

CRO-READ: CROATIAN NATIONAL REGISTRY OF EARLY AMBLYOPIA DETECTION

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Aim: To identify the achievements and define hurdles in conducting and reporting the results of the National Program of Early Amblyopia Detection.

Materials and methods: Demographic data of the patients and results of screening examination collected by Croatian National Registry of Early Amblyopia Detection between June 1st-December 31st 2017 were analyzed.

Results: The number of ophthalmologist who performed screening is very weak N=13 and 8/21 counties do not have a single contributing ophthalmologist. Of screened population (N=1504), only 46% of patients fulfill the age criteria. In Lika-Senj County, 100% of screened children were <4 years. The weighted relative number of four-year-old screened patients with respect to population by single age (4 year) demonstrated extremely low rate of 2.9%. When the same variable was distributed by county, 3/8 counties that performed screening scored 0%. Overall, 81% of children were screened negative, 9.6% were non-testable and 9.4% of children were referred to complete ophthalmological examination. The highest ratio of non-testables was in Šibenik-Knin and Varaždin County reaching 35% and 45% respectively.

Discussion: To the best of our knowledge, this is the first national amblyopia registry in the world. The Registry tracks adherence to well defined Croatian amblyopia screening policy and demonstrated poor compliance of referring physicians and reporting ophthalmologists.

Conclusion: The first six months of Registry establishment witnessed that amblyopia issue is still largely ignored and urgent actions need to be taken to improve the implementation process of National Program of Early Amblyopia Detection.

Descriptors: REGISTRY, AMBLYOPIA, SCREENING, CHILDREN, EARLY DETECTION, EARLY DIAGNOSIS, COMPLIANCE, BLINDNESS

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Between September 2011 and June 2014 Zagreb Amblyopia Preschool Screening (ZAPS) project performed vision screening for amblyopia detection by near and distance visual acuity (VA) testing using Lea Symbols in lines (1). Of 15.648 children aged 48-54 months attending kin-

dergartens in the City of Zagreb County 78.04% of children passed the screening test with cut-off pass value ≤ 0.1 logMAR (1). Results evidenced that estimated prevalence of amblyopia was 8.1%, considerably higher than reported elsewhere (1). The age-specific normative threshold is hence defined at ≤ 0.1 logMAR for 4-year-old children, using Lea Symbols in lines (1). The ZAPS study protocol missed no amblyopia cases, advocating that both near

Table 1
Distribution of contributing ophthalmologists by county

COUNTY	N	%
City of Zagreb	8	22.22
Šibenik-Knin	6	16.67
Osijek-Baranja	5	13.89
Vukovar-Srijem	4	11.11
Brod-Posavina	2	5.56
Dubrovnik-Neretva	2	5.56
Split-Dalmatia	2	5.56
Primorje-Gorski Kotar	2	5.56
Karlovac	1	2.78
Varaždin	1	2.78
Lika-Senj	1	2.78
Virovitica-Podravina	1	2.78
Zadar	1	2.78
Zagreb	0	0
Krapina-Zagorje	0	0
Sisak-Moslavina	0	0
Koprivnica-Križevci	0	0
Bjelovar-Bilogora	0	0
Požega-Slavonia	0	0
Istria	0	0
Međimurje	0	0
total	36	100

Figure 1
Entry form

Figure 2
Screening examination form

Table 2
Number of patients with registry record, municipalities/towns of the registered patients, counties of the registered patients and reporting ophthalmologists. MD-Doctor of Medicine

Patients registered (N)	1450
Municipalities/Towns (N)	246
County (N)	8
MD (N)	13

Complete ophthalmological examination

ID medical number

Amblyopia diagnosed No Yes

Type of amblyopia Refractive
 Strabismic
 Refractive+strabismic
 Deprivational

Amblyopia grade Mild
 Moderate
 Severe

Therapy Correction of refractive error
 Occlusion
 Correction of refractive error + occlusion
 Other

Other

Risk factors

Birth weight

Grams

Prematurity

Weeks

Positive family history for eye disease

Please describe

Tobacco use in family

Other

Discharge Unremarkable
 Referred to complete oph. examination to the same institution
 Referred to complete oph. examination to another institution
 Referred to follow-up to the same institution
 Referred to follow-up to another institution
 Other

Other

Other important notes

Figure 3
Comprehensive examination form

Follow up

ID medical number

Good patient compliance No Yes

Type of amblyopia Refractive
 Strabismic
 Refractive+strabismic
 Deprivational

Amblyopia grade Mild
 Moderate
 Severe

Therapy Correction of refractive error
 Occlusion
 Correction of refractive error + occlusion
 Other

Other

Status at discharge Cured
 Improvement
 Deterioration
 Unchanged
 Other

Other

Discharge Unremarkable
 Referred to complete oph. examination to the same institution
 Referred to complete oph. examination to another institution
 Referred to follow-up to the same institution
 Referred to follow-up to another institution
 Other

Other

Figure 4
Follow-up examination form

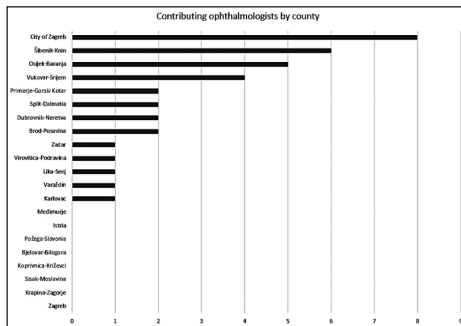


Figure 5
Distribution of contributing ophthalmologists by county plotted against the total number of ophthalmologists

