Screening and Treating Amblyopia: Are We Making a Difference?

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Purpose. To determine the rate of amblyopia in native Jewish Israelis compared with those who immigrated from the former Soviet Union (U.S.S.R.) after they were 10 years of age.

Methods. Health records of all 16-year-old subjects examined in the Israel Defense Forces Recruitment Center between 1998 and 2003 were analyzed. The number of subjects with best corrected visual acuity (BCVA) of 6/12 or less in at least one eye among native Israelis and among those who immigrated to Israel from the U.S.S.R. after they were 10 years of age was determined. Subjects who had any ocular disease except cataract, corneal opacity, strabismus, or ptosis were excluded.

Results. Of 305,712 subjects examined between 1998 and 2003, 292,255 were enrolled in the study. Of those, 260,186 (89%) were born in Israel and 32,069 (11%) were born in the U.S.S.R. and immigrated to Israel after they were 10 years of age. There were 2565 (0.98%) native Israelis and 483 (1.5%) immigrants who had BCVA of 6/12 or less in at least one eye (χ^2 test, $P < 0.00001$). The rate of amblyopia among subjects who had refractive errors was 14.6% among immigrants, as opposed to 8.0% among native Israelis ($P < 0.0001$), whereas amblyopia rates among those with strabismus, cataract, or ptosis were similar in native Israelis and immigrants (34.4%, 38.6%, 12.8% as opposed to 34%, 37.5%, 15.4%, respectively, $P = 0.5–0.61$).

Conclusions. The difference in the rate of refractive amblyopia as opposed to strabismic and deprivation amblyopia may be due to the difference in vision screening methods between both countries. (*Invest Ophthalmol Vis Sci.* 2007;48: 2084–2088) DOI:10.1167/iovs.06-0089

Amblyopia is a significant public health problem that affects between 2% and 5% of adults.[1] It is the leading cause of monocular vision loss in the United States among people younger than 40 years.[2] Although vision screening for amblyopia is widely endorsed,[3–5] it has been the subject of skepticism,[6–8] and the benefit of treating certain amblyogenic conditions has also been questioned.[9,10] The actual effect of screening for amblyopia and treating it on the prevalence of this disease is hard to quantify, since for ethical reasons, no comparison studies to nontreatment have been performed. Studies of the prevalence of amblyopia in developed countries where medical treatment is available, such as the United Kingdom, Sweden, and Australia, quote rates between 0.5% and 3%.[11–13] In developing countries, where national screening methods are less available and medical treatment is not always at hand, a much higher rate of amblyopia was expected. However, the reported rate of amblyopia is not much different: 0.3% in southern Jordan,[14] 1.29% in rural Indonesia,[15] and 2.5% in northern Mexico.[16] Moreover, population-based studies have shown that the prevalence of amblyopia can be different between ethnic groups, even when they live in the same environment.[17] It is therefore impossible to draw conclusions regarding the efficacy of screening and treatment by comparing the rate of amblyopia quoted in these studies in which different methods were used in different environments and in different ethnic groups.

In this study, we tried to evaluate the rate of amblyopia among Israeli Jews who were all uniformly examined at the age of 16. To evaluate the impact of screening and treating amblyopia, we compared the rate of amblyopia in Israelis who were born and raised in Israel and those who immigrated to Israel from the former Soviet Union after they were 10 years of age.

Methods

Data

On reaching the age of 16, all Israeli Jewish citizens (without any preliminary selection criteria) are considered "nominees for security service" and therefore are obligated by law to appear before the Israel Defense Forces Recruiting Office. The nominees undergo an extensive evaluation process, including a comprehensive medical examination by a general practitioner and detailed medical history. The medical history is given by the nominee's family physician and is based on his or her medical records, which include data on all surgeries or other procedures that the nominee has undergone. In addition, the nominee undergoes sociodemographic profiling. All this information is stored in a computerized database, from which all the data for this study were extracted.

The database for this study included all nominees for military service who were 16 years of age and appeared before the recruitment office between 1998 and 2003. Since this examination is enforced by law, the study population represents the entire Israeli Jewish population at this age.

