

Vision Screening of 4-year-old Children in Singapore

Hai C Lim, B L Quah, V Balakrishnan, H C Lim, V Tay, S C Emmanuel

ABSTRACT

Aim of the study: To evaluate the feasibility of an improved visual acuity screening program for Singapore 4-year-old preschool children and to draw up an appropriate referral criteria as well as evaluating the rates and outcomes of these referrals.

Method: A total of 450 children aged 4 to 4 1/2 years, who attended 3 polyclinics of the Family Health Service (FHS) for their 4-year-old Developmental Health Screening during the study period from 1/4/1997 to 30/6/1997 were recruited for the study. Children who were tested with Snellen (or Sloan) visual acuity chart resulting in visual acuity of 6/9 or worse, or failed to pass the 3 mm medium plate at 30 cm distance (300 seconds of arc) in the Frisby Stereotest, or were found to have strabismus, or were untestable in either visual acuity test or stereotest were offered referral to ophthalmologists in the hospitals for specialist assessment.

Result: 82.7% of the 450 children were successfully screened with Snellen (or Sloan) chart while 91.6% were successfully screened with Frisby Stereotest. In all, 180 children were evaluated by ophthalmologists. Majority of the children were referred because of their abnormal visual acuity test while only 2 children were referred for failing stereotest alone. Among the 180 children referred, 63 (35.0%) were found to have refractive errors for which spectacles were prescribed. Eight children had amblyopia and 2 children had strabismus which were not detected at the polyclinic screening. The untestable children evaluated had significantly higher abnormality rate (37.5%) than that of children who had 6/9 vision (8.8%) therefore they should be offered referral for further evaluation. There was high "refused referral" rate of 39.0%. Parents of children who were untestable or had 6/9 vision were found to be more likely to refuse offer of referral. If these two groups of children were excluded, the "refused referral" rate dropped to 13.3%. When the referral criteria for visual acuity was reset at 6/12 instead of 6/9, the referral rate dropped from 39.6% to a more

manageable 26.7% and the positive predictive value improved from 35.4% to 48.3% and none of the children with amblyopia were missed being screened-out.

Conclusion: The study confirmed the feasibility of doing visual acuity screening at 4 to 4 1/2 year-old. The referral criteria for abnormal visual acuity should be set at 6/12. The efficacy of adding Frisby stereotest needs further evaluation.

Keywords: Preschool, Visual acuity, Frisby stereotest, Referral criteria

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INTRODUCTION

Prior to this study, the polyclinics of the Family Health Service (FHS) conducted visual acuity screening on preschool children with the Snellen (or Sloan) charts at 5 years of age as the important visual acuity assessment in the FHS's Child Health Surveillance Program (CHSP) for Singapore preschool children. Only "high risk" children were offered an additional earlier screen at 3 years of age with single-letter Otago chart, when they had their 3 years of age old developmental screening which was conducted by nurses. The high risk selection was based on relevant birth history (e.g. prematurity), family history of poor vision, high refractive errors or strabismus and the presence of "abnormal" visual behaviour. A one month survey of children covered by the CHSP in 1995⁽¹⁾ showed that only about a quarter of children were screened at 3 years of age. The majority of children had to wait till they were 5 years old to get their first visual acuity test because they were not identified as "high risk". Late screening of preschool children may result in later detection and treatment of asymptomatic amblyopia, refractive error and strabismus. Our experience has shown that 3-year-old children are usually too immature to have their visual acuity assessed by the Snellen's chart. The single-letter visual chart like the Otago chart is easier to use but less sensitive than Snellen chart. Expert opinion from ophthalmologists was therefore sought to improve the vision screening program for preschool children

**Bedok Polyclinic
Family Health Service
Public Health Services
Ministry of Health**

Hai C Lim, MBBS,
MSc (Public Health)
Senior Registrar

**Singapore National
Eye Centre**

B L Quah
Senior Registrar

V Balakrishnan, MBBS,
MMed (Ophth),
FRCS Ed, FRC Ophth
Medical Director

**Geylang Polyclinic
Family Health Service
Public Health Services
Ministry of Health**

H C Lim, MBBS,
MMed (Public
Health), Grad. Dip.
(Geriatric Med.)
Senior Registrar