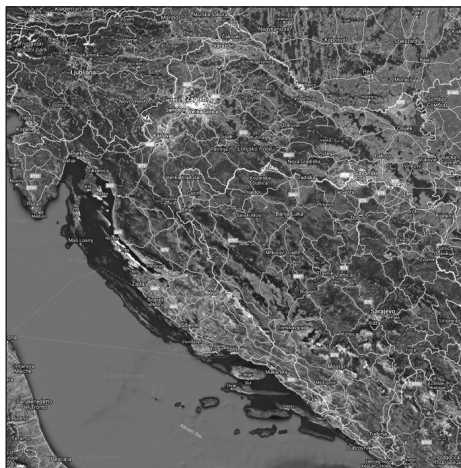


Figure 6
Map distribution of the patients with the registry record by municipalities/towns, relative aspect (modified from www.google.hr/maps/place/Croatia)

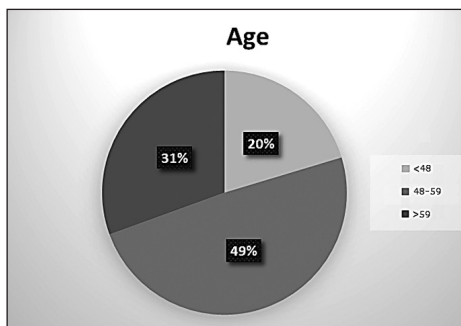


Figure 7
Demographic data of patients with registry record by age. Age is presented in months.

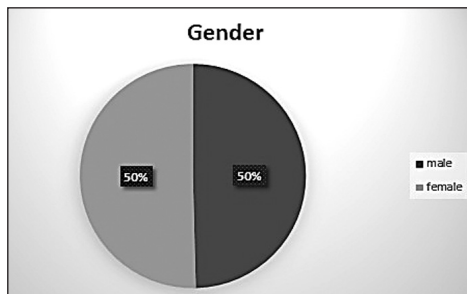


Figure 8
Demographic data of patients with registry record by sex

and distance VA testing should be performed when screening for amblyopia.

The ZAPS study changed the national recommendations for health surveillance in Croatia in favor of VA assessment of 4-year-old children. The high amblyopia prevalence of 8.1% tailored the need to make screening a governmentally guided policy. From June 1st 2015, vision screening of all 4-year-old children performed in ophthalmologists' practices is introduced as a national health policy (2). Since January 2016, founded on the ZAPS study results, vision screening of all 4-year-old children performed in ophthalmologists' practices has become the National Preven-

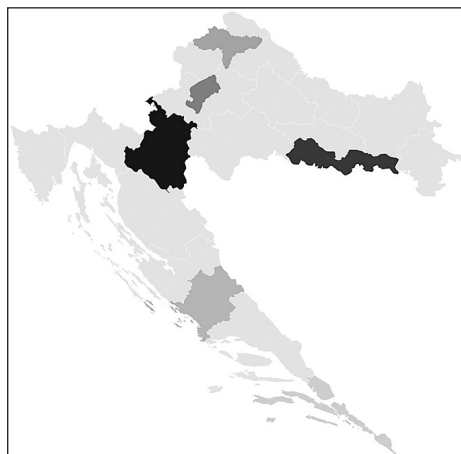


Figure 10
Map distribution of the weighted relative number of four-year-old patients with registry record by county, with respect to population by single age (4 years), relative aspect

tive Program of Early Amblyopia Detection (3). At the age of 48 months the child is referred to ophthalmologist who performs screening by testing VA at near and distance binocularly and monocularly using Lea Symbols in line charts (2). The age-specific normative threshold for determining abnormal monocular VA is set to ≤ 0.1 logMAR (1). Croatian National Amblyopia Day was introduced in 2016, celebrating September

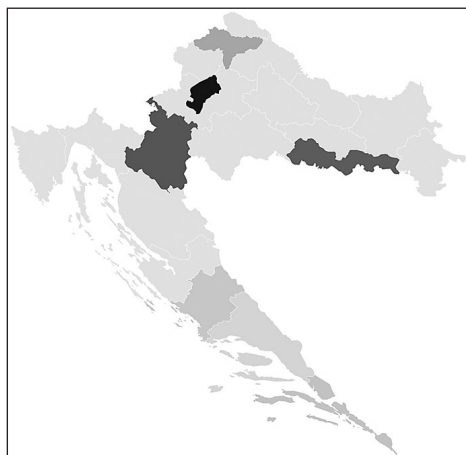


Figure 9
Map distribution of the patients with the registry record by counties, relative aspect

