

Contact Lens and Anterior Eye 2021

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Abstract

Aim: To understand the views of contact lens (CL) practitioners across the globe regarding what they perceive as opportunities and threats in CL practice.

Methods: A self-administered anonymised questionnaire, constructed in English and translated in six more languages, was distributed through reputed international professional bodies and academic institutions worldwide. The questionnaire included items on demographic characteristics, type of practice, and questions designed to explore practitioners' perspective on the future of their CL practice over the next five years.

Results: A total of 2408 valid responses were analysed. Multifocal CLs for presbyopia, CLs for myopia control, use of daily disposable (DD) CLs for occasional wear, and biocompatible materials to improve comfort were identified as promising areas of opportunities by practitioners (all 8/10). Respondents from North America, and Europe valued DDCLs for occasional wear moderately more favourable (Median: 9/10 for all) as compared to colleagues in Asia (Median: 8/10, $p < 0.001$), South America (Median: 8/10, $p < 0.01$), and Africa (Median: 8/10 $p < 0.01$). Multifocal CLs for presbyopia was perceived as a better opportunity by practitioners in North America and Europe (Median: 9/10 for both), as well as in Australasia (Median: 8/10), in comparison to Asia, Africa, and Middle East (for all Median: 6/10, $p < 0.001$). Practitioners expressed concerns about the availability of CLs and CL prescriptions online without direct professional involvement (both 9/10).

Conclusions: Overall, the most appealing opportunities for CL practice growth were identified in occasional use of DD CLs, biocompatible materials to reduce CL discomfort, multifocal CLs for presbyopia correction and management of myopia control with CLs. Lack of regulation in CL sales, especially online, seemed to be a constant threat. The insights from this study can be used to design targeted strategies to enhance CL practice across the globe and in specific geographical areas.

Key words: Contact lens practice, Opportunities, threats

Introduction

Refractive error has been acknowledged as the second greatest cause of avoidable blindness worldwide [1]. This is a matter of significant concern, especially when coupled with the increasing trend in myopia, estimated to affect half the world's population by 2050 [2]. In addition, presbyopia is one of the first signs of ageing and as life expectancy increases, this condition is affecting a higher proportion of the population and for a longer duration [3]. Contact lenses (CLs) are a relatively safe and effective modality for the correction of refractive errors and the estimated number of CL wearers worldwide is approximately 175 million [4]. This number represents a relatively small penetration into the potential market, considering the prevalence of refractive errors (for children <20 years of age, 11.7% have myopia, 4.6% hypermetropia and 14.9% are astigmatic) and the need for refractive correction among the general public [5]. The figures reported by CL manufacturing companies identify some areas of CL market growth [6]; however, it can be argued that the data presented may not be representing increased numbers of CL wearers, but rather a shift in the use of particular types of CLs, such as silicone hydrogel CLs [7] and scleral lens fittings [8]. CL dropout can be included among the current relevant factors limiting CL expansion and, as recently reported, it has remained largely constant over the last decades, despite innovations in the CL industry and clinical practice. The reason for CL dropout is multifactorial and therefore any proposed solutions for dropout are also multifactorial (such as ocular-related factors, lens comfort, visual experience and lens handling)[9, 10]. CL dropout rate varies, depending on geographic location, patient motivation, patient follow up, scope of practice in that country, as well as other factors, such as legislation of optometry profession [11].

CL practice across the world is at juncture with some potential opportunities, such as CLs for myopia control, multifocal lenses for presbyopia and specialty lenses; however, there are also looming threats such as increasing competition from online business. Practitioners across the globe face diverse scopes of practice and training paths [12]. Hence, their experiences and beliefs may reveal different perceptions regarding the future of CL practice and its facets.

The aim of this international survey was to understand the views of CL practitioners regarding what they perceive as opportunities, interventions and threats in CL practice. The findings will enable interested stakeholders to design targeted strategies to enhance CL practice and address the challenges ahead.

