Global trends in myopia management attitudes and strategies in clinical practice – 2019 update

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Abstract

Purpose. A survey in 2015 identified a high level of eye care practitioner concern about myopia with a reported moderately high level of activity, but the vast majority still prescribed single vision interventions to young myopes. This research aimed to update these findings 4 years later.

Methods. A self-administrated, internet-based questionnaire was distributed in eight languages, through professional bodies to eye care practitioners globally. The questions examined: awareness of increasing myopia prevalence, perceived efficacy of available strategies and adoption levels of such strategies, and reasons for not adopting specific strategies.

Results. Of the 1,336 respondents, concern was highest (9.0 ± 1.6; $p < 0.001$) in Asia and lowest (7.6 ± 2.2; $p < 0.001$) in Australasia. Practitioners from Asia also considered their clinical practice of myopia control to be the most active (7.7 ± 2.3; $p < 0.001$), the North American practitioners being the least active (6.3 ± 2.9; $p < 0.001$). Orthokeratology was perceived to be the most effective method of myopia control, followed by pharmaceutical approaches and approved myopia control soft contact lenses ($p < 0.001$). Although significant intra-regional differences existed, overall, most practitioners did not consider single-vision distance under-correction to be an effective strategy for attenuating myopia progression (79.6%), but prescribed single vision spectacles or contact lenses as the primary mode of correction for myopic patients (63.6 ± 21.8%). The main justifications for their reluctance to prescribe alternatives to single vision refractive corrections were increased cost (20.6%) and inadequate information (17.6%).

Conclusions. While practitioner concern about myopia and the reported level of activity have increased over the last 4 years, the vast majority of eye care clinicians still prescribe single vision interventions to young myopes. With recent global consensus evidence-based guidelines having been published, it is hoped that this will inform the practice of myopia management in future.

Keywords: myopia control; myopia progression; myopia management; orthokeratology; global; attitudes

Introduction

Due to the escalating global incidence of myopia, perpetual improvement in the evidence-based understanding of its vision risks and associated management remains essential. Holden *et al*. [1] projected myopia to affect half of the world's population by 2050 and with a propensity to become the leading cause for irreversible blindness. Deeming it a public health concern worldwide, The International Myopia Institute (IMI) released white papers (available online: https://www.myopiainstitute.org/imi-white-papers.html) synthesizing the latest and complete knowledge surrounding myopia across seven expert committees, including: Myopia Control Reports Overview and Introduction;[2] Defining and Classifying Myopia;[3] Experimental Models of Emmetropization and Myopia;[4] Myopia Genetics;[5] Interventions for Myopia Onset and Progression;[6] Clinical Myopia Control Trials and Instrumentation;[7] Industry Guidelines and Ethical Considerations for Myopia Control;[8] Clinical Myopia Management Guidelines.[9]

During the past two decades, research in the field of myopia has expanded, but global agreement on guidelines for an optimum and standardized treatment regimen is still limited. Similarly, reported practitioner perception in the literature is scarce. A survey by Jung *et al*. [10] noted that most Korean ophthalmologists preferred to prescribe full cycloplegic spectacle refraction for childhood myopia control, followed by orthokeratology and spectacle undercorrection, whilst atropine was mostly considered ineffective. An international perspective,[11] solely focused on the prescribing trends of pediatric ophthalmologists reported: 57% of the 940 respondents routinely engaged in myopia control, but a lack of consensus remained on when to initiate treatment; the main precursor for treatment was myopia progression of ≥ 1 D/year; 70% prescribed eye drops of which atropine 0.01% accounted for 63.4%; 86% recommended increased time spent outdoors, whilst 60.2% and 63.9% advised less screen viewing and smartphone use respectively. From the survey conducted in 2015, Wolffsohn *et al*. [12] reported that despite the high concern and activity over myopia progression and control respectively, most eye care practitioners worldwide prescribed single vision spectacles and contact lenses. This paper provides an update of

these attitudes and trends toward myopia management strategies in clinical practice four years later.

Method

A self-administered, internet-based cross-sectional survey in eight languages (Chinese, English, French, German, Italian, Portuguese, Russian and Spanish) was distributed using software SurveyMonkey (Palo Alto, California, USA) through various professional bodies across the world to reach eye care professionals (optometrists, dispensing opticians, ophthalmologists and others) globally. The survey matched the 2015 version (Wolffsohn *et al*., 2016) comprising of nine questions relating to the self-reported clinical management behaviours of practitioners for progressive myopia and practitioner's current opinions on myopia related clinical care including:

- level of concern about the increasing frequency of paediatric myopia in their clinical practice (rated as 'Not at all,' to 'extremely,' on a 10 point scale)
- perceived effectiveness, defined as the expected level of reduction in childhood myopia progression of a range of myopia control options (rated as a percentage from 0 to 100%)
- how active they would consider their clinical practice in the area of myopia control (rated as 'Not at all,' to 'fully,' on a 10 point scale)
- frequency of prescribing different myopia correction options for progressive / young myopes during a typical month
- minimum age a patient would need to be for them to consider myopia control options (assuming average handling skills and child/parent motivation)
- minimum amount of myopia that would need to be present to consider myopia control options (specified in half dioptre steps)
- minimum level of myopia progression (dioptres/year) that would prompt a practitioner to specifically adopt a myopia control approach (specified in quarter dioptre steps)
- frequency of adopting single vision under-correction as a strategy to slow myopia progression (reported as 'no,' 'sometimes,' or 'always')
- if they had only ever fitted single vision spectacles/contact lenses for myopic patients, what had prevented them (multiple options could be selected) from prescribing alternative refractive correction methods; options consisted of:
    - They don't believe that these are any more effective
    - The outcome is not predictable
    - Safety concerns
    - Cost to the patient makes them uneconomical
    - Additional chair time required

- Inadequate information / knowledge
- Benefit / risk ratio
- Other

There was an option to add further comments to each of the questions and the topic as a whole. Voluntary participation in the survey, following an explanation of the research, was anonymous, however, respondents were asked to provide basic demographic information about themselves (years of being qualified and everyday working environment). The data was collected between October 2018 and April 2019.

Statistical Analysis

Statistical analysis was conducted with SPSS (v21 IBM, New York, USA). Only complete surveys were analysed. Median, mean and standard deviations were calculated for each question response, with the results grouped by continent (Asia, Australasia, Europe, North America and South America) and countries within a continent where response rate allowed ($n \geq 30$), with Kruskal-Wallis tests applied to determine statistical difference (taken as $p < 0.05$) between them. For conciseness, only significant comparisons have been reported.

Results

Responses

The total number of 1,336 complete survey responses were received, with the distribution by continent being: Africa 13 (not included in further analysis), Asia 202, Australasia 79; Europe 717; Middle East 5 (not included in further analysis), North America 147; and South America 173. Country specific responses could be extracted from:

- Europe: Germany (n=68), Italy (n = 102), Netherlands (n = 40) Portugal (n = 76), Russia (n=78), Spain (n = 173) and UK/EIRE (n = 78)
- Asia: China (n = 37), Hong Kong (n = 59) and India (n = 30)
- North America; Canada (n = 47) and USA (n = 90)

Of the study participants, 72.5% (n=968) were optometrists, 19.6% (n = 262) were ophthalmologists, 6.7% (n = 90) were contact lens opticians and 1.2% (n = 16) were other types of eye care specialists. The principal working environment for 90.7% was in clinical practice (n = 1,212), 5.1% worked in academia (n = 68), 2.1% worked within industry (n = 29) and 2.1% (n = 29) worked in other environments. However, all study participants were registered eye care practitioners. The median number of years qualified was the 11-20 year category, with a normal distribution.