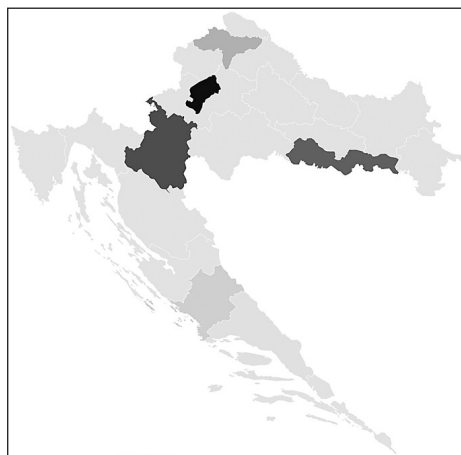


Figure 11
Map distribution of the screened patients by counties, relative aspect

Table 3
Number of patients with registry record by age (A) and by sex (B), by reporting ophthalmologists. MD-Doctor of Medicine

(A)									
MD identity number	Registered patients		< 48 months		48-59 months		≥ 60 months		
	N	%	N	%	N	%	N	%	
1	390	26.9	25	6.41	207	53.08	158	40.51	
2	268	18.48	78	29.1	159	59.33	31	11.57	
3	255	17.59	89	34.9	129	50.59	37	14.51	
4	152	10.48	15	9.87	54	35.53	83	54.61	
5	104	7.17	34	32.69	44	42.31	26	25	
6	95	6.55	13	13.68	50	52.63	32	33.68	
7	56	3.86	9	16.07	27	48.21	20	35.71	
8	45	3.1	25	55.56	16	35.56	4	8.89	
9	43	2.97	3	6.98	11	25.58	29	67.44	
10	20	1.38	2	10	3	15	15	75	
11	17	1.17	0	0	9	52.94	8	47.06	
12	4	0.28	2	50	2	50	0	0	
13	1	0.07	0	0	1	100	0	0	

(B)				
MD identity number	Male		Female	
	N	%	N	%
1	204	52.31	186	47.69
2	133	49.63	135	50.37
3	132	51.76	123	48.24
4	67	44.08	85	55.92
5	47	45.19	57	54.81
6	53	55.79	42	44.21
7	25	44.64	31	55.36
8	21	46.67	24	53.33
9	15	34.88	28	65.12
10	9	45	11	55
11	9	52.94	8	47.06
12	4	100	0	0
13	0	0	1	100

Table 4
Number and frequency of patients with registry record by county

COUNTY	Registered patients	
	N	%
City of Zagreb	641	44.21
Karlovac	268	18.48
Brod-Posavina	255	17.59
Varaždin	104	7.17
Osijek-Baranja	74	5.1
Šibenik-Knin	45	3.1
Dubrovnik-Neretva	43	2.97
Split-Dalmatia	20	1.38

12th (4). Croatian National Amblyopia Registry has been established in April 2017 (5). User friendly on-line application is accessed and completed by ophthalmologist who performs amblyopia screening and treatment (6). Data collection is supervised by Croatian Institute of Public Health and the Reference Centre of the Ministry of Health of the Republic of Croatia for Pediatric Ophthalmology and Strabismus. Constituting Croatian National Amblyo-

pia Registry is of utmost importance to provide high-quality data on amblyopia detection, treatment and prevalence, and to acknowledge its impact more adequately. High quality data and evidence-based best practices are the essence of value-based health enhancement. Disease registries are generally portrayed as systems for data collection and repositories for analysis and research of health outcomes over times. In addition, they are pillars for best practices distribution (7). Frequently, the favorable side issue of upgrading quality is lowered costs. As the final core tenet, they are implemented to improve the quality of life of the community in general. In 1970s Sweden was the first country to introduce national vision screening policy, but at the same time was also a pacesetter in disease registries founding. Sweden was proved to have the best health-care outcomes in Europe, even though health-care costs as ratio of GDP reached EU average of 9% (8). In 2011 the government acknowledged registries a national priority and increased financial support for their expansion five-fold to \$ 45 million per year (9).

Non-standardized patient record systems used by individual caregivers cannot yield sufficient data to boost health

Table 5
Number and frequency of patients with registry record by age of the patient

COUNTY	Age < 48 months		Age 48-59 months		Age ≥ 60 months	
	N	%	N	%	N	%
Karlovac	78	29.1	159	59.33	31	11.57
Brod-Posavina	89	34.9	129	50.59	37	14.51
Osijek-Baranja	9	12.16	37	50	28	37.84
City of Zagreb	55	8.58	313	48.83	273	42.59
Varaždin	34	32.69	44	42.31	26	25
Šibenik-Knin	25	55.56	16	35.56	4	8.89
Dubrovnik-Neretva	3	6.98	11	25.58	29	67.44
Split-Dalmatia	2	10	3	15	15	75

Table 6
Number and frequency of patients with registry record by sex

COUNTY	Male		Female	
	N	%	N	%
City of Zagreb	328	51.17	313	48.83
Karlovac	133	49.63	135	50.37
Brod-Posavina	132	51.76	123	48.24
Varaždin	47	45.19	57	54.81
Osijek-Baranja	34	45.95	40	54.05
Šibenik-Knin	21	46.67	24	53.33
Dubrovnik-Neretva	15	34.88	28	65.12
Split-Dalmatia	9	45	11	55

Table 7
Weighted relative number of four-year-old patients with registry record by county, with respect to population by single age (4 years). N=number of newborns in 2011 year (12)

