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The Potential Impact of Undiagnosed Vision Impairment on Reading Development in the Early Years of School

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This article presents a critical review of the literature surrounding the potential impact of undiagnosed and untreated vision impairment on reading development in the early years of primary school. Despite pre-school screening programmes, it is still possible for children to enter school with undiagnosed, uncorrected vision impairments. This can be due to healthcare access issues for children. Data reviewed indicated correlations between hyperopic vision impairment and poor reading development. However, the relationships reported remain complex, with myopic vision impairment being reported to correlate with high reading ability in some studies. In addition, correlation does not necessarily imply causation. Previous research in the field is reported. Deficiencies in the current literature base are discussed. Finally, recommendations for teaching practice and the nature of research that explores whether vision impairment is the cause of poor reading development for some children in school are suggested.

Keywords: elementary schools; hyperopia; myopia; reading development; reading attainment; refractive error; sight test; vision impairment

Introduction

The majority of children achieve success in school. However, about one in five children leave school with basic levels of literacy. Despite the efforts of teachers, support for learning teachers, support for learning assistants, educational psychologists, and provision of specialised literacy programmes, they fail to develop their literacy levels to the expected levels (Scottish Government, 2011). The Royal National Institute for the Blind (RNIB) estimates that as many as one in five children in UK schools may have an undiagnosed vision problem. Previous research identified that British children who had mild hypermetropia/hyperopia/hyperopic vision impairment were likely to be reading at a level significantly below that which was compatible with their intelligence level (Stewart-Brown, Haslum, & Butler, 1985). There is a correlation between visual perception anomalies and reading ability in primary school students (for example, Kavale, 1982; Simons, 1993). It is not known, however, whether poor vision (from refractive error) or accommodative stress (from uncorrected hypermetropia) is a factor. This raises the question of how many of the children failing to develop satisfactory literacy levels in school do so because of undetected or untreated vision impairment problems, in particular hypermetropia (long sight or far sight). The aim of this review is to identify current literature on vision impairment problems and reading development.

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Methodology

A broad literature search was carried out in an attempt to locate as many studies as possible that dealt with undiagnosed vision impairment problems and their effect on reading development. The intention was not to undertake a systematic review. Early in the process it was ascertained that this would have been most problematic, such was the breadth of research methodology, paradigm and outcomes measures. The aim of this work was to undertake a literature review of the current literature on vision impairment and the potential effect on reading development in the early years of school. Different combinations of key words were used for searches (e.g., "undetected vision problems", "schools"). Results were narrowed by subject area (e.g., "reading achievement", "refractive error", "vision impairment"). Inclusion criteria for articles were that articles dealt with vision impairment problems in school or pre-school populations and academic/reading development. Articles from any published or unpublished source that met the inclusion standards were included. The search included the years 1970–2013.

Electronic searches were made of the following educational databases:

- JSTOR
- ERIC
- EBSCO
- Psych INFO
- Dissertation Abstracts
- Web of Knowledge

Websites of the UK Government and the RNIB were searched. In addition to looking for studies by key terms and subject area, searches were conducted in specific journals. The tables of contents of the following journals were searched:

- *British Educational Research Journal*
- *Optometry*
- *Optometry and Vision Science*
- *Journal of Behavioral Optometry*
- *Journal of Learning Disabilities*

Seventy-three articles were identified and 42 articles were selected for inclusion. One of the limitations of current research literature identified was that, in all of the randomised controlled studies identified, findings were limited to medical outcomes (for example, Ingram, Arnold, Dally, & Lucas, 1990; Ingram, Walker, Wilson, Arnold, & Dally, 1986). A number of studies that were identified in the literature search but that were not subsequently selected for use in the review included data of this nature.