Self-reported concern about the increasing frequency of paediatric myopia (Figure 1)

Practitioners' concern about the increasing frequency of paediatric myopia in their practices was highest (9.0 ± 1.6; $p < 0.001$) in Asia and lowest (7.6 ± 2.2; $p < 0.001$) in Australasia among the surveyed continents, with similar levels across Europe (8.0 ± 2.2; $p < 0.001$), North America (7.9 ± 2.1; $p < 0.001$) and South America (8.5 ± 2.2; $p < 0.001$). In Asia, Chinese practitioners were more concerned (9.5 ± 1.2; $p < 0.001$) than those in Hong Kong (8.7 ± 1.4; $p < 0.001$) or India (8.9 ± 1.3; $p < 0.001$). In Europe, practitioners from Russia (8.7 ± 1.9; $p < 0.001$), Portugal (8.7 ± 2.0; $p < 0.001$) and Spain (8.5 ± 1.9; $p < 0.001$) were most concerned, followed by Italy (7.8 ± 2.2; $p < 0.001$) and the UK/EIRE (7.5 ± 2.5; $p < 0.001$), with lowest concern in the Netherlands (7.1 ± 2.3; $p < 0.001$) and Germany (6.4 ± 2.3; $p < 0.001$). In North America, practitioners from the USA (8.1 ± 2.0; $p < 0.001$) were more concerned than their Canadian neighbours (7.5 ± 2.2; $p < 0.001$).

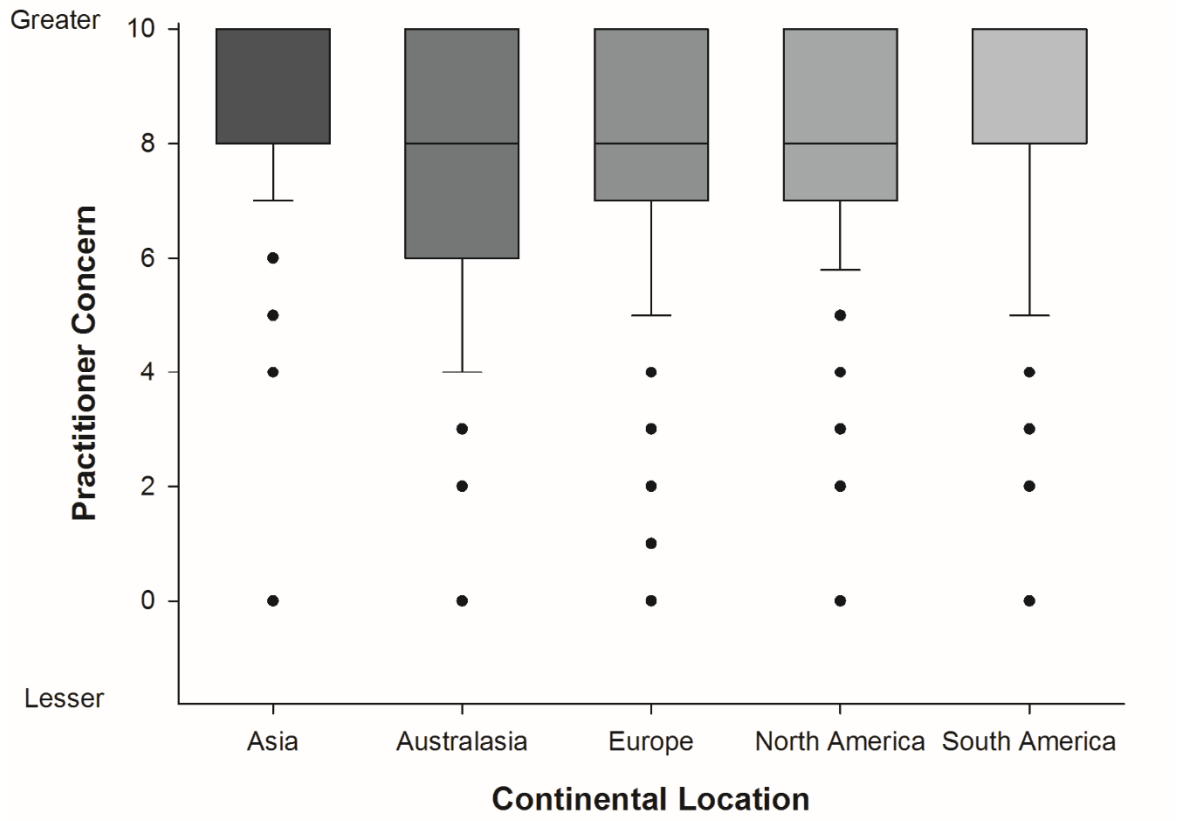

Figure 1: Level of practitioner concern (rated from 0-10) regarding the perceived increasing frequency of paediatric myopia in their practice for practitioners located in different continents. N=1,336. Box = 1 SD, line = median and whiskers 95% confidence interval.

Perceived effectiveness of myopia control options (Table 1)

Overall, orthokeratology was perceived by practitioners to be the most effective method of myopia control, followed by pharmaceutical approaches and approved myopia control soft contact lenses. The least effective perceived methods were single vision distance under-correction and single vision spectacles, as well as single vision soft contact lenses and refractive surgery options. These findings were largely consistent across all continents with some variations: practitioners from South America held the lowest relative consideration regarding the most effective perceived methods, whilst practitioners from Asia, Europe, and South America held the highest relative consideration for the least effective perceived methods ($p < 0.001$). Moreover, the single vision spectacles modality was considered the 7th least effective out of the 12 survey choices in South America ($p < 0.001$). Practitioners from Asia considered bifocals and progressive addition (PALs) lenses to be relatively more effective for reducing childhood myopia progression compared with practitioners from all other continents ($p < 0.001$). Practitioners from Australasia and North America perceived single vision distance under-correction, single vision spectacles, rigid gas permeable (RGP)

and single vision soft contact lenses, refractive surgery, and increased time outdoors as less effective than practitioners from other continents ($p < 0.001$).