COUNTY	4-year-old children	
	Registered (%)	Total (N)
Karlovac	24.19	1127
Brod-Posavina	13.82	1600
City of Zagreb	7.27	7389
Varaždin	4.39	1718
Šibenik-Knin	3.09	888
Dubrovnik-Neretva	1.51	1253
Split-Dalmatia	0.1	4784
Zagreb	0	3327
Krapina-Zagorje	0	1188
Sisak-Moslavina	0	1483
Koprivnica-Križevci	0	1113
Bjelovar-Bilogora	0	1191
Primorje-Gorski Kotar	0	2278
Lika-Senja	0	388
Virovitica-Podravina	0	801
Požega-Slavonia	0	761
Zadar	0	1684
Osijek-Baranja	0	2878
Vukovar-Srijem	0	1853
Istria	0	1883
Međimurje	0	1163

Table 8
Number of screened patients, counties of screened patients and reporting ophthalmologists

Patients (N)	1504	
County (N)	8	
MD (N)	13	
	N	%
Age <48 months	401	26.66
Age 48-59 months	697	46.34
Age >60 months	406	26.99
Male	690	45.88
Female	703	46.74
No data	111	7.38

outcome on the national level. However, the European Registry for Quality Improvement in Cataract Surgery gathered the majority of data after the second year (10). The aim of this half-year analysis is thus to identify the achievements and define hurdles in conducting and reporting the results of the National Screening Program of Early Amblyopia Detection. Although we report here the results of screening examination and not the ones of the complete

Table 9
Number and frequency of screened patients by county

COUNTY	Screened patients	
	N	%
City of Zagreb	654	43.48
Brod-Posavina	327	21.74
Karlovac	271	18.02
Varaždin	105	6.98
Osijek-Baranja	73	4.85
Šibenik-Knin	48	3.19
Split-Dalmatia	20	1.33
Lika-Senj	6	0.4

ophthalmological examination, as most of the complete ophthalmological examinations have been scheduled and have not yet been performed, we believe that this report on demographic data will bring benefits to the whole community. In Sweden public disclosure of the Registry data in 2006 resulted in dramatic clinical engagement of below-average caregivers: the average annual rate of improvement increased to 40% in 2009 (11). Demographic variables are crucial for accurate control of the pro-

Table 10
Age of the screened patients by county

COUNTY	Age < 48 months		Age 48-59 months		Age ≥ 60 months	
	N	%	N	%	N	%
Karlovac	90	33.21	150	55.35	31	11.44
City of Zagreb	67	10.24	320	48.93	267	40.83
Osijek-Baranja	12	16.44	34	46.58	27	36.99
Varaždin	35	33.33	44	41.9	26	24.76
Brod-Posavina	163	49.85	128	39.14	36	11.01
Šibenik-Knin	26	54.17	18	37.5	4	8.33
Split-Dalmatia	2	10	3	15	15	75
Lika-Senj	6	100	0	0	0	0

Table 11
Sex of the screened patients by county

COUNTY	Male		Female		No data	
	N	%	N	%	N	%
City of Zagreb	324	49.54	318	48.62	12	1.83
Šibenik-Knin	23	47.92	24	50	1	2.08
Karlovac	127	46.86	131	48.34	13	4.8
Split-Dalmatia	9	45	11	55	0	0
Varaždin	47	44.76	57	54.29	1	0.95
Brod-Posavina	131	40.06	122	37.31	74	22.63
Osijek-Baranja	29	39.73	40	54.79	4	5.48
Lika-Senj	0	0	0	0	6	100

ject as the success of each program is primarily defined by the coverage rate.

MATERIALS AND METHODS

The Croatian National Registry was established on June 1st 2017, and is opened to all ophthalmologists practicing in Croatia. Reporting to the Register is internet based, via the homepage <https://ambliopija.hzjz.hr/index.php/hr/>. There are 4 forms to be filled in time depending on the amblyopia existence and severity. The entry form, screening examination form, comprehensive examination form and follow-up examination form are presented in the Figures 1-4 respectively. The forms are designed in the multiple choice format predominately, limiting the option of entering free text. Practicing ophthalmologist signs in for participation via application form on the homepage and is accredited with registered username and password. Registered ophthalmologist has the access and possibility of analyzing one's own reported data, all other data is anonymous. Reports are made on all the screened cases on the date of screening examination. The Record is located at the Croatian Institute for Public Health and administered by panel of

executives approved by Croatian Institute for Public Health and the Reference Centre of the Ministry of Health of the Republic of Croatia for Pediatric Ophthalmology and Strabismus. Data input is manual, with automatic error-checking system. A pilot phase was conducted during April 1st-May 31st at the Reference Centre of the Ministry of Health of the Republic of Croatia for Pediatric Ophthalmology and Strabismus to test the system. Data collected between June 1st-December 31st 2017 were analyzed.

Definitions used. Contributing ophthalmologist was the one who registered in the registry system and obtained user name and password. Reporting ophthalmologist was the one who reported to the registry system. Non-testable child was the one who answered inconclusively (partially non-testable) or for whom the VA measurement could not be obtained at all (total non-testable).

