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Combination of 2 test methods, single-picture optotype visual acuity chart and spot™ vision screener, in the eye health screening program for 3-year-old children in Tokyo

A retrospective, observational study

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Abstract

To evaluate the usefulness of the Tokyo Metropolitan Government's Eye Health Screening Program for 3-year-old children, which combines the Single-Picture Optotype Visual Acuity Chart (SPVAC) and Spot™ Vision Screener (SVS) tests. This was a retrospective, observational, matched study. Patients who underwent the eye health screening program and had abnormalities were classified into 3 groups according to the outcomes of the SPVAC (SPVAC-passed, SPVAC-P; SPVAC-failed, SPVAC-F) and SVS (SVS-passed, SVS-P; SVS-failed, SVS-F) tests as follows: SPVAC-P/SVS-F, SPVAC-F/SVS-P, and SPVAC-F/SVS-F. We evaluated the age at examination, SPVAC and SVS test success rates, and SVS refractive power. Additionally, the rates of refractive error, amblyopia, and strabismus were compared among the 3 groups. The SPVAC-P/SVS-F, SPVAC-F/SVS-P, and SPVAC-F/SVS-F groups comprised 158, 28, and 74 eyes, respectively. The mean age was 37.4 months. The success rates of the SPVAC and SVS tests were 69.8% and 96.2%, respectively. The mean SVS hyperopia value in the SPVAC-F/SVS-F group (2.71 ± 1.50 D) was significantly higher than that of the SPVAC-P/SVS-F group. The mean SVS astigmatism and myopia values were −2.21 diopter (D) ± 1.09 D and −3.40 ± 1.82 D, respectively; they did not differ significantly from that of the SPVAC-P/SVS-F group. Significant differences were observed in the refractive error, amblyopia, and strabismus rates among the 3 groups. Regarding disease determination, no significant difference was observed among participants who passed and failed the SPVAC test, regardless of the outcome of the other test. However, a significant difference was observed between those passing and failing the SVS tests. The SPVAC method used to screen 3-year-old children should be modified to commence at 42 months of age or be replaced with a single Landolt C test. The SVS test is useful for screening younger patients. Furthermore, the SVS test showed that the degree of hyperopia was higher in patients who did not pass the SPVAC test.

Abbreviations: ANOVA = analysis of variance, ARF = amblyopia risk factor, BCVA = best-corrected visual acuity, CI = confidence interval, D = diopter, log MAR = logarithm of the minimum angle of resolution, SPVAC = single-picture optotype visual acuity chart, SVS = spot™ vision screener, TYOS = three-year-old health screening.

Keywords: amblyopia, child, infant, Japan epidemiology, preschool, vision screening methods, visual acuity

1. Introduction

The primary purpose of eye screening in children is amblyopia detection. Amblyopia is a developmental disorder of visual acuity that requires early detection and treatment.[1,2] A previous Japanese study revealed amblyopia rates of 0.13% to 0.18% in 3-year-old children[3] and 0.2% in 6 to 12-year-old children.[4] Amblyopia caused by corneal opacity, cataracts, glaucoma, ptosis, or an abnormal eye position can be detected through visual and slit-lamp examinations. However, amblyopia caused by refractive errors can be misdiagnosed. Therefore, it is important to conduct screening examinations for refractive values.[5]

Several studies have been reported on eye health examinations for amblyopia; however, these examinations have been conducted using a standardized plan.[6–8] Furthermore, the studies have not included community-based eye examinations.

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The datasets generated during and/or analyzed during the current study are not publicly available, but are available from the corresponding author on reasonable request.

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In Japan, eye health examinations have been conducted as part of the Three-year-old Health Screening (TYOS) program since 1990.[3,9] According to Hayashi et al[10], as of 2016, vision screenings for 3-year-olds were conducted in 95.8% of the cities in Japan. However, visual acuity screening test forms have not been standardized in the TYOS program. The Single-Picture Optotype Visual Acuity Chart (SPVAC) card and the Single Landolt C Test Card are used in Japan.[10–12] The Spot™ Vision Screener (SVS) is a handheld photoscreener that automatically detects refractive errors and amblyopia in 3-year-old children.[10,11] Despite its effectiveness in detecting amblyopia caused by refractive errors, it has not been included in the TYOS program.