Within Asia, Chinese practitioners generally held the highest relative consideration for most myopia control options, whereas practitioners from Hong Kong held the least overall perceived effectiveness for most myopia control options ($p < 0.001$). Similar effectiveness among practitioners from China, Hong Kong, and India was perceived for multifocal and approved myopia control soft contact lenses, as well as orthokeratology and pharmaceutical modalities ($p < 0.001$). Within Europe, the Netherlands generally held the lowest relative consideration for most myopia control options, whereas practitioners from Portugal, Russia, and Spain held the highest overall perceived effectiveness for most myopia control options ($p < 0.001$). Spanish practitioners perceived approved myopia control soft contact lenses and orthokeratology as more effective than their European colleagues, while Portuguese practitioners regarding refractive surgery as a more effective technique for myopia control than their European colleagues ($p < 0.001$). Russian practitioners perceived pharmaceutical methods as less effective than other European practitioners, while Italian practitioners and those from the UK/EIRE thought increased time spent outdoors was less effective at slowing myopia that other European practitioners ($p < 0.001$). Within North America, practitioners from the USA perceived rigid gas permeable (RGP) and multifocal soft contact lenses, as well as orthokeratology and pharmaceutical options, as more effective than their Canadian counterparts ($p < 0.001$).

Technique \ Continent		Asia	Australasia	Europe	North America	South America
Spectacles	Under-correction	11.6 ± 21.6	0.2 ± 6.6	6.9 ± 17.6	1.4 ± 4.6	14.9 ± 2 1.9
	Single Vision	17.6 ± 24.9	1.2 ± 3.8	13.4 ± 24.7	1.2 ± 3.7	21.3 ± 32.9
	Bifocals	33.0 ± 22.7	25.4 ± 17.4	19.4 ± 20.5	16.7 ± 15.1	16. 0 ± 22.2
	Progressive Addition (PALs)	32.9 ± 23.0	22.4 ± 15.2	20.9 ± 21.4	16.5 ± 14.9	18. 2 ± 24.6
Contact Lenses	Rigid Gas Permeable (RGP)	25.0 ± 27.8	8.4 ± 16.3	16.8 ± 24.1	6.8 ± 12.7	15.0 ± 25.1
	Single Vision Soft	18.1 ± 24.6	3.1 ± 10.3	13.1 ± 21.9	1.7 ± 4.5	16.3 ± 27.1
	Multifocal Soft	31.9 ± 23.6	35.7 ± 18.0	26.6 ± 22.5	31.4 ± 19.0	21. 9 ± 26.6
	Approved Myopia Control Soft	45.4 ± 24.0	45.6 ± 18.2	44.1 ± 24.4	42.9 ± 20.0	29. 0 ± 29.4
	Orthokeratology	60.7 ± 21.9	52.5 ± 21.2	52.1 ± 24.7	48.3 ± 22.0	34. 8 ± 31.1
Pharmaceutical		54.5 ± 23.6	52.1 ± 20.9	43.1 ± 26.9	45.6 ± 21.3	43. 0 ± 29.8
Refractive Surgery		20.6 ± 33.0	7.7 ± 21.3	13.9 ± 25.6	8.1 ± 22.2	13.9 ± 24.8
Increased Time Outdoors		43.6 ± 27.8	20.4 ± 20.5	37.1 ± 27.7	22.4 ± 20.1	40. 2 ± 31.8

Table 1: Perceived effectiveness (defined as the expected level of reduction in childhood myopia progression in percent) of myopia control options by practitioners in different continents. Data are expressed as mean ± S.D.

Perceived level of clinical activity in the area of myopia control (Figure 2)

Practitioners from Asia considered their clinical practice of myopia control to be the most active (7.7 ± 2.3; $p < 0.001$) among the surveyed continents, with similar levels for Australasia (7.3 ± 2.5; $p < 0.001$) and Europe (7.0 ± 4.2; $p < 0.001$), and least by practitioners from North America (6.3 ± 2.9; $p < 0.001$) and South America (6.4 ± 3.2; $p < 0.001$). North American practitioners perceived themselves to be the least active in this area of practice ($p < 0.001$). Within Europe, practitioners from Russia (8.5 ± 9.8; $p < 0.001$) reported the highest perceived level of clinical activity in myopia control and the lowest was reported by those from the UK/EIRE (6.1 ± 3.5; $p < 0.001$), with similar responses by Spain (7.0 ± 2.6; $p < 0.001$), Italy (7.0 ± 2.3; $p < 0.001$), Portugal (6.6 ± 2.5; $p < 0.001$), the Netherlands (6.6 ± 2.6; $p < 0.001$), and Germany (6.6 ± 3.0; $p < 0.001$). Within Asia, Indian practitioners (6.3 ± 2.6; $p < 0.001$) considered themselves relatively less active than their counterparts in China (8.4 ± 2.2; $p < 0.001$) or Hong Kong (8.1 ± 2.0; $p < 0.001$). Within North America, Canadian practitioners (5.7 ± 3.0; $p < 0.001$) considered themselves less active than those from the USA (6.6 ± 2.8; $p < 0.001$).

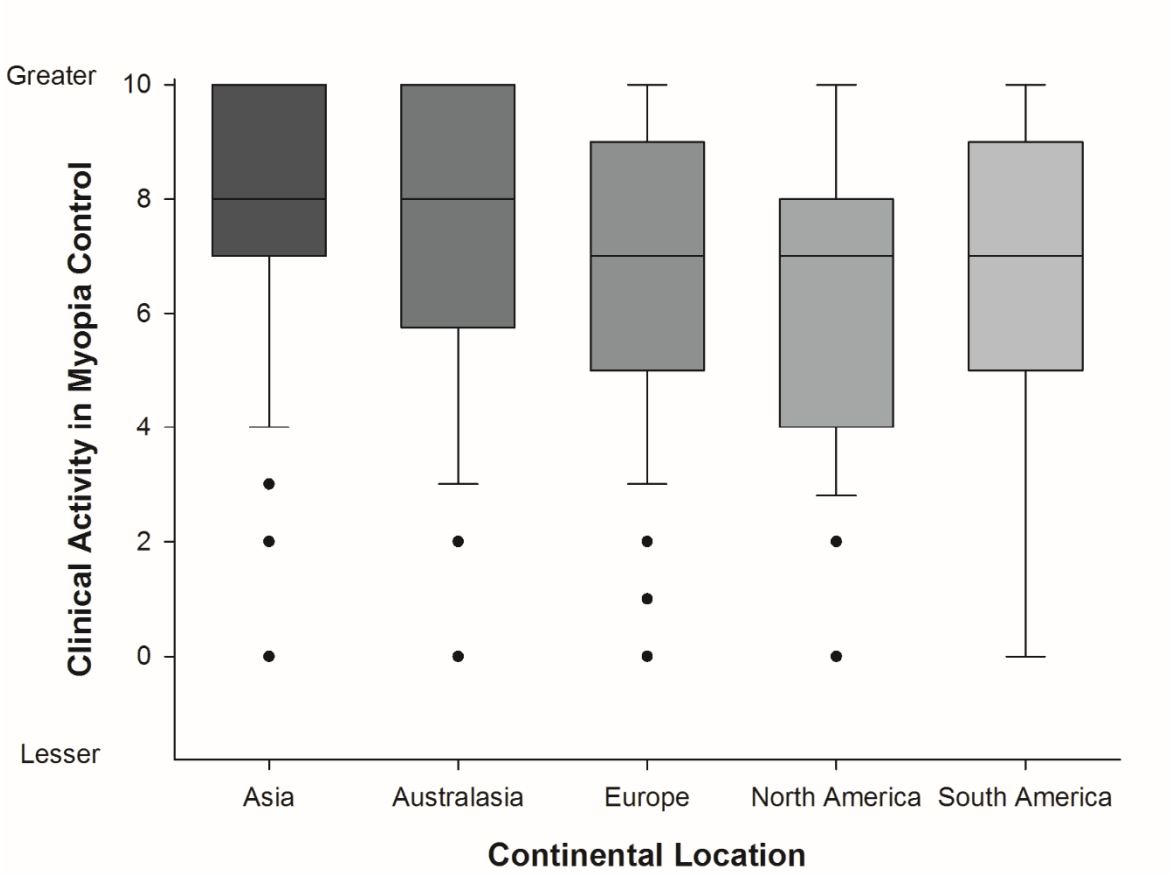

Figure 2: Perceived level of clinical activity in the area of myopia control for practitioners located in different continents. N=1,336. Box = 1 SD, line = median and whiskers 95% confidence interval.

