Institution: Ulster University

Unit of Assessment: Allied Health Professions, Dentistry, Nursing and Pharmacy (3)

Title of case study: ICS-4 Modernising Eyecare Practice in the Identification and Management of Childhood Myopia (Short-sight)

Period when the underpinning research was undertaken: Jan 2005 - Dec 2020

Details of staff conducting the underpinning research from the submitting unit:

Name(s):	Role(s) (e.g. job title):	Period(s) employed by submitting HEI:
Kathryn J Saunders	Professor	1998–present
Julie F McClelland	Senior Lecturer	2004–present
Karen MM Breslin	Lecturer	2000–present
Sara J McCullough	Lecturer	2012–present
Lesley A Doyle	Post-doctoral researcher	2015–present
Lisa O'Donoghue	Lecturer	2000–2015

Period when the claimed impact occurred: 1st August 2013 – 31st December 2020

Is this case study continued from a case study submitted in 2014? N

1. Summary of the impact

The prevalence of myopia (short-sight) is increasing, and the World Health Organisation (WHO) has recognised myopia and myopia-related eye disease as a serious public health concern. Evidence to support eyecare clinicians in the identification and management of myopia in white children was lacking as previous research focused on East Asian populations. By developing an evidence base that fills this significant gap, research at Ulster has improved eyecare practitioners' understanding of childhood myopia (**I1**), and Ulster's research findings have contributed to the modernisation of clinical practice in myopia diagnosis and management nationally and internationally (**I2**). The NHS website (previously NHS Choices) and other sources of public health information have updated their guidance to reflect our findings, and the International Myopia Institute, an industry-funded think tank, use our data to support the global drive to address the increasing visual health challenges posed by myopia (**I3**).

2. Underpinning research

Myopia is an increasingly common sight-threatening condition which arises when a mismatch occurs between eye size and optical power, resulting in blurred vision. In addition to the optical burden conferred by myopia, the excessive eye growth that characterises it is associated with increased risk of sight-threatening pathology. Myopia is predicted to affect half the world's population by 2050, imposing severe economic and health costs on individuals and society.

Up-to-date population-specific data are essential to characterise this important condition, and to ensure that detection, management and treatment paradigms are population-appropriate. With funding from the College of Optometrists and led by Professor Saunders our team's landmark research, the prospective Northern Ireland Childhood Errors of Refraction (NICER) study, addressed a significant knowledge gap relating to the profile of myopia in white children. The outcomes (including **R1-R6**) constitute the only robust contemporary data on myopia prevalence, onset, progression and risk factors for white UK children.

Between 2006 and 2008, a population-based, representative sample of over 1,000 school children aged 6-7 and 12-13 years was identified and recruited using stratified random cluster sampling. Established methodologies (aligned with international best practice) were applied to determine prevalence and magnitude of refractive error, including myopia. The study established that nearly 1 in 5 (17.7%) 12-13-year-old children were myopic at this time-point (**R1**). Heredity also has an important role in myopia development: the NICER study quantified this risk factor, determining that when both parents are myopic, white UK children are almost 8 times more likely

to develop myopia by 12-13 years of age (**R2**). Furthermore, the study identified higher academic attainment and more sedentary lifestyles as significant contributors to increased risk for myopia in this population. Our comparison of data from white children living in Australia with data from white children living in the UK demonstrated that white UK children are 3 times more likely than their Australian peers to be myopic in their early teens (**R3**). This disparity in ethnically similar but geographically disparate populations helped to establish the importance of environment, climate and culture in the development of myopia, further reinforcing the need for population-specific data to inform clinical protocols.

In subsequent studies we re-examined the visual and refractive status of NICER participants through childhood and early adulthood (2009-17), tracking eye growth and myopia incidence and progression 3, 6 and 9 years after initial baseline measures (**R4-R6**). Analysis of these unique prospective population-based data demonstrated for the first time that UK myopia prevalence has more than doubled among white school-aged children since the last data published in 1961 (7.2% vs 16.4%) (**R4**). This significant and rapid increase in prevalence provides further evidence that the recent myopia 'epidemic' cannot be attributed solely to genetics and that environmental factors are significant contributors.

We also made important discoveries about the development of myopia: UK children are becoming myopic at a younger age than in previous generations **(R4)** and childhood myopia now progresses more rapidly than was reported in the mid-20th Century **(R5)**. Our prospective data illustrate that eye growth and myopia progression are significantly faster between 6 and 9 years than they are between 12 and 15 years of age **(R5)**, evidencing that delay in onset of myopia is a key goal for restricting the negative impact of myopia. This finding challenges the traditional view that myopia typically manifests during teenage years. The 9-year prospective data (**R6**) were used to model the trajectory of eye growth and refractive change for UK children and young adults and further refined previously delineated myopia risk factors (refractive error, heredity, eye size). From these data, we developed novel percentile curves generated for eye size, which demonstrated that eye growth profiles which fail to respect centile boundaries are predictive of future myopia. This unique dataset characterising myopia progression and eye growth in a non-clinical cohort is an essential element of the global myopia evidence base, enabling rigorous stratification of myopia risk and informing clinical protocols and management, and policy and guidance for patients and professionals.

