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Can orthoptically trained personnel carry out pre-school vision screening in the absence of an orthoptist?

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Abstract

Aim: **To determine whether alternative personnel can carry out pre-school vision screening with the support of the visiting orthoptist providing the initial training. Also to determine whether standard protocols can be followed in relation to standards of testing and referrals.**
Methods: Group 1**: A retrospective cross-sectional study was carried out from January 2000 to January 2002 at RAF Akrotiri, Cyprus, to determine the number of true and false positive referrals prior to training.** ***Group 2*****: A retrospective cross-sectional study was then carried out to identify all the children who had been referred directly to the orthoptist since the implementation of the new programme in April 2001.** ***Group 3*****: A convenience sample was then taken from the children who had been previously tested by the health visitor or school nurse during 2001 and re-tested blind by the orthoptist to determine the number of false negative results.**
Results: **Prior to the introduction of the new direct referral system both the orthoptist and the ophthalmologist saw all patients at the same appointment. Of those referred, 41% were found to be false positives. Health visitors and school nurses underwent training with the visiting orthoptist. However, despite the training more than half the number of patients referred by the health visitors still proved to be false positive referrals. A total of 54% of patients referred were found to have no abnormality when examined by the orthoptist. Of the 34 children who were re-tested, 8 were found to be false negatives. The positive predictive value was only 46.34% for health visitors and school nurses.**
Conclusions: **The results of this study support the hypothesis that there is a difference in assessment of pre-school children by a health visitor compared with an orthoptist, as shown by the percentage of both false positives and false negatives.**

Key words: False negatives, False positives, Health visitors, Orthoptists, Vision screening

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Introduction

In the UK, the National Screening Committee produced a report in 2006[1] and made a series of recommendations on vision screening. The Committee agreed with the previous findings of the Hall Report, which defined the optimum age to conduct screening for visual defects as 4–5 years old, due to the ability of children of this age to 'perform visual acuity tests more reliably than 3-year-olds'. In this report, Hall also suggested that the person carrying out these tests should be an orthoptist.[2]

Hall's previous recommendations had indicated that other personnel such as school nurses or health visitors should be able to carry out the screening. This was due to the expense of an orthoptist and the fact that it was felt there would be better attendance if the child's screening tests were all carried out in one place.[3]

In some areas of the world that work to UK screening guidelines orthoptists are not routinely available to do the screening, and therefore use of other personnel has to be explored. This study aimed to determine how effective primary visual screening is when conducted by alternative personnel supported and trained by orthoptists. In addition we sought to determine whether standard protocols could be followed in relation to standards of testing and referrals.

Methods

In 2001 at RAF Akrotiri, Cyprus, health visitors and school nurses were trained to carry out the examination of pre-school children in the absence of a professionally trained orthoptist. The training was provided by the visiting orthoptist in the form of short lectures and practical sessions. Detailed guidelines were issued for the health visitors and school nurses to follow and a proforma was provided for use in the screening.

Groups

The study was split into three groups for analysis:

Group 1: A retrospective cross-sectional study was carried out from January 2000 to January 2002 of all referrals from all sources not on the direct referral forms. The exclusion criterion was: All adults.

Group 2: A retrospective cross-sectional study was then carried out to identify all the children who had been referred directly to the orthoptist using the new direct referral forms.

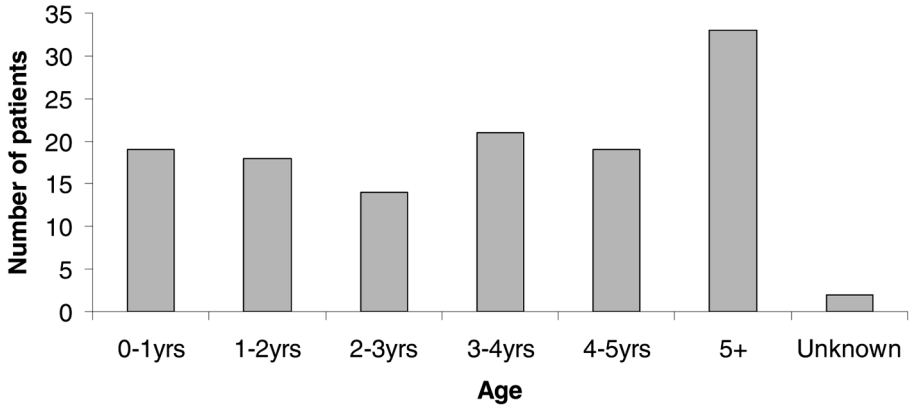

Fig. 1. Age range of all patients seen between January 2000 and January 2002.

Group 3: A convenience sample was then taken from the children who had been previously tested by the health visitor during 2001. These children were re-tested by the orthoptist to determine the number of false negative results.