Frequency of prescribing different myopia correction options for progressing / young myopes (Table 2)

The majority of progressing / young myopes were being prescribed single vision (full correction) spectacles (39.3 ± 30.0%), followed by single vision soft contact lenses (12.3 ± 15.5%) and orthokeratology (12.0 ± 20.0%). The least frequently prescribed myopia correction option was refractive surgery (0.8 ± 4.1%), followed by rigid gas permeable (RGP) contact lenses (2.1 ± 6.6%) and bifocal spectacles (2.4 ± 6.2%). Progressive addition (PALs) spectacles (8.8 ± 14.5%), multifocal soft contact lenses (6.8 ± 13.9%), approved myopia control soft contact lenses (7.3 ± 13.0%), and pharmaceutical options were prescribed at a similar frequency (8.2 ± 16.3%). These findings were largely consistent across all continents with some variations. Practitioners from Asia indicated prescribing single vision (full correction) spectacles most frequently, whereas those from Australasia prescribed them least often ($p < 0.001$). Also, practitioners from Asia indicated prescribing bifocal spectacles most frequently for progressing / young myopes, whereas those from South America prescribed them least often ($p < 0.001$). Practitioners from Australasia, and to a lesser degree, practitioners from Asia, prescribed progressive addition (PALs) spectacles more frequently than those from other continents, while the option was prescribed least often by South America ($p < 0.001$). South American practitioners prescribed conventional rigid gas permeable (RGP) contact lenses most frequently to these patients, while was done least often by their counterparts in Australasia ($p < 0.001$). Practitioners from North America and Australasia prescribed more single vision and multifocal soft contact lenses respectively, while Asian practitioners prescribed these options less often than other regions ($p < 0.001$). Approved myopia control soft contact lenses are being prescribed most in Australasia, Europe, and North America, while notably less in Asia and South America ($p < 0.001$). Practitioners from Australasia, and to a lesser degree, practitioners from Europe, prescribed orthokeratology more frequently than their counterparts, while this option was prescribed least frequently by South American practitioners ($p < 0.001$). South American practitioners indicated utilising pharmaceutical options notably most frequently for progressing / young myopes, while those from Asia and Europe did so the least ($p < 0.001$). South American practitioners also recommended refractive surgery more than other continents for these patients, but the prescribing frequency was still low ($p < 0.001$).

Within Asia, practitioners from India prescribed single vision spectacles, rigid gas permeable (RGP), single vision, multifocal, and approved myopia control soft contact lenses, as well as pharmaceutical myopia correction options most frequently ($p < 0.001$). Chinese practitioners

prescribed progressive addition (PALs) spectacles the most frequently and orthokeratology the least in comparison to Hong Kong and India ($p < 0.001$). Within Europe, practitioners from Russia and Spain prescribed single vision spectacles and soft contact lenses most frequently, whereas practitioners from the Netherlands prescribed these options the least ($p < 0.001$). Russian practitioners also prescribed bifocal and progressive addition (PALs) spectacles the most, whereas their colleagues from the Netherlands and Portugal did so the least ($p < 0.001$). German practitioners prescribed rigid gas permeable (RGP) and multifocal soft contact lenses most frequently, whereas those from the UK/EIRE and Portugal prescribed these options the least ($p < 0.001$). Spanish practitioners demonstrated the highest frequency of prescribing approved myopia control soft contact lenses ($p < 0.001$). Orthokeratology was prescribed the most in Italy and the Netherlands, and the least by Portuguese practitioners ($p < 0.001$). Russian practitioners had the highest frequency of prescribing pharmaceutical and refractive surgery options ($p < 0.001$). Within North America, practitioners from the USA prescribed single vision spectacles and soft contact lenses more frequently than their Canadian colleagues ($p < 0.001$).

Technique \ Continent		Asia	Australasia	Europe	North America	South America
Spectacles	Single Vision	54.7 ± 31.9	18.8 ± 22.3	37.3 ± 29.3	36.5 ± 30.5	49. 3 ± 35.8
	Bifocals	3.4 ± 7.7	2.8 ± 6.2	2.0 ± 7.5	2.6 ± 5.7	1.1 ± 4.0
	Progressive Addition (PALs)	11.0 ± 15.5	19.4 ± 20.3	4.5 ± 10.5	5.6 ± 14.3	3.7 ± 11.9
Contact Lenses	Rigid Gas Permeable (RGP)	1.8 ± 4.7	0.3 ± 1.1	2.9 ± 9.6	1.1 ± 9.1	4.5 ± 8.4
	Single Vision Soft	7.2 ± 13.0	9.6 ± 13.3	15.6 ± 17.3	16.6 ± 19.0	12.4 ± 14.8
	Multifocal Soft	1.7 ± 5.1	13.0 ± 18.5	5.5 ± 13.7	8.2 ± 15.5	5.6 ± 1 6.7
	Approved Myopia Control Soft	3.6 ± 8.7	10.5 ± 14.9	10.5 ± 16.9	9.6 ± 16.4	2.2 ± 8.3
	Orthokeratology	11.5 ± 20.4	16.8 ± 22.0	15.9 ± 24.4	12.3 ± 19.4	3.3 ± 11.8
Pharmaceutical		4.1 ± 11.9	8.7 ± 11.7	4.7 ± 15.0	7.2 ± 12.1	16.3 ± 30.7
Refractive Surgery		0.9 ± 4.1	0.1 ± 0.6	1.0 ± 6.7	0.4 ± 2.9	1.7 ± 6.3

Table 2: Frequency of prescribing myopia correction options (in percent) for progressing / young myopes by practitioners in different continents for progressing / young myopes. Data are expressed as mean ± S.D.

Minimum patient age that practitioners consider myopia correction options (Table 3)

Overall, single vision spectacles were prescribed from the youngest age (6.8 ± 4.2 years), whereas rigid gas permeable (RGP) contact lenses were reserved for older children (13.3 ± 5.3). Bifocal spectacles (8.9 ± 5.7), progressive addition (PALs) spectacles (8.9 ± 6.0), single vision soft contact lenses (9.0 ± 4.8), multifocal soft contact lenses (10.2 ± 4.9), specific

myopia control soft contact lenses (8.9 ± 4.0), orthokeratology (9.7 ± 4.8), and pharmaceutical (9.6 ± 6.0) options were all prescribed for a similar minimum patient age range. Practitioners from all regions generally did not recommend refractive surgery to patients under 18 years of age (19.6 ± 1.6). Practitioners from Asia, Australasia, and North America were more conservative in their minimum fitting age of rigid gas permeable (RGP) contact lenses than European and South American practitioners ($p < 0.001$). Practitioners from Asia were most conservative in their minimum patient age for prescribing single vision, multifocal, and specific myopia control soft contact lenses ($p < 0.001$). South American practitioners tended to be least conservative towards most myopia correction options relative to their colleagues ($p < 0.001$).

