Article • Prevalence of Vision Disorders Among School-Aged Children in Russia

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ABSTRACT

Purpose: There is a lack of adequate data on pediatric eye and vision disorders in Russia. In the present study, we estimated the prevalence of vision disorders among school-aged children who participated in a special vision program in Samara, Russia. A key feature in this study was the inclusion of binocular vision disorders among the conditions tested, so as to recognize the relationship between the learning-related visual dysfunctions.

Methods: Testing was done in a private clinic setting using a randomized sample of 100 school-aged children. It included clinical measures of visual acuity, ocular motility, and alignment; various measures of accommodation and vergence; stereo acuity; and visual-motor integration.

Results: Clinically significant scores were found in measures of visual acuity, refractive disorders, ocular motility, and alignment, as well as accommodative and vergence disorders.

Conclusions: From a public health perspective, data-driven decision-making can lead to enhanced healthcare outcomes. While this can be an effective approach, too often eye/vision care programs use a disease-specific vertically driven approach, limiting the clinical scope to visual acuity and refractive anomalies. This study illustrates the need to include testing for non-strabismic binocular vision disorders along with refractive anomalies in the assessment of school-aged children.

Keywords: prevalence, Russia, school-aged children, vision disorders, binocular vision

Introduction

The goal of public health is the prevention of disease, and the target of public health is a described population or community. The diagnosis of a public health problem is often accomplished by conducting a health survey of a population; results of public health measures include prevention of disease and improvement of quality of life in the whole community.[1] This research project has used a health survey testing approach and examines the prevalence of visual disorders in school-aged children, with particular emphasis upon those binocular vision conditions that relate to vision and learning.

Public health efforts appear in projects created to improve the current situation in Russia. For example, the Ministry of Health approved the procedure for minors to undergo clinical screening procedures during their schooling in educational institutions:

> *The Order of the Ministry of Health of the Russian Federation dated August 10, 2017 No. 514n On the Procedure for Conducting Preventive Medical Examinations of Minors took effect, regulations requiring a child to be examined by an ophthalmologist in the first year of life at 1 month, at 1 year, then at 3, 6, 7, 10, 13, 15, 16, 17 years of age.*[2]

This order was created to allow timely treatment and rehabilitation measures in accordance with the identified pathology, and also to reduce the likelihood of chronic diseases and their transition to a decompensated stage.[2]

It is a public health goal to organize and to improve medical care for young children, since proper follow-up provides a real opportunity to improve general health indicators, thereby reducing the incidence of visual impairment. The medical and social significance of studying young children is also determined by the fact that, in comparison with older children, it is possible to identify a problem, for example ametropia, at the early stages and prevent the development of serious complications such as amblyopia and strabismus.

According to the Department of Monitoring, Analysis, and Strategic Development of the Ministry of Health of the Russian Federation, the prevalence of ametropia is increasing every year. In 2011, 1,535,441 patients were registered, in 2014 - 1,690,367 people. By 2017, this figure has increased to 1,875,672 children.[3]

Refractive errors have to be treated on time in order to prevent the development of amblyopia, impaired binocular vision, and strabismus. Preserving children's vision, preventing blindness, and reducing the number of visually impaired children are among the goals of the public healthcare system in Russia.

In response to these needs, a Commission has been created involving leading ophthalmologists and other related eye care providers. It is working on the development of the professional standards for optometry, a relatively new profession in Russia. Optometrists can make a big difference in providing eye care to the pediatric population, taking the workload off the ophthalmologists, reducing the waiting lists and speeding up the process of getting the necessary eye care for patients.[4]

It is projected that by 2024, the proportion of children aged 0-17 years covered under the Medical Observation Provision of the first-ever diagnosed diseases of the eye and adnexa will be increased to 90%. These orders are reinforced by state and regional programs that are providing funds for the development of children's polyclinics and medical organizations involved in the healthcare of children.[3]

Purpose of Research

This research project is of particular importance, since there is a lack of adequate data on pediatric eye and vision disorders in Russia. In the present study, we estimated the prevalence of vision disorders among school-aged children who participated in a special vision program in Samara, Russia. A key feature in this study was the inclusion of binocular vision disorders among the conditions tested, so as to recognize the relationship between learning-related visual dysfunctions.