Method

Survey Design and Distribution

A survey was developed to seek demographics characteristics, type of practice, and practitioners' point of view on the future of their CL practice over the next five years. The survey was critiqued and refined by the manuscript authors, resulting in nine questions on opportunities (Table 2), five around interventions (Table 3), and twelve on potential threats (Table 4). A '0-10 point' numerical rating scale was used with '0' being not at all and '10' being maximum. The anonymised questionnaire was constructed in English and then translated in six different languages (Spanish, Italian, French, Korean, Russian, and Simplified Chinese) by native dual linguists. Backwards translation by a different translator, followed by review against the original version, ensured that the translation did not impact the meaning of the questions. Ethical clearance was obtained for the survey from Aston University, Birmingham, UK. The survey was distributed online (via social media platforms such as LinkedIn, Facebook, WhatsApp, and mailing lists, and a paper-based version was used in Russia. Reputed international professional bodies and educational institutions were involved in disseminating the survey. The end point was reached when the survey responses plateaued. The online survey could only be completed once from any device (multiple completion from the same device internet protocol address restricted by the software) to reduce accidental bias from multiple completion by an

individual. The survey was circulated between November 2019 and March 2020 (it should be noted that this was before the global COVID-19 pandemic). The responses have been categorised under each country and region they were received from in Table 1.

Statistical analysis

The statistical analysis was performed using SPSS (V 26, IBM, New York, USA). As the data distribution significantly differed from a normal distribution (Shapiro-Wilk; Kolmogorov–Smirnov $p < 0.05$), non-parametric comparisons were performed (Kruskal–Wallis one-way analysis of variance). The statistical significance was taken for p-values lower than 0.05, after having applied Bonferroni correction for multiple comparisons. Only relevant and significant comparisons have been reported for the sake of conciseness. Unless otherwise specified, median values (range) was considered as central tendencies. Generalised linear mixed model (GLMM) was used to verify the authenticity of differences in scores attributed to opportunities, interventions and threats across the geographical areas, while controlling for effect of demographics (age, sex, profession, type of practice and years prescribing CLs). Ordered logistic regression models were constructed with geographical areas as fixed effect, either or not including demographics as random effects for each of the question. Significance was checked for the models and for the interactions of random effects.

Results

Responses

A total of 2408 valid surveys were received and analysed. Responses were from 72 countries across the world: Africa 3.6% (n = 87), Asia 32.1% (n = 773), Australasia 2.5% (n = 60), Europe 35.2% (n = 848), Middle East 10.6% (n = 256), North America 7.0% (n = 169), and South America 8.9% (n = 215), as represented in Figure 1.

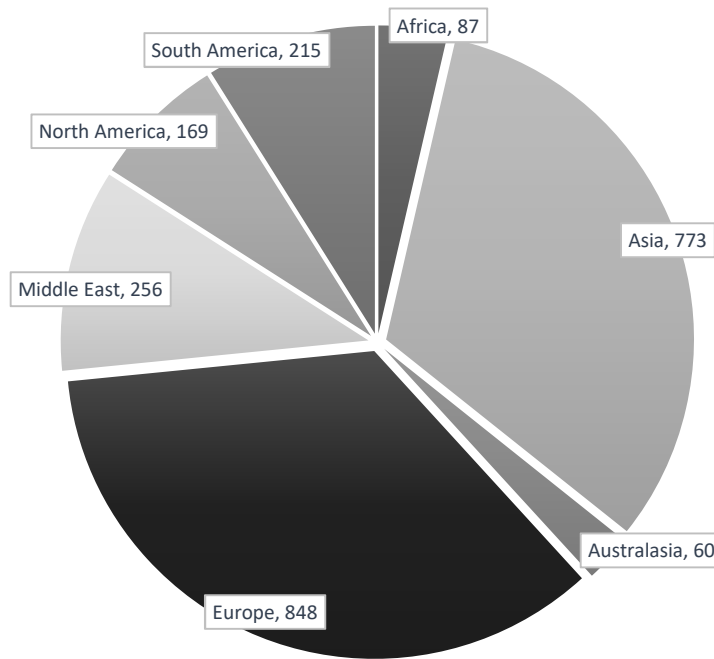


Figure 1. Number of responses received from each geographical area

There was a similar number of female (52%, n=1248) and male (47%, n=1141) respondents. The median age was 37.0 years, ranging from 19 to 82 years old, with a distribution skewed toward lower values. The median duration of working experience was 11.0 years (IQR: 18.0, 4.0 – 22.0).

