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Simple screening tests as a tool for early diagnosis of vision problems

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Abstract

Purpose. *In Poland, approximately 400,000 individuals are affected by glaucoma and 1.5 million by age-related macular degeneration (AMD). Early detection is essential for managing these conditions effectively.* **Aim.** *The aim of this study was to perform screening for visual impairments and evaluate the state of ocular vision in Polish population.* **Materials and Methods.** *A screening study was conducted with 373 participants during a preventive event from December 9-11, 2023. An anonymous questionnaire covering demographics and health conditions preceded five screening tests: a preliminary visual field test, Amsler test, dominant eye test, non-invasive tear film break-up test, and cover-uncover test.* **Results.** *The majority of participants (64.5%) were women, with a median age of 21 years. Myopia was reported by 32.7% of respondents, particularly among those aged 19-35, who also spent significant time on screens and reported limited sleep. The preliminary visual field test identified visual disturbances in 4.8% of patients, while 29% showed tear film instability. The Amsler test indicated potential macular issues in one-third of seniors, especially among those with hypertension. Eye dominance was observed in 64.4% of participants favoring the right eye, and the cover-uncover test revealed eye movement disorders in 5% of cases.* **Conclusions.** *Effective screening tests are vital for early detection and management of eye diseases, particularly in at-risk populations. The findings highlight the need for regular eye examinations to prevent vision loss and maintain ocular health. (Gerontol Pol 2025; 33; 10-17) doi: 10.53139/GP.20253309*

Keywords: *screening tests; myopia; AMD; dry eye disease; strabismus.*

Introduction

Nowadays, more and more attention is paid to the prevention and early detection of diseases, including those related to the eye. Screening tests play an important role in identifying potential eye problems, allowing for quick diagnosis and implementation of appropriate treatment. According to estimates by the World Health Organization, 2.2 billion people worldwide suffer from vision impairment or vision loss, of which at least half could have been prevented [1]. Currently, approximately 400,000 people in Poland suffer from glaucoma and 1.5 million from Age-related macular degeneration (AMD) [2]. Glaucomas are a group of eye conditions leading to the damage of the optic nerve and retinal ganglion cells and finally to irreversible sight loss. The disease cannot be cured but early detection allows for the implementation of therapy that delays the progression of the illness. The main method of treatment is lowering the intraocular pressure through laser treatment, the use of topical medications, and surgery [3]. AMD is a progressive chronic disease causing loss of central vision. There are two types of AMD: neovascular and nonneovascular AMD. Nonneovascular AMD is an early stage of the illness, which is characterized by a slow breakdown of photoreceptor cells in the macula, and the field of central vision gradually blurs. This condition may progress to neovascular AMD, which is identified by hemorrhaging and exudates in the retina and blindness. Early detection and management with lifestyle modifications can help with preserving visual acuity and slowing down the development of the disease. Additionally, early implementation of anti-VEGF agents in neovascular AMD can help preserve visual acuity [4,5]. Screening tests should be

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characterized by high sensitivity. This allows us to minimize the number of false negatives. A positive result should always be a signal to perform more advanced and precise diagnostic tests [6]. Our study was an attempt to investigate the efficacy of screening tests widely used in ophthalmology: the preliminary visual field test, Amsler test, dominant eye test, non-invasive tear film break-up test, and cover-uncover test.

Materials and Methods

The study was conducted among people who attended our preventive action which was held from 9th to 11th December 2023. The study included 373 participants. Every patient filled out an anonymous questionnaire which was followed by screening tests.

The questionnaire

The survey consisted of 16 closed-ended questions regarding age, gender, level of education, type of work performed, eye conditions (myopia, astigmatism, hyperopia), vision correction, diabetes mellitus, hypertension, cardiovascular diseases (CVD)/incidents, supplements, lifestyle, sleeping habits, screen time, gastroesophageal reflux disease (GERD), cigarette smoking and alcohol consumption.

Screening tests

The preliminary visual field test

The preliminary visual field test was performed using the confrontation method. It involved assessing the patient's field of vision by comparing it to the examiner's. The patient was asked to remove corrective glasses if worn and to sit comfortably in front of the examiner. The examiner observed the patient's responses and recorded any noticeable changes in the visual field, such as deficiencies, restrictions, or disturbances in color perception.