Visual Acuity

As part of the standardized examination, each nominee has his/her best corrected visual acuity determined by a qualified technician, using a standard Snellen chart. Visual acuity is determined separately for each eye. Subjects who can read all the letters of the 6/6 line without optical correction are assumed to have a 0-D refractive error. Subjects wearing glasses or contact lenses who miss no more than one letter of the 6/6 line have the power of this correction recorded and assumed as their present refraction. Refraction is performed if a nominee is unable to read all the letters of the 6/6 line but one. Initially an objective refraction is performed with an automatic refractometer. Next is a subjective refraction validation with a standard Snellen chart. If a visual acuity of 6/6 is still not achieved after subjective refraction, the nom-

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TABLE 1. Prevalence of the Amblyogenic Factors in Native Israelis and Immigrants from the Former Soviet Union

Amblyogenic Factor	Native Israelis (n = 260,186)	Immigrants from U.S.S.R. (n = 32,069)	P
Anisometropia ≥ 1 D sphere and/or cylinder	17,226 (6.3%)	1780 (2.9%)	<0.00001
Strabismus*	2,321 (0.89%)	259 (0.81%)	0.12
Strabismus and anisometropia	442 (0.16%)	50 (0.15%)	0.5
Bilateral myopia ≥7 D	1,706 (0.65%)	90 (0.28%)	<0.00001
Bilateral hyperopia ≥4 D†	440 (0.17%)	93 (0.29%)	<0.00001
Bilateral astigmatism ≥2 D†	2,156 (0.83%)	392 (1.2%)	<0.00001
Cataract	233 (0.09%)	30 (0.09%)	0.8
Ptosis	125 (0.05%)	13 (0.04%)	0.56

* Not including subjects with cataract.
† Not including subjects with strabismus.

inee is referred to an ophthalmologist. The ophthalmologist examines the nominee and determines the cause of his or her reduced vision. The results of this examination and the medical conditions or procedures that were obtained from the medical history are coded according to a special coding book, and the code is stored in the database.

Data Analysis

We extracted from the database two groups of subjects for further analysis: those who were born in Israel and those who were born in the former Soviet Union and immigrated to Israel after they were 10 years of age. This age cutoff was chosen because after this age, further amblyopia treatment in Israel was unlikely to influence the outcome of these subjects significantly. We excluded nominees who had any ocular disease except for strabismus, ptosis, cataract, or corneal opacity and determined the rate of best-corrected vision of 6/12 or less in one or both eyes in each group. All subjects with strabismus were counted as "strabismics" regardless of their refractive error (unless it was anisometropia). Similarly, all subjects with cataract were counted as "cataract" regardless of their refractive status or alignment. We used the χ^2 test and the Fisher exact test for statistical analysis.

RESULTS

A total of 305,712 16-year-old Israeli citizens were examined in the Israel Defense Forces Recruiting Center between 1998 and 2003. After all subjects who had ocular disease, except for cataract, corneal opacity, strabismus, or ptosis, and those who were born in countries other than Israel or the U.S.S.R. or who had immigrated to Israel before the age of 10 years were excluded, 292,255 subjects were enrolled in the study. Of those 260,186 (89%) were born in Israel, and 32,069 (11%) were born in the former Soviet Union and immigrated to Israel after the age of 10 years.

Table 1 presents the prevalence of several amblyogenic factors in both groups. As can be seen, anisometropia ≥1 D in sphere or cylinder and bilateral myopia ≥7 D were more common in the native Israelis, whereas bilateral hyperopia ≥4 D and bilateral astigmatism ≥2 D were more common in the immigrants from the former U.S.S.R. Other factors were equally distributed.

Best corrected visual acuity less than 6/12 in one or both eyes was significantly less prevalent in native Israelis than in immigrants from the former Soviet Union (Table 2).

In 75.5% of the native Israelis and 85.7% of the immigrants, a presumed cause of the amblyopia was found (Table 3). Refractive errors were the most common cause of amblyopia in both groups; however, in the immigrant group, refractive errors as a cause of amblyopia were significantly more frequent. The most prevalent cause of amblyopia was anisometropia. Although anisometropia as a risk factor was more common among native Israelis, the proportion of anisometropia as a cause of amblyopia was significantly more prevalent among immigrants. Bilateral astigmatism of >2 D was also significantly more common as a cause of amblyopia among immigrants, as was high hypermetropia. In contrast, high myopia, which was significantly more common among native Israelis as a risk factor, was also more common as a cause of reduced vision among this group. The rates of amblyopia caused by cataract, strabismus, or ptosis were similar between groups.

The significant role of refractive errors as a cause of amblyopia among immigrants was especially apparent when we examined the percentage of those who had reduced vision in each of the risk-factor groups (Fig. 1). Although the rate of amblyopia among those with strabismus, ptosis, or cataract was similar in both groups, amblyopia was almost twice as common among immigrants who had refractive error than in native Israelis. The same was true of anisometropia, high myopia, high hypermetropia, and high astigmatism.

