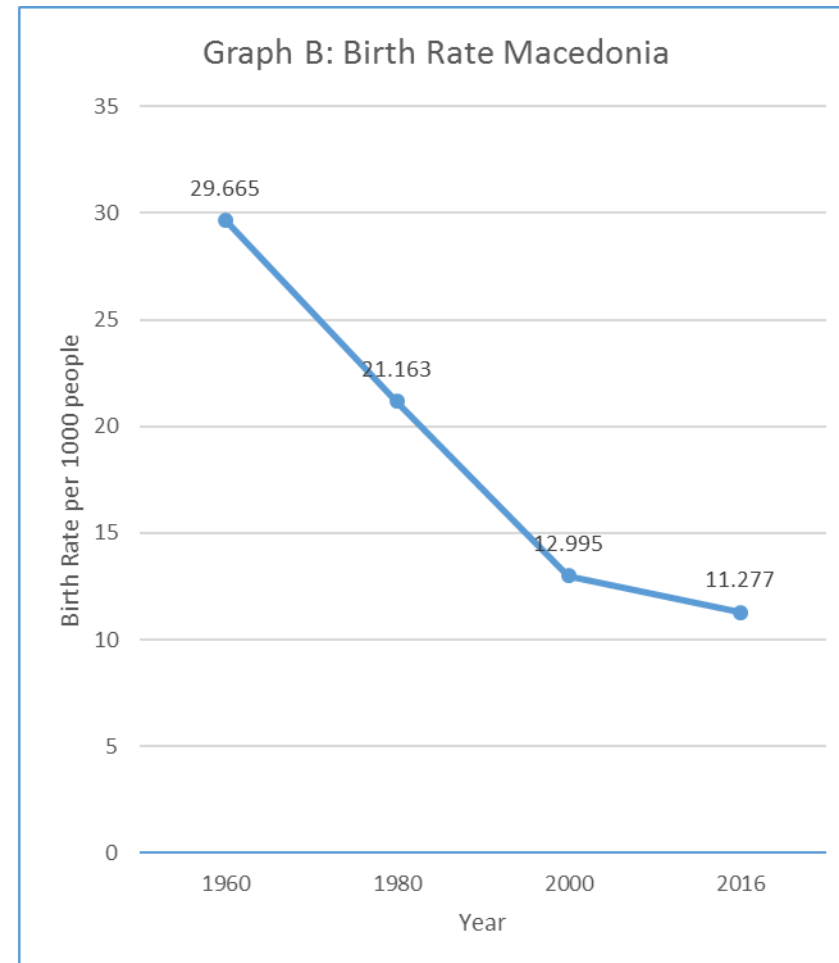
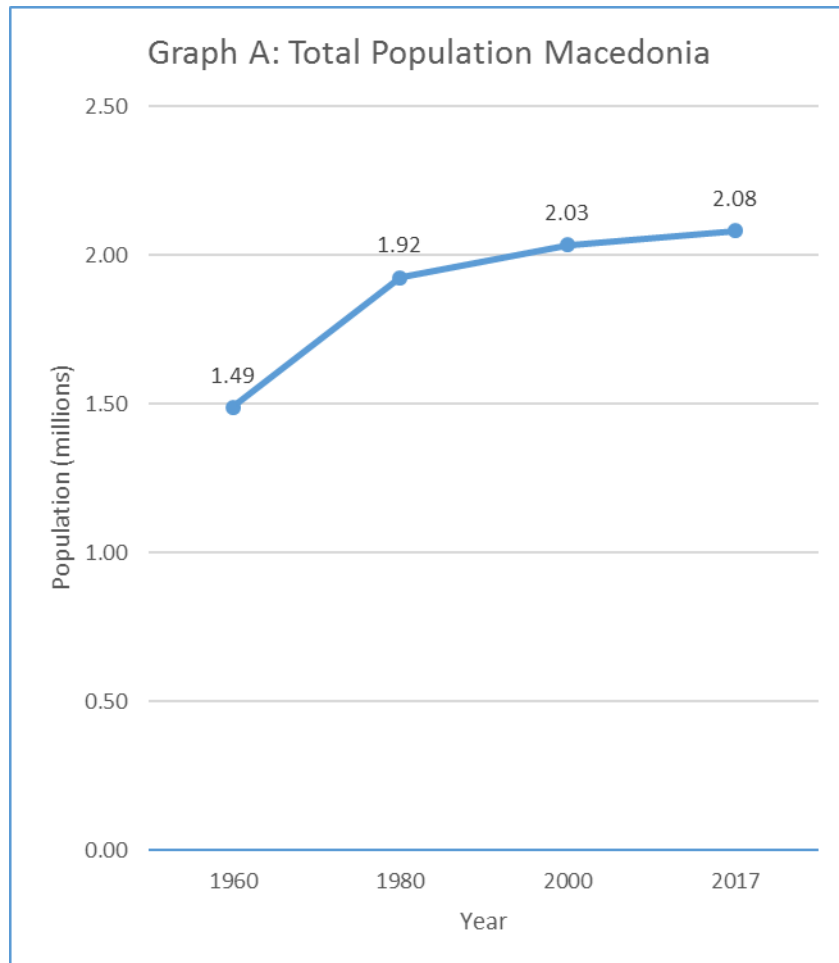
The population of Macedonia is 2,083,160 (World Bank, 2018a) and birth rate is estimated at 11.28 births/1,000 population in 2016 (World Bank, 2018b). The change in population and birth rate from 1960 to 2017 is shown in Figure 1, graphs A and B respectively.