Modified non-invasive tear film break-up test

The patient was told to blink freely for 5 seconds and after this time the stopwatch was started and the patient was instructed not to blink until he felt the urge to blink. The result below 10 seconds suggested an abnormal tear film [7]. Given the limitations, including the unavailability of advanced and costly tools like the Tearscope, keratometers or complex computerized systems (such as videokeratoscopy, ocular surface thermography, or lateral shearing interferometry), we employed a modified non-invasive tear break-up time test.

Amsler test is used to detect retinal damage and rule out AMD. The test was done for each eye separately. The patient covered one eye and set up the test card approximately 30–40 cm from the eyes and focused on the central dot. If the grid appeared wavy or distorted, damage to the macula was suspected.

Dominant eye test

The patient was asked to create a triangle with fingers, direct it on an object in the distance, and close the right eye. If the object remained in the frame, then the left eye was the dominant eye. If the centered object was no longer framed, then the right eye was considered the dominant eye.

A cover-uncover test is useful to detect tropia and discern it from a phoria. The test was performed by covering one eye for a few seconds and then uncovering it. If the eye deviated while covered and adjusting movement was observed when it was uncovered, it was positive for phoria. Tropia was identified when the uncovered eye moved to pick up fixation when the fixing eye was covered.

The obtained results were analyzed. The calculations for this study were performed using STATA software, version 18.0 (StataCorp, California, USA).

Results

In the analyzed group, the majority (64,5%) were women. The youngest person was 9 years old, and the oldest was 86 years old, with median age of 21 years. People under 18 years of age made up 42% of the group. The study group was divided into four age categories:

1. 0-18 (156 patients).
2. 19-35 (113 patients).
3. 36-60 (89 patients).
4. over 60 years old (15 patients).

32.7% of the respondents reported suffering from nearsightedness (myopia). It was observed in 35% of female patients, while 28.6% of the male respondents were affected. Myopia was predominant, especially in the second age group, where as many as 41.6% reported this issue. Chart 1 illustrates the prevalence of myopia by age group (Fig.1). The study shows that this age group spends the most time in front of a computer. Nearly 43% of patients aged 19-35 spend more than 6 hours a day on a computer. Additionally, their sleep rarely exceeds 6 hours, with only 2.5% of respondents in this age group reporting sleep durations over 6 hours.

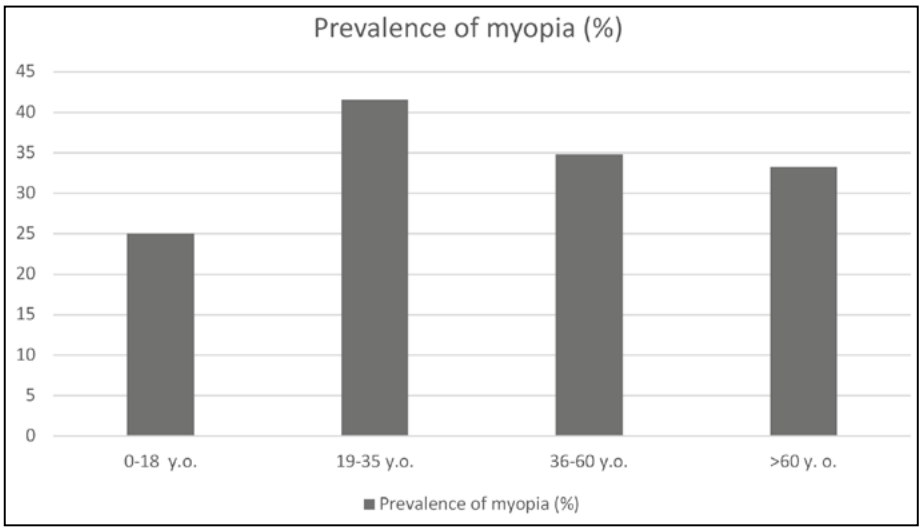

Figure 1. The prevalence of myopia by age group

During the preliminary visual field test using the confrontation method, in 18 cases (4.8% of examined patients), we detected visual disturbances, including defects in specific quadrants of one eye or tunnel vision. In the vast majority of cases, the patients had not received prior ophthalmological treatment, which underscores the importance of screening tests to ensure early intervention when necessary.

