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Exemplifying practice-based research: the influence of age on myopia progression

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ABSTRACT

Clinical relevance: The electronic storage of patient records and modern-day search engines present private practitioners with a unique opportunity to extract valuable data for investigative research purposes. However, practitioners seldom harness this resource and consequently a vast repository of clinical data remains largely unexplored.

Background: This study, based on real-world data from an optometric practice, stands as an example of how clinicians can actively contribute to research. In doing so it underscores the role played by age in determining the rate of natural myopia progression.

Methods: A retrospective data analysis of the refractive status, age and optical correction type of participants, was conducted over six years. Forty-four participants were recruited (25 contact lens and 19 spectacle wearers), with a presenting age varying from 5 to 20 years (median, 11 years). Non-cycloplegic, monocular foveal refractions were completed using a ShinNippon open-field autorefractor, corroborated with subjective refraction. The mean spherical equivalent refractive error was calculated for the participants' initial visit (baseline measure) and for a six-year follow-up visit (progression measure), with myopia progression defined as the difference between these measures. Statistical analyses were computed using Decision Tree Analysis, with a significance level set at 95%.

Results: The participant age at first visit exerted a significant influence on natural myopia progression over the assessment period (F 1,42 = 17.11, $p < 0.001$). Individuals aged ≤ 10 years had approximately twice the myopic progression (mean, −2.27 D) of those aged > 10 years (mean, −1.13 D). Neither degree of myopia at the initial visit nor optical correction type had a significant effect on progression ($p > 0.05$).

Conclusions: Utilizing the advantage of small real-world data samples, the benefit of research by private practitioners was demonstrated, providing evidence that the age at which a child first presents for an eye examination is highly influential in determining their rate of myopia progression.

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Introduction

Evidence-based practice is a fundamental principle in healthcare, requiring the incorporation of the best available research evidence by all stakeholders to ensure high-quality patient care. Within the healthcare domain, including optometry, there is an expanding opportunity for more research activities rooted in clinical practice due to increased collaboration among stakeholders.[1] However, despite the promising capabilities offered by electronic clinical data storage and advanced software algorithms for data retrieval and analysis, it is noteworthy that community optometrists rarely engage in such research endeavours. Leveraging the reservoir of clinical optometric data has the potential to advance the optometry profession, enhance the reputation of optometrists within their communities and, most importantly, elevate the standard of patient care.

A key objective in this study was to illustrate that clinicians working in community practice can actively contribute to research. To achieve this, the authors focussed on the critical area of myopia, aiming to deepen the understanding of the factors influencing its progression.

Commonly reported risk factors for developing myopia include genetics,[2,3] ethnicity,[1] gender,[4] prolonged near work,[5,6] low levels of hyperopia in young children,[7] insufficient outdoor time,[8,9] and peripheral hyperopic blur.[10–16] In addition, the age of myopia onset and the duration of its progression have gained significant attention as risk factors for high myopia. Evidence for age as a significant factor has been derived from extensive studies involving hundreds or even thousands of participants, including longitudinal cohort studies,[17–20] meta-analyses and retrospective analyses.[21–23]

In this paper, data from a single optometric practice was utilized to assess whether age has a clinically significant influence on the rate of natural myopia progression in children and young adults. While large sample studies are essential for addressing highly variable outcomes or detecting small effect sizes, this study capitalises on the potential for a small sample study to yield statistically and clinically significant results when dealing with a relatively large effect.

To assess the impact of age on myopia progression, accounting for the possible influence of optical correction type (conventional spectacles or contact lenses) and the initial recorded degree of myopia, a longitudinal retrospective analysis of the central refractive status of each participant was conducted over a six-year period. In its design, this communication underscores the advantage of practice-based research in using small data sets to reach valid clinical conclusions.

Methods

Research ethics

A retrospective review of the first author's (DB) clinical optometric records in the Optometry Department at Rambam

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Hospital, Haifa, Israel, was completed to identify participants for potential inclusion in the study. Age-appropriate individuals were discounted if they had any ocular condition that could affect refractive development (e.g. pterygium, post-operative refractive surgery, corneal disorders, cataract).

