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Visual parameters of Polish special schools students

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The purpose of this study was to coduct a visual screening of students in special schools with a set of tests chosen by the faculty and staff of the Department of Optometry and Visual System Biology of Poznań University of Medical Sciences. Students mentally handicapped ($N = 318$) between the age of 7 and 22 (mean age 14.4 ± 2.84) were screened. Group 1 were children aged 7 to 12 ($n = 65$), group 2 were subjects aged 13 to 16 ($n = 167$) and group 3 included people aged between 17 and 22 ($n = 86$). The scope of the screening included: auto-refractometer (Shin-Nippon A type) without cycloplegia, visual acuity for distance, positive lens test +1.00 D (diopter), spatial vision (stereo) at near, color vision and near point of convergence. 72 children (22.6%) were prescribed correction, but only 30 children actually wore glasses on a permanent basis (9.4%). Of those not using correction ($n = 288$): in group 1 the adopted criteria for visual acuity for the right eye were not met by the 38% of the respondents or 35% for the left eye; group 2 – 36% of the respondents failed (right eye) and 31% (left eye); 50% of students in group 3 did not meet the visual acuity criterion. Stereo was failed in groups 1 and 3 by almost 60% while in group 2 the test was failed by 47% of the respondents. The results of the refraction revealed a small degree of myopia in each eye of 38% in the entire sample. Hyperopia was found in 42% (right eye) of the students whereas 44% (left eye) in the entire sample. Astigmatism ranging from 0.75 to 2.00 D was noted in the case of 32% of people. This study indicates the need for a systematic vision screening, more than just visual acuity at distance, among the students in special schools.

Keywords: refractive errors, spatial vision, special schools, vision screening, visual acuity.

1. Introduction

A smoothly functioning visual system is one of the most important factors affecting the normal development and learning of a child. This fact is confirmed by research papers that have studied the ocular motility, accommodative and binocular vision and their influence on achieving the child's full academic maturity success in further educational steps [1–5]. The special school student is required to work harder than their healthy peers.

One of the objectives is also a child's adaptation to living in society. Multi-stage and complex rehabilitation of a mentally disabled child with vision problems should certainly receive adequate vision care. It is important to identify these children. One such way is a screening. The scope of such a screening should be wide enough to allow

evaluation of all the parameters relevant to the proper functioning of the visual system. Screening tests cannot diagnose a disease or irregularities in detail, but they can reveal those who do not meet accepted criteria, thus allowing the referral for a further specialized examination. Numerous studies of retarded patients prove that the occurrence of different types of visual anomaly is very common in this group. WOODRUFF *et al*. showed that over 49% of mentally disabled people required some spherical correction (myopia or hyperopia), whereas 37% had astigmatism [6]. Visual problems are high among people with mental illnesses (59% hyperopic, 22% myopic, 20% astigmatism, 28% strabismus) [7]. Worldwide there are many organizations working to improve the quality of life for people with disabilities, including mental disabilities. One of such initiatives is *Opening the Eyes of the World* that aims to improve the quality of vision, particularly with athletes participating in the Special Olympics. Based on the results of research conducted under this program, many works were published in the field of the quality of vision among the population of mentally disabled athletes. One study attempted to compare the examination results of visual functions in two groups of people with mental illnesses [8]. In special school in Terrassa, Spain, one group (athletes), and another group (with no physical activities), were studied. They performed the following tests: distance monocular visual acuity (Lea symbols), auto-refractometer, color vision (Ishihara tables) and an alternating one-sided shading test from 40 cm to detect strabismus. More than half of those in the no physical activity group (58%) did not meet a visual acuity (VA) criteria of (0.5) while in the athlete group 39% failed the VA criteria. The most common refraction defect in the group of non-athletes (53%) was hyperopia (up to 2.00 D). Among the athletes hyperopia occurred in 22% of the respondents but myopia (up to –2.00 D) was found in 26% of the athletes. A review of the Special Olympics data shows that 16% out of 11 023 surveyed athletes had other eye problems such as blepharitis, conjunctivitis, glaucoma, cataracts, optic nerve abnormalities or anomalies of the cornea [9]. Nearly 18% of the respondents had strabismus.