Within Asia, practitioners from Hong Kong were the most conservative in their minimum age for fitting rigid gas permeable (RGP), single vision and multifocal soft contact lenses, as well as pharmaceuticals ($p < 0.001$). Practitioners from India were the most conservative in fitting bifocal and progressive addition (PALs) spectacles, as well as orthokeratology ($p < 0.001$). Chinese practitioners were least conservative in prescribing bifocal spectacles, multifocal soft contact lenses, and pharmaceutical options ($p < 0.001$). Within Europe, practitioners from the Netherlands were the most conservative in their minimum age for fitting most of the myopia correction options, followed by the UK/EIRE, particularly for bifocal and progressive addition (PALs) spectacles, rigid gas permeable (RGP) contact lenses, as well as orthokeratology, pharmaceutical, and refractive surgery ($p < 0.001$). Within North America, Canadian practitioners were more conservative regarding bifocal spectacles and orthokeratology than their USA colleagues ($p < 0.001$).

Technique \ Continent		Asia	Australasia	Europe	North America	South America
Spectacles	Single Vision	7.0 ± 4.4 (1)	8.0 ± 6.0	6.0 ± 3.2 (8)	7.7 ± 5.9	5.5 ± 1.7 (16)
	Bifocals	10.4 ± 6.5 (12)	9.5 ± 6.9	9.0 ± 6.1 (38)	9.6 ± 7.0	5.9 ± 2.1 (66)
	Progressive Addition (PALs)	9.4 ± 4.9 (7)	7.6 ± 5.1	9.4 ± 5.7 (33)	10.4 ± 7.0	7.5 ± 3.6 (63)
Contact Lenses	Rigid Gas Permeable (RGP)	15.2 ± 5.6 (9)	15.4 ± 6.2	10.8 ± 4.8 (36)	14.2 ± 6. 2	10.9 ± 3.9 (42)
	Single Vision Soft	13.2 ± 5.2 (10)	11.1 ± 5.8	9.0 ± 3.9 (12)	10.4 ± 5. 3	10.2 ± 3.9 (28)
	Multifocal Soft	13.8 ± 5.9 (15)	9.9 ± 5.2	9.3 ± 4.5 (33)	9.4 ± 4.9	8.8 ± 4.1 (61)
	Specific Myopia Control Soft	10.8 ± 4.8 (10)	8.5 ± 3.9	7.8 ± 3.2 (7)	8.3 ± 3.9	9 .2 ± 4.2 (36)
	Orthokeratology	9.8 ± 5.1 (10)	9.6 ± 5.0	9.3 ± 4.0 (11)	10.7 ± 6.1	9.1 ± 4.2 (44)
Pharmaceutical		13.0 ± 7.6 (13)	8.5 ± 5.8	10.6 ± 6.9 (53)	9.5 ± 6.5	6.5 ± 3.2 (35)
Refractive Surgery		19.9 ± 2.1 (22)	20.4 ± 1.2	19.3 ± 2.7 (71)	20.4 ± 1 .2	18.2 ± 0.9 (71)

Table 3: Minimum patient age considered necessary by practitioners (from different continents) who prescribed these options for different myopia correction options. Data are expressed as mean ± S.D years (% that would not prescribe this refractive modality – no practitioners stated this to be the case with any refractive correction in Australasia or North America).

Minimum degree of myopia that needs to be present for practitioners to consider myopia control options (Table 4)

Overall, practitioners indicated that myopia would be corrected with single vision spectacles at the lowest degree of myopia (-0.82 ± 0.58 D), whereas it would be corrected with refractive surgery at the highest degree (-2.80 ± 1.72 D). All other myopia control options would be considered at approximately -1.50 D, except for rigid gas permeable (RGP) contact lenses that were considered at -2.50 D. Australasian and North American practitioners were willing to fit most modalities at a lower level of myopia than Asian, European or South American clinicians ($p < 0.001$). South American practitioners required a higher level of myopic refractive error before they would consider bifocal spectacles, multifocal soft contact lenses, and orthokeratology than all other regions ($p < 0.001$). Asian practitioners prescribed rigid gas permeable (RGP) and single vision soft contact lenses, as well as refractive surgery to children with a higher degree of myopia than others ($p < 0.001$). However, North American practitioners considered rigid gas permeable (RGP) contact lenses at a lower level of myopia than in other continents ($p < 0.001$). Practitioners from Asia and South America recommended approved myopia control soft contact lenses and pharmaceutical options at higher levels of myopia ($p < 0.001$).

Within Asia, Indian practitioners required a higher level of refractive error before they would consider bifocal and progressive addition (PALs) spectacles, as well as orthokeratology, pharmaceutical and refractive surgery options ($p < 0.001$) than practitioners from China or Hong Kong. Within Europe, Portuguese practitioners considered single vision, bifocal and progressive addition (PALs) spectacles, rigid gas permeable (RGP) and approved myopia control soft contact lenses, orthokeratology, pharmaceutical, and refractive surgery options for a higher myopia level than other countries in the continent ($p < 0.001$). Spanish practitioners also required a higher level of myopia for approved myopia control soft contact lenses and pharmaceuticals, as well as multifocal soft contact lenses ($p < 0.001$). Italian practitioners required high myopia levels when considering refractive surgery ($p < 0.001$). Practitioners from Russia required a higher level of myopia before utilising single vision soft contact lenses, but lower levels for pharmaceuticals relative to their European colleagues ($p < 0.001$). Practitioners from the UK/EIRE considered single vision, bifocal and progressive addition (PALs) spectacles, single vision, multifocal and approved myopia control soft contact lenses, and refractive surgery options for a lower myopia level than others in the continent ($p < 0.001$). German practitioners also required a lower level of myopia for single vision, bifocal and progressive addition (PALs) spectacles, as well as rigid gas permeable (RGP) and single vision soft contact lenses ($p < 0.001$). The same was reported by practitioners from the Netherlands regarding single vision and bifocal spectacles, and rigid gas permeable (RGP) and single vision soft contact lenses ($p < 0.001$). The only difference across North America was that Canadian practitioners required a higher level of myopia before they would consider rigid gas permeable (RGP) contact lenses than those from the USA ($p < 0.001$).