Amblyopia risk factor (ARF) detection using the SVS has been reported in 2013 and 2017.[13,14] The American Association for Pediatric Ophthalmology and Strabismus (AAPOS) revised its ARF guidelines in 2021.[15] Furthermore, Japan has also proposed its own ARFs (Table 1).

Combined visual acuity and refraction testing during eye examinations under the TYOS program can accurately assess amblyopia in 3-year-old children. In 2019, eye examinations for 3-year-old children in Nakano City (Tokyo, Japan) were conducted using only SPVACs. The SVS test was introduced in June 2020 to detect refractive-error amblyopia.

To our knowledge, no study has analyzed both SPVAC card and SVS tests in the TYOS program to evaluate refractive values, amblyopia, and eye position abnormalities. The SPVAC card test method is less useful as a screening method than the Single Landolt C Test Card test method or the SVS test method. Hence, we hypothesized that combining the SVS test with the SPVAC card test would improve the performance of the screening test. This study aimed to evaluate the average SVS refraction values, incidence of amblyopia, and ocular positional abnormality using combined SPVAC card and SVS tests during eye health examinations of 3-year-old children (TYOS program) in Nakano City.

2. Materials and methods

2.1. Study design

This retrospective, observational, matched study was performed according to the "Strengthening the Reporting of Observational studies in Epidemiology" guidelines. It was approved by the Japan Medical Association Review Committee (R4-21) and was conducted in accordance with the Declaration of Helsinki. In this study, personal information cannot be retrieved because the data is provided in an anonymized form. The ethics committee waived the requirement for informed consent due to the retrospective nature of the study.

This study included 262 eyes of 131 3-year-old participants (59 boys and 72 girls) who were examined in Nakano City between June 2020 and September 2020. All participants had undergone eye examinations with the SPVAC card and SVS tests under the TYOS program. The population of 3-year-old children during this period was 6739; of these, 6324 (93.8%) had undergone the screening examinations. A total of 438 (6.9%) patients were referred for comprehensive ophthalmological examinations. Among these, 261 (59.6%) underwent a thorough examination, and results were obtained for 131 (50.2%) participants (Table 2).

Based on the outcomes of the SPVAC and SVS tests, the examination outcomes were classified as follows: SPVAC-passed (SPVAC-P), SPVAC-failed (SPVAC-F), SVS-passed (SVS-P), and SVS-failed (SVS-F). The participants were then categorized into 3 groups on the basis of combined outcomes: SPVAC-P/SVS-F, SPVAC-F/SVS-P, and SPVAC-F/SVS-F.

2.2. TYOS program in Nakano City

The TYOS program consists of 3 steps. In the first step, which was conducted at home (i.e. a family test), a medical questionnaire was completed and visual acuity was measured using single-picture optotype test charts (Fig. 1) at a distance of 2.5 m. These test charts, developed by the Tokyo Metropolitan Government, corresponded to the logarithm of the minimum angle of resolution (log MAR) value of 0.3.

In the second step, which was conducted at a welfare center, the SPVAC card test was repeated by a public health nurse for children with difficulty with or poor results in the SPVAC card test. Subsequently, all participants underwent refraction and eye position testing, which were also performed by a public health nurse using the SVS photorefraction machine (version 3.1.01; Welch Allyn, NY). The SVS was retested once. Finally, in the third step, which was performed at a medical institution, children who met the criteria for a comprehensive examination based on the second examination during consultation with a non-ophthalmologist were asked to undergo a comprehensive examination. The comprehensive examination was tertiary in nature. This study was conducted in 14 ophthalmological institutions in Nakano City. The decision to use cycloplegic eye drops for the comprehensive examination was left at the physician's discretion.