The scope and organization of preventive health care in Poland for those covered by compulsory education until 19 years of age is determined by the Ordinance of the Minister of Health (December 22, 2004). The required vision screening performed in schools (including special schools) include only VA at distance, a test for strabismus (cover test) for seven-year-olds and color vision examination for ten-year-olds.

The Department of Optometry and Biology of the Visual System of the Poznań University of Medical Sciences, designed an extended set of tests for performing screening of the visual system:

- VA using standard optotypes (Landolt rings),
- VA at distance with +1.00 D lens,
- Spatial vision at near ("Titmus Stereo Fly" test),
- Color vision (Ishihara test),
- Near point of convergence (NPC),
- Non-cycloplegic auto-refractometer (Shin-Nippon A type).

The test set we suggested comes out of many years of Department experience in this matter: initially only the acuity and spatial vision have been assessed, combined with the auto-refractometer results. Several years ago a proprietary test set for the ocular performance screening has been introduced, including their wider panel [10]. The idea was on the one hand for the Polish optometrist to be able to perform the set of tests included in the program (without cycloplegia), and on the other hand, for the test set to possibly assess all the aspects of the vision process. The results of research conducted, using the above set of tests demonstrated that this was a good selection of tools to assess the vision process [10–12]. These results however come from children attending standard schools. This study set out to test the visual parameters of children in special schools, using this test panel.

2. Methods

The study group consisted of students from several Polish special schools (Specjalny Ośrodek Szkolno-Wychowawczy in Złota, Specjalny Ośrodek Szkolno-Wychowawczy in Zbylitowska Góra, Zespół Szkół Specjalnych im. Jana Pawła II in Rawicz, Zespół Szkół nr 31 in Bydgoszcz and Specjalny Ośrodek Szkolno-Wychowawczy im. Jana Korczaka in Toruń). Students ($n = 318$) between the age of 7 and 22 (mean age 14.4 ± 2.84) were surveyed. Only communicative children were examined. The handicapped students diagnosed as mentally handicapped (mild) were defined on the basis of the classification of mental development recommended by the World Health Organization (WHO) [13, 14].

The subjects were divided into three age groups. Group 1 were elementary school children between 7 and 12 ($n = 65$; 20.4% of study group), group 2 were secondary school children between 13 and 16 ($n = 167$; 52.5%), and group 3 were high school and college students between 17 and 22 ($n = 86$; 27%). Because of the large difference in numbers between the group of girls ($n = 113$, representing 35.5% of the study group) and boys ($n = 205$, representing 64.5% of the study group), the analysis data was not separated by gender.

The scope of the screening included: examining with use of an auto-refractometer (Shin-Nippon A type) without cycloplegia, examining VA for distance, positive lens test, the examination of spatial vision to near vision, color vision test and a close examination of the point of convergence.

The Landolt ring type of test was chosen deliberately since it allows VA evaluation in young children and patients with mental illnesses, especially those who have difficulty naming letters or digits. Positive lens test was performed to identify children with hyperopia. The method was the same as with the Landolt rings, except the respondent tried to recognize optotypes +1.00 D lens additionally introduced in front of the tested eye. The measurement of the NPC was taken by bringing a metal ball on a rod closer to the respondent's eye from an initial distance of 50 cm, 10–15° below and in front of the respondent's nose. The respondent's task was to observe the approaching ball

and report the moment they saw double (break) and then the moment the saw singly (recovery) as the ball was moved away. If the subject did not report those situations, it was assumed that the break distance was the moment where the movement of one eye moved out towards the temple and the recovery was the moment the deviated eye re-fixated on the ball.

Tests were conducted in adjusted classrooms using moderate light and a frosted 60 watt glass bulb was placed 60 cm from the target. Each procedure was approved by the children's parents or guardians, as well as by the Bioethics Committee of Poznań University of Medical Sciences.

The following values were taken as a criterion of the tests:

– VA for distance: 0.8 or better,

– Positive lens test: VA is decreased by would be at least 2 rows by a +1.00 D lens before the eye,

– Stereo vision for near: 60 arc seconds,

– Color vision: correctly identified 14 or more tables out of the first 17 (up to 3 errors),

– NPC: 12 cm merger breaking, 15 cm merger restoration.