**Bukit Batok Polyclinic
Family Health Service
Public Health Services
Ministry of Health**

V Tay, MBBS, MSc
(Public Health)
Senior Registrar

**Family Health Service
Public Health Services
Ministry of Health**

S C Emmanuel, MBBS,
MPH (Public Health),
PAMS
Director

Correspondence to:
Hai C Lim
Tel: (65) 441 3811
Fax: (65) 444 4568
Email:
Hai Chiew LIM/MOH/
SINGOV@SINGOV

in the Family Health Service. The recommended revised visual screening program was to carry out visual acuity test with the Snellen chart earlier for all children at 4 years old and in addition to carry out the Frisby stereotest.

This study was therefore conducted as a pilot project to:

- i) assess the feasibility of performing visual acuity test and Frisby stereotest in 4-year-old children in the Family Health Service polyclinics,
- ii) identify the appropriate criteria for referrals to hospital ophthalmology departments, for further evaluation of the visual problems and to measure the rates and evaluate the outcomes of these referrals.

MATERIALS AND METHODS

All children aged 4 to 4 1/2 years who attended 3 polyclinics, namely Bedok, Bukit Batok and Geylang Polyclinics for their 4 year old Developmental Health Screening, within the study period from 1/4/1997 to 30/6/1997 were recruited for the study. Children who had a known history of visual problems who had received treatment or were on active follow up for such problems were excluded from the study.

Test Procedures

(1) Visual history

This was obtained from the parents:

The presence of any of the following symptoms was included as positive for "abnormal visual behaviour":

- Squinting of an eye in any direction (esotropia or exotropia), constant or intermittent
- Frequent rubbing of eyes, tearing, sensitivity to light (photophobia)
- Frowning, or tilting his/her head to see
- Closing one eye while looking far in bright light
- Objecting strongly when one eye is covered

(2) Tests for Strabismus

These were done by polyclinic doctors and comprised the corneal reflex torch light test (Krimsky), the cover/uncover test and the alternating cover test for strabismus.

(3) Visual acuity tests

These were done by the trained staff nurses and consisted of the following tests:

The Snellen chart (alphabet or number; test distance - 6 metres) was used at Bedok and Bukit Batok Polyclinics. Children were asked to look at the image of the chart in a mirror set at a 3 metre distance.

The Sloan chart (alphabet) was used in Geylang Polyclinic as some polyclinics had already purchased

Sloan charts as an alternative to Snellen charts. This is similar to a Snellen chart but is modified for testing at 3 meters. It has the advantage of fitting easily into a normal consultation room without having to use a mirror.

If the children could not actually read the letters or numbers directly, they were asked to match them. If the first test was not successful a second test at the clinic within a month was offered. A child was given a maximum of two attempts at this test before being classified as "untestable".

(4) Frisby stereotests done by trained staff nurses

The Frisby stereotest consists of a non-stereo demonstration chart and three stereo-test plates. For this study, all tests were done at the distance of 30 cm. The test was started with the medium plate. If the child passed the medium plate, the examiner then went on to test with the thinnest plate. If the child failed the medium plate, the child was then tested with the thickest plate. Children who were able only to pass the thick plate or failed all three plates were considered to have failed the Frisby stereotest in this study. The child was considered untestable if he or she was unable to even respond to the demonstration chart. At a test distance of 30 cm, the stereo-acuity equivalent of the Frisby test plates are graded as follows:

	Thickness	Stereo-acuity
Thick Plate	6 mm	600 seconds of arc
Medium Plate	3 mm	300 seconds of arc
Thin Plate	1.5 mm	150 seconds of arc

(5) The total time taken to record the visual behaviour history and to carry out the visual acuity test and the stereotest were documented.

Referral

The following categories of children were offered referral to specialists, either to the Singapore National Eye Centre or the Ophthalmology Department of the National University Hospital.

- (1) Visual acuity of 6/9 or worse in any one eye
- (2) Failure to pass the Frisby stereotest's medium plate (300 seconds of arc) test or worse
- (3) Unsuccessful in completing the Frisby or Visual Acuity test (untestable)
- (4) Abnormal squint test including latent squint

At the hospital specialist clinics, these children were examined by an ophthalmologist and had cycloplegic refraction done and the cover/ uncover test, stereo-test as well as prism cover test if strabismus was found.