Prior prevalence studies in various countries

Table 1 represents an overview of the prevalence of vision disorders among school-aged children in various countries, including the United States,[5] Romania,[6] Japan,[7] Canada,[8] Saudi Arabia,[9] South Africa,[10] and India.[11] No such studies were found

Table 1. Overview of Prevalence Studies

	Age group	Criteria	Strabismus	Amblyopia	Refractive anomalies	Non-strabismic binocular vision disorders
Baltimore Vision Screening Project[5]	4-7 years	Visual acuity Heterophoria	3.1%	3.9%	8.2%	
Prevalence of vision and ocular disease conditions in a pediatric population[12]	0.5-18 years	Visual acuity Refractive status Vergence/accommodation	11.9%		64.9%	11.7%
The visual profile of Romanian children and adults assessed through vision screenings[6]	2-18 years	Visual acuity Refractive status Heterophoria Motility Convergence			55%	
The prevalence of strabismus and amblyopia in Japanese elementary school children[7]	6-12 years	Visual acuity Heterotropia	1.28%	0.14%		
Prevalence of amblyopia and other vision disorders in Newfoundland and Labrador children[8]	1.6-11.6 years	Visual acuity Refractive status Ocular alignment	4.3%		7.3%	
A clinic-based study of refractive errors, strabismus, and amblyopia in a pediatric age group[9]	1-15 years	Heterophoria at far	2.4%			
Refractive error in a sample of Black high school children in South Africa[10]	13-18 years	Visual acuity Refractive status			3-7%	
Prevalence of non-strabismic anomalies of binocular vision in Tumil Nadu[11]	7-17 years	Visual acuity Versions Near stereo acuity				31.5%

pertaining to Russia. While they do provide some base, one region of the world to another, generalizing the results must be approached with caution. Testing methodologies and the general scope of this research was not standardized from one study to another.

Three themes do tend to emerge, however, regarding refractive anomalies, strabismus, and non-strabismic binocular vision disorders. Prevalence rates of refractive anomalies ranged from 7.3% (Canada)[8] to 55% (Romania).[6] Strabismus rates ranged from 1.28% (Japan)[7] to 4.3% (Canada).[8] Non-strabismic binocular vision disorders were reported at 31% (India).[11] The summary notes above reflect data taken from screening-type projects. In contrast, one of the studies[12] approached the data as a prospective analysis of clinical records within the pediatric population seen at a college of optometry clinic. Prevalence data, using this methodology, give rates of refractive anomalies at 64.9%, strabismus at 11.9%, and non-strabismic binocular vision disorders at 17.1%. However, it is well to note that these data represent a clinical population, much different than a screening-type study. This illustrates that prevalence rates being reported are only as accurate as the population group studied and the actual testing that took place. That being the case, the testing parameters of this research were done in a clinical setting and were designed to be more inclusive.

The relationship between vision and learning

By design, this research project is focused upon the visual disorders of school-aged children due to the relationships found between vision and learning. Vision plays an essential role in the learning process; up to 90% of the information that we learn comes through our visual system. The visual system thus has a great impact on our everyday lives, especially when it comes to reading and performance at school.[13]

In 1986, Grisham and Simons[14] published a literature review going back to the1930s showing strong evidence that hyperopia and anisometropia are more prevalent among lower-achieving readers. In 1987, another study was published[15] showing significant evidence for the following visual conditions in reading-disabled students: high exophoria at near, low fusional vergence ranges, high fixation disparity measures, and the presence of anisometropia and convergence insufficiency.

In 1997, Kulp and Schmidt[16] investigated the relationship between performance on various vision tests and reading in 90 kindergartners (mean age 5.73 years) and 91 first graders (mean age 6.76 years) in Ohio. The results revealed that accommodative facility was predictive of successful reading performance and that visual performance was significantly related to reading performance even in children of average intelligence when IQ was partially controlled. A follow-up study was done by Kulp in1999,[17] where she examined the relationship between visual-motor integration skill and academic performance in 191 kindergarten through third-grade children. She confirmed that performance on a visual-analysis and visual-motor integration task was significantly related to academic performance in 7-, 8-, and 9-year-olds.