2.3. Inclusion criteria for comprehensive examination

The inclusion criterion for the comprehensive examination with the SPVAC card test was the display of the single-picture optotype card 4 times. To pass the test, the participant was required to answer at least 3 questions each for the right and left eyes. Failing the test was defined as providing fewer than 2 answers each for the right and left eyes, providing ≥3 answers for 1 eye but fewer than 2 answers for the other eye, or facing difficulties during the examination.

The inclusion criteria for the comprehensive examination of refraction using the SVS test were a spherical hyperopia power of >2.5 diopter (D), spherical myopia power of 2.0 D, and astigmatism of −2.0 D. The criteria for anisometropic eyes were spherical hyperopia, myopia, and astigmatism of ≥1.5 D. The Japanese ARF criteria were used for strabismus (Table 1).

Table 1

Amblyopia risk factors determined with SVS in 3-year-old by the Japan Ophthalmologists Association and Nakano City.

	Refractive risk factor (D)						Strabismus (PD)		
	Hyperopia SE	Myopia SE	Hyperopia	Myopia	Astigmatism	Anisometropia	V	I	O
Current criteria (≤)	2.5	1.25	–	–	1.75	1.0	8	5	8
Academic criteria (≤)	2.5	2.0	–	–	2.0	1.5	8	5	8
Spherical power criteria (<)	–	–	2.0	2.0	2.0	2.0	7	7	7
Nakano City criteria (≤)	–	–	2.5	2.0	2.0	1.5	8	5	8

D = diopter, I = inside, O = outside, PD = prism diopter, SE = spherical equivalent, SVS = Spot™ Vision Screener, V = vertical.

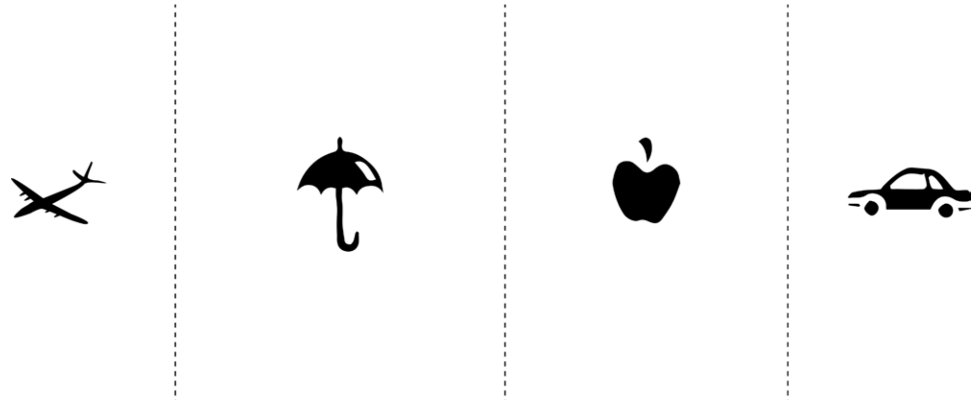

Figure 1. Single-picture optotype visual acuity charts in Nakano City, Tokyo.

Table 2

Percentage of the 3-years-old children's eye health screening program between June 2020 and March 2022.

	n	Rate (%)
A: Population	6739	
B: Number of screening programs	6324	B/A: 93.8
C: Those who needed a comprehensive examination number	438	C/B: 6.9
D: Number of comprehensive examinations	261	D/C: 59.6
E: Number of diagnostic results collected	131	E/D: 50.2

Patients who experienced difficulty during the SVS examination were also referred for the comprehensive examination. These standards were established by Nakano City.

2.4. Data measurement

The following data were measured in the 3 groups: age (in months) at the time of the SPVAC card test, SVS examination, and comprehensive examination; success rates of the SPVAC card and SVS tests; average detection rates of refractive errors and eye position abnormalities using the SVS test; and best-corrected visual acuity (BCVA). We evaluated the diagnoses using the SPVAC and SVS test results.

