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Abstract

We previously revealed the prevalence of strabismus and amblyopia in elementary school children between 6 and 12 years of age in Japan in the year 2003. Questionnaires asking the number of children with different types of strabismus and amblyopia were sent to all elementary schools in Okayama Prefecture in the year 2005, and the results in the year 2005 were compared with those obtained in the year 2003. The number of children covered by the return of questionnaires was 84,619 (74%) of 113,763 total pupils, including grades 1 to 6, in Okayama Prefecture in the year 2005. The total numbers of children with strabismus and amblyopia, including grades 1 to 6, were 844 (0.99%, 95% confidence interval: 0.94-1.06%) and 173 (0.20%, 95% confidence interval: 0.17-0.23%), respectively. The numbers of children with any type of exotropia and any type of esotropia were 524 (0.62%) and 187(0.22%), respectively. In the previous survey conducted in 2003, the number of children covered by the return of questionnaires was 86,531 (76%) of 113,254 total pupils. The total numbers of children with strabismus and amblyopia were 1,112 (1.28%, 95% confidence interval: 1.24-1.36%) and 125 (0.14%, 95% confidence interval: 0.12-0.17%), respectively. The numbers of children with any types of exotropia and esotropia were 602 (0.69) and 245 (0.28%), respectively. The prevalence of strabismus in this large population of Japanese elementary school children was significantly different between the years 2003 and 2005, while the prevalence of amblyopia was similar between the years.

KEYWORDS: prevalence, strabismus, amblyopia, elementary school, vision screening program

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Original Article

Comparison of Prevalence Rates of Strabismus and Amblyopia in Japanese Elementary School Children between the Years 2003 and 2005

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We previously revealed the prevalence of strabismus and amblyopia in elementary school children between 6 and 12 years of age in Japan in the year 2003. Questionnaires asking the number of children with different types of strabismus and amblyopia were sent to all elementary schools in Okayama Prefecture in the year 2005, and the results in the year 2005 were compared with those obtained in the year 2003. The number of children covered by the return of questionnaires was 84,619 (74%) of 113,763 total pupils, including grades 1 to 6, in Okayama Prefecture in the year 2005. The total numbers of children with strabismus and amblyopia, including grades 1 to 6, were 844 (0.99%, 95% confidence interval: 0.94–1.06%) and 173 (0.20%, 95% confidence interval: 0.17–0.23%), respectively. The numbers of children with any type of exotropia and any type of esotropia were 524 (0.62%) and 187 (0.22%), respectively. In the previous survey conducted in 2003, the number of children covered by the return of questionnaires was 86,531 (76%) of 113,254 total pupils. The total numbers of children with strabismus and amblyopia were 1,112 (1.28%, 95% confidence interval: 1.24–1.36%) and 125 (0.14%, 95% confidence interval: 0.12–0.17%), respectively. The numbers of children with any types of exotropia and esotropia were 602 (0.69%) and 245 (0.28%), respectively. The prevalence of strabismus in this large population of Japanese elementary school children was significantly different between the years 2003 and 2005, while the prevalence of amblyopia was similar between the years.

Key words: prevalence, strabismus, amblyopia, elementary school, vision screening program

Strabismus and amblyopia are primarily diseases of children and thus require early detection and treatment to achieve better visual acuity and binocular function. To form a policy for early detection of strabismus and amblyopia [1], it is necessary to understand the prevalence of both diseases in children.

In Japan, eye alignment is examined first in children at the ages of both 1 and 1/2 years and 3 years, primarily by pediatricians and clinical medical officers [2]. Children at 6 years of the age on April 1 begin attendance in grade 1 at elementary schools, which include Grades 1 to 6 in Japan. The School Health Law, enacted in 1948, requires that all pupils in Grades 1 to 6 be examined for vision and eye problems. Visual acuity testing is done by school teachers and eye disease screening by school ophthalmologists.

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Pupils with uncorrected visual acuity poorer than 1.0 (20/20) as well as suspected ocular diseases are further examined by extramural ophthalmologists, and the results are reported back to the schools.