Analysis

The data collected for this study was entered into a personal computer and data analysis done using the Microsoft Excel software.

RESULTS

In all a total of 450 children aged 4 to 4 1/2 years were screened at three polyclinics. They consisted of 152 children from Bedok, 100 children from Bukit Batok and 198 from Geylang Polyclinic. There was an almost equal distribution of Males (50.9%) and Females (49.1%). The ethnic distribution comprised 62.9% Chinese, 30.9% Malay, 4.9% Indian and 1.3% other races. There were more Malays compared to the national distribution due to an over-representation of Malays from both the Bedok and Geylang Polyclinics.

Time taken

The time taken for doing the visual screening procedures in the polyclinics, ranged from 2 to 35 minutes (mean =15.8 minutes, media =15.0 minutes).

Visual behaviour

Only 5.3% of the parents reported noticing some form of abnormal visual behaviour in their children.

Frisby stereotest

Of the 450 children tested with Frisby stereotest, 71.1% passed the thin plate (150 sec of arc), 16.9% passed the medium plate (300 sec of arc), 1.8% passed the thick plate (600 sec of arc), 1.8% failed all plates while only 8.4 % were untestable.

Visual acuity test (Snellen or Sloan chart) at polyclinics

Of the 450 children tested with Snellen (or Sloan) chart, 35.1% had 6/6, 20.9% had 6/9, 17.6 % had 6/12 and 9.1% had 6/18 or worse visual acuity (the more abnormal of the test results done on both eyes of a child are presented here). In all, only 78 children (17.3%) were untestable and 372 children (82.7%) were screened successfully for visual acuity.

Further analysis showed that 334 children (74.2%) were successfully screened at the first test and 37 children (8.2%) were successfully screened at the 2nd attempt of the test. Another 78 children (17.3%) were still untestable after two attempts (one child had in addition missing data for this item).

Among the 372 children who were successfully tested for visual acuity, 197 children (53.0) could read the chart directly while the other 174 children (46.8%) could not read and needed to match the letters (or numbers) (one child had in addition missing data for this item).

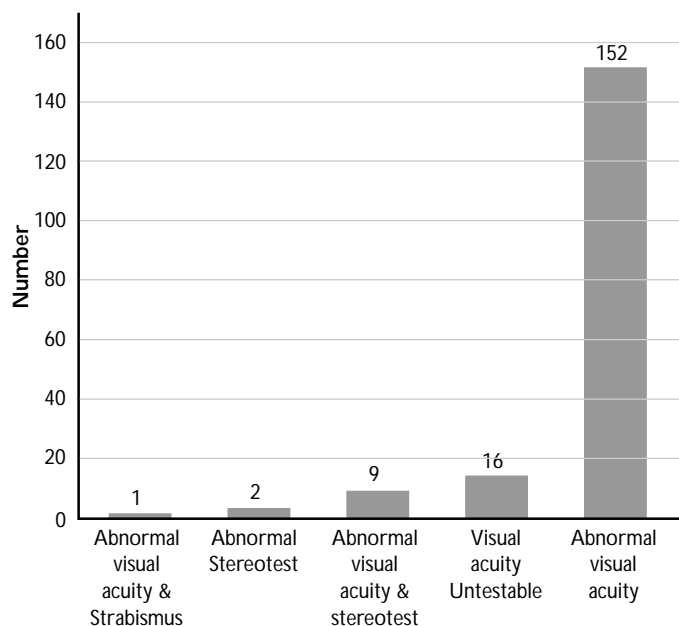


Fig. 1 Indication for referral to Ophthalmology Department.

Outcomes of referral

Based on the referral criteria set for the study, 294 children should have been referred to the ophthalmologists. However 86 cases directly refused referral. Another 28 cases either defaulted the second test appointment at the polyclinics or the referral appointments to the hospitals.

In all, only 180 children were examined by ophthalmologists at the Hospital Specialist Clinics.

The indications for referral of the 180 cases examined at hospitals is shown in Fig. 1. Most children were referred because of their abnormal visual acuity test or being untestable for visual acuity test. Only 2 children were referred purely for abnormal Frisby stereotest.