Analysis

The study used non-probability sampling. The data analysis aimed to validate the introduction of pre-school visual screening against a gold standard of testing which in this case was the orthoptist.

Statistical analysis was also carried out using the GraphPadStatMate, version 1.0.

The *t*-test was felt to be appropriate for the analysis of the data collected for this study as it was able to test the differences between observations (scores) collected from the health visitors and compare them with the observations (scores) collected from the orthoptist.

The visual acuity results obtained for groups 2 and 3 were analysed using the paired *t*-test by examining right and left eyes together, therefore analysing 24 eyes for group 2 and 68 eyes for group 3. Group 1 could not be analysed in this way as visual acuity testing was not carried out by the health visitors as routine prior to the new system.

The Kolmogorov-Smirnov test (KS-test) was also applied to the data. These values are shown in the results.

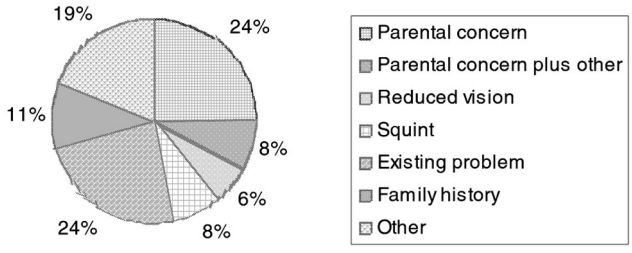

Fig. 2. Pie chart showing the percentage of patients referred per reason for referral. (The key starts at 12 o'clock on the chart.)

Results

Group 1

There was a wide spread of patients across the age ranges (Fig. 1). The majority of patients who were referred were less than 5 years of age.

Fig. 2 shows the reasons for referral. The majority of patients were referred by their general practitioner (GP) or Senior Medical Officer; this was before and since the introduction of the direct referral system for health visitors. Other referrals were from paediatricians, neurologists and other ophthalmologists. A small number of patients still continued to be referred via the GP even though the health visitor had initiated the referral.

Prior to the introduction of the new direct referral system 41% of referrals were found to be false positive to the orthoptist and ophthalmologist, taking up two appointments.

Group 2: Direct referrals

Data were collected on all the referrals made by health visitors following the training in pre-school visual assessment (Fig. 3). More than half the patients referred by the health visitors proved to be false positive referrals. A total of 54% of patients referred were found to have no abnormality when examined by the orthoptist. The patients referred by the health visitors were only booked to see the orthoptist and therefore only required one appointment. Any patients who were found to have an abnormality were seen by the ophthalmologist the same day and treatment was commenced.

Of the 41 patients referred, tests for visual acuity had been carried out on only 12. One patient had had the cover test and visual acuity testing carried out which indicated normal vision and a squint, but proved to be normal and was therefore a false positive result. One patient who was referred for family history was found by the orthoptist to have a significant squint with gross reduction of vision and subsequent ophthalmology examination could find no red reflex. This patient was therefore referred back to the UK for further investigations.

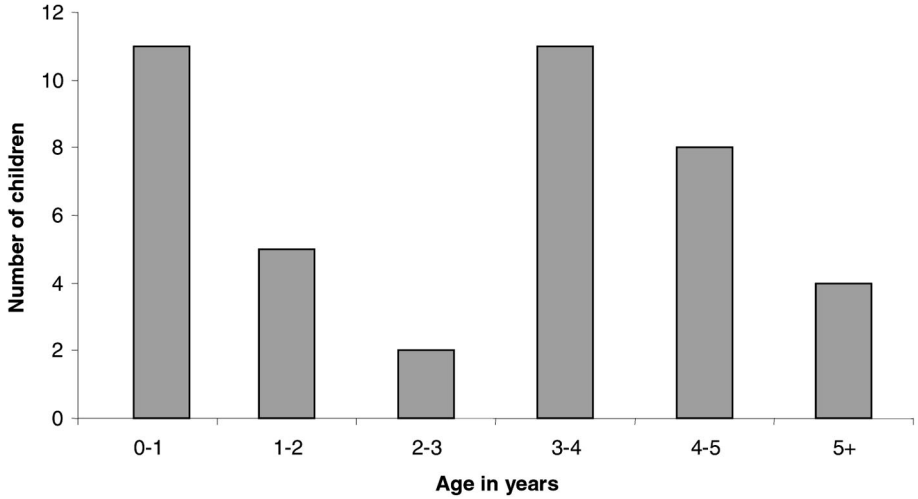

Fig. 3. Data were collected for all direct referrals made by the health visitors following the training in pre-school visual assessment.