RESULTS

Contributing ophthalmologists

Distribution of contributing ophthalmologists (N=36) by county is presented in the Table 1. Distribution of contributing

Table 12
 Number and frequency of screened patients (A) by age (B) and by sex (C), by reporting ophthalmologists.
 MD=doctor of medicine

(A)		Screened patients	
MD identity number	N	%	
1	399	26.53	
3	327	21.74	
2	271	18.02	
4	155	10.31	
5	105	6.98	
6	95	6.32	
7	55	3.66	
8	48	3.19	
10	20	1.33	
11	17	1.13	
14	6	0.4	
12	5	0.33	
13	1	0.07	
total	1504	100	

(B)	Age < 48 months		Age 48–59 months		Age ≥ 60 months	
	MD identity number	N	%	N	%	N
13	0	0	1	100	0	0
2	90	33.21	150	55.35	31	11.44
6	13	13.68	51	53.68	31	32.63
1	29	7.27	213	53.38	157	39.35
11	1	5.88	8	47.06	8	47.06
7	11	20	25	45.45	19	34.55
5	35	33.33	44	41.9	26	24.76
12	3	60	2	40	0	0
3	163	49.85	128	39.14	36	11.01
8	26	54.17	18	37.5	4	8.33
4	22	14.19	54	34.84	79	50.97
10	2	10	3	15	15	75
14	6	100	0	0	0	0
total	401	26.66	697	46.34	406	26.99

ophthalmologists (N=36) by county plotted against the total number of ophthalmologists is presented in Figure 5. Contributing ophthalmologists come from public ophthalmology clinics and departments (N=29) and private offices (N=7).

Patients with registry record

Number of patients with registry record, municipalities/towns of the registered patients, counties of the registered patients and reporting ophthalmologists is demonstrated in Table 2. Map distribution of the patients with the registry record by

Table 12

Number and frequency of screened patients (A) by age (B) and by sex (C), by reporting ophthalmologists.
MD=doctor of medicine

(C)	Male		Female		No data	
	N	%	N	%	N	%
12	3	60	0	0	2	40
6	54	56.84	41	43.16	0	0
1	204	51.13	191	47.87	4	1
8	23	47.92	24	50	1	2.08
11	8	47.06	8	47.06	1	5.88
2	127	46.86	131	48.34	13	4.8
10	9	45	11	55	0	0
5	47	44.76	57	54.29	1	0.95
4	63	40.65	86	55.48	6	3.87
3	131	40.06	122	37.31	74	22.63
7	21	38.18	31	56.36	3	5.45
14	0	0	0	0	6	100
13	0	0	1	100	0	0
total	690	45.88	703	46.74	111	7.38

municipalities/towns, relative aspect, is illustrated in Figure 6. Demographic data of patients with registry record (N=1450) by age and by sex is presented in Figure 7 and Figure 8 respectively. Table 3 outlines the number of patients with registry record by age and by sex, by reporting ophthalmologists. Number and frequency of patients with registry record by county, age of the patient with registry record by county and sex of the patient with registry record by county is defined by Table 4, Table 5 and Table 6 respectively.

Map distribution of the patients with the registry record by counties, relative aspect, is illustrated in Figure 9.

Table 7 details weighted relative number of four-year-old patients with registry record by county, with respect to population by single age (4 years) (12). Map distribution of the weighted relative number of four-year-old patients with registry record by county, with respect to population by single age (4 years), relative aspect, is illustrated in Figure 10.

Screening examination

Number of screened patients, municipalities/towns of screened patients, counties of screened patients and reporting ophthalmologists is demonstrated in Table 8. Map distribution of the screened patients

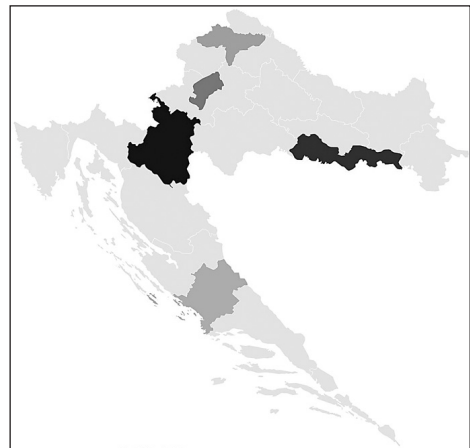


Figure 12
Map distribution of the weighted relative number of four-year-old screened patients by county, with respect to population by single age (4 years), relative aspect

Table 13

Weighted relative number of four-year-old screened patients by county, with respect to population by single age (4 years). N=number of newborns in 2011 year (12)

COUNTY	4-year-old children	
	Screened (%)	Total (N)
Karlovac	22.82	1127
Brod-Posavina	13.71	1600
City of Zagreb	7.42	7389
Varaždin	4.39	1718
Šibenik-Knin	3.48	888
Split-Dalmatia	0.1	4784
Zagreb	0	3327
Krapina-Zagorje	0	1188
Sisak-Moslavina	0	1483
Koprivnica-Križevci	0	1113
Bjelovar-Bilogora	0	1191
Primorje-Gorski Kotar	0	2278
Lika-Senj	0	388
Virovitica-Podravina	0	801
Požega-Slavonija	0	761
Zadar	0	1684
Osijek-Baranja	0	2878
Vukovar-Srijem	0	1853
Istria	0	1883
Dubrovnik-Neretva	0	1253
Međimurje	0	1163
total	2.93	40750

by counties, relative aspect, is illustrated in Figure 11. Number and frequency of screened patients by county, age of the screened patients by county and sex of the screened patients by county is defined by Table 9, Table 10 and Table 11 respectively. Table 12 outlines the number and frequency of screened patients by age and by sex, by reporting ophthalmologists. Table 13 details weighted relative number of four-year-old

screened patients by county, with respect to population by single age (4 years) (12).