Macedonia has a reported population density of 83 people per square kilometre in 2017 and this has risen from 59 people per square kilometre in 1961 (World Bank, 2018c). In terms of healthcare facilities, the total density of hospitals in 2013 was 4.08 per 100,000 population (WHO, 2016a). Infant mortality in 2017 is estimated at 12 deaths/1,000 live births in total (World Bank, 2018d).

The average life expectancy in Macedonia is estimated at 75.6 years (World Bank, 2018e), with a death rate of 9.8 deaths/1,000 population in 2016 (World Bank, 2018f). Macedonia has a gross national income per capita (PPP int. \$, 2013) of \$11,000 (WHO, 2016b). The estimated total expenditure on health per capita in 2014) was \$851 (Intl \$) and the total expenditure on health in 2014 as percentage of GDP was 6.5% (WHO, 2016b).



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



Source: Information sourced from World Bank (2018)



4 Vision Screening Commissioning and Guidance

Vision screening in Macedonia is organised both nationally and regionally, with no variation between protocols. Vision screening is funded through a non-public organisation (the country representative is not able to reveal the name of this) in collaboration with the Ministry of Health and United States Agency for International Development (USAID). Vision problems that are detected on vision screening or eye examinations are treated through funding from public health insurance, however, after 1 year of age, the patient pays 10% of the total cost.

Vision screening is embedded into a general preventative child healthcare screening system. The American Guidelines for Retinopathy of Prematurity (ROP) are used to determine some of the content and guidelines for vision screening. The vision screening programme was started in 2008. There has been no change to the programme since its implementation, however it is reviewed every two years, with paediatric ophthalmologists deciding upon any revisions needed. There is no specific funding for these reviews, it is carried out within the doctor's role.

Vision screening takes place in hospitals, kindergartens and schools and is conducted by ophthalmologists. There are two ophthalmologists that are trained to examine for ROP and a further 6-8 paediatric ophthalmologists that can conduct vision screening. There are general professionals who do not screen, but could do so with additional training, this includes nurses working in eye departments and special needs assistants that work in schools for children with visual impairment. There is specific training provided for vision screening which takes four years to complete. The content of the training is regularly updated, monitored or revalidated and is accredited.

There are no methods of quality monitoring for vision screening imposed by the government and no information is collected. Research has not been conducted concerning the vision screening programme in Macedonia, and there has been no cost-effectiveness analysis.



5 Screening programme

In Macedonia, ROP, congenital eye defects and reduced visual acuity are the vision screening target condition. 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 an ophthalmologist in a neonatology unit of a hospital. The tests used include eye inspection, red reflex testing, eye motility, retinal examination and pupillary reflexes. Every baby of less than 36 to 37 gestational weeks, regardless of birth weight, are screened, as well as any baby with a birth weight ≤ 1250 grams.

5.2 Vision screening - Birth to 3 months

Well, healthy babies up to the age of 3 months are screened by an ophthalmologist in a hospital. The tests used include eye inspection, fixation, red reflex testing, eye motility, retinal examination and pupillary reflexes. Babies are referred for further diagnostic examination after two abnormal or inconclusive test results.

5.3 Vision screening - 3 months to 36 months

Children aged 3 to 36 months are screened by an ophthalmologist at a University Clinic for eye diseases; there are three university eye clinics in Macedonia. The tests that are conducted include eye inspection, fixation, red reflex testing, eye motility, retinal examination, pupillary reflexes and cover test. Children are referred for further diagnostic examination after two abnormal or two inconclusive test results.

5.4 Vision screening - 36 months to 7 years

Children aged from 36 months to 7 years are screened by an ophthalmologist at a University Clinic. The tests that are conducted include eye inspection, fixation, red reflex testing, eye motility, retinal examination, pupillary reflexes, cover test, visual acuity measurement, colour vision and autorefractometry (Topcon RM 8900). The visual acuity measurement is conducted for the first time at 3 years of age using Snellen optotype charts, Tumbling E visual acuity charts and special charts with pictures and symbols, all of which are linear crowded charts. Visual acuity is measured again at 3.5, 4, 5 and 6 years of age; all of which are conducted by an ophthalmologist. All children are offered this screening at each of the ages stated. Children are referred for further diagnostic examination after two abnormal or two inconclusive test results.