2.5. Statistical analysis

Statistical analyses were performed using add-in software for Microsoft Excel (Excel add-in software, Bell Curve, Tokyo, Japan). All data samples were tested using Kolmogorov–Smirnov distribution tests. Normally distributed samples were tested using an analysis of variance (ANOVA). Non-normally distributed or independent samples were tested using Fisher exact test with Bonferroni correction or the Kruskal–Wallis test. Scheffe's test was used for multiple comparisons in ANOVA and the Kruskal–Wallis test. Fisher's exact test was used to compare 2 independent groups. Data are presented as mean ± standard deviation. The sample size was calculated using 95% confidence intervals (CIs). Statistical significance was set at $P < .05$.

3. Results

3.1. Demographic characteristics of the study population

Of the 262 eyes analyzed, 158, 28, and 76 were classified into the SPVAC-P/SVS-F, SPVAC-F/SVS-P, and SPVAC-F/SVS-F groups, respectively. The demographic data of the participants are presented in Table 3. No significant differences were observed in terms of sex, fetal weeks, or birth weight among the 3 groups ($P > .99$, $P = .524$, and $P = .361$, respectively). For all participants, the mean ages at the time of the screening and comprehensive tests were 37.4 ± 0.2 and 39.2 ± 0.5 months, respectively. Furthermore, the mean ages did not differ significantly among the 3 groups at screening ($P = .233$) and at the comprehensive examination ($P = .869$; Table 3).

The mean BCVA of all the participants was 0.24 ± 0.21 log MAR. It differed significantly among those who passed and those who failed the SPVAC test, regardless of whether the SVS test was performed ($P < .001$). Furthermore, the BCVA differed significantly between the SVS-P and SVS-F groups, regardless of the outcomes of the SPVAC test ($P = .003$; Table 3).

3.2. Comparison of the SPVAC and SVS Test results among the 3 groups

The success rate of SPVAC testing was 69.8% for all the participants. The success rate in the SPVAC-F/SVS-P group was 32.1% (9/28 eyes), but SPVAC testing was difficult in 19 eyes from 10 participants. The success rate in the SPVAC-F/SVS-F group was 21.1% (16/76 eyes), but SPVAC testing was difficult in 60 eyes from 30 participants. No significant differences were observed in the success rates of SPVAC testing between the SVS-P and SPS-F groups ($P = .301$; Table 4).

The success rate of SVS testing was 96.2% in all groups. The success rates in the SPVAC-P/SVS-F and SPVAC-F/SVS-F groups were 95.0% (150/158 patients) and 97.4% (74/76 patients), respectively. No significant difference was observed in SVS test success rates among the 3 groups ($P > .99$). SVS test results revealed strabismus in 4.6% of the eyes (12/262 eyes; Table 4).

3.3. Comparison of the mean SVS refractive value among the 3 groups

The mean refractive values of each eye, as measured using the SVS test, were compared among the 3 groups. The hyperopic spherical power value for the SPVAC-F/SVS-F group (2.71 ± 1.5 D) was significantly greater than that for the other groups ($P < .001$). The myopic spherical power value for the SPVAC-F/SVS-F group (−3.40 ± 1.82 D) was significantly greater than that for the SPVAC-F/SVS-P group ($P = .011$). The astigmatism power value for the SPVAC-P/SVS-F group was significantly lower than that for the SPVAC-F/SVS-P group (−2.21 ± 1.09 D vs −0.86 ± 0.60; $P < .001$; Table 4).

3.4. Comprehensive examination

Diagnoses based on the results of the SPVAC test were compared among the 3 groups. Overall, 56.7% (88/158), 7%

Table 3

Demography of the study population.