Vision Impairment in School-Age and Pre-School Populations

Vision impairment is reported to be widespread amongst school-age populations in both the United States and the United Kingdom (Ethan & Basch, 2008; RNIB, 2005). The RNIB estimates that there are about 24,000 children in the United Kingdom who have a vision problem. This represents about one in five children. The RNIB (2005) also reported concern that many of these vision problems are going undetected due to the move towards pre-school-only screenings in 2003. Similar issues are reported in the United States, where it is reported that one in five children has a vision problem; these

vision problems are reported to be disproportionately high amongst students from low-income families (Ethan & Basch, 2008). This group of students represent an important sub-group in schools. The majority may not have vision problems severe enough to warrant further investigation or the establishment of a record of additional support needs. However, the vision problems, if undocumented and untreated, may impact academic performance in schools. These figures, however, are based on extrapolation estimates. One of the aims of this review is to look at a wider range of studies to try and gain a more accurate estimate of the rate of undiagnosed vision impairment in school-age children.

Vision Impairment and Reading Development

A synopsis of the focus and findings of studies in this section is presented in Table 1. The act of reading requires the coordination of a number of visual activities including: a focused image on the retina (refraction and accommodation), a disease-free retina and optic nerve (for visual acuity), efficient eye movement along the line of print (saccades), good convergence (if binocular), two integrated images in the brain (fusion), and minimal effort required for fusion. Subsequently, the information needs to be processed (visual cortex) and the process of reading needs to be learned through repetition, language, and assimilation. There is knowledge that this learning process is often handicapped by an inability to deconstruct and reconstruct phonemes. Many of these latter activities are far removed from the visual system, both conceptually and anatomically. The review will limit itself to vision impairment that can be treated effectively. The impact of undiagnosed and non-treatable vision impairment is well known to the author, as retinitis pigmentosa is present in his immediate family (see Thurston et al., 2010). However, this is not the focus of this article.

A study at Mather School in Boston, MA, USA reported that 50% of students had a visual problem that could affect their ability to learn to read. The study concluded that it was important to test students for near-vision problems as well as distance vision during screenings. However, descriptive statistical data were not available for this study and so the veracity of these findings could not be established (Orfield, 2001). Other studies have reported smaller percentages of subjects with abnormal refractive error. In a study of 1096 six-month-old to nine-month-old infants in Cambridge, UK, about 11% were found to have a significant refractive error (Atkinson, Braddick, Durden, Watson, & Atkinson, 1984). A study of 50 juvenile offenders and 54 graduate students in New York State reported that whilst no graduate students had near-vision problems, 16% of juvenile offenders had near-vision refractive problems that could affect reading ability (Johnson & Zaba, 1999). However, these data are from a small sample and multiple tests were used. Results should therefore be treated with caution and the benefit of extrapolating results beyond this sample may be limited.

A strong correlation is reported between vision impairment and reading problems in school-age students. Hypermetropia/hyperopia and anisometropia have been identified as possible near-point vision impairment that could lead to poor reading due to an inability to decode letters. It was reported that the use of font sizes of 16 point plus in the early years of school could offset such potential problems for the majority of children. However, a causal relationship between vision anomalies and poor reading has not been established in the current literature (Simons, 1993). A meta-analysis of 161 studies reported that visual potential problems in up to eight visual skills (but not visual acuity) were correlated to poor reading ability. However, when corrected for the

Table 1. Refractive vision anomalies and reading development.