3. References to the research

All outputs have been subject to peer review and overseen by international editorial boards as part of the publication process.

R1. O'Donoghue L, McClelland JF, Logan NS, Rudnicka AR, Owen CG and Saunders KJ (2010) Refractive error and visual impairment in school children in Northern Ireland. *British Journal of Ophthalmology*, 94(9):1155–1159. doi: 10.1136/bjo.2009.176040.

R2. O'Donoghue L, Kapetanankis VV, McClelland JF, Logan NS, Owen CG, Saunders KJ and Rudnicka AR. (2015) Risk Factors for Childhood Myopia: Findings from the NICER Study. *Investigative Ophthalmology & Visual Science*, 5;56(3):1524–30. doi: 10.1167/iovs.14-15549.

R3. French AN, O'Donoghue L, Morgan IG, Saunders KJ, Mitchell P and Rose KA (2012) Comparison of Refraction and Ocular Biometry in European Caucasian Children Living in Northern Ireland and Sydney, Australia. *Investigative Ophthalmology and Visual Science*, 53(7):4021–4031. doi: 10.1167/iovs.12-9556.

R4. McCullough SJ, O'Donoghue L and Saunders KJ (2016) Six Year Change among White Children and Young Adults: Evidence for Significant Increase in Myopia among White UK Children. *PLoS One*, Jan 19;11(1):e0146332. doi: 10.1371/journal.pone.0146332.

R5. Breslin KMM, O'Donoghue L and Saunders KJ (2013) A prospective study of spherical refractive error and ocular components among Northern Irish schoolchildren (The NICER Study). *Investigative Ophthalmology & Visual Science*, 54:4843–4850. DOI:10.1167/iovs.13-11813.

R6. McCullough SJ, Adamson G, Breslin KMM, McClelland JF, Doyle L and Saunders KJ (2020) Axial growth and refractive change in white European children and young adults: predictive factors for myopia. *Scientific Reports*, 10(1);15189 DOI: 10.1038/s41598-020-72240-y. PMID: 32938970; PMCID: PMC7494927.

The Northern Ireland Childhood Errors of Refraction (NICER) study	College of Optometrists	Saunders	GBP48,030	2005-2008
The Northern Ireland Childhood Errors of Refraction (NICER) study Phase 2	College of Optometrists	Saunders, McClelland, O'Donoghue	GBP50,466	2009-2012
The Northern Ireland Childhood Errors of Refraction (NICER) study Phase 3	College of Optometrists	Saunders, McClelland, O'Donoghue	GBP107,144	2013-2016
The Northern Ireland Childhood Errors of Refraction (NICER) study Phase 4	College of Optometrists	Saunders, O'Donoghue, McCullough	GBP149,935	2017-2021

4. Details of the impact

Significance and Reach: Our research profiling myopia in white children has been instrumental in the establishment of myopia as a serious pan-ethnic public health concern and has directly influenced clinical practice, public health information and the global industry response to this significant public health concern.

I1: Clinicians' Knowledge of Myopia is Enhanced

Our research has updated and deepened eyecare practitioners' knowledge of myopia, enabling them to deliver more targeted and timely care. The UK's leading optometric professional organisations, the College of Optometrists and the Association of Optometrists (AOP), have recognised the fundamental shift in clinical best-practice and patient expectation in relation to myopia. In response, they have produced a range of resources utilising NICER study outcomes (**R1, R2, R4**) to increase eyecare practitioners' understanding of childhood myopia and to improve their proactive detection and management of the condition (**C1, C2**).

NICER-informed resources published by the College of Optometrists have reached over 12,000 optometrists (number of GOC-registered optometrists in UK=14,000) (**C1**). The AOP, the UK's premier membership association for optical providers, which provides legal representation for over 80% of UK optometrists, has disseminated NICER findings to over 7,000 optical practices through professional guidance and a family-focused children's eyecare resource pack (**C2**). Professional bodies and optical industries worldwide have responded to the clinical implications of NICER study outcomes by inviting our team to inform thousands of eyecare providers at national and international clinical training events (including in China and North America, and across Europe) and through articles in professional journals (**C3**).

This activity has demonstrably improved professional knowledge: the proportion of UK and Irish optometrists surveyed who correctly recognised the growing prevalence of myopia substantially increased from 66% (2015) to 89.5% (2018) and, importantly, the proportion of respondents affirming the earlier age of onset of myopia in modern children also increased (from 40.9% to 64.4%) (**C4**). Enhanced knowledge of the prevalence, expected age of onset and risk factors associated with modern myopia equips clinicians to target children at increased risk more accurately, resulting in earlier detection and treatment. Prompt detection and correction of myopia improves educational as well as visual outcomes and offers more opportunity to apply anti-myopia treatments.