We identified 3 cases of tunnel vision among the patients, none of whom were aware of the issue. These patients were males, aged 49, 37, and 24, respectively.

The modified non-invasive break-up time (NBUT) is the time elapsed from the blink, which spreads the tears across the surface of the eye and restores the continuity of the tear film, to the moment when it breaks up. The test helps assess the thickness and quality of the lipid layer of the tear film, which is responsible for maintaining its surface tension and stability. In an ophthalmologist's office, the invasive version of test is usually performed by applying a small amount of fluorescein to the conjunctival sac. In our study, a simplified version of the test was used. 29% of the participants had a tear break-up time of less than 10 seconds, indicating a shortened time and an increased likelihood of lipid layer dysfunction. Six individuals (1,6% of the participants) had a tear breakup time of less than 5 seconds. This result indicates a tear film instability syndrome, caused by lipid layer dysfunction, leading to inadequate lubrication of the eye's surface. The average obtained score varied depending on the age group. For 1st group (children) it was 29 seconds, in age groups 2nd and 3rd it was 18 seconds, and senior age group got an average result of 21 seconds. We also examined how the NBUT test result correlates with the time spent in front of a screen. The results showed us that spending up to 3 hours in front of the screen does not result in a pathological test result and such patients achieved an average of 25 seconds.

However, an increase in the time spent in front of a screen results in a decrease in the scores obtained during the test. This means that the light emitted from phone screens or other devices negatively affects the quality of the tear film and may exacerbate the symptoms of dry eye syndrome. Our patients were asked about the number of hours they sleep in order to determine whether this factor affects the continuity of the tear film.Patients sleeping up to 8 hours achieved an average result of 23.4 seconds. Interestingly, in the group sleeping more than 8 hours, an average NBUT score increased significantly to 41.3 seconds. These findings suggest a correlation between sleep duration and the quality of the tear film, as indicated by the NBUT results. Specifically, while moderate sleep appears to be associated with lower scores, longer sleep durations may improve tear film stability.

The next test we conducted among the patients was the Amsler grid test. One in three seniors we tested received an abnormal result, which may suggest potential issues with the macula, the central part of the retina responsible for sharp, detailed vision. This could indicate conditions such as age-related macular degeneration (AMD), macular edema, or other retinal disorders. Distorted, blurred, or missing areas in the grid are signs that warrant further investigation by an ophthalmologist. Interestingly, nearly half of the patients from all age groups reporting hypertension received abnormal results in the Amsler grid test, which may suggest a potential correlation between elevated blood pressure and retinal or macular dysfunction. This finding highlights the importance of monitoring ocular health in patients with hypertension.

In the eye dominance test, 64.4% of patients showed dominance of the right eye, 27.6% showed dominance

of the left eye, while 8% of the examined individuals did not show dominance of either eye.

By conducting the cover/uncover test, we detected eye movement disorders in 5% of patients. The prevalence according to gender and age group is shown in table I.

Table I. Prevalence of manifest strabismus by gender and age group

	Total n (%)	Manifest strabismus (%)
Total	369 (100)	18 (4.9)
Gender		
Male	131 (35.5)	8 (6.1)
Female	238 (64.5)	10 (4.2)
Age group		
0-18	154 (41.7)	2 (1.3)
19-35	112 (30.4)	8 (7.1)
36-60	88 (23.8)	7 (8)
>60	15 (4.1)	1 (6.7)
Collectively adults (19->60)	215 (58.3)	16 (7.4)

Discussion

Early detection is a very important step in diagnosing and treating the disease. The American Academy of Ophthalmology recommends that adults should have a complete eye exam at least once in their twenties, thirties, and forties. People over 65 should visit an ophthalmologist at least once every year or two [8].