DISCUSSION

Screening and treating amblyopia is a well-accepted public health policy in most developed countries.[3–5] However, the impact of the screening and treatment on the actual prevalence of amblyopia is hard to quantify. This question has even led to the recommendation that a randomized controlled trial in which the control group is not treated should be performed.[18] In this study, we tried to determine the effect of different screening and treatment methods on one ethnic group: Israelis of Jewish origin. We have found that those who spent the first 10 years of their lives in the former Soviet Union had a 53% higher chance of having amblyopia than did those who were born and raised in Israel.

A comparison between the two groups concerning the prevalence of amblyogenic factors, exhibits a difference in some factors but not in all. Although no difference was found

TABLE 2. The Prevalence of Amblyopia in Native Israelis and Immigrants from the Former Soviet Union

	Subjects Enrolled	Subjects with Amblyopia	Prevalence of Amblyopia	P
Native Israelis	260,186	2565	0.98%	<0.00001
Former USSR immigrants	32,069	483	1.5%	

TABLE 3. Causes of Amblyopia in Native Israelis and Immigrants from the Former Soviet Union

Cause of Amblyopia	Native Israelis (n = 2565)	Immigrants from USSR (n = 483)	P
Anisometropia, total	1,389 (49.1%)	260 (53.8%)	0.05
Strabismus	221 (7.8%)	31 (6.4%)	0.28
Bilateral myopia ≥7 D	135 (4.7%)	13 (2.7%)	0.04
Bilateral hyperopia ≥4 D	76 (2.7%)	32 (6.6%)	<0.00001
Bilateral astigmatism ≥2 D	237 (8.4%)	69 (14.3%)	0.00003
Cataract	60 (2.1%)	7 (1.4%)	0.33
Ptosis	16 (0.56%)	2 (0.4%)	0.67
Undetermined	692 (24.5%)	69 (14.3%)	

in the rate of strabismus, ptosis, or cataract, native Israelis had significantly more anisometropia and high myopia, and immigrants had significantly more high hypermetropia and astigmatism. These differences may be explained by environmental factors. It is possible that native Israelis had an increasing amount of close work during childhood and therefore had more myopia and less hyperopia.

To evaluate the effect of screening and treatment on each group, we compared the rate of amblyopia in subjects who had these amblyogenic factors. As can be seen in Figure 1, we found that immigrants had double the rate of amblyopia caused by refractive errors, but similar rates of strabismic or deprivation amblyopia.

We consider that the significant difference in the prevalence of amblyopia between the two groups derives from the different screening methods and treatment for amblyopia used in Israel and the former Soviet Union. Vision screening in Israel is performed at governmental public health clinics and is available to everyone without charge. A pediatrician examines every infant before the age of 6 months. During this examination, each eye is tested for fixation and after and the red reflex is assessed. At the age of 3 years, a verbal examination of visual acuity is performed by a nurse. A third examination is conducted at the beginning of the first year of elementary school, when each child's vision is examined by an ophthalmologist or optometrist. Every child who fails these examinations is referred to an ophthalmologist for further treatment. Since all Israeli citizens are medically insured, follow-up treatment is available to all at no charge.

In the former Soviet Union, attempts were also made to screen children and treat them when amblyopia was diagnosed[19–32]; however, no uniform system of screening was used. Moreover, as opposed to the high availability and quality of medical services in Israel, the availability and quality of medical services varied among the different states of the Soviet Union, and, in rural areas, not all children were actually screened and treated.[19,28] Sometimes, even when amblyopia was diagnosed, glasses, especially with high cylinder, were hard to find.

It is possible that conditions such as strabismus, ptosis, and cataract, which are more apparent, were diagnosed and treated early in both countries and therefore had a similar outcome. However, children with refractive errors that can be diagnosed only by a qualified vision screener had their errors diagnosed less promptly in the U.S.S.R. and therefore had worse outcomes.