Technique \ Continent		Asia	Australasia	Europe	North America	South America
Spectacles	Single Vision	-1.0 ± 0.9	-0.6 ± 0.2	-0.9 ± 0.7	-0.7 ± 0.4	-0.9 ± 0.7
	Bifocals	-1.8 ± 1.4	-0.9 ± 0.4	-1.8 ± 1.3	-1.2 ± 1.0	-2.3 ± 1.7
	Progressive Addition (PALs)	-1.7 ± 1.2	-0.8 ± 0.3	-1.8 ± 1.3	-1.2 ± 1.1	-2.0 ± 1.6
Contact Lenses	Rigid Gas Permeable (RGP)	-2.9 ± 2.0	-2.5 ± 2.1	-2.4 ± 2.0	-2.0 ± 1.6	-2.7 ± 2.1
	Single Vision Soft	-1.8 ± 1.4	-1.0 ± 0.4	-1.3 ± 0.9	-1.0 ± 0.5	-1.5 ± 1.2
	Multifocal Soft	-1.7 ± 1.2	-1.0 ± 0.4	-1.6 ± 1.3	-1.2 ± 0.7	-1.9 ± 1.6
	Approved Myopia Control Soft	-1.8 ± 1.5	-1.0 ± 0.4	-1.5 ± 1.1	-1.2 ± 0.7	-1.9 ± 1.6
	Orthokeratology	-1.7 ± 1.3	-1.3 ± 0.7	-1.6 ± 1.0	-1.3 ± 0.7	-2.1 ± 1.6
Pharmaceutical		-1.9 ± 1.8	-1.2 ± 0.5	-1.5 ± 1.3	-1.3 ± 1.0	-1.9 ± 1.2
Refractive Surgery		-3.8 ± 2.4	-2.2 ± 1.0	-3.3 ± 2.3	-2.0 ± 1.2	-2.7 ± 1.7

Table 4: Minimum level of patient myopia (in dioptres) before myopia correction options would be considered by practitioners from different continents who prescribed these options. Data are expressed as mean ± S.D.

Minimum annual amount of patient myopia progression that would prompt a practitioner to specifically adopt a myopia control approach (Figure 3)

The minimum myopia progression rate that practitioners considered warranted a myopia control approach was 0.51 to 0.75 D/year for the majority of respondents (36.7%), with 82% indicating a level between 0.25 and 1.00 D/year. Practitioners from Australasia indicated they would adopt myopia control strategies for the lowest level of myopia progression, followed by Europe and North America ($p < 0.001$). Highest rates of progression were required in South America, followed by Asia ($p < 0.001$). Practitioners from Australasia, Europe, and North America particularly indicated a range between 0.26 and 0.75 D/year of patient myopia progression that would prompt the adaptation of a myopia control approach. In comparison, the range increased to between 0.26 and 1.00 D/year for Asian practitioners and spread further between 0.26 and > 1.00 D/year among South American practitioners ($p < 0.001$). Other factors influencing practitioners' management decisions, as identified from the free text responses, included ethnicity (1 respondent), absolute degree of refractive error at the time (2 respondents), environmental factors/lifestyle (2 respondents), lighting exposure (2 respondents), parental decisions (2 respondents), ocular biometry (3 respondents), family history of myopia (6 respondents), and age of myopia onset (10 respondents).

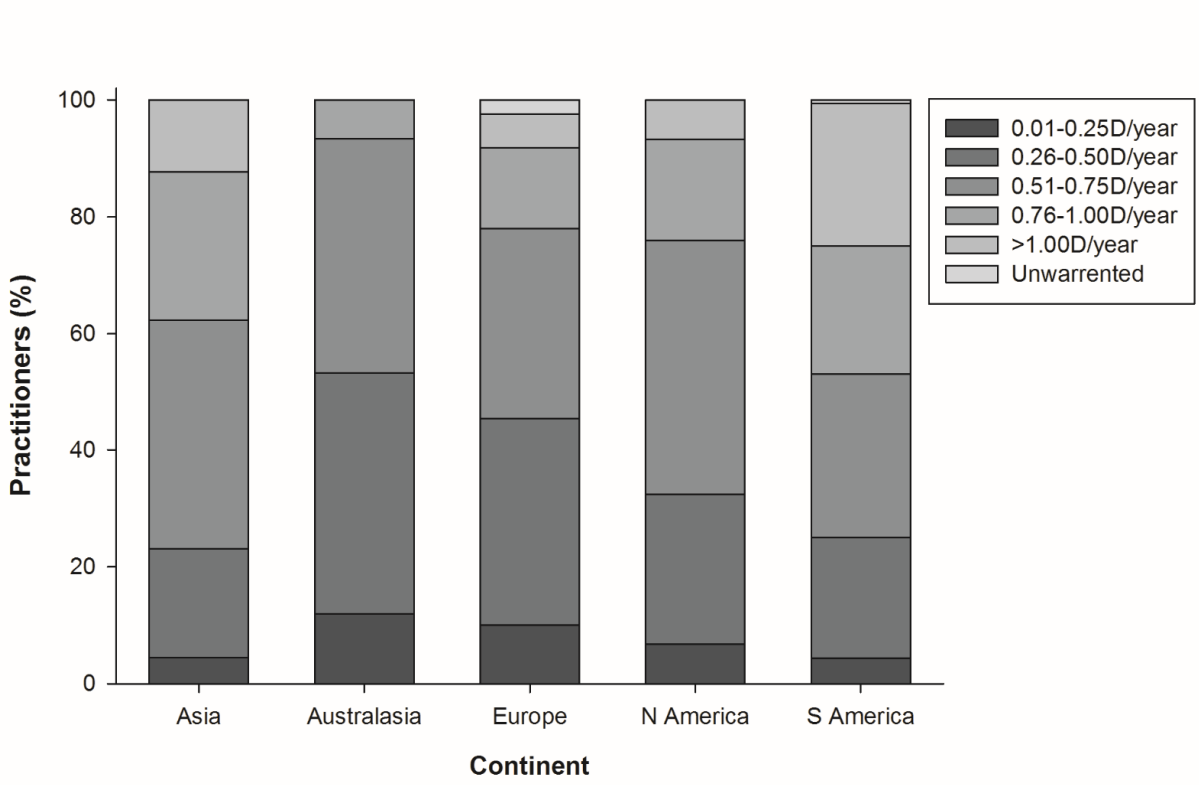

Figure 3: Minimum annual amount of patient myopia progression, in dioptres per year (D/year), that practitioners located in different continents considered to necessitate a myopia control approach. N=1,336

Use of single-vision under-correction as a strategy to slow myopia progression (Figure 4)

Overall, most practitioners did not consider single-vision distance under-correction to be an effective strategy for attenuating myopia progression (79.6%). South American practitioners used this strategy relatively more than all other regions ($p < 0.001$). Within Asia, Indian practitioners utilised under-correction more than those from China or Hong Kong ($p < 0.001$). Within Europe, practitioners from Portugal, Russia, and Spain indicated using under-correction as a strategy to control myopia more than their counterparts ($p < 0.001$). Within North America, there was no difference in the use of under-correction between Canada and the USA ($p = 0.999$).