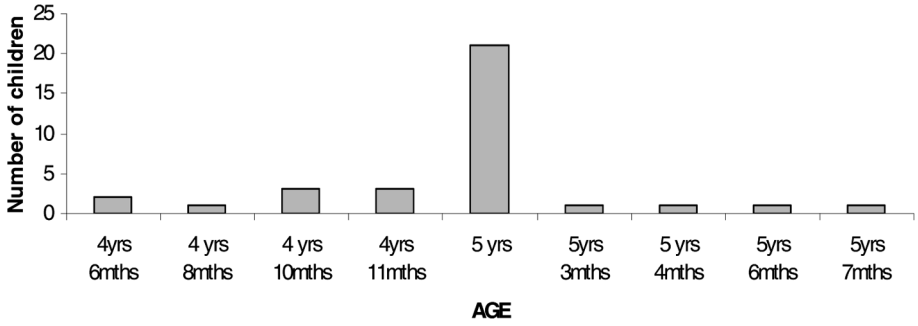

Fig. 4. Age range of children at re-test by the orthoptist.

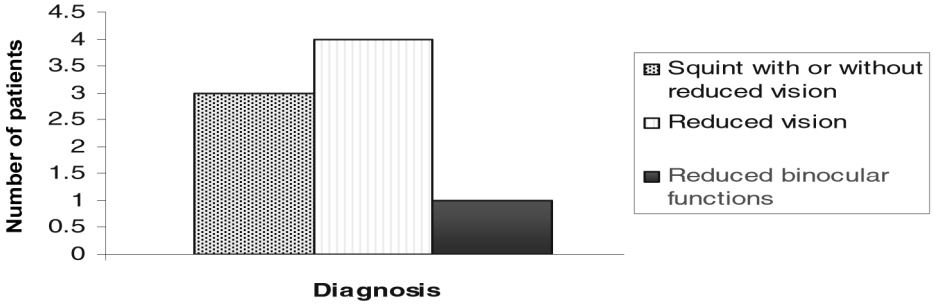

Fig. 5. The diagnosis of false negative results.

The patients were referred using a referral proforma and standards of testing. However, these were found to be incomplete upon receipt of referral and only the patients referred for reduced vision had had any tests carried out on them.

Of the 6 patients who were referred for squints only 2 proved to be true positives. However, 1 patient who was referred for a left convergent squint and who had no vision recorded actually had a right convergent squint with reduced vision requiring a moderate hypermetropic correction. The other true positive who was referred had had no test carried out prior to referral, and was also found to have significant reduction of vision.

Group 3: False negatives

Fig. 4 shows the age range of children re-tested by the orthoptist.

Of the patients who were re-tested, 24% were found to be false negatives. Fig. 5 shows the number of false negatives by diagnosis.

Table 1 shows that the health visitors appropriately diagnosed only 54.17% of the pre-school children as not having a vision defect, which means that 45.83% are missed. If the 75 patients above can be regarded as a representative consecutive series drawn from the population likely to be screened, then the prevalence of visual

Table 1. Sensitivity and specificity

		Gold standard +ve	Gold standard −ve		
Test	+ve	19	22	41	PPV
	−ve	8	26	34	NPV
		27	48	75	

	Sensitivity	Specificity	Lower CL	Upper CL	
Sensitivity	70.37	N/A	N/A		0.1722
Specificity	54.17	54.03	54.31		0.141
PPV	46.34	46.19	46.49		0.1526
NPV	76.47	N/A	N/A		0.1426
Likelihood ratio of a positive test			1.5354		
Likelihood ratio of a negative test			0.547		

CL, confidence limit; N/A, not applicable; NPV, negative predictive value; PPV, positive predictive value.

defects in those being tested by health visitors will be 36%.

Therefore of the 75 patients tested the positive predictive value was 46.34% and the negative predictive value 76.47%. It is, however, difficult to draw conclusions from this small sample, and further statistical analysis is required.

Further statistical analysis

Group 2: Direct referrals

To determine whether there was a difference between the visual acuity scores recorded by health visitors and orthoptists the two-tailed paired *t*-test was used. This found that there was a significant difference ($p = 0.0012$; $t = 3.698$, $\mathrm{df} = 23$) between the visual acuity scores recorded by the health visitors and the orthoptist.

The mean difference was 0.2458 logMAR (95% confidence interval of the difference: 0.1083 to 0.3834). The paired *t*-test assumes that the differences are sampled from a Gaussian distribution. This assumption is tested using the method of Kolmogorov and Smirnov. The Kolmogorov–Smirnov (KS) distance is 0.27. The *p* value is 0.0533. The data passed the normality test with $p > 0.05$.