Map distribution of the weighted relative number of four-year-old screened patients by county, with respect to population by single age (4 years), relative aspect, is illustrated in Figure 12. Frequency of optotypes used for screening by county is presented in Table 14. Frequency of op-

Table 14
Frequency of optotypes used for screening by county

COUNTY	Lea symbols		Pictures		Numbers		Tumbling E	
	N	%	N	%	N	%	N	%
City of Zagreb	499	76.3	137	20.95	18	2.75	0	0
Brod-Posavina	327	100	0	0	0	0	0	0
Karlovac	3	1.11	0	0	0	0	268	98.89
Varaždin	82	78.1	22	20.95	0	0	1	0.95
Osijek-Baranja	55	75.34	0	0	0	0	18	24.66
Šibenik-Knin	2	4.17	0	0	1	2.08	45	93.75
Split-Dalmatia	0	0	18	90	2	10	0	0
Lika-Senj	0	0	6	100	0	0	0	0
total	968	64.36	183	12.17	21	1.4	332	22.07

optotypes assembly used for screening by county is presented in Table 15. Number and ratio of unremarkable screening results by county and by reporting ophthalmologists, are detailed in Table 16 and Table 17. Number and ratio of optotypes, and optotypes assembly used for screening examinations by reporting ophthalmologists is presented in Table 18 and Table 19 respectively. Number and ratio of non-testable patients

by county and by reporting ophthalmologists is presented Table 20 and Table 21 respectively. Overall number of screened negative patients and non-testable patients is summarized in Table 22.

DISCUSSION

VISION 2020 promotes the world without needlessly visually impaired people. The World Bank forecasts that human

Table 15
Optotypes assembly used for screening by county

COUNTY	inline		single	
	N	%	N	%
City of Zagreb	618	94.5	36	5.5
Brod-Posavina	327	100	0	0
Karlovac	169	62.36	102	37.64
Varaždin	99	94.29	6	5.71
Osijek-Baranja	57	78.08	16	21.92
Šibenik-Knin	48	100	0	0
Split-Dalmatia	0	0	20	100
Lika-Senj	6	100	0	0
total	1324	88.03	180	11.97

Table 16
Number and ratio of unremarkable screening results by county

COUNTY	N	%
Brod-Posavina	287	87.77
City of Zagreb	552	84.4
Karlovac	221	81.55
Osijek-Baranja	55	75.34
Lika-Senj	4	66.67
Šibenik-Knin	29	60.42
Varaždin	63	60
Split-Dalmatia	7	35
total	1218	80.98

population will reach 9.77 billion in 2050 year (13). If nothing is done, about 500 million people will be amblyopic needlessly. Preschool vision screening meets all the World Health Organization's criteria for evaluation of screening programs (14). The importance of implementing amblyopia preventive activities is of utmost value in order to achieve Sustainable Development Goals and Health 2020 Goals. Zagreb Amblyopia Preschool Screening (ZAPS) study demonstrated amblyopia prevalence of 8.1% (1). Based on the ZAPS study results, Croatian Ministry of Health released National Preventive Program of Early Amblyopia Detection, mandatory for all 4-year-old children (3). The child is referred to ophthalmologist who performs screening by testing visual acuity at near and distance binocularly and monocularly using Lea Symbols in line charts. To facilitate its implementation, Croatian Parliament introduced National Amblyopia Day in 2016, celebrated on September 12th. Constitution of Croatian National Amblyopia Registry, released by Ministry of Health as user-friendly on-line application in 2017, was of utmost importance to provide high-quality performance and monitor the outcomes of National Program of Early

Table 17
Number and ratio of unremarkable screening results by reporting ophthalmologists. MD-Doctor of Medicine

MD identity number	N	%
1	321	80.45
3	287	87.77
2	221	81.55
4	144	92.9
5	63	60
6	82	86.32
7	42	76.36
8	29	60.42
10	7	35
11	13	76.47
14	4	66.67
12	5	100
13	0	0

Amblyopia Detection (6). Before the formation of the Registry, reporting standards of amblyopia care and outcome results were not performed across the system. To the best of our knowledge, this is the first national amblyopia registry of its kind in the world. Registry engages the medical community comprising primary care physicians, primary care pediatricians and ophthalmologists as the key stakeholders. In general, innovation delivers knowledge and increases capability, but generates tension between the aspirants of new order and dwellers of the old one. The first six months of Registry establishment witnessed that amblyopia issue is still largely being ignored and urgent actions need to be taken to improve the implementation process of National Preventive Program of Early Amblyopia Detection. First of all, less than 5% of the four-year-old population is covered by the screening (Table 13). ZAPS study results demonstrated

Table 18
Frequency of optotypes used for screening by reporting ophthalmologists. MD-Doctor of Medicine

MD identity number	Lea symbols		Pictures		Numbers		Tumbling E	
	N	%	N	%	N	%	N	%
1	399	100	0	0	0	0	0	0
3	327	100	0	0	0	0	0	0
2	3	1.11	0	0	0	0	268	98.89
4	0	0	137	88.39	18	11.61	0	0
5	82	78.1	22	20.95	0	0	1	0.95
6	95	100	0	0	0	0	0	0
7	55	100	0	0	0	0	0	0
8	2	4.17	0	0	1	2.08	45	93.75
10	0	0	18	90	2	10	0	0
11	0	0	0	0	0	0	17	100
14	0	0	6	100	0	0	0	0
12	5	100	0	0	0	0	0	0
13	0	0	0	0	0	0	1	100

