Whole-population vision screening in children aged 4–5 years to detect amblyopia

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Amblyopia is a neurodevelopmental disorder that affects at least 2% of most populations and can lead to permanently reduced vision if not detected and treated within a specific period in childhood. Whole-population screening of children younger than 5 years is applied in many countries. The substantial diversity in existing programmes reflects their heterogeneous implementation in the absence of the complete evidence base that is now a pre-requisite for instituting screening. The functional importance of amblyopia at an individual level is unclear as data are scarce, but in view of the high prevalence the population-level effect might be notable. Screening of all children aged 4–5 years (eg, at school entry) confers most benefit and addresses inequity in access to timely treatment. Screening at younger ages is associated with increased risk of false-positive results, and at older ages with poor outcomes for children with moderate to severe amblyopia. We suggest that the real-life adverse effects of amblyopia should be characterised and screening and diagnosis should be standardised.

Introduction

Developmental neuroplasticity starting at birth drives structural and functional changes in the eye and brain during maturation of the visual system. Amblyopia is a neurodevelopmental disorder that arises secondary to disruption of normal processes during this sensitive period. It most commonly arises because of visual blur from defocus (refractive amblyopia), failure to maintain alignment of the eyes (strabismic amblyopia), structural disorders of the eye, such as cataract, that obscure incoming images (form-deprivation amblyopia), or a combination of these features. Both eyes might be affected, but the disorder is predominantly unilateral, and is generally associated with impaired or absent stereoacuity (depth perception).[1,2] Any childhood ocular disorder carries a risk of amblyopia and, therefore, it is the most prevalent disorder managed in paediatric ophthalmology. Standard clinical practice is to implement treatment within the critical period, which is thought to span from infancy to around age 7–9 years, to improve vision and enable development along as normal a vision trajectory as possible.[3]

Visual acuity is the key visual function. WHO and other organisations use acuity in the better eye to classify individuals as non-impaired, visually impaired, severely visually impaired, or blind.[4] Thus, individuals with reduced acuity in one eye, irrespective of severity, are not classified as visually impaired. In the UK, in more than 97% of children with severely reduced vision in both eyes the diagnosis is made early in childhood.[5] Diagnosis frequently arises owing to the concerns of carers and caregivers or in the context of the routine universal Newborn and Infant Physical Examination programme (figure 1) or other disorder-specific screening programmes. As amblyopia is a developmental disorder, affected children may grow up without a comparative visual experience and are likely to be unaware of the poorer vision in the amblyopic eye. Thus, screening at age 4–5 years is primarily aimed at identifying unilateral impaired vision with the aim of beginning intervention early.

In 1995, Snowdon and Stewart-Brown[6] reported a systematic review of childhood vision screening to detect amblyopia that was commissioned by the UK Health Technology Assessment body, which is responsible for independent assessment of effectiveness, costs, and effects of health-care interventions. They showed an absence of good quality research into efficacy of treatments for and disability associated with amblyopia. The conclusion was a recommendation that the UK National Screening Committee, the body responsible for the continuation, modification, or withdrawal of existing population screening programmes, consider whether to discontinue screening.[6] The findings were opposed by the international ophthalmic community, but did lead to a rationalisation of the existing practices in the UK. The findings also led to substantial primary research throughout the world that began to provide information on whole-population childhood vision screening programmes, which exist in most industrialised countries.

We undertook a systematic review of the evidence on childhood vision screening to detect amblyopia (figure 2, appendix pp 1–3). Here we summarise our findings, focusing on the fundamental public health issues—the appropriateness and effectiveness of universal childhood

Search strategy and selection criteria

We searched Medline, Embase, PsychINFO, and the Cochrane library for papers published between January, 1995, and December, 2013 (appendix pp 1–2). We used the search terms "randomised control trial", "cohort", "case-control or longitudinal', "child or preschool", "amblyopia", "strabismus", "squint", "hypermetropia or myopia or anisometropia", "screening", and "prevalence or surveillance". Systematic reviews, randomised, controlled trials, and population-based observational studies were prioritised. Studies that were identified from the reference lists of selected papers but that had not been identified by the search were included. We excluded narrative reviews, conference abstracts, and non-English publications.

See Online for appendix

vision screening and the effectiveness of treatments for amblyopia.[7] For brevity we do not report on factors such as screening for risk factors or other conditions that might predispose to amblyopia or on screening thresholds. Similarly, we do not discuss other screening programmes, such as neonatal and infant programmes to detect major eye anomalies or screening of preterm children for retinopathy of prematurity, or best practice clinical surveillance of children at increased risk of ophthalmic disorders, such as those with hearing impairment or neurodevelopmental disorders.

