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Polish Ophthalmic and Pediatric Society consensus statement on vision screening of school-age children

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ABSTRACT

The most common cause of reduced visual acuity in children is uncorrected refractive errors. Unlike adults, the symptoms of various ophthalmic diseases and refractive errors in children can go unnoticed for a long time. Therefore, vision screening in children is an essential part of prophylactic procedures to immediate diagnose and treat refractive errors. The article presents the consensus of the Polish Ophthalmic Society and the Polish Pediatric Society on recommended eye examinations for school-age children.

KEY WORDS: amblyopia, refractive error, hiperopia, myopia, vision screening, development of vision in children.

INTRODUCTION

According to the World Health Organization (WHO), about 153 million people worldwide are visually impaired as a result of uncorrected refractive errors. Children also belong to this population [1, 2]. The development of vision is a dynamic process and the first two years of a child's life are the most important and critical for his or her future vision [3]. Unlike adults, children with unilateral and bilateral visual impairments may function well and not show visual disturbances in this regard. Visual abnormalities in children most often remain asymptomatic for a long time. It should be remembered that if visual abnormalities are detected too late they cannot be treated. It may lead to amblyopia, which means reduced vision in a structurally normal eye secondary to abnormal visual experience early in life. Amblyopia is one of the major health problems in childhood, because if not detected before 7 years of age, it leads to irreversible visual impairment in adult life, impaired binocular vision and even practical blindness in one eye [4].

The main cause of childhood visual impairments is refractive errors, which are responsible for 56-94% of amblyopia cases [5-7]. The type of refractive errors is age-dependent. Hyperopia is typical of infants, gradually decreasing towards emmetropia [7, 8]. Early development of emmetropia is a risk

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factor for the occurrence of myopia. Uncorrected refractive errors affect general development, resulting in lower educational achievements and impairment of learning abilities [4, 8-10].

Normal visual acuity is of special importance, particularly at the beginning of the school education. Taking into consideration the amount of close-distance visual activities performed at school and at home, the assessment of close-distance vision is indispensable.

Hyperopia is the most common refractive error diagnosed in early childhood and occurs in up to 14% of preschool children [11]. Uncorrected hyperopia in childhood can result in amblyopia and spatial orientation problems [11, 12]. Uncorrected hyperopia in toddlers and school children may lead to educational difficulties and mobility problems [7, 9, 10]. The constant accommodation effort to overcome uncorrected hyperopia may result in strabismus at any age [13]. Constant accommodation effort exercised for close-distance vision activities may also end up in headache and eye discomfort [14-17]. The discrepancy in refractive errors of both eyes exceeding 3-4 diopters may cause decreased visual acuity and sometimes irreversible amblyopia.

Currently myopia has become a serious and growing health problem [18]. The global prevalence of myopia has been estimated at two billion and is projected to rise to five billion by 2050, which will account for half the world's population [19]. Myopia, in addition to being a refractive error, also increases the risk of disorders such as retinal detachment, retinal degenerations, choroidal neovascularization, glaucoma and cataracts, which can even lead to blindness [20-22].

Nowadays, more and more children use computers or other electronic devices for many hours with high eye strain, which adversely affects the condition of the eye, and consequently promotes the development of myopia. In addition, children spend less and less time outdoors in natural lighting, which also increases the risk of development and progression of myopia [23, 24].

Anisometropia, depending on the value of the difference in the refractive error between the right and left eye, can lead to amblyopia and cause various degrees of difficulties in the development of stereoscopic vision. Although amblyopia is caused by ophthalmic disorders, it develops in the area of the visual centers of the occipital cortex. Anisometropia and amblyopia, not detected early enough, cause visual disability, limiting the possibility of education and employment in professions requiring full stereoscopic vision [25, 26].

Besides visual impairment, there are other, equally important and dangerous diseases of the eyeball in children, such as congenital cataracts and retinoblastoma. It is possible to treat these diseases effectively if they are detected at an early stage of development. Although the incidence of retinoblastoma and cataracts is low, the consequences of not treating these diseases are very serious.

Globally, annual economic losses related to uncorrected refractive errors are estimated to be at least USD 202 billion [27, 28]. The costs associated with diagnosis, treatment, and lost earning opportunities have been estimated at USD 4 billion in the United States [29, 30].