Goldstand, Koslowe, and Parush[18] compared visual and visual-information processing skills between North American children with and without mild reading and academic problems and examined the incidence of visual deficits among them. Seventy-one seventh graders were compared as to scores on an accepted vision screening battery, testing visual perception, visual-motor integration, and academic performance. Visual deficits were found in 68% of the participants, with significantly higher prevalence in boys compared to girls. Non-proficient readers had significantly poorer academic performance and vision-screening scores than did proficient readers.

Grisham, Powers, and Riles[19] measured visual skills and visual acuity in 461 students who had been identified by the schools as poor readers (average age 15.4 years). In this sample, 80% of the students were found to be inadequate or weak in one or more of the following visual skills: binocular fusion ranges at near, accommodative facility, and near point of convergence. More students were deficient in binocular fusion ranges than in either accommodative function or near point of convergence. In contrast, only 17% had deficient visual acuity, defined as 20/40 or worse in one eye. The results support and extend previous studies showing that large numbers of poor readers in high school may be at high risk for visual skill dysfunction.

Dusek, Pierscionek, and McClelland[20] compared visual function measures of two groups of school age children (6-14 years of age) in Austria: 825 delayed readers and 328 children showing normal achievement in reading. The 825 delayed readers had been evaluated by an educational psychologist and found to have a normal IQ and no learning disability. Those readers showed statistically worse measures in several areas of functional vision, including visual acuity, convergence, and accommodation.

This confirms the importance of a full assessment of binocular visual status in order to detect and to remedy these deficits and thus prevent the visual problems from continuing to impact educational development negatively.

Chen, Bleything and Lim[21] established the relationship between vision problems and academic performance in 1,103 year-2 school children in Malaysia. Children with average and above-average achievement showed a different visual performance profile from those children with low academic achievement. They had a statistically significantly better pass rate in physical aspects (visual acuity), physiological aspects (oculomotor balance), and perceptual aspects (visual-motor integration/visual-spatial and visual-analysis skills).

Kulp et al.[22] compared early literacy of 4- and 5-year-old uncorrected hyperopic North American children with that of emmetropic children using the visual assessment and the Test of Preschool Early Literacy (TOPEL). A total of 492 children (244 hyperopes and 248 emmetropes) participated. Greater deficits in TOPEL scores were observed in hyperopic children with ≥4.0 D than were observed in emmetropes. The largest deficits in TOPEL scores were observed in hyperopic children with binocular near VA of 20/40 or worse or near stereoacuity of 240 seconds of arc or worse compared with emmetropic children. Kulp et al.[23] also compared attention, visual-motor, and visual-perceptual skills in 4- and 5-year-old North American children. The sample included 244 uncorrected hyperopes (≥3 to ≤6 D, astigmatism ≤1.5 D, anisometropia ≤1 D) and 248 emmetropes (hyperopia ≤1 D; astigmatism, anisometropia, and myopia each <1 D) without amblyopia or strabismus. The Mean Sustained Attention score was worse in hyperopes compared with emmetropes, and the Mean Receptive Attention score was worse in 4 to 6 D hyperopes compared with emmetropes. Hyperopes with reduced near visual acuity (20/40 or worse) had lower scores than emmetropes. Hyperopes with stereoacuity of 240 seconds of arc or worse scored significantly lower than emmetropes. Overall, hyperopes with better near visual function generally performed similarly to emmetropes.

Alvarez-Peregrina et al.[24] looked at the visual health (visual acuity, near point of convergence, ocular motility) of 10, 218 elementary school children ages 6-12 across Spain. Children with poor academic performance had worse visual health than those with good academic performance.

Methods

The study population consisted of a random sample of school-aged children seen in a private clinic in Samara; this a major metropolitan city of 1,300,000 people located in the Volga region of Russia. The governmental polyclinic system includes basic eye care that consists of visual acuity testing, refractive status measures, and fundus evaluation. In this particular study, the clinical testing was done in a private eye clinic setting, where the baseline eye examination is broader and includes fundus and anterior segment evaluation, visual acuity, refractive status, and accommodative and binocular vision functions, such as cover test, near point of convergence, and vergence ranges.