Study	Focus	Findings
Orfield (2001)	A study in Mather School, Boston, MA, USA looking at undetected visual problems	50% of students had a visual problem that could affect their ability to learn to read The study concluded that it was important to test students for near-vision problems, as well as distance vision during screenings No descriptive statistics available for the study and so further analysis was not possible
Atkinson, Braddick, Durden, Watson, and Atkinson (1984)	Undetected vision problems were reported for a sample of 1096 six-month-old to nine-month old infants	11% of children who would not have normally been referred to the eye clinic were found to have a significant refractive error 5% hypermetropic (>+3.5D[a]) 4.5% myopic 1.3 % anisometropic (>+1D) 0.3% strabismic On average, 71% of parents sent letters attended clinical appointments
Johnson and Zaba (1999)	Vision tests and literacy levels measured in juvenile offender and graduate students	16% of juvenile offenders had near-vision refractive problems that could affect reading ability 25% of variance in reading test scores was accounted for by observed tracking and convergence problems in juvenile young offenders
Simons (1993)	Meta-analysis of 161 studies on reading ability and visual errors	Visual potential problems in up to eight visual skills (but not visual acuity) were correlated to poor reading ability Vision anomalies lead to issues of failing to learn to decode letters into sounds, because the vision anomaly prevents discrimination of letter patterns at near point In early years of school these are most likely linked to being able to discriminate the shape of print at "near point"
Krumholtz (2000)	Test of relationship between visual error (farsightedness) and reading ability in three public schools in New York City	Hypermetropia/hyperopia were found to be associated with lower levels of reading 25 students were given vision correction (predominantly prescription eyeglasses). Of this sample, 21 (84%) gained over 20 percentage points in their achievement test percentile rank
Kulp (1999)	Correlations between visual acuity and reading test score in a sample	Significant correlation between visual acuity and reading test score

(*Continued*)

Table 1. (*Continued*).

Study	Focus	Findings
	of 53 first-grade students in Cleveland, OH, USA	on the Stanford Reading Test in a sample of 191 children, mean age 7.78 years Significant correlation between Beery VMI score and Stanford Reading Test standardised score ($R = -0.426$)
Vaughn, Maples, and Hoenes (2006)	A study of 91 third-grade, fifth-grade and seventh-grade students in Charleston, AR, USA looking at relationship between reading development and visual errors	Significant inverse correlations were found between academic performance on Stanford Reading Tests and vision symptoms. The worse the vision symptoms, the lower the academic performance in a sample of 44 third-grade students. Individual sub-scales on the Stanford Reading Test revealed negative correlations between the College of Optometrists in Vision Development Quality of Life Outcome Assessment Task Force 30-item questionnaire (COVD-QOL) and academic performance on the test ($R = –0.40$, range –0.41 to –0.51)
Snowdon and Stewart-Brown (1998)	A review of vision problems and reading attainment	Negative correlations were found between exotropia at near and vertical phorias and reading attainment
Stewart-Brown, Haslum, and Butler (1985)	A study of 15,000 children in 21 studies in the United Kingdom looking at relationship between reading development and visual errors	Children with myopia were more likely to be reading at a higher level than their peers Those who failed near-vision tests were significantly likely to be reading at a level below their intelligence level, but results were mixed and conclusions unreliable
Rosner and Rosner (1997)	A study of 782 first-grade through fifth-grade students looking at relationship between reading development and visual errors	Significant higher reading achievement test scores amongst myopic students—effect size against control group = +0.19 Significant lower reading achievement test scores among hyperopic students—effect size against control group = –0.26
Goldstand, Koslowe, and Parush (2005)	A study that compared 46 proficient readers and 25 non-proficient readers from the seventh grade in Jerusalem looking at relationship between reading development and visual errors	Non-proficient readers had lower reading scores and poorer vision screening scores Statistics were reported as significant, but descriptive statistics were not reported, making it not possible to accurately determine effect sizes between the groups

(*Continued*)

Table 1. (*Continued*).