3. Results and discussion

Of all the respondents (n = 318), 72 children (22.6%) had been prescribed correction, but only 28 children wore glasses permanently (8.8%), 15 reported wearing glasses periodically (4.7%), but on the examination day only two of those children brought them to school. Therefore generally 275 children (86.4%) do not wear glasses permanently (Table 1). This condition may be that the prescribed lenses were improperly selected or that the refractive error had changed and the respondent had an inadequate spectacle prescription. This situation may also result from a lack of specialist eye examinations.

T a b l e 1. The number of people (N) using spectacle correction and the number of respondents who do not use correction, and their percentage in the various age groups.

	Children wear glasses permanently	Children wear glasses periodically	Children do not wear glasses permanently
Group 1	N = 7 (10.8%)	N = 4 (6.2%)	N = 54 (83%)
Group 2	N = 13 (7.8%)	N = 6 (3.6%)	N = 148 (88.6%)
Group 3	N = 8 (9.3%)	N = 5 (5.8%)	N = 73 (84.9%)

The problem of inadequate vision examinations for people with intellectual disabilities was also confirmed by JUNYENT *et al*. [8] where they reported that 26.6% of mentally disabled patients had never previously received a vision examination. Optical prescriptions were worn by 43.3% but 76.8% were not properly selected (by more than 1.00 D). Not using a correction may also be a result of psychological factors. Children and young people with visual impairment often feel stigmatized by

T a b l e 2. The number of people (N) in each age group that did not meet the accepted criteria of passing the tests (respondents not using correction or not having it with them on the day of the examination).

	Group 1	Group 2	Group 3
VA for distance RE	N = 25 (38.5%)	N = 60 (35.9%)	N = 43 (50%)
VA for distance LE	N = 23 (35.4%)	N = 53 (31.7%)	N = 39 (45.3%)
VA for distance of +1.00 D lens RE	N = 28 (43.1%)	N = 61 (36.5%)	N = 38 (44.1%)
VA for distance of +1.00 D lens LE	N = 27 (41.5%)	N = 48 (28.7%)	N = 39 (45.3%)
Spatial vision	N = 40 (61.5%)	N = 79 (47.3%)	N = 50 (58.1%)
NPC – merger breaking	N = 5 (7.7%)	N = 9 (5.4%)	N = 7 (8.1%)
NPC – merger restoration	N = 7 (10.8%)	N = 23 (13.8%)	N = 7 (8.1%)
Color vision	N = 2 (3.1%)	N = 8 (4.7%)	N = 6 (6.9%)

RE – right eye, LE – left eye.

T a b l e 3. The number of people (N) among the respondents using a spectacle correction (n = 30), which did not meet the accepted criteria of visual parameters.

	Children wear glasses permanently
Visual acuity for distance RE	N = 18 (60%)
Visual acuity for distance LE	N = 18 (60%)
Spatial vision	N = 20 (66.7%)
NPC – merger breaking	N = 1 (3.4%)
NPC – merger restoration	N = 1 (3.4%)
Color vision	N = 0

RE – right eye, LE – left eye.

their peers because of wearing glasses. Therefore, apart from the visual examination itself, the importance of the child and of their parent/guardians education concerning the benefits of wearing a corrective prescription and of the consequences of not complying is paramount. All the more, among the students of special schools, care for the visual complex in terms of its correction, rehabilitation, and treatment can be essential in developing and educating these children. Of the entire test group as much as 275 children (86.4%) did not use correction, demonstrating a dramatic need for optometric care in this population group.

Results concerning the number of people in each age group that did not meet the accepted criteria are found in Tables 2 and 3.

This study indicates that respondents who do not use correction (n = 288) did not meet the accepted criteria of passing the tests in group 1 – the VA 38.5% (right eye (RE)) and 35.4% (left eye (LE)). In group 2 more than 30% of the respondents' VA were worse than 0.8 or 35.9% (RE) and 31.7% (LE). Nearly 50% of students of group 3 did not pass the distance VA (50% RE, and 45.3% LE).

The plus lens test of 1.00 D for the RE was not passed in groups 1 and 3 by more than 40%. In group 2 the criteria was not met by 36.5% (RE) and 28.7% (LE). In the examination of stereo vision at near, the adopted criterion was not met in groups 1

and 3 by 60% of the respondents, while in group 2, 47.3% of the respondents did not pass the test. The NPC for the break was not passed by close to 8% of the subjects in groups 1 and 3 and by 5.4% of group 2. With the recovery, 10.8% of the respondents in group 1 and 13.8% in group 2 as well as 8.1% in group 3 did not meet the accepted criteria to pass the NPC test. Disturbances in color vision were noted in the case of 2 patients in group 1, 8 in group 2, and 6 in group 3.

