Uncorrected childhood refractive error in the United Kingdom

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Introduction

The World Health Organization (WHO) and the International Association for the Prevention of Blindness (IAPB) jointly developed the ‘Vision2020: the right to sight’ initiative, designed to reduce the prevalence of avoidable causes of visual impairment [1]. Although uncorrected refractive error is reported to be the most common cause of visual impairment in school-age children in industrialised and developing countries [2], until the current study little had been known about the extent of the problem in the United Kingdom. The Northern Ireland Childhood Errors of Refraction (NICER) study is a population based study of refractive error in school children aged 6-7 years and 12-13 years, living in Northern Ireland (NI), a geographically separate region of the United Kingdom (UK). Whilst the primary aim of the NICER study was to describe the prevalence of childhood myopia and its putative risk factors, it also facilitated a robust examination of the issues of uncorrected refractive error in children and children’s compliance with prescribed spectacle wear. The current paper describes the prevalence of visual impairment resulting from uncorrected refractive error in school-children in Northern Ireland and identifies the proportion of children who fail to comply with spectacle wear.

Fig. 1: A display board in a school - the schools actively engaged with the study.

Methods

Working in collaboration with Aston University, England, the NICER study is part of an ongoing investigation of refractive error and vision in school children in the UK.

Children were initially recruited by stratified random cluster sampling of primary and post-primary schools representative of the urban/rural and deprived/non-deprived Northern Irish population [3]. Data are presented from 1067 children examined in NI between May 2006 and March 2008.
Following consent from child and parent/guardian, participants were tested in school during school hours. Parental questionnaires were used to obtain data on familial, environmental and social factors including history of spectacle wear, optometric intervention and socioeconomic status.

Measures taken included:

- assessment of ocular posture
- measurement of monocular LogMAR vision & visual acuity Following cycloplegia (one drop 0.5% proxymetacaine hydrochloride followed by one drop of 1% cyclopentolate hydrochloride):
- keratometry and axial length (Zeiss IOLMaster)
- refractive error (Grand Seiko autorefractor)

**Definitions**

Data from both eyes were used to assign refractive grouping. Spherical equivalent refraction (SER) was defined as the sphere + ½ cylinder. Participants were classified as having:

- myopia (SER ≤ -0.50DS in either eye) [4]
- hyperopia (SER ≥ +2.00DS in either eye, if not previously classified as myopic) [4]
- astigmatism (≥1.00DC in either eye) but not if previously classified as myopic or hyperopic [5]

Participants were also classified according to presence of:

- anisometropia (≥1.00D interocular difference in SER)

Subjects could therefore have been classified as myopic and anisometropic.

Whilst the authors recognise that there is a lack of consensus as to how refractive error should be classified, the above definitions have been based on the Refractive Error Study in Children (RESC) protocol [4] and a consensus from the Refractive Error Working Group of the WHO [5].

Whilst many clinicians would prescribe spectacles, especially for significant levels of hyperopia and astigmatism, where the unaided distance vision is 0.30logMAR or better, for the purposes of this paper the definition of visual impairment employed (worse than 0.30 logMAR) was that recommended by the IAPB for children under the age of 16 years [6]. Visual impairment in either eye was considered.

Economic status was assessed using a Geographical Information Systems approach using the unit postcode address information and the Northern Ireland multiple deprivation measure was applied to assign an area-based rank measure of economic deprivation to each child [7].

![Fig. 2: Even younger children participated fully.](image)

**Statistical Analysis**

All statistical analyses were carried out using Intercooled Stata 11 (Statacorp, Texas, USA). Prevalence estimates with 95% confidence intervals have been adjusted to allow for clustering within schools. Chi squared tests have been used to study gender, economic status (converted to quintiles) and age group differences. Results are considered statistically significant if p<0.05.

**Results**

Participants: Of those invited, 57% (n=398) of 6-7-year-olds (mean age 7.07, 49.5% male) and 60% (n=669) of 12-13-year-olds (mean age 13.1, 50.5% male) participated. Reflective of the Northern
Irish population, 98.7% of participants were white and this paper presents data from 392 white 6-7-year-olds and 661 white 12-13-year-olds.

**Spectacle correction**

Of the 6-7-year-old children, 12.8% (CI 9.0-16.5) gave a history of current spectacle wear. This did not vary significantly with gender ($c^2=2.5$, $p=0.112$) or economic status ($c^2=5.9$, $p=0.206$). Of the children who gave a history of current spectacle wear 24% (12/50; CI 12.3-36) did not have their spectacles at school. Failure to bring their spectacles to school was not related significantly to either gender ($c^2=3.6$, $p=0.058$) or economic status ($c^2=0.98$, $p=0.91$). Of the children with a history of spectacle wear but failure to bring them to school 50% (6/12, CI 20-80) had reduced vision poorer than 0.3 logMAR in either eye.