Table 19
Optotypes assembly used for screening by reporting ophthalmologists. MD-Doctor of Medicine

MD identity number	inline		single	
	N	%	N	%
1	399	100	0	0
3	327	100	0	0
2	169	62.36	102	37.64
4	119	76.77	36	23.23
5	99	94.29	6	5.71
6	95	100	0	0
7	55	100	0	0
8	48	100	0	0
10	0	0	20	100
11	1	5.88	16	94.12
14	6	100	0	0
12	5	100	0	0
13	1	100	0	0

Table 20
Number and ratio of non-testable patients by county

COUNTY	partially		totally	
	N	%	N	%
Varaždin	45	42.86	2	1.9
Brod-Posavina	28	8.56	9	2.75
City of Zagreb	13	1.99	8	1.22
Lika-Senj	1	16.67	0	0
Split-Dalmatia	0	0	4	20
Osijek-Baranja	0	0	0	0
Šibenik-Knin	0	0	17	35.42
Karlovac	0	0	17	6.27

Table 21
Number and ratio of non-testable patients by reporting ophthalmologist

MD identity number	partially		totally	
	N	%	N	%
1	11	2.76	7	1.75
2	0	0	17	6.27
3	28	8.56	9	2.75
4	1	0.65	1	0.65
5	45	42.86	2	1.9
6	1	1.05	0	0
7	0	0	0	0
8	0	0	17	35.42
10	0	0	4	20
11	0	0	0	0
12	0	0	0	0
13	0	0	0	0
14	1	16.67	0	0

the likelihood of parental rejection of the screening is 1.48% (1). Hence, we assume the reason for such a low coverage ratio could be either poor referral rate from pediatric primary care offices or non-reporting of the ophthalmologist who perform screening. Although the exact referral rate

cannot directly be evaluated from the Registry data, it should always be emphasized that screening program is a national, mandatory, governmental health policy addressing children of specific age.

Table 22
Overall number of screened negative patients
and non-testable patients

	N	%
Patients screened negative	1218	80.98
Non-testable, partially	87	5.78
Non-testable, totally	57	3.79
Patients screened positive	142	9.45
total	1504	100

The number of contributing ophthalmologists is still very weak (N=36) and 8 out of 21 counties do not have a single contributing ophthalmologist (Table 1). However, only 13 contributing ophthalmologists reported patient data to the Registry (Table 2). On the other hand, in the single County City of Zagreb, there were 17 health-care providers who performed screening of 15648 children aged 48-54 months in the 2011-2014 periods (1). We may only prejudice the reasons for such deficient effectiveness of contributing ophthalmologists. Collecting data and reporting results put an additional workload. Moreover, the process is not paid and it is operated in spare time, as time for the process is not scheduled during working hours. Counties of contributing ophthalmologists are concordant with counties of patients' origins. There is also a discrepancy of 3.6% between the number of patients registered (N=1450) (Table 2) and the number of screened patients (N=1504) (Table 8).

Screening tests are defined for a specific target disease and population, defined by the age, sex and risk factors. National Preventive Program of Early Amblyopia Detection is mandatory for all children aged 48-59 months. The process metrics showed poor adherence to the accepted clinical standards, first evidenced when age variable was analyzed. Of screened population, only 46% of patients fulfill the

age criteria (Table 8). In Lika-Senj County 100% of screened children were younger than 4 years (Table 10). There are several reasons for determining the age of 4 years as the most appropriate for screening examination, and one of them is testability (1). It is evidenced that over-referrals are more common among 3-year-old children as 3-year-old children testability rate reaches about 80% compared to >90% in the 4-year-old group (15).

The weighted relative number of four-year-old screened patients (N=696) with respect to population by single age (4 year) (N=40750) demonstrated extremely low overall rate of 2.9% (Table 13) (12). When the same variable was distributed by county then three of eight counties that performed screening scored 0% (Table 13). For comprehensive, widespread adoption of the Registry, all stakeholders need to be actively engaged. Primary care physicians and pediatricians are at the forefront to drive this change. Only children aged 48-59 months are to be referred to the screening examination. During 2016 and 2017 Croatian Institute for Public Health allocated 250.000 amblyopia brochures to the primary care pediatricians' offices as educational elements to be distributed to target population, emphasizing the significance of screening (5).

The Registry tracks adherence to well defined Croatian amblyopia screening policy and demonstrated poor compliance of reporting ophthalmologists. Although the procedure of the screening examination is well defined, screeners used different screening methodology (3). Three counties, The City of Zagreb, Brod-Posavina and Karlovac County performed >80% of screening examinations (Table 9). Among reporting ophthalmologists >75% of children were screened by 4 ophthalmologists (Table 12A). Five ophthalmologists used only Lea Symbols in line charts for screening adhering to policy (Table 18). Lea

Symbols in lines test is the most discriminative VA test as it does not underestimate amblyopia. There is still a large percentage of picture optotypes and tumbling E charts used for screening. Four ophthalmologists used tumbling E in 94%, 99%, 100%, and 100% of cases and three screeners used picture optotypes in 88%, 90% and 100% of examinations (Table 18). Two ophthalmologists used single pictures and single tumbling E arrangement (Table 19). The Allen picture test is not standardized and not recommended by the World Health Organization, while tumbling E and Landolt C are not appropriate for the preschool children screening due to underdevelopment of right-left laterality (16-24). Isolated single optotypes are not used in daily clinical practice as they overestimate VA (15, 25).