Outcome of test for Strabismus

Only 1 child was found to have "esotropia" by the polyclinic doctor. This child also was found to have abnormal visual acuity and able to pass the Frisby stereotest thin plate. The child was later found to have no strabismus at the hospital specialist evaluation .

Two children (1.1%) were found to have strabismus which was not detected at polyclinic screening. One had intermittent exotropia and had been referred for having failed the visual acuity and Frisby tests. The other child had superior oblique palsy and dissociated vertical deviation and was referred for abnormal visual acuity.

Outcome of visual acuity test

Table I summarizes the results of the visual acuity tests (Snellen or Sloan charts) done in the polyclinics for both the "referred" group and the "not referred" group. It

Table I. Visual acuity results at polyclinics (in the worse eye) vis-a-vis diagnosis at hospital specialist

Visual acuity results at polyclinics	Not Referred	Referred: Diagnosis found at hospital specialist assessment								Total
		Refractive error		Refractive error & Amblyopia		Normal		Sub-total		
		No	%	No	%	No	%	No	%	
6/6	156	0	0.0	0	0.0	2	100.0	2	100.0	158
6/9	36	5	8.6	0	0.0	53	91.4	58	100.0	94
6/12	9	25	35.7	1	1.4	44	62.9	70	100.0	79
6/18 & worse	7	21	61.8	5	14.7	8	23.5	34	100.0	41
Untestable	62	4	25.0	2	12.5	10	62.5	16	100.0	78
Total	270	55		8		117		180		450

(Two children with "6/6" vision in the "referred" group had been referred because of their abnormal stereotest results.)

also presents the abnormalities diagnosed by the hospitals in the "referred" group. Children with normal vision and those found to have very mild refractive errors that did not need correction by glasses, were included in the "normal" group.

Of the 180 children who were assessed by ophthalmologists in hospitals, 117 (65.0%) were found to be normal or had only minor refractive errors that did not need intervention. 63 (35.0%) children had refractive errors for which spectacles were prescribed. The majority (85.5%) of those who needed spectacles had astigmatism. The remainder had myopia (6.5%) or both astigmatism and myopia (8.0%). None of these children were prescribed spectacles for hypermetropia. Cycloplegic refraction was performed on all children.

The refractive errors of the 63 children who needed spectacles were as follows:

Astigmatism	range -0.50 to -5.00 D.S. mean -1.59, median -1.5 D.S.
Myopia	range -0.50 to -5.50 D.S. mean -1.30, median -1.00 D.S.
Spherical Equivalent	range -5.88 + 3.00 D.S. mean -0.07, median 0.25 D.S.

Eight children had amblyopia. The visual acuity deficit for the definition of amblyopia was 6/12 or worse for the best corrected vision, or at least 2 Snellen line difference in the visual acuity between the 2 eyes on two consecutive examinations by the ophthalmologist. All these children had refractive amblyopia of which three-quarters were meridional and one-quarter were anisometric.

Outcome of the untestable children referred to hospitals

The 16 children found untestable with Snellen (or Sloan) visual acuity charts were referred for hospital specialist assessment. Among these children, 10 cases were

discharged without treatment, 4 cases were prescribed glasses and 2 cases were diagnosed to have amblyopia and were prescribed glasses. The abnormality rate for untestable children was 37.5% which is similar to that of the children with 6/12 visual acuity (37.1%) and significantly higher ($p < 0.01$) than the abnormality rate of children with 6/9 visual acuity (8.8%).

Rates of Refractive error and Amblyopia in the study population

Children who had no abnormality as well as those found to have minimal refractive error during the study that did not need intervention, were included in the "normal" group.

If an assumption was made that all children who were not referred were presumed to be "normal", the abnormality rates computed are:

Refractive error	= 63/450	= 14.0%
Amblyopia	= 8/450	= 1.8%

The above abnormality rates represented the actual "yield" of the screening process in this study, since abnormal cases not referred had no chance to be evaluated by the hospitals and in reality could not be detected by the screening program offered.