The schools then summarize and send uncorrected visual acuity and overall ocular disease incidence, together with other health statistics, to the municipal education committees. The education committees then organize and forward all data to the Prefecture Governments. Data from all Prefectures are finally submitted to the Ministry of Education, Culture, Sports, Science, and Technology of the Central Government [3]. Both the Prefecture Governments and the Education Ministry publicize the school health statistics on their websites <<http://www.pref.okayama.jp>> and <<http://www.mext.go.jp>> [3]. However, the prevalence of strabismus and amblyopia cannot be determined from these data because the school statistics only report the prevalence of overall eye diseases.

We previously surveyed the prevalence of strabismus and amblyopia in children from 6 to 12 years of age at elementary schools in Okayama Prefecture by sending questionnaires to each school in the year 2003 [3]. Okayama Prefecture, with its population of 2 million, is located in the western part of Honshu, the main island of Japan. In this study, we repeated the survey in the year 2005 and tested whether the prevalence rates of strabismus and amblyopia were at the same levels.

Materials and Methods

A questionnaire asking the number of children in each grade and the number of children with a diagnosis of strabismus or amblyopia was sent by mail to each elementary school in Okayama Prefecture in July 2005. This survey was approved by the Education Committee of Okayama Prefecture, and a letter of recommendation to answer this survey was sent to the education committee of each municipality and then to the principal of each elementary school. The questionnaires were answered by teachers in charge of school health and then sent back by mail to us.

In the questionnaire, the number of children with a diagnosis of strabismus or amblyopia was first indicated. If known, the respondents then provided more detailed classifications of strabismus and amblyopia.

The diagnostic entities in strabismus were exotropia, esotropia, intermittent exotropia, infantile esotropia, accommodative and partially accommodative esotropia, vertical strabismus, and congenital superior oblique muscle palsy [3]. In addition, fill-in spaces for exophoria and esophoria were provided in the year 2005 survey to avoid confusion between phoria and tropia (strabismus). The questionnaire stated the exclusion of exophoria and esophoria from the entity of strabismus. The diagnostic entities in amblyopia were based on the textbook classification: anisometropic, ametropic, strabismic, and form deprivation amblyopia.

Separately, another questionnaire was sent to ask whether each school had a school ophthalmologist and whether they carried out an annual eye examination of all children by an ophthalmologist.

The binomial 95% confidence interval of the prevalence was calculated by the formula for the Gaussian approximation: $p \pm 1.96 \times \text{square-root} [p(1-p)/n]$ where p is an observed value and n is the number of samples [4].

Results

The questionnaires were returned from 340 (77.8%) of 437 total schools. The number of children covered by the return of questionnaires was 84,619 (74.4%) of 113,763 total pupils, including grades 1 to 6 in Okayama Prefecture in the year 2005. The total numbers of children with strabismus and amblyopia in grades 1 to 6 were 844 (0.99%, 95% confidence interval: 0.94–1.06%) and 173 (0.20%, 95% confidence interval: 0.17–0.23%), respectively. The numbers of children with any type of exotropia and esotropia were 524 (0.62%) and 187 (0.22%), respectively (Table 1).

A separate questionnaire to ask the current status of school ophthalmologists and eye examinations at each school had a return rate of 306 (70%) of 437 total schools (Table 2). School ophthalmologists were in charge in 216 (70.5%) of 306 schools, while eye examinations of all children by ophthalmologists were conducted in 270 (88.2%) of 306 schools. The number of schools that had neither school ophthalmologists in charge nor eye examinations of all children by ophthalmologists was 34 (11.7%) of 306 schools.

Discussion

In the previous survey conducted in 2003, the number of children covered by the return of questionnaires was 86,531 (76.4%) of 113,254 total pupils. The total numbers of children with strabismus and amblyopia were 1,112 (1.28%, 95% confidence interval: 1.24–1.36%) and 125 (0.14%, 95% confidence interval: 0.12–0.17%), respectively. The numbers of children with any types of exotropia and esotropia

were 602 (0.69%) and 245 (0.28%), respectively (Table 3) [3]. The prevalence of strabismus in this large population of Japanese elementary school children was significantly different between the years 2003 and 2005, as the 95% confidence intervals do not overlap with each other. In contrast, the prevalence of amblyopia is similar between the years 2003 and 2005, as the 95% confidence intervals do overlap with each other.