Study	Focus	Findings
Dusek, Pierscionek, and McClelland (2010)	A study of 825 students with reading difficulties and 325 control students with no difficulties aged six to 14 years in Austria looking at relationship between reading development and visual errors	Students with slower reading speeds were more likely to have refractive errors and difficulties with binocular vision Students with a mean refractive error of +3D were slower at reading (effect size = −0.66) and made more error (effect size = –0.65)
Maples (2001)	A study of 1329 students from Iowa looking at relationship between reading development and visual errors	Regression analysis indicated that visual factors were a more significant predictor of student performance than race or socio-economic status Percentage of variance predicted for reading by vision scores (DEM[b] vertical and Beery tests) was 35.8%, whereas 0.5% of variance was predicted by socio-economic status For mathematics, Wold and Beery vision tests predicted 45.9% of grade performance whereas race predicted 2.2% of variance
Williams, Latif, Hannington, and Watkins (2005)	A study of 1298 eight-year-old children in Wales, looking at relationship between reading development and visual errors	12.8% of students were found to have hyperopia as detected by a "fogging test". Of these, 59% had vision correction requirements (+0.75–3D) and 41% had >+3D Students with new diagnoses of hypermetropia/hyperopia and refractive errors of between +1.25D and +3D scored significantly lower scores on national assessments in literacy Effect sizes on reading scores for children diagnosed with refractive errors were as follows: >+3D for both eyes –0.96; >+1.25D in one eye –0.68
Clarke et al. (2003)	A randomised controlled trial of 177 children aged three to five years with mild to moderate unilateral impairment of acuity (6/9 to 6/36) detected by screening	Children with poor acuity (6/36 to 6/18) showed significant positive effects on visual acuity of treatment with glasses only (effect size = 0.61) or glasses and patching (effect size = 1.29)

Notes:[a]D = Dipotre. [b]DEM = Developmental Eye Movement.

Intelligence Quotient, visual memory, visual discrimination, and visual motor integration were associated with poor reading. This finding presents a degree of debate because two of these three areas are not related to visual acuity (Kavale, 1982). Students with hypermetropia/hyperopia (farsightedness) in three public schools in New York City were found to be associated with lower levels of reading. Students with problems

tended to be located in the bottom quartile of reading ability. In this study 25 students were given vision correction (predominantly prescription eyeglasses). Of this sample, 21 (84%) gained over 20 percentage points in their achievement test percentile rank (Krumholtz, 2000).

The American Optometric Association recognises that undetected eye problems will prevent individuals performing to their full academic potential (American Optometric Association, 2008). Vision anomalies reportedly lead to issues of failing to learn to decode letters into sounds. This is principally because the vision anomaly prevents discrimination of letter patterns at near point (Simons, 1993). Use of the Beery Developmental Test of Visual Motor Integration (Beery VMI; which included a section on visual acuity) found a significant correlation between visual acuity and reading test score on the Stanford Reading Test in a sample of 53 first-grade students in Cleveland, OH, USA. However, two issues present themselves when interpreting data from this study. Firstly, this effect was correlational and not causative. Secondly, it is difficult to extract the relative correlational weight that visual acuity had on reading score. The Beery VMI provides data on three aspects of visual motor integration as three subscales. These sub-scales are Visual–Motor Integration, Visual Perception, and Motor Coordination. Data from the study from the Beery VMI were presented as a composite score. Correlations between individual sub-scales and reading test scores were not presented except for the standardised score of the Stanford Reading Test (0.426), which was significant. This made the relative contribution of each sub-scale to the overall correlation with reading score difficult to interpret (Kulp, 1999).

In a study of 91 third-grade, fifth-grade and seventh-grade students in Charleston, AR, USA, significant inverse correlations were found between academic performance on Stanford Reading Tests (a widely used standardised test that assesses vocabulary, comprehension, and scanning skills) and vision symptoms. The worse the vision symptoms, the lower the academic performance. The relationship was strongest for third-grade students and demonstrated a negative significant correlation between better perception of vision and performance on the Stanford Reading Test (mean $R = -0.49$) (Vaughn, Maples, & Hoenes, 2006).

In a review of vision impairment and reading attainment, negative correlations were found between exotropia at near and vertical phorias and reading attainment (Snowdon & Stewart-Brown, 1998). However, the authors also conclude that there is no clear evidence that pre-school children benefit from the correction of minor refractive errors that are common in childhood. There is evidence that children with such minor eye defects often make choices not to wear glasses. They recommend the need for future research to include the use of properly designed randomised controlled trials to allow for the benefits and costs of interventions to be systematically established. In a review of 21 studies that included more than 15,000 UK children, it was reported that those who failed near-vision tests were significantly likely to be reading at a level below that for their intelligence level. However, patterns of attainment were mixed and it was not possible to make strong conclusions and recommendations from the dataset (Stewart-Brown, Haslum, & Butler, 1985).