Another way of computing the abnormality rates is to make the assumption that the abnormalities in children not referred were the same as in those referred. Based on this assumption, the number of children computed to have refractive errors in the "not referred" group would be 36 and the number of children computed to have amblyopia in the "not referred" group would be 10. Therefore, the abnormality rates computed under the above assumptions are:

Refractive errors	= (36 + 63) / 450	= 22.0 %
Amblyopia	= (10 + 8) / 450	= 4.0 %

Referral criteria

Data from Table I were used to construct the following two cross tabulations between the results of visual acuity tests done in the polyclinics and the diagnosis given by the hospitals, using two different referral criteria. The two cut off points of abnormal visual acuity for referral to hospitals were: "6/9 or worse" and "6/12 or worse". (Table II, III)

"Refused referral" rate

Based on data presented in Table I, if the referral criteria for abnormal visual acuity was set at "6/9 or worse plus Untestable", 39.0% of children who should have been referred were not referred. A comparison of the visual acuity of children in the "referred" and "not referred" groups shows that the group of children who were "not referred" had higher proportion (69.2%) of 6/9 vision as compared to the "referred" group which had only 35.8% with 6/9 vision.

The "not referred" group (23.0%) also had a higher proportion of untestable cases as compared to the "referred" group (8.9%). In fact, 79.5% of the total number of untestable cases were not referred.

If the referral criteria for abnormal visual acuity were re-set at "6/12 or worse" and cases who were untestable in visual acuity test were excluded as well, the "refused referral" rate would drop drastically to 13.3%.

DISCUSSION

The Family Health Service reviews its preschool vision screening program periodically. Up to this point in time there has been no one ideal test available that is simple, cheap and highly effective. Several newer methods have held both promises and limitations. Some are attractive but are yet to be proven^(2,3,4,5). The value of earlier detection of amblyopia in preschool screening remains controversial^(6,7,8). Ideally, to make a real impact on preventing amblyopia, children need to be screened from infancy⁽⁷⁾. Photoscreening from infancy appears promising⁽⁵⁾ but the current understanding of the natural history of esotropia, amblyopia, refractive risk factors is limited, which does not permit the prophylactic potential of the early screening⁽²⁾. After infancy, the early toddler years require repeated longitudinal re-screenings to be done as visual acuity, refractive errors and stereopsis changes may not reach adult acuity until the age of 3 to 5 years old^(8,9,10,11,12). There is no evidence to support drastic change to the current program.

It was decided that the Family Health Service can continue with the conventional Snellen test which is simple, cheap and well established. However, one area that the program can be improved is by lowering the age for screening with Snellen visual acuity test. In this study, Snellen (or Sloan) test done on 4-year-olds gave

Table II. Visual acuity by polyclinics correlated against Diagnosis by hospitals when cut off point of abnormal visual acuity was equal to "6/9 or worse".

Visual acuity by polyclinics	Diagnosis by hospitals		Total
	Normal	Abnormal	
Normal (6/6)	2	0	2
Abnormal* (6/9 or worse + untestable)	115	63	178
Total	117	63	180

*Abnormal Visual Acuity = "6/9 or worse" + "Untestable"
 False positive rate = 115/178 = 64.6%
 Positive predictive value = 63/178 = 35.4%
 Total number of "abnormal" cases = 114 (not referred) + 178 (referred) = 292

In summary: Screened-out rate = 292/450 = 64.9%
 Referral rate = 178/450 = 39.6%

Table III. Visual acuity by polyclinics correlated against Diagnosis by hospitals when cut off point of abnormal visual acuity was equal to "6/12 or worse".

Visual acuity by polyclinics	Diagnosis by hospitals		Total
	Normal	Abnormal	
Normal (6/6 + 6/9)	55	5	60
Abnormal* (6/12 or worse + untestable)	62	58	120
Total	117	63	180

*Abnormal Visual Acuity = "6/12 or worse" + "Untestable"
 False positive rate = 62/120 = 51.7%
 Positive predictive value = 58/120 = 48.3%
 Total number of "abnormal" cases = 78 (not referred) + 120 (referred) = 198

In summary: Screened-out rate = 198/450 = 44.0%
 Referral rate = 120/450 = 26.7%

NB: "Screened-out rate is defined as the number of children screened out to be "abnormal" based on the referral criteria, out of the total number of children screened.