According to the WHO, effective screening programs are designed to detect serious health problems even in the asymptomatic period. The tests used for screening should be simple, cheap, reliable and accessible, and the diseases screened should be economically viable to treat [31].

Ocular disorders meet the above criteria, and therefore ophthalmic screening tests in children should be performed. The effectiveness of eye treatment in children directly depends on the detection of possible defects at an early stage of development.

The primary goal of screening tests in children is therefore to detect ophthalmic disorders, which will enable early referral to a specialist, implementation of treatment and, as a consequence, avoidance of permanent visual disturbances [4].

SCHEDULE OF OPHTHALMIC SCREENING TESTS IN CHILDREN

Screening at 6-9 weeks of age

The test should be performed after the infant is 6 weeks old, and not later than at 9 weeks old.

The examination is carried out by a physician as part of primary health care, during a patronage visit.

1. External assessment of the eyelids and eyeballs

During the examination, the following should be assessed:

- whether the eyelids are symmetrical and there is no ptosis,
- whether there are no defects in the skin of the eyelids (exclusion of a congenital eyelid fissure),
- whether both eyeballs remain in the orbit,
- whether the eyeballs are symmetrical,
- whether the corneas are translucent.

2. Test of red reflex from the fundus

The examination should be carried out in a darkened room, which will cause the maximum possible dilatation of the pupils of the child. Both of the child's eyes should be illuminated simultaneously to assess the reflex visible in the pupil.

The subject of the test is: the color, shape and symmetry of the reflex from the fundus. Correct reflex should be of the same color (red, red-orange), lightness and shape in both eyes.

Any brighter reflection, white reflex (leukocoria) or no reflex from the fundus, as well as asymmetrical reflection or deformation of its shape, should be considered as an abnormality.

3. Assessment of patency of the tear ducts

During the examination, the site of projection of the lacrimal sac is assessed, i.e. the medial edge of the lower eyelid – the tear groove formed by the lacrimal bone, frontal bone and the maxillary bone process.

Pay attention to:
- skin color,
- the existence of possible embossing,
- excessive heat,
- lacrimation, tear stagnation in the conjunctival sac,
- the presence of purulent discharge on the edges of the eyelids, eyelashes and in the conjunctival sac.

4. Assessment of fixation abilities

From a distance of 1-1.5 m from the child, an object – a bright-colored toy (red, green, orange or yellow) – should be shown, and then slowly moved horizontally and vertically. During the test, the ability to fix the eyesight on the stimulus and to follow it is assessed.

Screening at 6-8 months of age

The test should be performed after the age of 6 months, not later than at 8 months.

The examination is carried out by a primary care physician during a vaccination visit.

1. Hirschberg light reflex test

A test based on the observation of the position of light reflections on the cornea.

From a distance of 30-50 cm, both eyes of the child should be illuminated simultaneously. The examiner observes the positions of light reflections located on the corneas. Reflections of light should be at the same points in both eyes; they should be symmetrical, centered, not shifted in relation to each other. This test is performed using a diagnostic flashlight or an ophthalmoscope.

2. Test of red reflex from the fundus

The examination should be carried out in a darkened room, which will cause the maximum possible dilatation of the pupils of the child. Both of the child's eyes should be illuminated simultaneously to assess the reflex visible in the pupil.

The subject of the test is: the color, shape and symmetry of the reflex from the fundus. Correct reflex should be of the same color (red, red-orange), lightness and shape in both eyes.

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Pay attention to:
- skin color,
- the existence of possible embossing,
- excessive heat,
- lacrimation, tear stagnation in the conjunctival sac,
- the presence of purulent discharge on the edges of the eyelids, eyelashes and in the conjunctival sac.

Screening at 3-4 years of age

The test should be performed after the age of 3 years and not later than at 4 years.

The test is carried out independently by a primary care physician and a nurse in kindergarten.

The examination should be performed during a preventive medical examination – health balance of a 4-year-old.