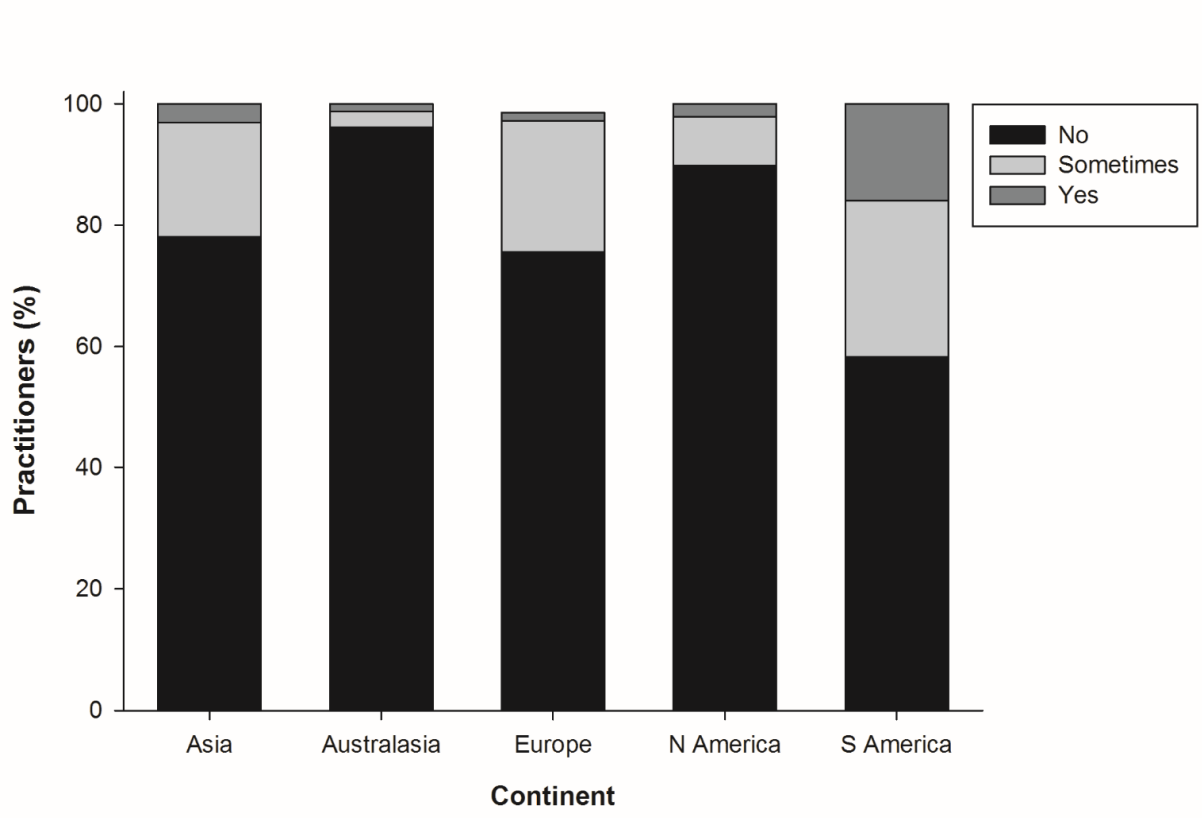

Figure 4: Use of single-vision distance under-correction as a strategy to slow myopia progression by practitioners located in different continents. N=1,336.

Factors preventing the prescription of a myopia control approach (Figure 5)

The most common reasons practitioners gave for not adopting myopia control strategies were: they were felt to be uneconomical (20.6%); they considered there to be inadequate information about the modalities (17.6%); they viewed the outcomes to be unpredictable (9.6%); concerns about safety (8.5%); they perceived them to be ineffective for reducing myopia progression (7.9%); the benefit to risk ratio was too low (7.0%); and additional chair time (3.1%). There was no significant difference in the distribution of these factors between or within continents ($p > 0.05$). Free text comments identified other factors affecting the prescription of these strategies to relate to the relative availability of the myopia control treatments and the instrumentation necessary to prescribe them, and the need for consistent regulations and informational materials.

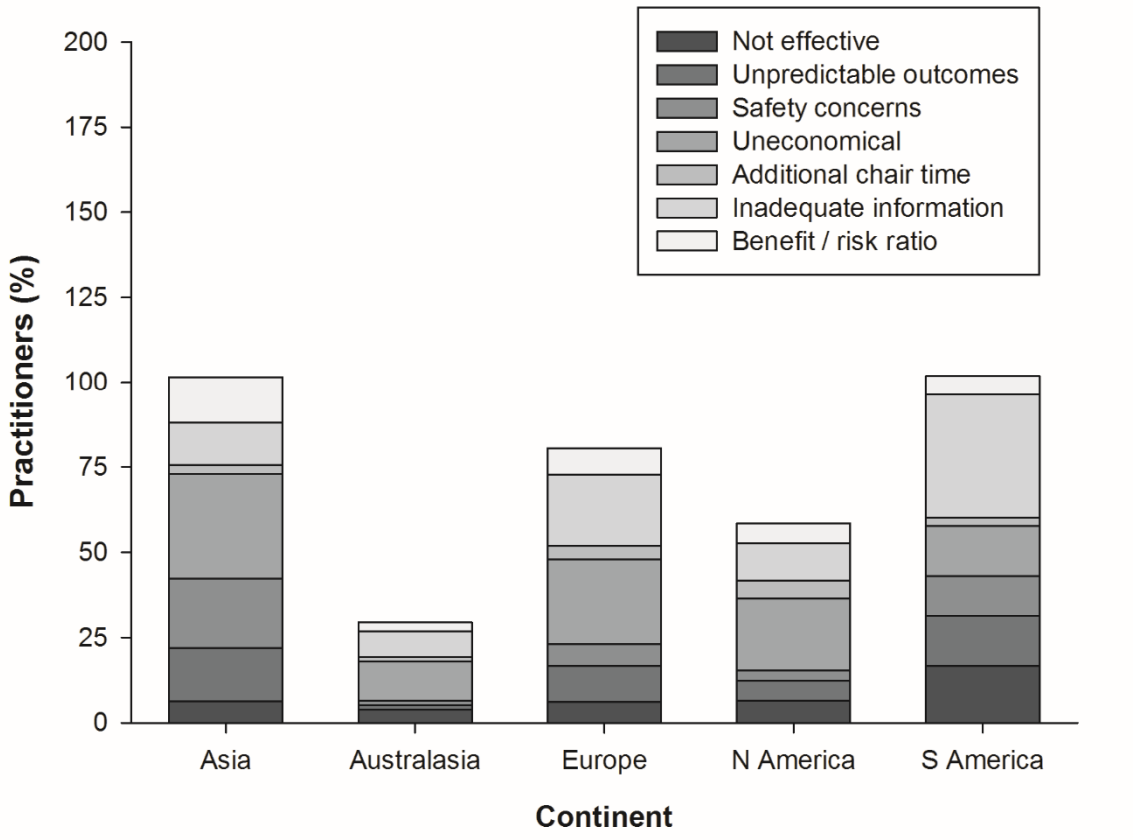

Figure 5: Factors preventing practitioners located in different continents from prescribing a myopia control approach. N=1,336.