	SPVAC-P/SVS-F group	SPVAC-F/SVS-P group	SPVAC-F/SVS-F group	*P*-value
Eyes	158/262 (60.3%)	28/262 (10.7%)	76/262 (29.0%)	
Sex – M:F (eyes)	72:86	10:18	36:40	1.000*
Fetal age (wk)	38.4 ± 2.0 95% CI (38.1–38.7)	38.4 ± 1.8 95% CI (37.7–39.1)	38.1 ± 2.4 95% CI (37.6–38.6)	.524†
Birth weight (g)	2927.2 ± 486.3 95% CI (2850.8–3003.6)	2808 ± 454.7 95% CI (2631.7–2984.3)	2834.8 ± 667.4 95% CI (2682.3–2987.3)	.361†
Age at the screening program (mo)		All 37.4 ± 0.2 95% CI (37.38–37.42)		
	37.6 ± 1.3	37.2 ± 0.4	37.4 ± 1.0	.233†
Age at comprehensive examination (mo)		All 39.2 ± 0.5 95% CI (39.1–39.3)		
	39.0 ± 2.8	39.8 ± 3.8	38.8 ± 2.5	.869†
BCVA (log MAR)		All 0.24 ± 0.21 95% CI (0.21–0.27)		
	0.21 ± 0.18[1]	0.16 ± 0.15[2]	0.35 ± 0.26[3]	1 vs 2 .559† 1 vs 3 <.001† 2 vs 3 .003†

BCVA = best-corrected visual acuity, F = fail, log MAR = logarithm of the minimum angle of resolution, P = pass, SPVAC = single-picture optotype visual acuity chart, SVS = Spot™ Vision Screener.
*Fishers exact test with Bonferroni correction.
†Kruskal–Wallis test/Scheffe test.

Table 4

Comparison of screening tests based on refractive values.

	SPVAC-P/SVS-F group	SPVAC-F/SVS-P group	SPVAC-F/SVS-F group	*P*-value
SPVAC success rate (%)		All 69.8 (183/262 eyes)		
	100 (158/158 eyes)*[1]	32.1 (9/28 eyes)*[2]	21.1 (16/76 eyes)*[3]	*2 vs *3 .301*
SVS success rate (%)		All 96.2 (252/262 eyes)		
	95.0 (150/158 eyes)	100 (28/28 eyes)	97.4 (74/76 eyes)	1.000*
Abnormal eye position detection rate (%)		All 4.6% (12/262 eyes)		
	8.0 (12/150 eyes)	0 (0/28 eyes)	0 (0/75 eyes)	1.000*
Hyperopia (D)	1.59 ± 0.97 95% CI (1.43–1.75)	0.54 ± 0.48 95% CI (0.35–0.73)	2.71 ± 1.50 95% CI (2.36–3.06)	<.001†
Myopia (D)	–1.57 ± 1.15**[1] 95% CI (–1.39 to –1.76)	–0.92 ± 0.62**[2] 95% CI (–0.68 to –1.16)	–3.40 ± 1.82**[3] 95% CI (–2.98 to –3.82)	**1 vs**2 .736** **1 vs**3 .067** **2 vs**3 .011**
Astigmatism (D)	–2.21 ± 1.09※[1] 95% CI (–2.03 to –2.39)	–0.86 ± 0.60※[2] 95% CI (–0.63 to –1.09)	–2.17 ± 1.33※[3] 95% CI (–1.86 to –2.48)	※1 vs ※2 <.001† ※1 vs ※3 .991† ※2 vs ※3 <.001†

D = diopter, F = fail, log MAR = logarithm of the minimum angle of resolution, P = pass, SPVAC = single-picture optotype visual acuity chart, SVS = Spot™ Vision Screener.
*Fishers exact test with Bonferroni correction.
†Kruskal–Wallis test/Scheffe test.
** ANOVA test/Scheffe test.

(2/28), and 78.9% (60/76) of the eyes required treatment in the SPVAC-P/SVS-F, SPVAC-F/SVS-P, and SPVAC-F/SVS-F groups, respectively. A significant difference was observed in the number of cases requiring treatment among the 3 groups ($P < .001$). However, no significant difference was observed between the eyes that passed and those that did not pass the SPVAC test ($P = .503$; Table 5).

The SVS test results were compared among the 3 groups. Overall, 57.3% (86/150), 7% (2/28), and 81.3% (60/74) of the eyes required treatment in the SPVAC-P/SVS-F, SPVAC-F/SVS-P, and SPVAC-F/SVS-F groups, respectively. A significant difference was observed in the number of cases requiring treatment among the 3 groups ($P < .001$). Furthermore, a significant difference was also observed between the SVS-P and SVS-F eyes ($P < .001$; Table 6).