Of the students using glasses (n = 30) during VA with their correction, the criterion for the RE and LE was not met by 60% of the respondents. In the examination of spatial vision 66.7% of the respondents did not pass the criterion. The NPC test, both in terms of break and recovery was not passed by the 3.4% of people. Color vision examination was passed by all the students in this group.

Average scores achieved by age groups not using correction are included in Tables 4 and 5.

Visual acuity for people not using the correction in groups 1 and 2 for RE and LE was on average 0.9. In group 3, subjects attained an average of 0.86 RE and 0.84 LE. The average value of spatial vision in group 1 was 400″, 350″ in group 2 and 800″ in group 3. The NPC break was approximately at a distance of 7 cm for subjects

T a b l e 4. The average scores on the parameters of vision, achieved by the respondents not using correction in all age groups.

	Group 1		Group 2		Group 3	
	Average	SD	Average	SD	Average	SD
Visual acuity for distance RE	0.91	0.55	0.91	0.50	0.86	0.57
Visual acuity for distance LE	0.91	0.50	0.95	0.50	0.84	0.57
Spatial vision [″]	400	1250	350	1079	800	1940
NPC – merger breaking [cm]	7.6	6.4	7.7	4.3	8.2	4.4
NPC – merger restoration [cm]	11.3	5.2	10.3	4.6	11.6	5.9
Color vision [NE]	0.6	2.3	0.5	1.7	0.7	2.1

RE – right eye, LE – left eye, SD – standard deviation, [″] – arc seconds, [NE] – the number of errors.

T a b l e 5. The average scores on the parameters of vision process, achieved by subjects using glasses permanently (n = 30), measured in worn correction.

	Children wear glasses permanently	
	Average	SD
Visual acuity for distance RE	0.70	0.35
Visual acuity for distance LE	0.75	0.34
Spatial vision [″]	570	1490
NPC – merger breaking [cm]	7.4	2.6
NPC – merger restoration [cm]	10.9	4.0
Color vision [NE]	0	0

RE – right eye, LE – left eye, SD – standard deviation, [″] – arc seconds, [NE] – the number of errors.

T a b l e 6. The auto-refractometer test results, broken down into types of common refractive errors (groups 1, 2 and 3).

Refractive errors		Group 1		Group 2		Group 3	
		RE	LE	RE	LE	RE	LE
Myopia	Spherical equivalent from –0.25 to –4.00 D	*N* = 21 (32.3%)	*N* = 18 (27%)	*N* = 84 (50.3%)	*N* = 85 (50.8%)	*N* = 34 (39.5%)	*N* = 34 (39.5%)
	Spherical equivalent from –4.25 to –8.00 D	*N* = 2 (3%)	*N* = 1 (1.5%)	*N* = 2 (1.2%)	*N* = 2 (1.2%)	*N* = 2 (2.3%)	*N* = 2 (2.3%)
	Spherical equivalent above –8.25 D	*N* = 1 (1.5%)	*N* = 2 (3%)	*N* = 1 (0.6%)	*N* = 0 (0%)	*N* = 0 (0%)	*N* = 0 (0%)
Hyperopia	Spherical equivalent from +0.25 to +4.00 D	*N* = 28 (43%)	*N* = 31 (47.7%)	*N* = 43 (25.8%)	*N* = 45 (26.9%)	*N* = 27 (31.4%)	*N* = 32 (37.2%)
	Spherical equivalent from +4.25 to +8.00 D	*N* = 2 (3%)	*N* = 0 (0%)	*N* = 5 (2.9%)	*N* = 5 (2.9%)	*N* = 3 (3.5%)	*N* = 4 (4.7%)
	Spherical equivalent above +8.25 D	*N* = 0 (0%)	*N* = 0 (0%)	*N* = 1 (0.6%)	*N* = 2 (1.2%)	*N* = 0 (0%)	*N* = 0 (0%)
Astigmatism	Cylinder from +0.75 to +2.00 D	*N* = 19 (29.2%)	*N* = 14 (21.5%)	*N* = 39 (23.4%)	*N* = 33 (19.8%)	*N* = 21 (24.4%)	*N* = 21 (24.4%)
	Cylinder from +2.25 to +4.00 D	*N* = 3 (4.6%)	*N* = 5 (7.7%)	*N* = 15 (8.9%)	*N* = 9 (5.4%)	*N* = 5 (5.8%)	*N* = 8 (9.3%)
	Cylinder above +4.25 D	*N* = 2 (3%)	*N* = 1 (1.5%)	*N* = 1 (0.6%)	*N* = 2 (1.2%)	*N* = 3 (3.5%)	*N* = 2 (2.3%)