Discussion

This report updates a study from 2015 [12] that examined the self-reported attitudes and practices of eye care practitioners towards myopia control approaches across the globe. More than one thousand practitioners responded, principally spread over five continents. The exact response rate is not known, as maximum coverage was promoted by involving professional bodies whose members may not all be practicing eye care practitioners. However, it may be presumed that questionnaires are completed both by people cynical and enthusiastic to the issue being examined, balancing the average response. In addition, the recruitment approach across nations was the same, allowing cross-national comparisons. The majority of the respondents (92.1%) were again (91% in 2015)[16] optometrists and ophthalmologists, reflecting those professions legally allowed to prescribe vision care correction and, in many regions, pharmaceuticals as well.

Once again, as one might expect from the high prevalence rates of myopia in Asia, Asian practitioners, especially those practicing in China, were more concerned about the increasing prevalence of paediatric myopia in their practices than clinicians in any of the other continents. A similar pattern existed in relation to how active they considered their clinical practice in the area of myopia control. Data collected over the last decade on myopia prevalence suggests it is approximately 30% in 30-35 year olds in Spain [13] and may be increasing in Portugal,[14] but is as high as 58% in Italian university students, and as low as 23% in 12-13 year olds in the UK [15] and 28% in Dutch school children;[16] hence it is unclear why the former two country's practitioners are more concerned than the latter two. The prevalence of myopia in the USA is around 42% in 12-54 year olds [17] and around 29% in 11 to 13 year olds in Canada [18] which might explain their lower concern. The myopia occurrence is not documented in Russia or Germany to warrant their higher and lower concern in Europe respectively.

Overall, orthokeratology was again perceived by practitioners to be the most effective method of myopia control (24-49% retardation of myopia in 2015 versus 35-61% in 2019 across the continents). However, in this survey update, eye care practitioners' correctly perceived pharmaceutical approaches and approved myopia control soft contact lenses to be similarly effective, in accordance with the IMI white paper by Wildsoet *et al*.[6] Pharmaceutical approaches were not broken down into different drugs and concentrations, which might be informative for future surveys due to the differences in efficacy, mismatch between axial length and refractive error progression and rebound effect.[6] While single vision distance under-correction has been shown fairly conclusively to increase, rather than decrease, the rate of myopia progression in children,[19,20] there were still practitioners who consider the converse to be true; this was confirmed by a question later in the survey, with under-correction still practiced as a method of myopia control, particularly by practitioners

from South America, Portugal, Russia and Spain within Europe and India within Asia; however the reported use of undercorrection as a strategy for myopia control has decreased from the original survey (27.3% of practitioners used undercorrection at least some of the time in 2015 versus 20.4% in 2019.[12]

Despite the self-perceived activity of practitioners in the area of myopia control, still over half of progressing and/or young myopes were being prescribed single vision spectacles or contact lenses (52%), with continental and national differences in the adoption of refractive correction options known to reduce myopia progression. However, this is an improvement in comparison to the reported 68% from the original study four years ago.[12] Strangely, there are still some practitioners who believe refractive surgery is a suitable management for young, progressing myopes, especially in South America! Approximately one third of practitioners not adopting myopia control approaches felt them to be uneconomical and/or that there was inadequate information about them; about another one third of respondents suggested that outcomes were unpredictable, the relative safety of these strategies was concerning, myopia control methods were ineffective and/or that the benefit to risk ratio was too low; with some also mentioning the involved additional chair time. Further comments raised the issue of availability of some myopia control options, presumably of novel myopia control lenses, as current approaches are off-label, highlighting the need for regulatory oversight and guidance.[8] Limited access to necessary instrumentation was also raised as a potential barrier, as more advanced contact lens fitting, such as orthokeratology, require the use of corneal topography.[9] Attempts to specifically manipulate peripheral retinal focus of an individual may also require instrumentation to rapidly and robustly assess peripheral retinal shape, axial length and/or refraction with myopia control ophthalmic medical devices.[7] However, this strategy might not ‘translate’ well from animal studies to human trials.[21,22]

Spherical equivalent refractive error (measured under cycloplegia) is currently the single best predictive measure of juvenile myopia development, with children aged six years with less than +0.75D of hyperopia being at increased risk of developing myopia (Zadnik et al., 2015). Most practitioners were again comfortable fitting single vision spectacles to myopic patients of this age, but in this update tended to wait until a child was older for single vision soft contact lenses and pharmaceuticals in addition to the more complex designs such as PALs, novel myopia control soft contact lenses and orthokeratology RGPs compared to that reported in 2015.[12] Interestingly, one potential advantage of orthokeratology is that the parents or carer can manage lens application, removal and lens care, along with the lenses not having to leave the home, which can make this modality a popular option for parents or carers with younger myopic children. This is exemplified by Hong Kong, an early adopter of

orthokeratology, where its use is considered at an earlier age than other countries in the region.

Research suggests that lower levels of hypermetropia at a young age is a strong risk factor for myopia development,[23] so it would seem that practitioners remain too conservative in waiting until mild-moderate levels of myopia (approximately -1.50 D for most interventions) are present before control approaches are considered.[21,23] However, this is an improvement in comparison to the reported -2.00 D minimum degree of myopia from the original study four years ago.[12] Some optical treatments such as orthokeratology are more effective for mild levels of myopia,[24] so this may affect practitioner thinking. Myopia progresses at much faster rates in children in comparison to teenagers, thus supporting the need for earlier intervention.[25] There may be also a “window of opportunity” for myopia treatment according to the age of onset, rate of progression and myopia magnitude.[26] More research is needed on the relative benefits of myopia control strategies in adolescents and even young adults. Interestingly, Australasian and North American practitioners, but not those from Asia this time, considered most myopia control approaches at a lower level of myopia than other continents. Chinese practitioners still considered prescribing pharmaceutical modalities at a younger age, and at a much lower level of myopia, compared with practitioners from other countries in the region. This may be due to different countries having different regulations and practitioners with different backgrounds (for example training, education and scope of practice), which can affect local practice habits, irrespective of the prevalence of myopia and need for correction or retardation. The rate of patient refractive progression that triggered practitioners to prescribe a myopia control approach generally mirrored the prevalence rate of myopia in each region; for example in Asia, myopia progression needs to be greater for a practitioner to commence myopia control treatments. The higher the prevalence of myopia, generally the higher the level of myopic refractive error developed in individuals and the subsequent higher risk of ocular pathology.27] Practitioners understandably also identified several other factors that, combined with the degree of myopic progression, influenced their decision to prescribe myopia control approaches; these included ethnicity, absolute degree of refractive error at the time, environmental factors/lifestyle, lighting exposure, parental decisions, ocular biometry, family history of myopia, and the age of myopia onset.

In conclusion, this updated global survey of current trends in eye care practitioner myopia management attitudes and strategies in clinical practice has identified that, despite growing evidence of the negative impact of even low levels of myopia on health economics, and moderate levels of practitioner concern and perceived activity (particularly where the prevalence of myopia is highest) uptake of appropriate techniques has improved, but remains generally poor. Furthermore, myopia control techniques are not being applied early

enough in a child's ocular development to elicit their optimum effect. Adequate education of practitioners is lacking, along with access to appropriately regulated myopia control 'labelled' products with efficacy and safety data. The recent IMI white papers provide a global evidence-based consensus to inform practitioners of models of eye care, including the development of instrumentation to enhance management selection, which address the myopia epidemic to reduce the growing health burden.

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