"Referral rate" is defined as the number of children who accepted referral for further evaluation, out of the total number of children screened.

The false negative rate cannot be computed because too few cases with 6/6 visual acuity were evaluated.

a success rate of 82.7% which is similar to the success rate of 83.1% with Snellen chart on 5-year-olds reported in the last study done in the Family Health Service in 1991⁽¹⁾. This study has shown that the screening age can be brought down from 5 to 4 years old without having to increase the untestable rate significantly. This will also have the advantage of combining the vision screening program with the existing 4 years old developmental health screening done by polyclinic doctors, thus cutting down an additional visit for the children thereby encouraging higher coverage for the checks.

The study has highlighted a few potential problems in the FHS vision screening program:

- (1) The screening test is time consuming requiring an average of approximately 15 minutes. It is likely that testing 4-year-old children with the Snellen chart takes a longer time than when done on 5-year-olds, as there is still a large proportion of children (46.9% of those completed the test) who cannot read and need to "match" letters at 4 years of age.
- (2) There is still relatively high proportion (17.3%) of "untestable" children. This group of children cannot be ignored by simply postponing the test to a later age, as this study has shown a high yield of abnormality among them. The abnormality rate of untestable children (37.5%) was significantly higher ($p = 0.01$) than that of children who had 6/9 vision (8.8%). Therefore it is recommended that "untestable" children be included in the "abnormal" group and be referred for hospital evaluation. Unfortunately, the untestable children had shown to be more likely to refuse referral. In such cases, they should be closely followed up. The majority (79.5%) of untestable children refused the referral offered. It was not easy at the polyclinic level to distinguish between "poor vision" and "untestable". Attention to details like having alternative eye-occluders, using large letters for matching may cut done on "untestable" rate. Better training of nurses was noted to be important and needs to be pursued.
- (3) There is a need to find an alternative method that gives higher success rate in this group of children who cannot be tested with Snellen chart. One test we may want to explore is the Sonksen picture test⁽¹⁷⁾ which was shown to be able to test 98% of children aged 21 to 60 months old successfully in a median times of one to five minutes. The children are tested binocularly without having to use eye-occluder. In the mean time, before a better alternative is found, the single-letter Otago chart currently available in the FHS polyclinics should be retained as a back-up test for children who are untestable with Snellen chart.
- (4) The problem of high rate of refusal for referral has to be addressed. A simple survey of the reasons for refusal by parents to referrals will need to be carried out so that corrective measures can be implemented. A well designed and persuasive health education to parents emphasizing the importance of early intervention for amblyopia the high prevalence of visual problems in Singapore children and why untestable children should be referred may help to reduce the refusal.
- (5) Another problem faced in the FHS vision screening program for preschoolers is the poor results in

screening for strabismus. Test for strabismus carried out in polyclinics had shown to be not reliable in the Department's past study⁽¹⁾ and again in this study. In this study, the only case of "strabismus" detected in the polyclinic turned out to be a false positive case. Furthermore the two cases of strabismus detected during the hospital specialist assessment were missed during the polyclinic screening. Testing for strabismus in young children is a difficult skill to become adept in. Training of FHS doctors in strabismus testing is a necessity.

Frisby stereotest was introduced as a supplementary test to the linear monocular visual acuity tests in screening for amblyopia, anisometropia and strabismus through the demonstration of binocular vision. Frisby was chosen out of other available stereo-tests as it is a simple, easy-to-use and durable instrument. With some modification it could even be used in children as young as 6 months old⁽¹³⁾. Unlike random-dot stereotests, the Frisby stereotest does not require the use of polaroid glasses. The choice of a stereo-threshold of 300 seconds of arc for referral in the study was an arbitrary one. The study by Saunders et al⁽¹³⁾ with a modified Frisby stereotest showed that the majority of normal non-strabismic subjects aged 6 months to 47 months demonstrated a stereo acuity of at least 600 second of arc while positive responses to 300 second of arc (medium plate at 30 cm) improved slowly with age to reach about 80% at 30 months of age. The choice of 300 seconds of arc for this study as the passing threshold can be considered a reasonable one. Frisby stereotest has been shown to be useful in demonstrating binocular function without approaching stereo-threshold. This can be achieved even with gross stereopsis of 730 seconds of arc, using the thick plate⁽¹⁵⁾. We were however unable to demonstrate the usefulness of the addition of Frisby stereotest to the program in this study. The majority of abnormal children referred were screened out by Snellen visual acuity test alone. Frisby stereotest only provided 2 extra children in the referrals, both of them did not need intervention. 54 children (12%) were either untestable or were unable to achieve at least 300 seconds of arc in the Frisby stereotest. Unfortunately, only 11 of these 54 children attended the hospital specialist departments. Analysis of the small number of children referred may be the reason why the added advantage of the Frisby stereotest could not be demonstrated by the study. A larger sample is required to evaluate the value of this test.