This research was reviewed by an independent ethical review board and conforms with the principles and applicable guidelines for the protection of human subjects in biomedical research. The study adhered to the tenets of the Declaration of Helsinki and was approved by the Health and Life Sciences Research Ethics Committee at Aston University (document #1225) and the Rambam Hospital Ethical Committee (document #0421–17-RMB). Participants, or their parent/guardian if the participant was under 18 years of age, gave informed consent for the use of their clinical data following a full explanation of the study via telephone.

Procedure

All participants agreeing to the use of their data were either myopic single vision contact lens wearers or single vision spectacle wearers, all had good general and ocular long-term health, all were patients of the first author, and all had follow-up refractive error measures spanning a minimum of six years after their initial visit. A total of 44 participants were recruited (25 contact lens wearers; 19 spectacle wearers). The age at which participants first presented at the optometry clinic for an eye exam varied from 5 to 20 years (whole cohort median = 11 years; contact lens group median = 11 years; spectacle wearers group median = 8 years).

The contact lens wearers were chosen from a cohort of patients wearing CooperVision Frequency 55 Aspheric (Methafilcon A) monthly disposable soft contact lenses, and who wore their contacts for a minimum of six days per week. The spectacles wearers were all fitted with single vision, standard plastic (CR-39) lenses.

All refractive data were acquired using a ShinNippon Vision K5001 open-field autorefractor, corroborated with standard objective hand-held retinoscopy and subjective refraction. All refractions were completed without cycloplegia using monocular viewing. The mean spherical equivalent (MSE) refractive error for central vision was calculated for the initial visit of the participant (baseline measure, BM) and for their six-year follow-up visit (progression measure, PM). Myopia progression was determined as the difference between the baseline and progression measures. In using mean spherical equivalent (MSE) measures of refractive error, the upper limit of acceptable cylindrical error was set at 3 D. For the whole cohort of 44 participants, the mean cylindrical error was 0.50 D (SD = 0.74 D).

The dependent variable was the change in degree of myopia (dioptres) over a period of six years. The independent variables were the age (years) at which participants first presented at the clinic of DB for an eye exam ('presentation age', baseline measure), the measured myopic refractive error at baseline (dioptres), and the optical correction type worn by participants (conventional single vision contact lenses or spectacles). These influencing variables were extracted from records at the first eye examination, and cases were then selected based on which individuals had a six-year follow-up appointment.

Statistical analyses

Decision Tree Analysis (DTA) was carried out using IBM SPSS Statistics software version 28.0.1 (SPSS, Inc, Chicago, IL) and findings were tested for statistical significance at the 95% level ($p < 0.05$). The mean spherical equivalent (MSE) refractive data for the right and left eyes of participants were highly correlated (Pearson correlation coefficient ($r(42) = 0.92$, $p < 0.001$), and as a consequence only the right eye results are presented. DTA adopts a hierarchical output, where the independent variables (i.e. presentation age, baseline level of myopia, optical correction type) are shown in order of the strength of their association with the dependent variable (i.e. myopic progression over six years). This is a form of multivariate analysis that removes confounding factors between the independent variables entered before showing the remaining associations in hierarchical order (i.e. the most and least influential variables appear at the top and bottom of the tree, respectively, with irrelevant variables removed altogether).

Discretization (i.e. splitting of variables into groups) of independent variables occurs automatically and branches only form for statistically significant associations. The Chi-squared Automatic Interaction Detection (CHAID) tree-growing method was adopted, which builds decision trees using chi-square statistics to identify optimal splits.

The minimum sample size for parent and child nodes was set at six and three, respectively. The maximum tree branching levels was arbitrarily set to 10 to ensure maximum tree growth was achieved.

Results

In Table 1, the refractive error (mean spherical equivalent, dioptres) is shown for both the baseline measure (BM) of myopia and the six-year natural progression measure (progression measure, PM). Results are shown for both contact lens wearers (CL) and spectacle wearers (S). For the whole cohort ($n = 44$), the median value of myopia at baseline (−1.50 D) doubled after six years of progression.

For contact lens wearers, the median increased from −1.50 D at baseline to −2.75 D after six years of progression; for spectacle wearers, the median increased from −1.25 D at baseline to −2.75 D after six years. Figure 1 shows, for the whole cohort, the extent of myopic progression of each participant (mean spherical equivalent, MSE, dioptres) plotted against their recorded age (years) at baseline. Note the clear downward trend in the degree of myopic progression with increasing age.