Clinical testing followed a prescribed, spelled-out protocol and was done by eye care professionals of the Center for Vision Correction Doctor Linz Clinic. The baseline eye examination was augmented with a special emphasis upon binocular vision and functional vision. Findings from the 100 children were recorded using a prescribed testing protocol. Care was taken to assure compliance with the Declaration of Helsinki.25 Informed consent was required to provide potential participants or their legally authorized representatives with the information necessary to make a decision about participating in this research. Parental permission was obtained by way of an informed consent document.

Procedures

The following tests were performed:

- Convergence Insufficiency Symptom Survey questionnaire (CISS)
- Distance and near visual acuity (VA) (See Appendix for conversion of different visual acuity notations).
- Auto-refractometry
- Ocular motility and alignment (EOMs, DEM)
- Accommodative and vergence function
- NPC, CT, vergence ranges
- Dynamic retinoscopy (MEM)
- Stereoacuity
- Accommodative and vergence facility
- Visual-motor integration (Beery-Buktenica VMI test)

Results

Study population

A total of 100 school-aged Russian children between 6 and 18 years were examined in the described eye clinics between November 1, 2019 and

April 5, 2020. The male/female ratio was 37/63. It is important to recognize that this study represents the prevalence of conditions in a clinical population as opposed to a general population.

Subjects were divided into 3 groups according to their age and grade level. Group I included elementary school children aged 6 to 10 years (n = 45), Group II included middle school children aged 11 to 14 years (n = 31), and Group III included high school children aged 15 to 18 years (n = 24).

Prevalence of vision disorders

The design of this project started with the baseline eye examination done in the clinic but was then augmented by a broad-based binocular vision assessment, this being critical in the relationship between visual performance and learning. The tables included in this report are set up with the name of the test procedure, followed by the mean and the standard deviation findings for that test procedure, then followed by a cutoff score. The cutoff score is that point where the doctor in clinical practice would do further investigation as to that particular visual disorder. Hence, the prevalence scores listed aim to indicate those visual conditions in need of clinical care. Tables 2 – 4 illustrate the distribution of vision disorders for each study group. Highlights are found below:

- CISS questionnaire, Group II showed the highest failure (prevalence) rate (36%) compared to Group I (16%) and Group III (25%).
- Distance visual acuity was the most prevalent finding in this study: 71 to 94% failure rate in all age groups, Group II being the most affected. In comparison, the prevalence rate for near visual acuity was much lower in this study population when compared to similar research projects.
- Refractive disorders were significant in the study: 87 to 94% of subjects were found to be ametropic.
- Ocular motility testing had a prevalence rate of 24% in Group I, in contrast to the low prevalence rates in Groups II and III. The Developmental Eye Movement test was failed in 13 to 16% in all age groups.
- Distance cover test failure rate was 27% in Group I, 19% in Group II, and 21% in Group III. Near cover testing suggested that many subjects tested positive for a deviation, with 49% prevalence in Group I, 42% in Group II, and 29% in Group III.
- Stereoacuity scores were quite high and similar in all age groups: 29 arc sec in Group I, 36 arc sec in Group II, and 29 arc sec in Group III. The failure rate was 4% in Group I, 23% in Group II, and 29% in Group III.
- Positive relative vergence (PRV): Distance break was failed by 24% and recovery was failed by 20% of the subjects in Group I.
- Negative relative vergence (NRV): Distance break was failed by 12.5% and recovery was failed by 17% of the subjects in Group III. Near findings showed a significantly high failure rate in the break point: 58% in Group I, 55% in Group II, and 54% in Group III.
- Vergence facility testing revealed that 36% in Group II did not fit into the norms, followed by 27% in Group I, and 13% in Group III.
- Near point of convergence (NPC) break value fail rate was 60% in Group I, 74% in Group II, and 75% in Group III.
- Accommodative status showed significant fail rates of 31% in Group I, 29% in Group II, and 33% in Group III.
- Accommodative facility testing showed a low prevalence in all study groups.
- Visual-motor integration testing revealed the following prevalence rates: 4% in Group I, 7% in Group II, and 8% in Group III.