Of the 12-13-year-old children, 25% (CI 22-28) gave a history of current spectacle wear, statistically significantly higher than in the younger age group ($c^2=23.5$, $p=0.000$). This did not vary significantly with economic status ($c^2=7.2$, $p=0.042$). However boys aged 12-13-years were statistically less likely to have been prescribed spectacles than girls of the same age ($c^2=4.2$, $p=0.042$). There was no statistically significant difference between the two age groups in terms of having their spectacles available at school ($c^2=0.009$, $p=0.925$); with 23% (39/167; CI 16.3-30) of the 12-13-year-olds failing to bring their spectacles to school. Whilst bringing spectacles to school was not related significantly to gender ($c^2=0.003$, $p=0.986$) it was related significantly to economic status ($c^2=13.1$, $p=0.011$) with children in the lowest economic quintile being least likely to bring their spectacles to school. Of the children not bringing their spectacles to school 33.3% (13/39; CI 21-46) had vision poorer than 0.3 logMAR in either eye.

**Uncorrected refractive error**

Table 1 presents refractive error data from the children who did not wear spectacles and who had impaired vision in at least one eye. Uncorrected myopia was the primary cause of impaired vision in 12-13-year-old children who did not have spectacles, compared with 6-7-year-olds where the cause of impaired vision could be attributed equally to hyperopia, myopia and astigmatism.

Of the younger children with no spectacles 2.1% (CI 0.40-3.7) have reduced vision associated with ametropia, compared with 4.1% (CI 2.1-6.0) of the older children.

**Discussion**

There is a low prevalence of reduced distance vision associated with uncorrected refractive error in this population. In Northern Ireland vision screening of children takes place at 4-5-years of age and eye examinations and spectacle provision are provided free of charge under the National Health Service. These data provide evidence that this system is effective in ensuring that children with a refractive error associated with poor vision are being detected. However having good vision at school entry does not guarantee that vision will remain good throughout the school years and as vision screening is not repeated in older children, teachers and parents need to be aware that with...
the increasing prevalence of myopia in later childhood, children should be encouraged to have their eyes examined regularly.

A significant issue in Northern Ireland, is that almost one in four children who had been prescribed a spectacle correction did not bring their spectacles to school and a substantial number of these children were described as visually impaired in at least one eye (50% of 6-7-year-olds; 33% of 12-13-year-olds) without their spectacles. Without evidence to the contrary it seems logical that this may impact upon the children’s educational achievements.

In the older age group children from more economically deprived backgrounds were less likely to bring their spectacles to school. At this age, peer pressure is often considerable and issues such as not being able to afford designer frames and cosmetically enhanced lenses (which are not fully funded by the UK’s National Health Service) may have an impact on compliance. Recently Thomson and Kain [8] have studied teenagers’ attitudes to spectacles and have identified that the major reason for failure to wear prescribed spectacles was due to concerns about appearance. Health promotion activities should be tailored to addressing these concerns and improving compliance and when considering older children, should be targeted at those from more economically deprived backgrounds. Whilst the optometry profession engages in health promotion activities designed to raise awareness of the importance of childhood eye examinations these activities need to be expanded to include events that promote the wearing of prescribed spectacles in childhood.

There is a paucity of information on children’s compliance with spectacle wear throughout Europe, although it is an issue both in rural China where 18% of children (n=1892, mean age 14.7 years) did not wear their spectacles [9] and in America where almost two thirds of children did not comply with the suggested treatment regime (including spectacle wear), [10] suggesting that this problem may not be specific to Northern Irish children. One of the main reasons given in the Chinese study for non-wear of spectacles was the belief they may weaken the eyes [9].

**Conclusion**

In Northern Ireland there is little visual impairment due to uncorrected refractive error but failure to wear prescribed spectacles contributes significantly to the number of school children in Northern Ireland who could be considered as having a visual impairment. Many children who have been prescribed spectacles do not bring them to school and this may have educational implications.

**Further Work**

The NICER study is currently re-testing the original cohort, three years after their initial participation. One aim of this follow-on study is to examine compliance amongst spectacle wearers with increasing age and to evaluate visual status from those with continuing poor compliance, particularly in the younger age group. Further publications from the original NICER data will also explore the ability of logMAR acuity to accurately detect refractive error.

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