A study of 782 first-grade through fifth-grade students in Iowa found significant lower reading achievement test scores among hyperopic students whose refractive error exceeded 1.25D. The study reported a negative effect size against a comparison group of –0.26. Conversely myopic students were observed to have higher reading test scores than the comparator group (effect size = +0.19) (Rosner & Rosner, 1997). A study that compared 46 proficient readers and 25 non-proficient readers from the seventh grade in

Jerusalem reported that non-proficient readers had lower reading scores and poorer vision screening scores. Sixty-eight per cent of students had an identified vision problem. It was concluded that vision difficulties should be considered a contributory factor in students with academic difficulties (Goldstand, Koslowe, & Parush, 2005). A study of 825 students with reading difficulties and 325 control students with no difficulties aged six to 14 years old in Austria reported that students with slower reading speeds (effect size = –0.65) and who made more errors (effect size = –0.66) were more likely to have refractive errors (with +3D errors). It was concluded that children with poor reading have higher proportions of visual function anomalies (Dusek, Pierscionek, & McClelland, 2010). In a study of vision and academic performance of 1329 students from Iowa, interesting correlations were found between vision problems and student attainment. Regression analysis indicated that visual factors were a more significant predictor of student performance than race or socio-economic status. In reading, the percentage of variance predicted for reading by vision scores (DEM vertical and Beery tests) was 35.8% whereas 0.5% of variance was predicted by socio-economic status. For mathematics, Wold and Beery vision tests predicted 45.9% of grade performance whereas race predicted 2.2% of variance. There may be an issue of confounding variables in this sample, if, for instance, children from lower socio-economic backgrounds were less likely to have visited an optician or ophthalmology department for screening. However, even with the possibility of error and despite being only from one context and with a limited sample size, this study does raise questions regarding the significant role that vision issues can play in academic performance of school students (Maples, 2001). A study of 1298 eight-year-old children served by Rhondda Cynon Taff Community Paediatric Service, Wales reported that students with new diagnoses of hypermetropia/hyperopia and refractive errors of between +1.25D and +3D scored significantly lower scores on national assessments in literacy (SATs) than comparison groups with no vision problems. Negative effect sizes were reported on reading scores for children diagnosed with hyperopic refractive errors as follows: >+3D for both eyes = –0.96, and >+1.25D in one eye = –0.68. Thirty per cent of this sample had been referred to educational psychology services to investigate their development delay (Williams, Latif, Hannington, & Watkins, 2005).

In summary, the average number of students reported to have an undiagnosed vision impairment and of school age was 22.45%. However, ignoring the Oldfield study (which was not peer reviewed and lacked descriptive statistics), the figure for the three remaining studies was 13.27% (based on three studies of 2443 students). The average effect size on reduced reading ability for children identified as being hyperopic was –0.85 (based on six studies with a total of 3082 children in Grade 7 or below). The mean correlation between standardised reading score and degree of vision impairment was –0.423 based on two studies and 282 students in Grade 7 or below.

The studies reporting correlations between reading performance and vision impairment, however, have not established cause and effect. Whilst it might appear that this relationship implies causality, this is not necessarily the case. These relationships may be relational and directional, but not causal. The lack of certainty regarding the value of screening and prescribing spectacles to school students with low refractive errors makes it ideal for study via a randomised controlled trial. The lack of controlled studies that investigate refractive error and reading was recently noted in a review of reading and vision (Handler & Fierson, 2011). A similar call to arms was made by Ethan and Basch (2008).

Screening, Diagnosis and Treatment

A synopsis of the focus and findings of studies in this section is presented in Table 2. The reasons why students may not have vision impairments diagnosed and treated may be complex. In Scotland, vision screening is undertaken by orthoptists (Scottish Government, 2005a). Vision screening may also take place at a single point in secondary school (although this is not consistent throughout Scotland). Orthoptic assessments are available to all children being assessed for learning difficulties on demand (Scottish Government, 2005b). If a child fails the vision screening tests, a letter is sent home advising them to seek an appointment with an optometrist. There is no process of follow-up to ascertain whether children are subsequently taken for further tests or receive a prescription (Scottish Government, 2010a). This is the point at which it is possible

Table 2. Screening, diagnosis and treatment.