Another explanation of the difference in the rates of amblyopia between groups may be a higher rate of amblyogenic factors in the immigrant group at the amblyogenic age—that is, before the age of 10 years—that were not detected during the screening at 16 years. Since the medical history taken for both groups was as accurate as possible (from the subject and from the family physician) and since physical examination was performed in all subjects, it is likely that factors such as strabismus, ptosis, or media opacities, even if successfully treated in the past, would have been noted. Indeed, we have found no difference in the rate of these factors between groups. As for refractive factors, since refraction was performed only in sub-

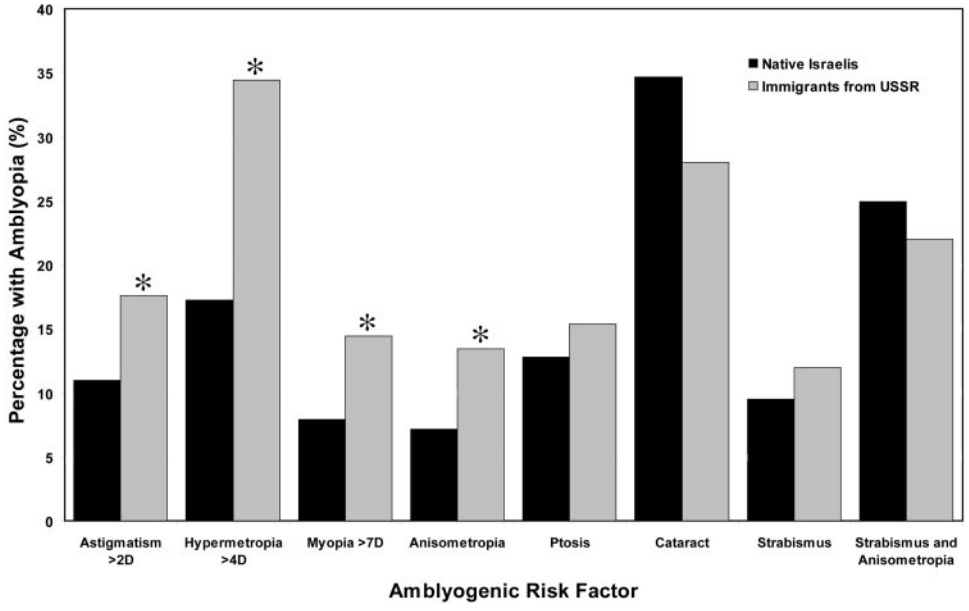

FIGURE 1. The rate of amblyopia among those with amblyogenic factors in each group. *Statistically significant difference.

jects with uncorrected visual acuity of <6/6, it is possible that subjects with bilateral hyperopia that had been successfully treated with glasses and later reduced to low hyperopia were defined as having normal vision in our study. Since bilateral hyperopia was a minor cause of amblyopia in our study and in others, we do not believe that this could have significantly influenced our results.

The impact of the method of screening on the prevalence of amblyopia was compared in a study in the United Kingdom that showed that screening at the ages of 8, 12, 18, 25, 31, and 37 months ("deluxe screening") reduced the prevalence of amblyopia to 0.6% as opposed to 1.8% in a group that was screened only once at the age of 37 months.[33] The effectiveness of screening is also supported by studies from Scandinavia. The implementation of a national vision screening policy in the past two decades led to the opportunity to compare the rate of amblyopia before and after screening was implemented. In a study from Denmark, the rate of amblyopia among those who were not screened ($n = 1000$) was 2.9% as opposed to residual amblyopia of 1% among school children who were screened.[34] A Swedish study screened 2178 7-year-old children,[35] 1530 of whom had been screened at the age of 4 years.[36] Only 0.07% of the children rescreened at 7 years were found to have amblyopia as opposed to 1.8% in the former screening performed at 4 years. Another Swedish study ($n = 1278$) found that screening reduced the prevalence of amblyopia by 50% and almost completely eliminated severe amblyopia.[36]

The most prevalent cause of amblyopia in our study was refractive errors such as anisometropia, followed by strabismic and mixed strabismic and anisometropic amblyopia. Similar observations were reported in other population-based studies such as those in Australia and Singapore.[12,17,37]

To the best of our knowledge, our study is the largest population-based study that addresses the issue of the efficacy of vision screening. The rate of residual amblyopia in the screened population of native Israelis (0.98%) was similar to that found other large sample studies, such as in Denmark ($n = 1000$, 1%),[34] and the United Kingdom ($n = 6081$, 1.1%)[33] and higher than the prevalence in Singapore ($n = 122{,}596$, 0.35%).[17]

In conclusion, our study demonstrated the effect of the availability of screening and treatment on the prevalence of amblyopia. Since elaborate equipment or manpower capabilities are not necessary for the screening and treatment of this condition, the results provide strong evidence supporting the need for a formal, government-directed vision-screening program as a public health policy.

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