A major drawback, common in the previous survey

Table 1 The prevalence of strabismus and amblyopia in elementary school children in Okayama Prefecture, Japan in 2005

Grade (Age*)	Grade 1 (6 years)	Grade 2 (7 years)	Grade 3 (8 years)	Grade 4 (9 years)	Grade 5 (10 years)	Grade 6 (11 years)	In total
Total number of children	19,179	19,121	19,221	18,528	19,197	18,517	113,763
The number of children surveyed	14,275	14,279	14,511	13,661	14,261	13,632	84,619
Total number of children with phoria	86	74	81	84	108	85	518
Unknown type of phoria	11	11	16	13	18	15	84
Exophoria	71	58	63	64	84	68	408
Esophoria	4	5	2	7	6	2	26
Total number of children with strabismus	138	156	135	111	149	155	844
Unknown type of strabismus	21	25	14	13	24	13	110
Exotropia	78	89	83	80	93	101	524
Intermittent exotropia	24	21	28	25	31	27	156
Esotropia	34	38	35	17	28	35	187
Accommodative esotropia	3	5	3	2	2	2	17
Other types of strabismus	5	4	3	1	4	6	23
Total number of children with amblyopia	36	28	24	35	22	28	173
Unknown type of amblyopia	24	16	11	19	12	16	98
Anisometropic amblyopia	6	6	8	12	7	5	44
Ametropic amblyopia	6	2	4	2	1	3	18
Strabismic amblyopia	0	4	1	2	2	4	13
Deprivation amblyopia	0	0	0	0	0	0	0

*The age at each grade is that on April 2.

Table 2 The presence or absence of a school ophthalmologist and an annual eye examination for all children by an ophthalmologist at each elementary school in Okayama Prefecture in the year 2005

		Have an annual eye examination of all children by an ophthalmologist	
		Yes (The number of schools)	No (The number of schools)
Have a school ophthalmologist	Yes (The number of schools)	214	2
	No (The number of schools)	56	34

The return mails from 306 (70%) of 437 total elementary schools in Okayama Prefecture.

and in the present study, is that the data were collected by questionnaires sent to schools. The return rate was around 80%, and the returned questionnaires covered approximately 3 quarters of the total children of elementary schools in Okayama Prefecture. Another problem is the validity of the diagnoses. The diagnoses of strabismus and amblyopia in this study were made by a large number of ophthalmologists in Okayama Prefecture. After the previous survey in 2003, we provided the results to all ophthalmologists in Okayama Prefecture at meetings of the Okayama Prefecture Ophthalmologists' Association and also by the proceedings. We reiterated the aims of school eye examinations and asked the ophthalmologists to make valid diagnoses and indicate the correct diagnostic terms in the documents sent back to schools.

The number of children simply diagnosed with strabismus or amblyopia were designated as "unknown type of strabismus" and "unknown type of amblyopia," respectively, in the 2003 and the 2005 surveys. The number of children with an unknown type of strabismus decreased in the 2005 survey compared with the 2003 survey, indicating more reliable diagnoses in the repeat survey. In contrast, the number of children with an unknown type of amblyopia remained at the

same level between the 2003 and 2005 surveys. These findings suggest that ophthalmologists are not necessarily diligent in using the diagnostic terms for the modern classification of amblyopia. Strabismic amblyopia is easily diagnosed as such since amblyopia occurs in the setting of strabismus. Form deprivation amblyopia is usually associated with congenital cataract and blepharoptosis, and is basically rare. The 2 most common types of amblyopia, anisometropic and ametropic amblyopia, are simply diagnosed as amblyopia in the general clinical setting. Despite the unknown type of amblyopia, namely, simple diagnosis of amblyopia, occupying a large portion of the total number of children with amblyopia, the current and previous surveys would thus properly estimate the overall prevalence of amblyopia.