Summary comparisons by age group

- Distance visual acuity showed a high prevalence in all age groups, whereas near visual acuity prevalence remained about the same over all age groups (33-39%).
- Refractive disorders showed high prevalence in all age groups.
- Stereo acuity prevalence scores were 23 - 29% in the middle school and high school groups but only 4% in the elementary school group.
- Negative relative vergence (near) scores show consistently high prevalence rates in all three age groups.
- NPC measures show high prevalence rates in all age groups.
- Accommodative status (MEM) showed a high prevalence rate of 25 to 33% in all age categories.
- Accommodative facility failure rates increased with age.

Discussion

This is the first study of its kind in Russia, using strict diagnostic criteria and a comprehensive eye examination to determine the prevalence of binocular vision disorders in a clinical pediatric

Table 2. Vision Disorders: Group I, Elementary School

	Mean (Stdv)	Cut-off Score	Disorders N	Disorders %
History: CISS	8.98 (5.27)	≥16	7	15.56
Visual acuity: distance				
• Right eye	0.56 (0.43)	<1.0	32	71.11
• Left eye	0.54 (0.39)	<1.0	36	80.00
• Both eyes	0.61 (0.42)	<1.0	32	71.11
Visual acuity: near				
• Right eye	0.93 (0.15)	<1.0	15	33.33
• Left eye	0.95 (0.09)	<1.0	15	33.33
• Both eyes	0.96 (0.08)	<1.0	11	24.44
Refractive disorders				
• Right eye (sph)	-0.79 (1.75)	< 0.0 D or ≥ +0.75 D	39	86.67
• Right eye (cyl)	-0.34 (0.49)	> -1.0 D	1	2.22
• Left eye (sph)	-0.66 (2.09)	< 0.0 D or ≥ +0.75 D	38	84.44
• Left eye (cyl)	-0.44 (0.53)	> -1.0 D	3	6.67
Ocular motility: EOM		Any restriction	11	24.44
Ocular motility: DEM	99.73 (14.93)	Std Score Mean 100; Stdv 15	7	15.56
Binocular vision: cover test				
• Distance	2.04 exo (5.92)	1 exo +/- 2Δ	12	26.67
• Near	0.78 exo (7.35)	3 exo +/- 3Δ	22	48.89
Binocular vision: stereopsis	28.89 (13.39)	60 arc sec	2	4.44
Vergence ranges: distance				
• PRV break	19.20 (10.20)	19Δ ± 8 (cut-off = 11)	11	24.44
• PRV recovery	13.60 (9.60)	10Δ ± 4 (cut-off = 6)	9	20.00
• NRV break	7.87 (3.98)	7Δ ± 3 (cut-off = 4)	1	2.22
• NRV recovery	5.00 (3.72)	4Δ ± 2 (cut-off = 2)	4	8.89
Vergence ranges: near				
• PRV break	30.09 (10.04)	21Δ ± 6 (cut-off = 15)	5	11.11
• PRV recovery	24.73 (12.34)	10Δ ± 7 (cut-off = 3)	2	4.44
• NRV break	16.69 (5.78)	21Δ ± 4 (cut-off = 17)	26	57.78
• NRV recovery	12.38 (5.92	13Δ ± 5 (cut-off = 8)	8	17.78
Vergence facility	9.68 (4.01)	8 cpm	12	26.67
Near point of convergence				
• NPC break	5.76 (1.25)	3 cm ± 2.5	27	60.00
• NPC recovery	7.24 (1.67)	5 cm ± 3	6	13.33
Accommodation				
• MEM right eye	0.47 (0.37)	< +0.25 D or > +0.5 D	14	31.11
• MEM left eye	0.49 (0.39)	< +0.25 D or > +0.5 D	14	31.11
• Facility	8.13 (1.65)	6 yo 3 cpm ± 2.5	0	0.00
	10.28 (1.48)	7 yo 3.5 cpm ± 2.5	0	0.00
	10.45 (2.87)	8-12 yo 5 cpm ± 2.5	0	0.00
Visual-motor integration (VMI)		Std Score Mean 100; Stdv 15		
	109.18 (10.48)	>15	2	4.44