1. Visual acuity test

Visual acuity testing should be performed using Snellen charts. Each of the tables contains appropriate symbols (optotypes) arranged appropriately in lines from the largest to the smallest. Charts with appropriate optotypes should be selected for the examination, depending on the age and knowledge of numbers, letters or pictures by the child. The visual acuity test identifies the indicated optotypes in order: from the highest order to the lowest. The test should be performed separately for each eye, from a distance of 5 m. Attention should be paid to whether the unexamined eye is completely covered. Visual acuity is recorded as a fraction. In the denominator, enter the value next to the last row of optotypes correctly recognized by the patient, and in the numerator, the distance from which the child reads the marks (5 m). If the subject correctly reads the optotypes from the lowest, last row, it means that he or she has full visual acuity.

2. Cover/uncover test

During the examination, the child should be instructed to look at an object about 5-6 m away. The examiner covers the child's right eye and at the same time observes the left eye to detect possible fixation movements. He repeats the procedure for the other eye, observing the possible adjustment movement of the right eye. Lack of eye movement indicates their correct positioning. Movement of the eye when it is exposed indicates improper positioning of the eyeballs and may be used to detect strabismus, including hidden strabismus.

Maintenance of proper fixation by the child during the test seems to be crucial for a successful test. It should be remembered that during the examination, the child should have both eyes open (including the eye covered by the examiner's hand). The test can be done with one's own hand, paper, or another cover.

3. Assessment of color vision

The test is performed in bright lighting conditions from a distance of about 50 cm. For the examination, it is necessary to use Ishihara tables in the form of a book or a single sheet of paper. Each board consists of a circle with a system of small circles of a different color compared to the background, forming numbers or irregular lines. The first digit in the tables is seen by both healthy people and people suffering from color vision disorders; it is used to detect the simulating person. During the examination, the child has

to read the numbers on the boards. Younger children, who do not know the numbers, should be examined with the help of tables containing irregular lines – the child follows a finger from the starting point to the end on a line marked with a color other than the background.

Screening at 6-7 years of age

The test should be performed after the age of 6 years and not later than at 7 years.

Table I. Recommended schedule for child vision screenings

Age of the child	Recommended tests
6-9 weeks of age	External assessment of the eyelids and eyeballs Test of red reflex from the fundus Assessment of patency of the tear ducts Assessment of fixation abilities
6-8 months of age	Hirschberg light reflex test Test of red reflex from the fundus Assessment of patency of the tear ducts
3-4 years of age	Visual acuity test Cover/uncover test Assessment of color vision
6-7 years of age	Visual acuity test Cover/uncover test Assessment of color vision
12- 13 years of age	Visual acuity test Cover/uncover test Assessment of color vision

The test is carried out independently by a primary care physician and a nurse in kindergarten/primary school.

The examination should be performed during a preventive medical examination – health balance of a 6-year-old.

1. Visual acuity test

Visual acuity testing should be performed using Snellen charts. Each of the tables contains appropriate symbols (optotypes) arranged appropriately in lines from the largest to the smallest. Charts with appropriate optotypes should be selected for the examination, depending on the child's age and knowledge of numbers, letters or pictures. The visual acuity test identifies the indicated optotypes in order from the highest to the lowest. The test should be performed separately for each eye, from a distance of 5 m. Attention should be paid to whether the unexamined eye is completely covered. Visual acuity is recorded as a fraction. In the denominator, one should enter the value next to the last row of optotypes correctly recognized by the patient, and in the numerator, the distance from which the child reads the marks (5 m). If the subject correctly reads the optotypes from the lowest, last row, it means that he or she has full visual acuity.

2. Cover/uncover test

During the examination, the child should be instructed to look at an object about 5-6 m away. The examiner covers the child's right eye and at the same time observes the left eye to detect possible fixation movements. He repeats the procedure for the other eye, observing the possible adjustment movement of the right eye. Lack of eye movement indicates their correct positioning. Movement of the eye when

Table II. Recommended ophthalmic examinations performed by primary care physician and/or nurse

A primary care physician	A nurse in kindergarten/school
Screening at 6-9 weeks of age External assessment of the eyelids and eyeballs Test of red reflex from the fundus Assessment of patency of the tear ducts Assessment of fixation abilities	
Screening at 6-8 months of the child's life Hirschberg light reflex test Test of red reflex from the fundus Assessment of patency of the tear ducts	
Screening at 3-4 years of age Visual acuity test Cover/uncover test Assessment of color vision	**Screening at 3-4 years of age** Visual acuity test Cover/uncover test Assessment of color vision
Screening at 6-7 years of age Visual acuity test Cover/uncover test Assessment of color vision	Screening at 6-7 years of age Visual acuity test Cover/uncover test Assessment of color vision
Screening at 12-13 years of age Visual acuity test Cover/uncover test Assessment of color vision	Screening at 12-13 years of age Visual acuity test Cover/uncover test Assessment of color vision

it is exposed indicates improper positioning of the eyeballs and may be used to detect strabismus, including hidden strabismus.