4. Discussion

In this study, we evaluated combined SPVAC and SVS tests during eye screening among 3-year-old children in Nakano City, Japan. This study's novelty lies in the fact that we evaluated the results of the picture visual acuity chart (SPVAC) rather than that of the single Landolt C card test, and the rate of diagnosis was evaluated separately for the SPVAC and SVS test results. We further explored findings from eye screenings of 3-year-old children in previous studies to identify areas of improvement.

The rate of comprehensive examinations in this study was 6.9% (Table 2). In a previous study, the rate of comprehensive examinations was 27.6% based on the SVS test.[10] Conversely, it was 11% when the Single Landolt C Test Card was combined with the SVS test; this is higher than that observed in the current study.[11] We suggest that the high referral rate in previous studies was due to differences in the criteria employed.

No significant differences were noted in the mean fetal week or birth weight among the study groups. Low birth weight infants have refractive errors,[16] and the rate of strabismus is 4.9% to 20%[17,18] and that of amblyopia is 40.1%.[18] In this study, infants with low birth weight were not affected (Table 3).

The success rate of the SPVAC test was 69.8% for all the participants in the comprehensive examination. The success rate using either the 0.3log MAR single-picture chart test or the Single Landolt C Test Card in a previous study at the same age of examination months was 95.0% (1658 of 1746 cases), and the number of participants with a visual acuity worse than 0.3log MAR was 88.[12] Using the single Landolt C card test in 42-month-old children, 750 of 813 participants (92.2%) were successfully tested at home.[11] The low test success rate in the present study is attributable to a problem with the test method, resulting in several difficulties during testing. We suggest improving the method of SPVAC testing by performing it at 42 months, as in previous studies, or switching it to a single Landolt C card test.

The SVS test was performed in the same month as was the SPVAC test. In a previous study, the participant age at SVS testing was 42 months[12,13] and the success rate was 99.7%.[12] The success rate of the SVS test in the present study was high because the measurements were taken by health nurses and the testing time was short.

In a previous study on SVS refractive measurements, the Sure Sight Screener® was used in a non-mydriatic group with a log MAR value of 0.3 and in another group with log MAR

Table 5

Comparison of comprehensive examinations with SPVAC test.

	SPVAC-P/SVS-F group #1 (eyes)	SPVAC-F/SVS-P group #2 (eyes)	SPVAC-F/SVS-F group #3 (eyes)	*P*-value
Normal	58/158 (36.7%)	24/28 (86.0%)	10/76 (13.2%)	*#1 vs #2
Hyperopia	31	11	1	<.001
Astigmatism	18	3	4	*#1 vs #3
Myopia	9	10	5	<.001
Treatment needed	88/158 (56.7%)	2/28 (7.0%)	60/76 (78.9%)	*#2 vs #3
Hyperopia	3	1	3	<.001
Astigmatism	6	0	5	
Myopia	3	1	4	
Ametropic amblyopia	56	0	37	†SPVAC pass group vs SPVAC no pass group
Anisometropic amblyopia	8	0	11	(#1 vs #2 + #3)†
Esotropia/ esophoria	8	0	0	.503
Exotropia/ exophoria	3	0	0	
Oblique muscle dysfunctions	1	0	0	
Diagnosis is impossible	12/158 (7.6%)	2/28 (7.0%)	6/76 (7.9%)	

F = fail, P = pass, SPVAC = single-picture optotype visual acuity chart, SVS = Spot™ Vision Screener.
*Fishers exact test with Bonferroni correction.
†Fishers exact test.

Table 6

Comparison of comprehensive examinations with SVS test.