Table 3. Vision Disorders: Group II, Middle School

	Mean (Stdv)	Cut-off Score	Disorders N	Disorders %
History: CISS	12.77 (9.01)	≥16	11	35.5
Visual acuity: distance				
• Right eye	0.29 (0.31)	<1.0	29	93.5
• Left eye	0.34 (0.35)	<1.0	28	90.3
• Both eyes	0.36 (0.34)	<1.0	28	90.3
Visual acuity: near				
• Right eye	0.92 (0.17)	<1.0	12	38.7
• Left eye	0.92 (0.16)	<1.0	12	38.7
• Both eyes	0.95 (0.11)	<1.0	9	29.0
Refractive disorders				
• Right eye (sph)	-2.06 (2.01)	< 0.0 D or ≥ +0.75 D	29	93.5
• Right eye (cyl)	-0.57 (0.37)	> -1.0 D	2	6.5
• Left eye (sph)	-2.02 (1.60)	< 0.0 D or ≥ +0.75 D	26	83.9
• Left eye (cyl)	-0.51 (0.39)	> -1.0 D	4	12.9
Ocular motility: EOM		Any restriction	1	3.2
Ocular motility: DEM	103.58 (15.71)	Std Score Mean 100; Stdv 15	5	16.1
Binocular vision: cover test				
• Distance	1.29 exo (4.47)	1 exo +/- 2Δ	6	19.4
• Near	2.13 exo (6.81)	3 exo +/- 3Δ	13	41.9
Binocular vision: stereopsis	36.19 (19.76)	40 arc sec	7	22.6
Vergence ranges: distance				
• PRV break	19.68 (8.16)	19Δ ± 8 (cut-off = 11)	5	16.1
• PRV recovery	13.65 (6.15)	10Δ ± 4 (cut-off = 6)	3	9.7
• NRV break	9.74 (6.51)	7Δ ± 3 (cut-off = 4)	0	0.0
• NRV recovery	6.58 (5.13)	4Δ ± 2 (cut-off = 2)	2	6.5
Vergence ranges: near				
• PRV break	30.13 (10.18)	21Δ ± 6 (cut-off = 15)	2	6.5
• PRV recovery	22.71 (11.24)	10Δ ± 7 (cut-off = 3)	2	6.5
• NRV break	16.87 (5.80)	21Δ ± 4 (cut-off = 17)	17	54.8
• NRV recovery	12.81 (5.88)	13Δ ± 5 (cut-off = 8)	6	19.4
Vergence facility	9.84 (4.63)	8 [cpm]	11	35.5
Near point of convergence				
• NPC break	6.77 (2.03)	3 cm ± 2.5	23	74.2
• NPC recovery	9.16 (3.80)	5 cm ± 3	14	45.2
Accommodation				
• MEM right eye	0.45 (0.27)	< +0.25 D or > +0.5 D	9	29.0
• MEM left eye	0.48 (0.25)	< +0.25 D or > +0.5 D	8	25.8
• Facility	9.62 (4.52)	8-12 yo 5 cpm ± 2.5	1	3.2
	10.71 (4.18)	13-20 yo 8 cpm ± 2.5	1	3.2
	10.45 (2.87)	8-12 yo 5 cpm ± 2.5	0	0.00
Visual-motor integration (VMI)		Std Score Mean 100; Stdv 15		
	103.94 (10.54)	>15	2	6.5