The results of the decision tree analysis are shown in Figure 2. The decision tree shows which of the independent variables (i.e. presentation age, baseline myopia, and optical correction type) were associated with the dependent variable (i.e. myopic progression over six years). The root node (node 0) of this decision tree shows the typical six-year myopic progression (mean = −1.65 D, standard deviation = 1.07 D) for all 44 cases. Note that neither the baseline degree of myopia nor optical correction type (conventional spectacles or contact lenses) had any significant effect on myopic progression over the six-year assessment period.

The independent variable of presentation age, however, exerted a statistically significant influence on progression

Table 1. Myopia progression data for 44 participants. Mean spherical equivalent (MSE) in dioptres (D) of foveal refractive error for baseline measure (BM) of myopia and the six-year follow-up progression measure (PM) for both contact lens wearers ($n = 25$) and spectacle wearers ($n = 19$). Other abbreviations: participant number (#); type of optical correction (OC: S = spectacles, CL = contact lenses); presentation age (age, years).

PN	OC	Age (yrs)	BM (D)	PM (D)
1	CL	7	−1.00	−3.00
2	S	8	−0.50	−2.75
3	S	7	−1.50	−6.50
4	CL	8	−3.75	−4.25
5	CL	14	−0.25	−1.50
6	CL	12	−1.50	−2.00
7	CL	9	−0.75	−3.63
8	S	11	−0.50	−1.00
9	CL	14	−4.75	−6.00
10	S	15	−0.25	−0.38
11	S	12	−0.75	−1.25
12	CL	6	−2.00	−4.75
13	CL	8	−3.00	−6.00
14	S	7	−2.00	−3.75
15	CL	11	−0.50	−1.75
16	CL	16	−4.13	−6.50
17	S	9	−1.75	−2.75
18	CL	11	−0.50	−2.00
19	CL	10	−1.75	−3.25
20	CL	14	−1.50	−2.50
21	S	8	−1.25	−3.00
22	S	5	−2.00	−3.25
23	S	7	−1.25	−5.75
24	CL	11	−1.00	−1.50
25	S	18	−2.00	−2.75
26	CL	12	−0.50	−2.75
27	CL	8	−2.75	−6.38
28	CL	13	−1.50	−3.00
29	CL	11	−2.50	−3.50
30	S	12	−1.50	−2.00
31	CL	13	−1.00	−2.00
32	CL	17	−2.00	−3.13
33	CL	11	−0.25	−1.50
34	CL	11	−1.13	−2.63
35	S	7	−2.50	−4.00
36	CL	20	−4.00	−4.13
37	CL	10	−3.50	−6.50
38	S	11	−1.00	−2.75
39	CL	10	−1.75	−2.75
40	S	14	−5.25	−7.50
41	S	8	−1.13	−3.75
42	S	7	−2.00	−4.00
43	S	5	−1.00	−2.50
44	S	11	−1.25	−2.50
Median		11 yrs	−1.50 D	−3.00 D

(F 1,42 = 17.11, $p < 0.001$). Automatic discretisation of age led to node 1 for presentation ages of 10 years or less, and node 2 for presentation ages above 10 years. Cases aged 10 years or less typically had approximately twice the myopic progression (mean = −2.27 D, SD = 1.17 D) compared with those aged over 10 years (mean = −1.13 D, SD = 0.63 D).

Discussion

One of the primary goals of this study was to demonstrate that clinicians in community practice can make meaningful contributions to research. To accomplish this, efforts were concentrated on investigating myopia with the aim of enhancing comprehension of the factors that affect its development over time. Specifically, real-world data from a single optometric practice was used to determine whether presentation age has a clinically significant influence on myopia progression in children and young adults.

Completing a small sample ($n = 44$) retrospective study with independent variables of presentation age, initial degree of myopia and optical correction type, decision tree analysis showed that only age exerts a statistically significant influence on myopia progression ($p < 0.001$, Figure 2). Importantly, this finding aligns with the results of several large sample studies that have reported a substantial influence of the age of myopia onset on the magnitude of myopia in later childhood.[17–20,22]

The optometric data base employed, although an extensive data set, necessarily placed a legitimate resource constraint on the amount of data that could be collected. That significant results were obtained using a small sample of cases demonstrates just how great an influence presentation age is on myopia progression.