Despite this study not being able to provide conclusive evidence for introducing Frisby stereotest to the program, it may still be worthwhile including the test in the program for the following reasons: (i) The

test was found to be “fun” and “easy “ for 4-year-old children, with a lower untestable rate of 8.4% compared to Snellen visual acuity test. It can therefore be used as an “ice breaker” for the anxious 4 year-old children before doing the Snellen test. It also offers an assessment of a different kind of visual function other than visual acuity; (ii) the stereovision test can supplement the test for strabismus; (iii) it can also be used to test the younger age group when the Snellen test is not possible. Since the demonstration of the stereopsis in infant and toddlers rules out the possibility of profound visual deficits, its value lies in the ability to test younger children. The Lang and Frisby stereotest are recommended for testing stereo-vision in 8 to 30 month-old toddlers⁽¹⁶⁾.

What then should the referral criteria be for abnormal visual acuity? Using “6/18” as the referral criteria is out of question as too many cases who require intervention will be missed. If the referral criteria for abnormal visual acuity is set at “6/9”, there will be a very high false positive rate of 64.6% and there will be an unacceptable high referral rate of 39.6% generated when compared to other reports which range between 1.4 to 21.9%^(14,17,18). This study has established the referral criteria for abnormal visual acuity test as “6/12”. It will reduce the referral rate to a more manageable level of 26.7% improve false positive rate to 51.7% and give a positive predictive value of 48.3% at the expense of losing 5 children in this study who needed glasses prescribed for astigmatism.

These children may however not suffer any adverse long term visual consequences as none of them had amblyopia at the time of examination.

Using “6/12” for referral gives a “screened-out” rate of 1.7% for amblyopia while that for refractive error was 14.2% which are similar to the “screened-out” rate for 5-year-old children obtained in the FHS 1991 study where the screened out rate for amblyopia was 1.7% and refractive error was 11.6% ($p=0.1658$). Both studies have under-reported the prevalence of the conditions as those who refused referral could not be evaluated and were presumed to be normal in the visual screening program. This study did not aim to present the prevalence rate of visual abnormality in the population.

CONCLUSION AND RECOMMENDATIONS

1. This study has confirmed the feasibility of lowering the visual acuity screening age from 5 years old to 4 years old, with a success rate of 82.7% in carrying out the Snellen (or Sloan) Visual Acuity Test.
2. The problem of high proportion of children whose parents refused the offer of referral should be addressed and measures taken to reduce it.
3. Although this study could not demonstrate the usefulness of adding the Frisby stereotest to the

routine screening procedure, we still recommend its inclusion into the program. It is a fun and easy test to do resulting in fewer untestable children and as a test for binocular vision, it can be complementary to the monocular visual acuity test. As tests for strabismus currently carried out by polyclinic doctors were found to be unreliable, Frisby stereotest can be a valuable supplementary test for strabismus. Its efficacy should be re-evaluated using a larger sample in the future.

4. The referral criteria for visual acuity should be set at 6/12 or worse. Children who were not testable with Snellen or Sloan chart, should be treated as “abnormal” cases and offered referral since they have similar rates of visual abnormality as children with 6/12 vision.
5. Parents’ observation of abnormal visual behaviour of their children cannot be relied upon in detecting abnormal vision as only 5.3% of parents in the study noticed abnormal visual behaviour in their children.
6. Out of the total 450 children screened, 1.7% were found to have amblyopia, 14.5% were prescribed glasses for refractive error. The high “yield” from this screening program confirms the value of performing the visual screening for our 4-year-old children.

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