	SPVAC-P/SVS-F group #1 (eyes)	SPVAC-F/SVS-P group #2 (eyes)	SPVAC-F/SVS-F group #3 (eyes)	*P*-value
SVS success numbers	150	28	74	
Normal	54/150 (36.0%)	24/28 (86.0%)	10/74 (13.5%)	*#1 vs #2
Treatment needed	86/150 (57.3%)	2/28 (7.0%)	60/74 (81.3%)	<.001
Hyperopia, Astigmatism, Myopia	10	2	12	*#1 vs #3
				<.001
				*#2 vs #3
				<.001
Ametropic amblyopia	56	0	37	†SVS pass group vs SVS no pass group (#2 vs
Anisometropic amblyopia	8	0	11	#1 + #3)
Esotropia/esophoria				<.001
Exotropia/exophoria				
Oblique muscle dysfunctions	12	0	0	
Diagnosis is impossible	10/150 (6.7%)	2/28 (7.0%)	4/7 (5.4%)	

F = fail, P = pass, SPVAC = single-picture optotype visual acuity chart, SVS = Spot™ Vision Screener.
*Fishers exact test with Bonferroni correction.
†Fishers exact test.

values worse than 0.3.[12] The mean SVS hyperopic spherical power of the group that did not pass the SVS test under non-mydriatic conditions in the present study is similar to that reported in previous studies (Table 4).

Spherical power values were used for evaluation in the present study because equivalent spherical power values result in low values for hyperopia, which may cause refractive errors. Equivalent spherical power values are not recommended for screening programs.[7]

We did not observe cycloplegia or mydriasis during SVS measurements. Srinivasan et al[19] compared refractive changes between SVS examinations under non-mydriatic conditions and cycloplegic retinoscopy examinations under mydriatic conditions in 3-year-old children; they reported an average increase of 1.02 ± 1.19 D for spherical power and a decrease of 0.52 ± 0.73 D for cycloplegia. For a correct diagnosis, it is important to measure the refraction values under mydriasis. If possible, cycloplegic refraction testing should be performed for all participants.

The incidence of refractive errors differs between Asians and people of other ethnicities.[20] In the present study, it was not possible to identify the individuals, but it was speculated that many of them had Asian heritage.

In a previous study, the rate of amblyopia, strabismus, and refractive errors requiring treatment in 42-month-old children following comprehensive examination was 31.2% (29/93 cases).[11] In the present study, the rate of passing the picture acuity test was higher than that in the previous study (Tables 5 and 6); this was attributed to the younger participant age and worse corrected visual acuity at the comprehensive examination in this study (Table 3), making a correct diagnosis impossible.

In this study, no significant difference was observed in the treatment rates between the SPVAC-P and SPVAC-F groups. However, a significant difference was observed in the treatment rates between the SVS-P and SVS-F groups (Tables 5 and 6). These results suggest that the SVS test is useful for diagnosis when the patient is younger than the standard age of the examination.

Strabismus was found in 4.6% of the eyes in the SVS test (Table 4) and in 12 of 262 eyes in the comprehensive examination (Tables 5 and 6). The reported rate of strabismus in 3-year-old children is 0.20% to 0.34%.[3] We conclude that a high rate of strabismus was observed only in participants who underwent a comprehensive examination.

Matsuo et al[11] reported that 18% of patients with ametropic and anisometropic amblyopia did not pass the single Landolt C test but passed the SVS test. In this study, hyperopic and myopic eyes in the SPVAC-F/SVS-P group required treatment. These results suggest that visual acuity testing is necessary as a screening test in the health examinations of 3-year-old children.

4.1. Study limitations

This study had some limitations. The SPVAC test was performed in Tokyo; thus, it was difficult to compare its findings with those from other prefectures that use the single Landolt C test. The Landolt C test is widely used in non-English-speaking countries.[21,22] The Lea Symbols chart, which is similar to the SPVAC, has a higher specificity than the other visual acuity charts (Parr vision).[23] Additionally, the age at examination was young, and several participants did not pass the SPVAC test. Moreover, the diagnosis was inconclusive owing to poorly corrected visual acuity test results in the comprehensive examination. Finally, the comprehensive examination rate was low at 59.6% (Table 2).

5. Conclusion

Based on the study findings, we recommend that SPVAC screening of 3-year-old children should commence at 42 months of age or that the test be changed to a single Landolt C test. The SVS test is useful for screening younger patients. The SVS test showed that the degree of hyperopia was higher in patients who did not pass the SPVAC test. It is also necessary to improve the rate of comprehensive examinations.

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