Study	Focus	Findings
Scottish Government (2010b)	A study examining the benefits of pre-school screening for students in Scotland	Unless parents followed up on the results of screening and took their child to an optometrist, there was no benefit to the screening process
Preslan and Novak (1998)	A study examining whether pre-school screening led to follow-up treatment for students in 285 students in Baltimore	Only 30% and 20% of students were in compliance with prescribed treatments one and two years respectively after the screening
ABT Associates (2009)	A study examining whether pre-school screening led to follow-up treatment for students in the USA	Screening led to a 144% increase in successful treatment for amblyopia
Feldman, Milner, Sackett, and Gilbert (1980)	A study examining whether pre-school screening led to follow-up treatment for 763 screened and 743 non-screened kindergarten children in Halton County, ON, Canada	Screened students showed significantly less vision problems and significantly less moderately severe (visual acuity ≤20/50) than the unscreened population; 53% more screened students were wearing glasses
Kemper, Fant, Bruckman, and Clark (2004)	A study examining whether pre-school screening led to follow-up treatment for 2229 children screened during the 2000/01 school year in Michigan	25% of those identified with a visual problem had follow-up treatment
Kimel (2006)	A study of 175 parents of kindergarten through fifth-grade students in Rockford Public School District in Michigan examined the reasons why a diagnosis may not result in treatment of vision problems	Parents reported that they did not have time to take children to an eye-care provider due to both parents working, did not believe the result of the test and did not see vision treatment as a priority
Orfield, Basa, and Yun cited in Marshall, Meetz, and Harmon (2007)	A study to see if screening glasses provision was correlated to enhanced reading performance	Provision of reading glasses and vision therapy correlated with improvements in teacher grades, percentiles, and grade equivalents on standardised tests in reading and mathematics for a school-age population of low socio-economic status (85% free school meals)

for refractive vision problems to go untreated. Without parental involvement, treatment will not be provided even to children in whom refractive errors have been identified. This was confirmed in research undertaken by the Scottish Government. Subsequent follow-up of children who had received a vision screening indicated that, unless parents followed up on the results of screening and took their child to an optometrist, there was no benefit to the screening process (Scottish Government, 2010b). It is recommended that children with visual acuity of less than 20/30 or who have greater than a two-line difference on tests within the passing range (Snellen letters, Tumbling E, Allen figures, LEA symbols)—that is, 10/12.5 and 10/20 or 20/25 and 20/40—should be referred (American Academy of Pediatrics, 2003). In the United Kingdom, poor acuity is defined as a best-corrected acuity of 6/12 (20/40) or worse on crowded letters, or of 6/9 (20/25) or worse on single letters, at age four (Anker, Atkinson, Braddick, Nardini, & Ehrlich, 2004).