In contrast, neither the initial degree of myopia nor the type of optical correction worn (conventional single vision spectacles or contact lenses) had any significant influence on myopia progression ($p > 0.05$), though it is accepted that larger sample sizes may show progression to be influenced by these variables. Marsh-Tootle et al.[24] for example, reported a small but not clinically significant difference in myopic

Figure 1. Degree of myopic progression over six years (dioptres) as a function of presentation age (years) for 44 participants. Myopia progression was determined as the difference between a participant's baseline (i.e. initial visit) mean spherical equivalent (MSE) myopic error and their mean spherical equivalent error at a six-year follow-up visit.

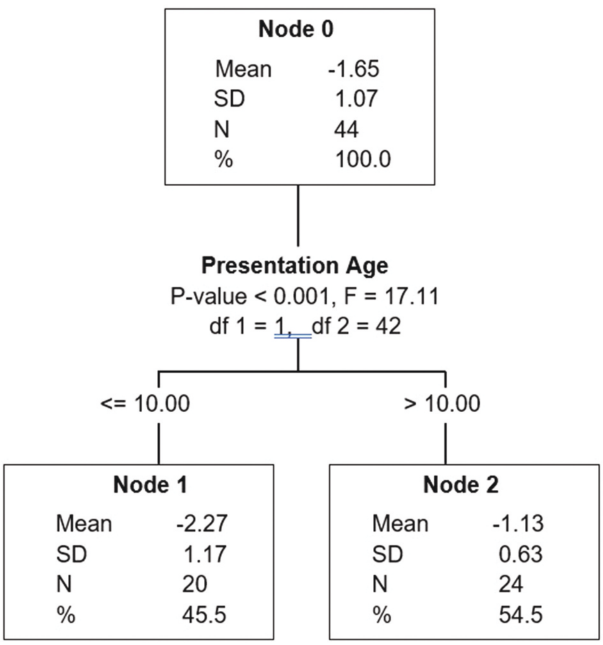

Figure 2. Decision tree showing significant ($p < 0.05$) associations between the six-year natural myopia progression data (from table 1) and the independent variables of presentation age, baseline degree of myopia and optical correction type. Node 0 (root node) shows that myopic progression was found in 100% of cases ($n = 44$), with a six-year progression of – 1.65 D. The only association with myopia progression was with the independent variable of presentation age. First branching level leads to nodes 1 and 2 ($p < 0.001$), showing 45.5% (20 cases) aged ≤10 years have a progression of – 2.27 D (node 1), while 54.5% (24 cases) aged >10 years have a progression of – 1.13 D.

progression between conventional contact lens wearers and spectacle wearers.

Decision tree analysis revealed a noteworthy insight: individuals aged 10 years or younger experienced approximately twice the myopic progression (mean = −2.27 D) over a six-year period compared to those aged over 10 years (mean = −1.13 D). This finding stands out as a significant achievement for a small-sample study conducted in community practice as it mirrors the results of two recent studies[20,22] that involved many hundreds of participants.

Collectively, these findings emphasise the clinical importance of early myopia detection and can potentially guide parental decisions regarding appropriate intervention strategies to slow down myopia progression, such as multi-focal contact lenses or orthokeratology. With this knowledge in hand, parents of myopic children, especially those under 10 years of age, may be more inclined to consider myopia control treatments as a viable option.

The six-year retrospective data collection – completed by early 2021 – coincided with a period when myopia management was not widely offered by eye-care practitioners.[25] However, with the current global availability of effective myopia control strategies, ophthalmic prescribing practices are rapidly changing. Bullimore et al.[26] argue that this creates challenges for any prospective myopia study in terms of formulating a suitable control group and suggests, among other things, the use of historical controls. The current study contributes to control group evidence, providing useful data for natural myopia progression rates in children using standard vision correction, informing virtual control groups for future studies.

In summary, it is important to acknowledge the evolving landscape of healthcare research and the expanding potential for practice-based research activities in optometry through enhanced collaboration among stakeholders.[1] This study demonstrates the power of partnership between primary care practitioners and academia, highlighting the valuable contributions that primary care practice can make to the field of clinical optometric research.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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