Table 4. Vision Disorders: Group II, High School

	Mean (Stdv)	Cut-off Score	Disorders N	Disorders %
History: CISS	11.83 (8.47)	≥16	6	25.0
Visual acuity: distance				
• Right eye	0.43 (0.37)	<1.0	19	79.2
• Left eye	0.44 (0.37)	<1.0	20	83.3
• Both eyes	0.50 (0.41)	<1.0	19	79.2
Visual acuity: near				
• Right eye	0.94 (0.09)	<1.0	9	37.5
• Left eye	0.94 (0.09)	<1.0	9	37.5
• Both eyes	0.97 (0.07)	<1.0	5	20.8
Refractive disorders				
• Right eye (sph)	-1.23 (1.99)	< 0.0 D or ≥ +0.75 D	22	91.7
• Right eye (cyl)	-0.38 (0.24)	> -1.0 D	0	0.0
• Left eye (sph)	-1.17 (2.05)	< 0.0 D or ≥ +0.75 D	21	87.5
• Left eye (cyl)	-0.40 (0.28)	> -1.0 D	0	0.0
Ocular motility: EOM		Any restriction	0	0.0
Ocular motility: DEM	105.88 (16.95)	Std Score Mean 100; Stdv 15	3	12.5
Binocular vision: cover test				
• Distance	2.08 exo (4.24)	1 exo +/- 2Δ	5	20.8
• Near	2.83 exo (4.04)	3 exo +/- 3Δ	7	29.2
Binocular vision: stereopsis	29.27 (16.14)	40 arc sec	7	29.2
Vergence ranges: distance				
• PRV break	20.13 (7.51)	19Δ ± 8 (cut-off = 11)	2	8.3
• PRV recovery	15.04 (6.33)	10Δ ± 4 (cut-off = 6)	1	4.2
• NRV break	7.75 (2.47)	7Δ ± 3 (cut-off = 4)	3	12.5
• NRV recovery	5.46 (2.89)	4Δ± 2 (cut-off = 2)	4	16.7
Vergence ranges: near				
• PRV break	29.75 (6.26)	21Δ ± 6 (cut-off = 15)	0	0.0
• PRV recovery	21.58 (9.40)	10Δ ± 7 (cut-off = 3)	0	0.0
• NRV break	16.67 (6.48)	21Δ ± 4 (cut-off = 17)	13	54.2
• NRV recovery	12.75 (4.56)	13Δ ± 5 (cut-off = 8)	3	12.5
Vergence facility	11.69 (4.45)	8 cpm	3	12.5
Near point of convergence				
• NPC break	6.71 (1.76)	3 cm ± 2.5	18	75.0
• NPC recovery	8.79 (2.78)	5 cm ± 3	9	37.5
Accommodation				
• MEM right eye	6.71 (1.76)	3 cm ± 2.5	18	75.0
• MEM left eye	8.79 (2.78)	5 cm ± 3	9	37.5
• Facility	0.50 (0.23)	< +0.25 D or > +0.5 D	8	33.3
	0.48 (0.22)	< +0.25 D or > +0.5 D	6	25.0
	11.00 (4.94)	13-20 yo 8 cpm ± 2.5	2	8.3
Visual-motor integration (VMI)		Std Score Mean 100; Stdv 15		
	104.28 (9.02)	>15	2	8.3

population. A limitation of this study is that the population only represents one large metropolitan region, the Volga area. Prevalence data reported in this study should be used with discretion as they represent a clinical population, where there would be a larger percentage of patients with binocular vision disorders than in a general population. Taking this factor into account, the prevalence data reported in this study are likely higher than what would be found in a general population.

A very important outcome of this study is the significance of the values obtained because the testing protocol included binocular vision functions. In contrast, the most common parameters that are taken during a regular eye examination are visual acuity, refractive status, and the state of the fundus. Accommodative/vergence testing, ocular motility, and visual-motor integration are left out, creating a meaningful gap in the medical records. Also, it is important to take into account that visual-motor integration testing has been used as a predictor of academic performance.[26] This suggests that being learning disabled also puts one at risk for misbehavior such as juvenile delinquency.[27]

Conclusion

The overall aim of this project was to help meet a public healthcare goal using a data-driven strategy to develop and to strengthen a health care system, thus improving Ministry of Health requirements for minors to undergo clinical screening procedures during their school years.[2] Subsequent regulations were published in 2019 emphasizing the increase in the prevalence of ametropia among children.[3]

This research set out to create a database as to the prevalence of vision disorders among school-aged children in Russia; it is intended to dovetail with prior actions taken by the Ministry of Health directed toward reducing the number of visually impaired children. A particular strength of this database is the focus upon non-strabismic binocular vision disorders, so as to recognize the established connection between vision performance and learning.

From a public health perspective, data-driven decision-making can lead to enhanced healthcare outcomes. While this can be an effective approach, too often eye/vision care programs use a disease-specific vertically driven approach, limiting the clinical scope to visual acuity and refractive anomalies. This study illustrates the need to include testing for non-strabismic binocular vision disorders along with refractive anomalies in the assessment of school-aged children.

This research project is only the beginning; it relates to but one major region in Russia. Other studies looking at other portions of Russia could follow. In addition, like studies are indicated for other nations in Europe. Such an endeavor could build a vision-related database, all to drive needed changes in the provision of enhanced eye and vision care to the school-aged child.

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