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

Table 1	Ophthalmologist
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	Fix	RR	EM	RE	PR	CT	VA	CV	AR
Preterm babies	✓	✗	✓	✓	✓	✓	✗	✗	✗	✗
0 to 3 months	✓	✓	✓	✓	✓	✓	✗	✗	✗	✗
3 to 36 months	✓	✓	✓	✓	✓	✓	✓	✗	✗	✗
3 to 7 years	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓

Key:

EI: Eye Inspection; Fix: Fixation; RR: Red Reflex Testing; EM: Eye Motility; RE: Retinal Examination; PR: Pupillary Reflexes; CT: Cover Test; VA: Visual Acuity Measurement; CV: Colour Vision; AR: Autorefraction



Table 3: Location of vision screening for each age group

Table 3	Hospital	University Eye Disease Clinic
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 Macedonia, automated screening is conducted in some areas using the Topcon RM 8900. The cost of this device is 5,000 Euros. The maintenance costs and years before a replacement is needed are not known.

This test is conducted at age 3 years, with referral for amblyogenic risk factors, including refractive errors, anisometropia, strabismus, media opacity, or reduced stereovision. If a child passes the visual acuity test, but fails the autorefraction, that child will be referred and treated if needed. Testing is conducted on all children, as opposed to a select group who are borderline/fails on visual acuity testing. There is no comparative data between areas that do use this and do not use this device.



7 Provision for Visually Impaired

In Macedonia, there is one school for blind or severely visually impaired children; this is located in Skopje, which has specialised school programmes. There are 50 children, from the age of 7 to 18 years that attend this school. There are also two day centres for children with visual impairment, one in Skopje and one located in Veles (another city in Macedonia). The centre in Skopje caters for children up to 6 years of age and has a capacity up to 15 children. The centre in Veles caters for children up to 18 years of age. However, at the moment there are 6 children from the age of 5-6 years. These children have financial support from the Macedonian Government.



8 Knowledge of existing screening programme

8.1 Prevalence/Diagnosis

There is no data available concerning the prevalence of treated or untreated amblyopia, persistent amblyopia, or strabismus.

8.2 Coverage

It is not known how many children are invited for vision screening; however, every premature baby is invited with a letter by a neonatologist. The coverage and attendance of all vision screening programmes, before the age of 7 years, is not known.

8.3 Screening evaluation

The percentage of false negative results of vision screening is estimated at 2% and the percentage of false positive referrals is estimated at 3%. There is no data pertaining to the positive predictive value of a refer result after vision screening, the sensitivity of vision screening, or the specificity of vision screening.

8.4 Treatment success

The percentage of children attending their referral appointment is not known as there is no registration documentation of noncompliance with referral after an abnormal screening test result. It is estimated that all children who are identified as having strabismus, before the age of 7 to 8 years, are treated. The same is true for children with amblyopia. It is estimated that 7 patients per year are treated for congenital cataract and amblyopia with strabismus per year, by an ophthalmologist. However, there is no data available concerning the success of treatment or the number of children who go untreated, per year.

Children who fail testing are referred to an ophthalmologist who is the only professional who prescribes glasses for children under 7 years of age. Other treatment options include patching, penalisation with glasses, atropine and cataract surgery where indicated. Not all children are treated due to capacity problems and also payment problems.



9 Costs of vision screening in children

9.1 Cost of vision screening

The monthly salary costs) for vision screening professionals is estimated at 550 Euros. Ophthalmologists get paid 5 to 8 Euros per hour in Macedonia. Training of general preventative child healthcare professionals is not known, there is no access to this data.

9.2 Cost of treatment for amblyopia

The estimated costs for treatment of typical patients with refractive amblyopia and strabismic amblyopia, including follow-up is not known. In Macedonia, for a child under the age of 1 year, there is no payment needed for treatment, follow-up or for surgery as this is covered by public state health insurance. After the age of 1 year, for medical examinations, the patient pays 10% of the total cost and 90% is covered by public state health insurance. The total cost is dependent on the number of visits to the ophthalmologist, this data is not available.

9.3 Cost of Treatment for strabismus

The estimated costs for strabismus surgery, including follow-up is 300 Euros. Patients under public health insurance pay 30 Euros and the remaining 270 Euros is covered by the insurance.

9.4 Cost of treatment for cataract

The estimated costs for congenital cataract surgery. Including follow-up of deprivation amblyopia is 450 Euros in public hospitals; the patient pays 45 Euros and the rest is covered by public health insurance. The cost in a private hospital rises to 1,000 Euros.



10 References

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