Vision screening in schools is often reported to be effective at identifying vision problems. However, subsequent follow-up treatment is reported to be inconsistent. In a sample of 285 students in the Baltimore primary school system that were screened for vision problems, only 30% and 20% of students were in compliance with prescribed treatments one and two years respectively after the screening (Preslan & Novak, 1998). A review of vision screenings by the National Health Service reported that screenings did not result in effective treatments for amblyopia (Stewart-Brown & Snowdon, 1998). However, a US report claimed that a 144% increase in successful treatment for amblyopia could be attained through the use of vision screening programmes (ABT Associates, 2009). Screenings are reported to increase the number of students who wear glasses and can help prevent worsening of vision problems one year post screening. In a sample of 763 screened and 743 non-screened kindergarten children in Halton County, ON, Canada, screened students showed significantly less vision problems and significantly less moderately severe vision (visual acuity 20/50 or worse) than the unscreened population. It was also reported that 53% more screened students were wearing glasses (Feldman, Milner, Sackett, & Gilbert, 1980). In a sample of 2229 children screened during the 2000/01 school year in Michigan, it was found that only 25% of those identified with a visual problem had a follow-up treatment (Kemper, Fant, Bruckman, & Clark, 2004). A study of 175 parents of kindergarten through fifth-grade students in Rockford Public School District in Michigan examined the reasons why a diagnosis may not result in treatment of vision problems. Questionnaires returned from parents of students who had been identified as having a vision problem by a school screening programme and did not receive follow-up treatment established the major factors that parents cited as being the reason for lack of treatment for their children. Parents reported that they did not have time to take children to an eye-care provider due to both parents working, did not believe the result of the test, and did not see vision treatment as a priority. Eighty-five per cent of students who did not receive follow-up treatment were in receipt of free school meals and nearly two-thirds would have received free eye care through the Medicaid scheme (Kimel, 2006). A review of screening studies within the National Health Service found that the benefits of such screening programmes on correction of small refractive problems were debatable (Sheldon, Wilson, Boutle, & Sharp, 1998). It has been reported that an intervention of reading glasses and vision therapy correlated with improvements in teacher grades, percentiles, and grade equivalents on standardised tests in reading and mathematics for a school-age population of low socio-economic status (85% free school meals). However, correlational data do not demonstrate cause and effect. The lack of a cluster-randomised design leaves question marks over the

generalisability of such findings (Orfield, Basa, & Yun cited in Marshall, Meetz, & Harmon, 2007).

A randomised controlled trial into the effects of screening and treatment by glasses and patching of 177 three-year-old to five-year-old children with unilateral vision impairment indicated that treatment of children with moderate impairment (6/9 to 6/36) gave effect sizes of 0.61 and 1.29 on visual acuity measured by ability to read letters and symbols six months following examination (Clarke et al., 2003). These large effects in vision improvement demonstrate the importance of treatment for children with moderate "+" unilateral vision impairment.

Conclusion

Many studies examine the role of testing and treating specific parts of the visual system and the optometric and ophthalmic outcome of such activities. Smaller numbers of studies attempt to link eye health to academic data. In these studies, academic outcomes are often a secondary focus of the research. In the studies that looked at academic outcomes, a large number reported a correlation between refractive (particularly undetected and untreated) vision impairment and lower levels of reading. The average effect size on reduced reading ability for children identified as being hyperopic was –0.85 (based on six studies with a total of 3082 children in Grade 7 or below). The mean correlation between the standardised reading score and degree of vision impairment was –0.423 based on two studies and 282 students in Grade 7 or below. However, very few published studies have looked beyond these correlational effects and tried to establish cause and effect on reading attainment outcomes in the early school years. This pattern was noted by previous researchers, but little has changed in the intervening years. This is mainly due to the fact that academic outcomes were not necessarily considered outcome variables in those studies conducting experimental designs on treatment of refractive errors. This means there is a lack of evidence of causation between refractive errors and poor reading.

Despite the lack of evidence of causation, the literature review does raise the question of how many children who are failing to read in UK schools may be doing so because of poor vision that could be treatable. It is not possible to answer this question on the current evidence base. However, best estimates from the literature are that 13.27% of students in pre-school to Grade 7 may have an undiagnosed and untreated vision impairment that could affect their ability to read and decode letter shapes (based on three studies of 2443 students). What is required is a robust randomised controlled trial that would establish causation between refractive errors and reading development. If causation was established, then the lack of treatment compliance in current screening programmes may be an area where policy and practice may also need review.

It is also imperative that teachers consider the possibility of vision impairment for children who are showing aptitude in other areas of the curriculum but appear unable to learn to read effectively. Teachers can also make adaptations in schools. This can be done by keeping font sizes large (>16 point font) and switching between near-point and board work, and keeping careful observations on students that struggle with either learning situation. It also needs to be borne in mind that as children grow and develop, vision impairment can lessen or increase. Therefore it is incumbent upon all teachers, not just those in the early years of school, to bear in mind vision impairment when addressing learning difficulties.

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