Maintenance of proper fixation by the child during the test seems to be crucial for a successful test. It should be remembered that during the examination, the child should have both eyes open (including the eye covered by the examiner's hand). The test can be done with one's own hand, paper, or another cover.

3. Assessment of color vision

The test is performed in bright lighting conditions from a distance of about 50 cm. For the examination, it is necessary to use Ishihara tables in the form of a book or a single sheet of paper. Each board consists of a circle with a system of small circles of a different color compared to the background, forming numbers or irregular lines. The first digit in the tables is seen by both healthy people and people suffering from color vision disorders; it is used to detect the simulating person. During the examination, the child has to read the numbers on the boards. Younger children, who do not know the numbers, should be examined with the help of tables containing irregular lines – the child follows a finger from the starting point to the end on a line marked with a color other than the background.

Screening at 12-13 years of age

The test should be performed after the age of 12 years and not later than at 13 years.

The test is carried out independently by a primary care physician and a nurse in school.

The examination should be performed during a preventive medical examination – health balance of a 12-year-old.

1. Visual acuity test

Visual acuity testing should be performed using Snellen charts. Each of the tables contains appropriate symbols (optotypes) arranged appropriately in lines from the largest to the smallest. Charts with appropriate optotypes should be selected for the examination, depending on the child's age and knowledge of numbers, letters or pictures. The visual acuity test identifies the indicated optotypes in order from the highest to the lowest. The test should be performed separately for each eye, from a distance of 5 m. Attention should be paid to whether the unexamined eye is completely covered. Visual acuity is recorded as a fraction. In the denominator, one should enter the value next to the last row of optotypes correctly recognized by the patient, and in the numerator, the distance from which the child reads the marks (5 m). If the subject correctly reads the optotypes from the lowest, last row, it means that he or she has full visual acuity.

2. Cover/uncover test

During the examination, the child should be instructed to look at an object about 5-6 m away. The examiner covers the child's right eye and at the same time observes the left eye to detect possible fixation movements. He repeats the procedure for the other eye, observing the possible adjustment movement of the right eye. Lack of eye movement indicates their correct positioning. Movement of the eye when it is exposed indicates improper positioning of the eyeballs and may be used to detect strabismus, including hidden strabismus.

Maintenance of proper fixation by the child during the test seems to be crucial for a successful test. It should be remembered that during the examination, the child should have both eyes open (including the eye covered by the examiner's hand). The test can be done with one's own hand, paper, or another cover.

3. Assessment of color vision

The test is performed in bright lighting conditions from a distance of about 50 cm. For the examination, it is necessary to use Ishihara tables in the form of a book or a single sheet of paper. Each board consists of a circle with a system of small circles of a different color compared to the background, forming numbers or irregular lines. The first digit in the tables is seen by both healthy people and people suffering from color vision disorders; it is used to detect the simulating person. During the examination, the child has to read the numbers on the boards. Younger children, who do not know the numbers, should be examined with the help of tables containing irregular lines – the child follows a finger from the starting point to the end on a line marked with a color other than the background. Preterm babies, up to the age of 3, are examined in accordance with the guidelines – "Management of retinopathy of premature babies – indications developed by the Expert Team of the Pediatric Ophthalmology Section of the Polish Ophthalmology Society".

CONCLUSIONS

Visual screening is effective in detecting visual and ocular disorders. Most conditions should be detected by the age of 6 years. Observation for signs and symptoms of vision problems and visual acuity screening are necessary in order to detect visual disorders and refractive errors, such as myopia, hyperopia, and astigmatism at any age. Screening for distance visual acuity can detect myopia, amblyopia and astigmatism.

School vision screening programs are not universal for all European countries. Screening should be a part of the primary school health program and the target population should be children entering primary schools. Follow-up with vision referrals is the most important component of a vision screening program and often the most difficult task and the most time-consuming one.

DISCLOSURE

The authors declare no conflicts of interest.

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