Group 3: False negatives

To determine whether there was a difference between the visual acuity scores of children previously tested by health visitors and given a negative result and then subsequently tested by the orthoptist, a two-tailed *t*-test was performed on a convenience sample. A significant difference was found ($p = 0.0024$, $t = 3.170$, $\mathrm{df} = 63$).

The mean difference was −0.02969 logMAR (95% confidence interval of the difference: −0.04840 to −0.01097).

The paired *t*-test assumes that the differences are sampled from a Gaussian distribution. This assumption was tested using the method of Kolmogorov and Smirnov. The KS distance was 0.51. The *p* value was < 0.0001.

Discussion

The results of this study provide considerable support for the recommendations made by the National Screening Committee, and evidence that there is a difference in assessment of pre-school children by a health visitor or school nurse compared with an orthoptist. This is shown by the percentage of both false positives and false negatives.

In this study the positive predictive value was only 46.34% for health visitors, although other studies have shown higher values.[4]

In another study Ingram *et al*. found that 41% of children referred to their service had normal visual acuity. They argued that the specificity of visual acuity measurements as a screening test for identifying children with amblyopia and refractive errors is reduced because in most schools it is not performed under standardised conditions, leading to unnecessary referrals.[5] This could be one factor contributing to the high percentage of false positives found is this study, as the screening was carried out in sometimes very poor conditions. Testing was carried out in either corridors at schools or in the medical centre, with either poor lighting or extremes of lighting. Also the health visitors and school nurses used various tests, even though an equipment list had been provided. Testing distances varied, which may have led to the incorrect recording of visions, as they may have not been converted correctly to the Snellen equivalents.

Although there has been some disagreement amongst professionals as to the methodology of screening, it is widely accepted that testing of stereopsis together with visual acuity is probably the most effective method.[6]

In this study it was shown that even though the health visitors and school nurses had been given an equipment list together with standards of testing to be carried out, this was not adhered to. Nor were the proformas for referral filled in which documented the test results. Insufficient tests were ultimately to blame for a significant number of the false positives and false negatives, as children may have squints or defects of binocular vision that will not be identified unless further additional tests to visual acuity are carried out. It can be seen that in particular 4 of the false negative results obtained by the orthoptist were in fact squints that had not been previously detected.

Although the Guidelines for Children's Eye Care issued in May 2002 do not include stereopsis, they do not exclude it. The authors did, however, set the minimum requirement that a primary screen should encompass. The health visitors and school nurses were relying on visual acuity alone.

Visual acuity testing is the most widely used screening test for children, but when used alone it has several disadvantages. It does not distinguish between amblyopia and simple refractive errors and does not detect strabismus or suppression. It also requires the use of occluders, which may distract the child and decrease co-operation. In addition the large number of visual acuity tests available creates difficulties of standardisation for judging results.[6]

The lack of use of tests may, however, be due to a number of other issues such as lack of confidence or

understanding due to poor training. The health visitors were given training by the visiting orthoptist in the form of a lecture with a video together with practical sessions in clinics. The competency of the health visitors was not, however, formally evaluated, and therefore this in itself could be a contributory factor in poor assessments by health visitors.

Orthoptists form a high percentage of health care professionals completing visual screening in schools, and research shows them to be qualified and effective screeners: 'far from finding it difficult to obtain reliable results with young children, most orthoptists would be professionally offended not to achieve results in pre-school children'.[7] In this study the health visitors often recorded an inability to obtain any results due to poor co-operation, whereas orthoptists have more experience in dealing with the 'uncooperative' child.

On average the orthoptist took 5 minutes to see each child, with usually 20 children seen in the morning and 15 in an afternoon session. The health visitors were seeing on average 7 in a session.

The reasons for referral by the health visitor, such as parental concern or family history, tended to be the factors that they most relied on. Although this was indicated to be acceptable in the standards, it should also be supported by a subsequent assessment. This was not the case.

The effectiveness of orthoptists in the detection of visual defects means they are the best people to perform visual assessment of pre-school children, but further evaluation needs to be carried out in order to design a service when there is not a permanent orthoptist. Is it the case that some screening is better than none?

Conclusions and recommendations

This study shows that alternative personnel such as health visitors or school nurses are ineffective at carrying out pre-school vision screening. In this study the false positive rate surprisingly increased after training, which could be due to increased awareness of vision problems. What is more worrying, however, is the number of false negatives.

The service that had been implemented was found to demonstrate a degree of inefficiency due to a number of reasons. The visual acuity test performed by the health visitors appeared to be insufficient and on occasion inaccurate. Additional or alternative tests must be carried out to achieve a higher true positive referral rate as shown by Stewart *et al*.[4] This study, however, provides considerable support to the recommendation that orthoptists should carry out pre-school visual screening services.

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