In the 2005 survey, we included a new entity of phoria including exophoria and esophoria in the questionnaires given to schools. The overall rate of strabismus was lower in the 2005 survey than in the 2003 survey (0.99% versus 1.28%). In both the 2003 and 2005 surveys, the questionnaires stated that phoria was excluded from the entity of strabismus. However, the lack of a space for filling in the number of children with phoria in the 2003 survey might have mistakenly led to including phoria in the entity of strabismus, and

Table 3 The prevalence of strabismus and amblyopia in elementary school children in Okayama Prefecture, Japan in 2003

Grade	Grade 1	Grade 2	Grade 3	Grade 4	Grade 5	Grade 6	In total
(Age*)	(6 years)	(7 years)	(8 years)	(9 years)	(10 years)	(11 years)	
Total number of children	19,187	18,540	19,172	18,561	18,817	18,977	113,254
The number of children surveyed	14,330	14,329	14,894	14,085	14,427	14,466	86,531
Total number of children with strabismus	179	166	184	190	210	183	1112
Unknown type of strabismus	53	40	26	44	37	45	245
Exotropia	90	93	105	98	118	98	602
Intermittent exotropia	10	17	21	17	24	20	109
Esotropia	33	31	47	43	51	40	245
Accommodative ET	3	1	6	4	3	2	19
Other types of strabismus	3	2	6	5	4	0	20
Total number of children with amblyopia	25	31	20	22	15	12	125
Unknown type of amblyopia	18	22	10	12	11	8	81
Anisometropic amblyopia	3	4	7	4	3	2	23
Ametropic amblyopia	3	3	2	2	0	2	12
Strabismic amblyopia	1	2	1	4	1	0	9
Deprivation amblyopia	0	0	0	0	0	0	0

Cited from the reference [3]. *The age at each grade is that on April 2.

might, therefore, have led us to overestimate the rate of strabismus.

The current as well as the previous survey [3] show that annual school eye examinations at elementary schools in Japan, conducted according to the School Health Law, function to detect strabismus and amblyopia. Children with strabismus or amblyopia are sent to ophthalmologists to receive appropriate treatment for the diseases. The most frequent forms of amblyopia, anisometropic and ametropic amblyopia, are treated by prescribing glasses for hyperopia, myopia, and astigmatism [5]. Intermittent exotropia, the most common form of strabismus in Japan [3], is usually observed as far as children maintain binocular fusion and normal levels of stereopsis [6]. Even after surgical alignment for constant or intermittent exotropia, long-term follow-up is mandatory to maintain eye alignment because of the frequent relapse of exotropia. Accommodative esotropia, a common type of esotropia, is also followed with glasses for hyperopic correction [7]. Infantile esotropia is operated on in earlier years of life and followed up for a long time to maintain eye alignment and visual acuity [8, 9]. Because of such ongoing treatment and long-term follow-up strategy for strabismus and amblyopia [10], children with these diseases are repeatedly detected at the annual school eye examinations and sent to ophthalmologists every year to confirm that the treatment is being properly undertaken.

The children in grades 1, 2, 3, and 4 in the year 2003 survey correspond to those in grades 3, 4, 5, and 6 in the year 2005 survey, respectively. The number of children with amblyopia in grades 1, 2, 3, and 4 in 2003 is basically the same as that of those with amblyopia in grades 3, 4, 5, and 6 in 2005, respectively. This correspondence is due to the treatment for amblyopia with glasses usually being continued in elementary school pupils up to age 12 in order to maintain better visual acuity in the amblyopic eyes. In contrast, the number of children with strabismus in grades 3, 4, 5, and 6 in 2005 was smaller than the number of those with strabismus in grades 1, 2, 3, and 4 in 2003, respectively. These findings cannot be attributed to the effects of treatment for strabismus since the overall number of children with strabismus was higher in 2003, probably due to the inclusion of phoria, as discussed above. Caution must be taken in these comparisons between the corresponding grades

in 2003 and 2005 since the same schools did not necessarily return the questionnaires and children might have moved in and out of particular schools in the interim between these years.

In conclusion, we have shown the prevalence rates of strabismus and amblyopia to be approximately 1% and 0.2%, respectively, in a large population of Japanese elementary school children. In another study, we also revealed lower prevalence rates of strabismus and amblyopia in 1.5- and 3-year-old children, compared with elementary school children [2]. These prevalence rates would serve as fundamental data to form a new policy by reviewing the current school eye examination systems and also to conduct genetic approaches to understanding the mechanism of strabismus with the genetic background [11-14]. Our results finally suggest that ophthalmologists should participate more actively in school eye examinations as school ophthalmologists.

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