Myopia, the most common form of refractive error, has reached concerning pandemic levels, with projections indicating that it could impact nearly 5 billion individuals in 2050, including around 1 billion people who will be affected by high myopia [9]. A segment of individuals with myopia develop pathologic myopia, marked by abnormal and progressive elongation of the eyeball, which is now recognized as a significant cause of vision impairment and blindness globally [10]. Research indicates that genetic factors provide a baseline level of risk for the development of myopia; children with myopic parents are at a higher risk of developing myopia, with the risk doubling if one parent is myopic and increasing fivefold if both parents are myopic [11]. However, recent findings highlight the significant impact of environmental factors, which have led to an epidemic of myopia in the developed countries of East and Southeast Asia. The prevalence rises in European children starting from ages 7 to 8 [12], with reported rates ranging from 17% to 36% among teenagers of European descent [13,14]. Changes in educational systems, prolonged close-range activity over time and the amount of time children spend outdoors have played a crucial role in the onset of this myopia epidemic and these factors can be modified to support prevention [9,15]. Why is spending time in daylight so crucial? The main hypothesis suggests that light triggers dopamine release in the retina, which in turn prevents the eye from elongating during development [16]. According to Modjtahedi et al., while the existing evidence linking outdoor time to a slowdown in myopia progression is limited, there is compelling evidence that spending time outdoors can delay or prevent the onset of myopia [17]. A study spanning three years found that just 40 minutes of outdoor activity resulted in a notable difference compared to the control group [18]. Additionally, a meta-analysis indicated that each additional hour spent outside each week decreased the risk of myopia progression by 2% [19].

The preliminary visual field test using the confrontation method is a simple and quick screening procedure used in ophthalmology. It involves assessing the patient's field of vision by comparing it to the examiner's, using moving objects or gestures. The patient is asked to remove corrective glasses if worn and to sit comfortably in front of the examiner. The examiner observes the patient's responses and records any noticeable changes in the visual field, such as deficiencies, restrictions, or disturbances in color perception. The confrontation visual field test serves as a screening method and can detect obvious defects in the visual field. If suspicious changes are found, more detailed tests, such as static perimetry, are recommended to confirm the initial diagnosis.

Visual field disturbances can be caused by various eye, neurological, or systemic conditions. These include glaucoma, which often manifests as defects in the peripheral visual field that can progress, leading to significant narrowing of the central visual field. On the other hand, age-related macular degeneration (AMD), which affects sharp vision, can lead to disturbances in the central part of the visual field in advanced cases. Vascular or neurodegenerative brain diseases may cause visual field disturbances due to damage to brain areas responsible for processing visual information. It is also important to note that visual field disturbances can be caused by other factors such as head injuries, brain tumors, infections, developmental abnormalities, or vitamin deficiencies. In case of suspected visual field disorders, it is essential to consult an ophthalmologist for a comprehensive eye examination.

Dry eye disease (DED) is a complex multifactorial condition characterized by the disruption of tear film balance, resulting in a continuous cycle of inflammation

and damage to the ocular surface. The global prevalence of dry eye disease (DED) is estimated to be between 5% and 50%, with variations across different populations and is a serious problem worldwide for the healthcare [20]. Early diagnosis and treatment is important for enhancing patient's comfort and reducing symptoms. Diagnosis typically relies on a combination of the patient's medical history and various clinical tests that identify abnormalities in the tear film or ocular surface. These assessments may involve Ocular Surface Disease Index (OSDI) or other questionnaires, ocular surface staining, lipid layer evaluation, non-invasive tear breakup time (NBUT), tear osmolarity measurements, Schirmer Test, meibography, and examinations of the eyelid [21]. Currently, there is no definitive treatment for this condition, with management typically involving the use of topical eye drops that contain active ingredients and lifestyle changes. Some studies suggest lipid containing eye drops as preferred treatment [22].

Magno et al. reported that patients who experienced poor sleep quality were 50% more likely to suffer from dry eye compared to those with good sleep quality. Additionally, poor sleep quality significantly heightened the risk of experiencing highly symptomatic dry eye in relation to a clinical diagnosis [23]. Hanyuda et al. studied the relationship between DED and unhealthy sleep patterns in the Japanese population. Greater difficulties in falling or staying asleep, as well as waking up feeling tired, were significantly associated with a higher prevalence of dry eye disease (DED) in both genders. In comparison to individuals who slept for 8 hours a day, those who slept less had a higher prevalence of DED in both sexes [24].

Previous studies have shown that the Amsler Grid has moderate sensitivity and specificity in detecting AMD but is an inexpensive and easy-to-use method [25]. Some studies indicated that the test had high sensitivity in detecting patients with moderate to severe vision impairment from glaucoma [26]. A Systematic Review and Meta-analysis conducted by Bjerager et al. showed that the Amsler grid had much lower specificity in the detection of neovascular AMD when control participants were patients with diagnosed non-neovascular AMD in comparison to the situation where the control group consisted of healthy people [27].