The majority of responses came from Optometrists, 82.1% (n = 1977), followed by CL specialists, 7.6% (n = 184), Ophthalmologists, 5.2% (n = 126), Opticians, 4.0% (n = 96), and other operators involved in CL practice, 1.0% (n = 24). One response was considered invalid due to ambiguous response.

Table 1 reports the number of responses from each Country, grouped in the geographical areas aforementioned.

Table 1. Number of replies received from each Country, grouped in geographical areas

Africa	87	Australasia	60	Middle East	256
Algeria	1	Australia	41	Bahrain	3
Botswana	4	New Zealand	19	Iraq	2
Ghana	4	Europe	848	Israel	2
Kenya	37	Belgium	7	Jordan	86
Mauritius	1	Bulgaria	1	Kuwait	3
Morocco	1	Czech Republic	1	Lebanon	1
Namibia	1	Denmark	1	Oman	46
Nigeria	1	Finland	12	Qatar	4
South Africa	33	France	60	Saudi Arabia	47
Tunisia	1	Germany	11	United Arab Emirates	62

Uganda	1	Greece	2	North America	169
Zimbabwe	2	Ireland	1	Canada	113
Asia	773	Italy	87	USA	56
China	197	Latvia	2	South America	215
Hong Kong	102	Netherlands	47	Argentina	43
India	159	Norway	1	Bolivia	2
Indonesia	56	Portugal	1	Brazil	1
Malaysia	67	Russia	112	Caribbean	1
Nepal	40	Slovenia	1	Colombia	49
Pakistan	1	Spain	436	Ecuador	30
Philippines	20	Sweden	1	Grenada	1
Singapore	53	Switzerland	10	Guatemala	3
South Korea	47	Ukraine	3	Mexico	65
Sri Lanka	18	United Kingdom	51	Peru	18
Taiwan	12			Uruguay	1
Thailand	1			Venezuela	1
				Total	2408

Of the professionals represented, 48.5% (n = 1167) reported to be working in stand-alone/Independent practices, three-times the values of the Hospital-based practitioners, 16.2% (n = 389), which was the second most represented sub-group; 13.4% (n = 322) of questionnaires were returned by practitioners working in local optical chains and 12.0% (n = 289) in national optical chains, and the least were University based practices 8.3% (n= 199).

GLMM identified that the differences of scores across the geographical areas were significant (all p < 0.05) for all items tested, whether or not demographics were included in the models. In addition, the analysis demonstrated that demographics, included as random factors/covariates, did not show any significant interaction (all p > 0.05).

Potential Opportunities

Overall, multifocal CLs for presbyopia, CLs for myopia control, the use daily disposable (DD) CLs by occasional wearers, and the availability of biocompatible materials to improve comfort (Median: 8/10 for each of them) were perceived by practitioners as promising opportunities for CL practice development. In contrast, the use of diagnostic, therapeutic or bionic CLs, and fitting coloured/cosmetic CLs were perceived as less favourable (Median: 5/10 for both).