I2: Management of Myopia in Clinical Practice is Modernised

Through the application of our research by professional organisations and industry, eyecare practitioners are better placed to proactively identify and manage myopia for the benefit of

patients. Driven by growing evidence (including **R4**) supporting the need for myopia-retarding interventions such as anti-myopia eye drops, contact lenses and spectacles, the College of Optometrists introduced 'Myopia Management Guidance for Optometrists' in 2019 (**C5**). NICER study outcomes (**R6**) are continuing to inform the further refinement of this guidance. Outcomes from the NICER study (**R4**) were also used to set new recommendations for the frequency with which children with, or at risk for, myopia should have an eye test during revision of the College of Optometrists' Guidance for Professional Practice (2019-20) (**C5**). This national Guidance is a key resource for optometrists in all clinical settings. It describes what constitutes good practice and supports practitioners in clinical decision-making.

CooperVision, one of the world's largest contact lens companies, has used our research to drive the clinical imperative for practitioners to prescribe myopia-slowing interventions, using NICER outcomes **(R4)** in its promotional and instructional material for the anti-myopia MiSight® contact lens. Since launching in the UK, MiSight® uptake has been rapid: over 300 optometric practices have prescribed MiSight® to over 3,000 UK children since 2017. Worldwide, over 17,000 children have benefited (**C6**).

I3: Public Health Resources are Updated to Reflect NICER Study Findings and NICER Study Data Support the Drive to Address the Global Myopia Challenge

NICER study data have been used to educate and empower patients and the public with guidance on modern myopia, its development profile and the risk factors with which it is associated. In 2018, the NHS website (previously NHS Choices), which is accessed by over 50,000,000 users a year, updated its advice on the age of onset of childhood myopia to reflect our research findings (**C7; R4**). The College of Optometrists' 'Look After Your Eyes' website uses our outcomes to inform parents about the increase in prevalence and earlier age-onset of modern childhood myopia (**C8; R1, R4, R5**). The extensive coverage of our research (**R1-R4**) in print and broadcast media including The Times, BBC1's 'Health: Truth or Scare' and BBC Radio 5Live, has reached over nine million individuals (**C3**).

The global reach of our research is evidenced in the optical industry's response to the identification of myopia as a significant worldwide public health concern. Following a meeting of the World Health Organisation and the Brien Holden Vision Institute in 2015, the International Myopia Institute (IMI) was formed, bringing together an international consortium of experts to address the worldwide challenge posed by myopia. The IMI uses our data (**R4**) to illustrate global myopia prevalence and to call for safe and effective solutions to the modern myopia epidemic (**C9**). In 2019 the IMI included our research (**R2, R4, R5**) in a landmark series of agenda-setting 'White Papers' (**C10**) from which clinical summaries have been developed and translated into many languages. These resources include the most up-to-date information on myopia classification and patient management and are aimed at eyecare practitioners, governments, policy makers, educators and the general public.

5. Sources to corroborate the impact

C1. The College of Optometrists' member resources: 'NICER study findings on myopia' (2016), 'Focus on Myopia' (2018), 'Turning the Tide' (2019). Evidence for number of members of the College of Optometrists and total number of UK optometrists.

C2. The Association of Optometrists professional and public resources: 'Guidance on Juvenile Myopia Control' (2018), **'**Children's Eye Health – A Guide for Every Family' (2018); ECOO Blue Book 2020.

C3. Media and clinical training reach material (2013-2020). The media includes, The Times (24.04.15), BBC1 (25.04.17 and iPlayer), BBC Radio 5Live (23.01.16), The Telegraph (20.07.15), The Sunday Times (18.09.16), The Daily Mail (21.01.16, 02.09.13), The Daily Mirror (21.01.16), The FT (12.10.16), The Guardian (25.09.18).

C4. Survey analysis indicating optometrists' knowledge about myopia has been updated (2015-2018) through targeted dissemination of NICER study outcomes.

C5. College of Optometrists Guidance for Professional Practice revised and new myopia-specific clinical guidance for professional practice issued: 'Myopia Management: Guidance for Optometrists' (2019) and 'Guidance for Professional Practice: Frequency of Eye Examinations' (revision period 2019-2020).

C6. Coopervision MiSight® website and LinkedIn material evidencing reach and use of NICER.

C7. NHS website 2018 updated public health advice regarding the age of onset of myopia. Pre- and post-2018 versions and data analytics for page views of new site.

C8. The College of Optometrists' 'A Short Guide To Your Child's Eyes' from its award-winning public-facing website 'Look After Your Eyes', which uses NICER study outcomes to advise and inform parents.

C9. International Myopia Institute (IMI) website. Formed in 2016 under the impetus of the WHO declaration of myopia as a significant public health concern, the IMI uses NICER study data to illustrate the global scale of the myopia problem.

C10. IMI research-derived resources that use NICER study outputs: 'Clinical Management Guidelines Report' and 'Defining and Classifying Myopia: A Proposed Set of Standards for Clinical and Epidemiologic Studies'.