Early detection of neovascular AMD allows for the implementation of appropriate treatment. Currently there is no cure for this condition but anti-vascular endothelial growth factor (anti-VEGF) therapy can slow down the progression of the disease [28]. Approved anti-VEGF drugs include pegaptanib, ranibizumab, aflibercept, bevacizumab, brolucizumab, and faricimab, which reduce neovascularization by binding VEGF receptors or blocking VEGF [9]. Many patients can achieve good results that allow them to function normally. It is very important to detect the disease and start treating it as early as possible.

Our analysis showed a high rate of right-eye dominance which is consistent with the results of other studies [29,30]. Wang et al. reported similar findings and also found no association between ocular dominance and spherical equivalent (SE) [29]. Jiang and colleagues demonstrated that individuals with anisometropia exhibited a stronger ocular dominance compared to those without it. Additionally, in myopic anisometropic individuals, the dominant eye was more myopic, while in hyperopic anisometropes, it was less hyperopic [31]. The usefulness of the eye dominance test is especially relevant to the pediatric age group. Children may be at risk for developing amblyopia (commonly known as lazy eye) when there is a significant disparity in the refractive error between their eyes. If the vision is not corrected, the brain tends to "turn off" the eye with the weaker vision. To address amblyopia, the dominant eye is covered with a patch, encouraging the child to use and strengthen the weaker eye [32].

Only a few studies have been conducted concerning the prevalence of manifest strabismus among adults. Oscar Hultman et al. conducted a study using Hirschberg corneal reflex test on 3,785 adults, which demonstrated the prevalence of strabismus in 1.1% of the patients but history of strabismus was found in 4.6% of cases [33]. Hashemi et al. conducted studies with cover test among children over the age of 5 and individuals over the age of 21, reporting strabismus prevalence rates of 4.3% and 4.9%, respectively [34]. There are several factors contributing to the variation in strabismus prevalence across studies. These include differences in examination techniques, the experience of those conducting the tests, and sampling variations. As a result, it's challenging to make definitive comparisons between studies, since methodological differences may account for the observed discrepancies rather than actual differences in population or geographic prevalence [33].

Strabismus is a significant issue, especially in the case of children. Risk factors for developing strabismus in pediatric population include: low birth weight (less than 1250g), a family history of strabismus, and a personal history of congenital eye abnormalities (such as infantile cataracts or retinoblastoma), as well as systemic conditions that can threaten vision and have ocular implications (like pauciarticular juvenile rheumatoid arthritis, which can lead to iritis and cataracts) [35]. Screening in the pediatric age group is extremely important and sho-

uld be done by every primary-care physician. Timely identification of strabismus provides advantages including:

- development or restoration of binocular vision (depth perception),
- removal of double vision,
- restoration of a normal head posture,
- expanded visual field for patients with esotropia,
- improvement of cosmetic appearance [36].

Prompt diagnosis and effective treatment of strabismus in children can enhance visual acuity and binocular single vision, decrease the risk of amblyopia and future misalignment, optimize visual potential, prevent potential visual impairment, and possibly maintain long-term visual quality [37].

This study has some limitations. Firstly, the study excluded the most ill patients because only those who were able to come and participate in the event were included. This could potentially disturb the results. Secondly, the screening tests were performed by many researchers and it could also affect the results.

Conclusions

Screening tests in ophthalmology are aimed not only at detecting existing problems but also at monitoring the health of the eyes, especially in people at risk of visual diseases such as glaucoma, age-related macular degeneration, or strabismus syndromes. Through the effective use of screening tests, it is possible to prevent progressive vision disorders and minimize their negative impact on the patient's daily functioning.

Statements and Declarations

Funding
Not applicable

Conflicts of Interest/Competing Interests
Not applicable

Ethics Approval
The study was conducted in accordance with the Declaration of Helsinki.

Consent to Participate
Informed consent to participate in this study was obtained from all individual participants included in the study.

Consent for Publication
Consent for publication of identifiable data/images was obtained from the individuals involved.

Data Availability
The datasets generated and/or analyzed during the current study are available from the corresponding author upon reasonable request.

Conflict of interest
None

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