RE – right eye, LE – left eye, *N* – the number of people.

for groups 1 and 2 and 8 cm for group 3. Recovery occurred at an average distance of 11 cm for groups 1 and 3 and at 10 cm in group 2.

The average VA for subjects who used correction ($n = 30$), measured, while wearing glasses, 0.7 RE and 0.75 LE with those wearing correction, the average stereo value of 570″. The NPC break was on average, about 7 cm, and recovery occurred at about 11 cm.

The auto-refractometer test results for different age groups, broken down into types of common refractive errors, are shown in Table 6.

Auto-refractometer testing showed that most of the respondents in group 1 achieved scores of spherical equivalent at range of 0.25 to 4.00 D (43% RE and 47.7% LE). A small measure of myopia (spherical equivalent of –0.25 to –4.00 D) concerned 32.3% RE and 27% LE. Astigmatism in the range of 0.75 to 2.00 D was noted in more than 20% of children. In group 2 over 50% measured a small amount of myopia while close to 25% of people examined at range of 0.25 to 4.00 D of hyperopia. A small measure of astigmatism affected nearly 20% of the respondents. Group 3 most commonly showed the occurrence of a low-grade myopia (39.5%), a small amount of hyperopia was measured in about 30% of the group and the astigmatism ranging between 0.75 and 2.00 D of the cylinder was present in 24.4% of the older group. Summarizing the results of the examination with an auto-refractometer, for all respondents ($n = 318$) it can be stated that nearly 45% of the examined special school students had myopia (46.2% RE and 45.3% LE). Hyperopia was measured in 34.3% RE and 37% LE. Astigmatism occurred in 32% of the groups. The prevalence of small amounts of astigmatism noticed at special schools students is also confirmed by our earlier work [15].

Considering the non-cycloplegic auto-refractometer data, it is possible that the results were distorted due to the impact of accommodation. If, for example, the result is –0.50 D, we might be dealing either with a short-sighted person or an accommodating hyperopic person. This is why it is important to check other parameters such as VA at distance and VA at distance through the plus lens, enabling the detection of the hyperope. The greatest probability of obtaining an auto-refractometry result falsified with accommodation will be in the group of patients with low-grade myopia. The number of people with low-grade myopia that did not meet the VA criterion for distance through the lens of 1.00 D (RE) is 25 (7.8% of the group) and 22 respondents (6.9%) LE. These results may indicate that these were hyperopic subjects who accommodated during with auto-refractometry. Thus it can be concluded that the subjects with low-grade myopia were actually 38.4% in each eye. A small degree of hyperopia RE was 42.1% of the groups and 44% LE. The prevalence of the occurrence of hyperopia over myopia among people with intellectual disabilities is also confirmed by the results of other studies [7, 8].

Only 9.4% of students out of those surveyed, wore glasses permanently, despite the fact that 60% of them did not meet the VA distance criterion for both eyes. This may indicate a poorly matched correction, no current refractive defect correction, or

the occurrence of other disorders, such as amblyopia. To better diagnose the causes, a more detailed specialist examination of the vision system should be administered.

4. Conclusion

The results of these data indicate a need for similar action in other special school institutions. A large number of subjects do not meet the criteria for VA but also for stereo or the plus lens test. Therefore, examining just the VA in screening examination may cause an overlook of children with other visual problems such as a binocular and/or blurred vision. It indicates that the vision screening should contain more complex set of tests than just a standard test of VA for distance.

The results of an auto-refractometer test and the positive lens test show a greater number of hyperopic than myopic people in the examined group. Uncorrected hyperopia can lead to the occurrence of ailments related to near visual work (*e.g.*, blurring of the letters, fatigue when reading, or sore eyes and headaches) and this in turn can lead to avoidance of reading, writing or other activities in near, which could adversely impact the school progress.

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