Definitions and prevalence of amblyopia

Vision matures owing to structural and functional development of the eyes and visual pathways in early childhood. By definition, vision of 0·0 logMAR (6/6 Snellen) is taken to be normal adult acuity. Neonates have an average acuity worse than 1·0 logMAR (6/60), which improves to near adult levels by age 5–6 years.[8] As there is no internationally agreed definition or vision threshold for amblyopia, reported prevalence varies (tables 1, 2). This variation is compounded by substantial heterogeneity in study methods and characteristics of study populations, especially with respect to age and ethnic origin of participants (figure 3), with the latter in particular resulting in small subgroup sample sizes,[13–16,18] and the existence or absence of a screening programme. Among white children the prevalence of amblyopia at age 4–5 years was estimated in two studies to be 2·5%,[16,18] with an overall age-standardised estimate for children younger than 6 years of 1·9%.[14,15] These rates fall below the 4·0% population prevalence threshold for screening advocated by WHO, although, overall international prevalence estimates range from 1·0% to 5·0% (tables 1, 2). These differences make formal comparison difficult and preclude meaningful meta-analysis.

Data for the UK from the Avon Longitudinal Study of Parents and Carers (ALSPAC)[34] indicate a prevalence of 3·6% (95% CI 3·3–4·1) among children aged 7 years when the definition of amblyopia as vision worse than 0·2 logMAR (6/9·5 Snellen), an interocular difference of at least 0·2 logMAR (equivalent to 2·0 lines on a logMAR chart), or normal vision at age 7 years with a history of treatment for amblyopia is used. This estimate is higher than those derived from most studies based on national census records and using the same definition of amblyopia, which report an average prevalence of roughly 2·0%.[13,14,16,35]

Effects of amblyopia

Impaired vision in both eyes is recognised as having substantial effects on development, health, and quality of life, but the Health Technology Assessment body report by Snowdon and Stewart-Brown[6] found no robust evidence of disability in individuals with unilateral amblyopia. Research has since been directed at understanding the effects of reduced vision in one eye. Inconsistent associations have been made between unilaterally reduced vision in adulthood and impairment of mental health, general health, social functioning, and general quality of life in large population-based studies in industrialised countries.[36,37] All

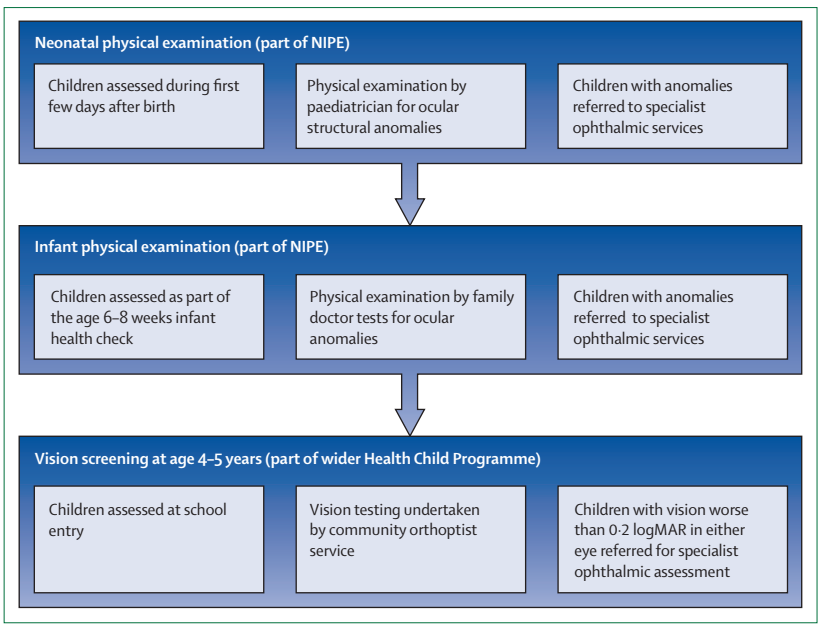

***Figure 1*: Framework of UK childhood whole-population eye and vision screening programmes**
NIPE=Newborn and Infant Physical Examination Programme.

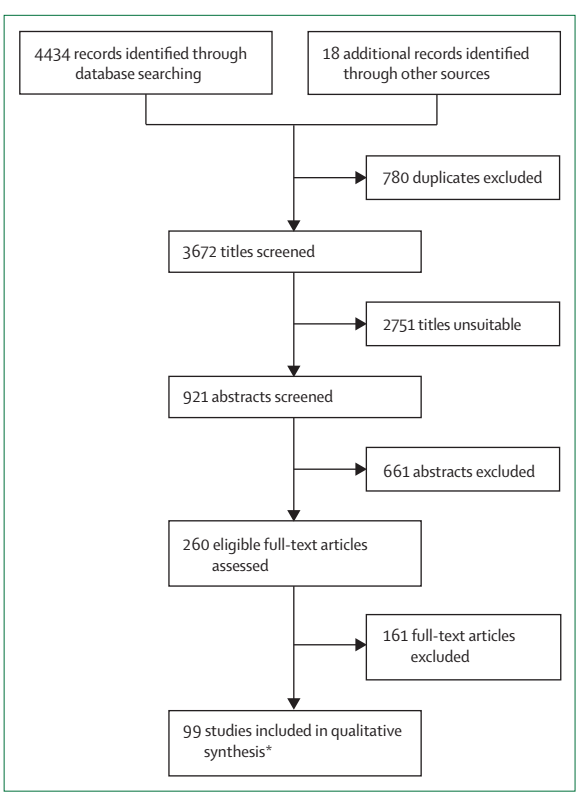

***Figure 2*: Literature search**
*Based on Centre of Evidence Based Medicine criteria.