Overall 81% of children were screened negative, 9.6% were non-testable and 9.4% of children were referred to complete ophthalmological examination (Table 22). These results are in accordance with the ZAPS study in which 78% of children passed the screening test, and 22% were referred to perform complete ophthalmological examination (1). The highest ratio of non-testables was in Šibenik-Knin and Varaždin County reaching 35% and 45% respectively (Table 20).

The Registry is evidenced as a comprehensive powerful platform for improving all segments of the amblyopia prevention process as significant challenges still exist in the area of allocating contributing ophthalmologists, referring children of appropriate age to screening examination, performing the screening in agreement with national preferred practice patterns and reporting the results of screening examination. Overall, reported problems in conducting and implementing screening strategies are mainly related to compliance, lack of population education and organizational issues (26-28). In Croatia for example, in colorectal and breast cancer

screening program, the response rate was 19% and 49% respectively (27, 28). Screening programs for children on the other hand have a major sociological implication because they deliver a lifetime benefit.

Although the Government consented reporting data to the Registry is mandatory, at present no mechanisms exist to oblige providing healthcare professionals to follow the governmental release. Government should be focused on providing regulatory framework to compel stakeholders to refer, screen and report data. Audit is planned to be introduced to enhance the data-validation process and reliable, high-quality reporting. Uniform standards for screening examination has already been created, thus the ophthalmologists should adhere to them in order to prevent the use of needless procedures of complete ophthalmological examinations. Support of the Government, wide community involvement and media promotion are needed for comprehensive eye care strategy to be fully generated and successfully delivered.

Abbreviations:

ZAPS - Zagreb Amblyopia Preschool Screening
VA - Visual Acuity
logMAR - Logarithm of Minimal Angle of Resolution
MD - Doctor of Medicine
N - Absolute Number

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SUKOB INTERESA/CONFLICT OF INTEREST

Autori su popunili *the Unified Competing Interest form* na www.icmje.org/coi_disclosure.pdf (dostupno na zahtjev) obrazac i izjavljuju: nemaju potporu niti jedne organizacije za objavljeni rad; nemaju financijsku potporu niti jedne organizacije koja bi mogla imati interes za objavu ovog rada u posljednje 3 godine; nemaju drugih veza ili aktivnosti koje bi mogle utjecati na objavljeni rad. *All authors have completed the Unified Competing Interest form at www.icmje.org/coi_disclosure.pdf (available on request from the corresponding author) and declare:*

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Sažetak

HRVATSKI NACIONALNI REGISTAR RANOG OTKRIVANJA SLABOVIDNOSTI

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Cilj: Identificirati uspješnost i definirati poteškoće u provođenju Nacionalnog programa ranog otkrivanja slabovidnosti.

Materijali i metode: Analizirani su demografski podaci pacijenata i rezultati probira prikupljeni u Hrvatskom nacionalnom registru ranog otkrivanja slabovidnosti u periodu od 1. lipnja do 31. prosinca 2017.

Rezultati: Broj oftalmologa koji su provodili probir na slabovidnost je izrazito nizak N=13, a za 8/21 županija ne postoje podaci o provođenju probira. Od pregledane populacije (N=1504), samo 46% djece zadovoljava kriterij dobi. U Ličko-senjskoj županiji, 100% pregledane djece bilo je dobi <4 godine. Ponderirani relativni broj pregledanih četverogodišnjaka s obzirom na ukupni broj četverogodišnjaka pokazao je izuzetno nizak odaziv. Kad se navedena varijabla raspodijeli po županijama, u čak 3/8 županija koje su sudjelovale u probiru pokrivenost je bila 0%. Sveukupno, 81% djece je imalo uredan nalaz, 9,6% nije bilo moguće testirati, a 9,4% djece je upućeno na cjeloviti oftalmološki pregled. Najveći udio djece koju nije bilo moguće testirati bilo je u Šibensko-kninskoj i Varaždinskoj županiji, te je iznosio 35%, odnosno 45%.

Diskusija: Pregledom literature, ovo je prvi nacionalni registar slabovidnosti u svijetu. Registar prati provođenje Nacionalnog programa ranog otkrivanja slabovidnosti u Hrvatskoj i pokazuje slabu suradljivost liječnika primarne zdravstvene zaštite i oftalmologa.

Zaključak: U prvih šest mjeseci postojanja Registra pokazalo se da je pitanje slabovidnosti još u velikoj mjeri zanemareno, te je potrebno poduzeti hitne mjere kako bi se poboljšao proces provedbe Nacionalnog programa ranog otkrivanja slabovidnosti.

Deskriptori: REGISTAR, SLABOVIDNOST, PROBIR, DJECA, RANO OTKRIVANJE, RANO DIJAGNOSTICIRANJE, SURADLJIVOST, SLJEPOČA