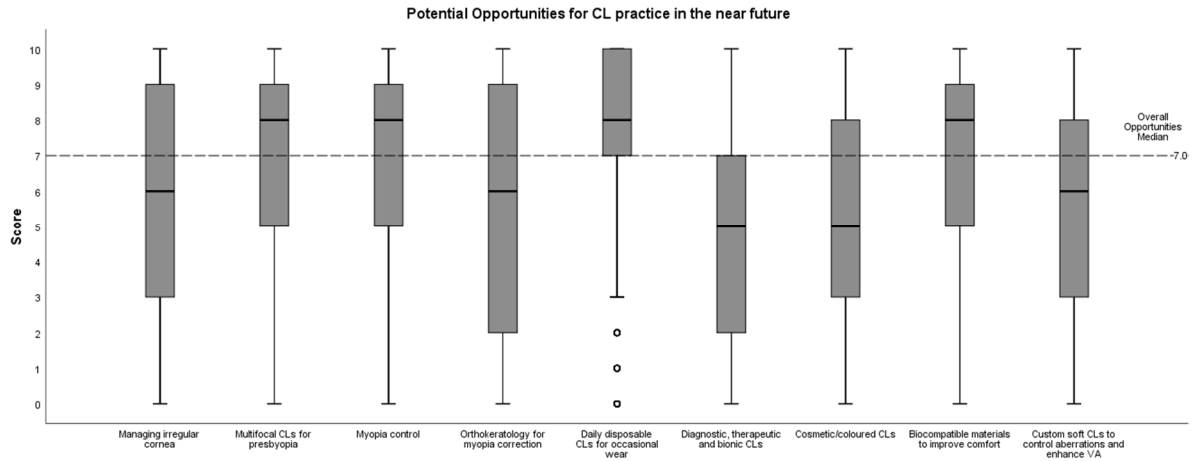


Figure 2. Global average scores for potential opportunities to CL practice in near future, on a scale from 0 (worst) to 10 (best). CL: contact lenses, VA: visual acuity (Median values are represented as lines surrounded by boxes representing upper and lower quartiles; the whiskers demonstrate the 95% confidence interval, with circles for data outside this).

Practitioners across the globe rated use of DD CL for occasional wear favourably (either 8 or 9), although there were statistically significant differences between regions. Nonetheless, practitioners in Australasia, North America, and Europe valued the option moderately more favourable (Median: 9/10 for all) as compared to colleagues in Asia (Median: 8/10, $p < 0.001$), South America (Median: 8/10, $p < 0.01$), and Africa (Median: 8/10, $p < 0.01$). Furthermore, scores from Middle East (Median: 9/10) were statistically higher than from Asia ($p = 0.005$). In terms of biocompatible CL materials to improve comfort, practitioners who rated this opportunity higher were located in Europe, North America, and South America (Median: 8/10 for all precedents), compared to African colleagues (Median: 6/10, $p < 0.05$).

The use of multifocal CLs for presbyopia was perceived as a better opportunity by practitioners in North America and Europe (Median: 9/10 for both), as well as in Australasia (Median: 8/10), in comparison to Asia, Africa, and Middle East (for all Median: 6/10, $p < 0.001$).

For CL management of myopia control, responses were very favourable from Australasia (Median: 9/10), North America, and Europe (Median: 8/10 for both). With lower scores being recorded in Asia

(Median: 7/10, $p < 0.005$), South America (Median: 7/10, $p < 0.05$), Middle East (Median: 6/10, $p < 0.001$), and Africa (Median: 6/10, $p < 0.05$).

There was a greater diversity of opinion recorded with regard to orthokeratology as an option for myopia control. The highest value was registered in Australasia (Median: 9/10), higher than in Europe (Median: 7/10, $p < 0.01$) and Asia (Median: 7/10, $p = 0.001$). For all the preceding regions, the values were higher than in Middle East (Median: 5/10, $p < 0.001$), North America (Median: 4/10, $p < 0.001$), and Africa (Median: 3/10, $p < 0.001$). Values from Australasia ($p < 0.001$) and Europe ($p < 0.05$) were also significantly higher than in South America (Median: 5/10).

Practitioners' opinions regarding coloured/cosmetic CLs showed marked variability across the geographical areas, with the highest scores received from practitioners working in Middle East (Median: 8/10, $p < 0.001$), followed by those in Asia (Median: 7/10, $p < 0.001$), whilst the lowest scores were expressed by Australasian practitioners (Median: 2/10, $p < 0.05$).

Table 2. Global and regional average scores (expressed as median and interquartile range) of potential opportunities, interventions, and threats in CL practice, on a scale from 0 (worst) to 10 (best).

OPPORTUNITIES	Global	Africa	Asia	Australasia	Europe	Middle East	North America	South America
Managing irregular cornea	6.0 (3.0-9.0)	7.0 (3.0-9.0)	6.0 (3.0-8.0)	7.0 (3.3-10.0)	6.0 (3.0-9.0)	7.0 (5.0-8.0)	7.0 (3.0-10.0)	8.0 (6.0-10.0)
Multifocal CLs for presbyopes	8.0 (5.0-9.0)	6.0 (2.0-8.0)	6.0 (4.0-8.0)	8.0 (7.0-10.0)	9.0 (7.0-10.0)	6.0 (3.0-8.0)	9.0 (7.0-10.0)	8.0 (5.0-9.0)
Myopia control	8.0 (5.0-9.0)	6.0 (4.0-8.0)	7.0 (5.0-9.0)	9.0 (7.0-10.0)	8.0 (5.8-10.0)	6.0 (3.0-8.0)	8.0 (6.0-10.0)	7.0 (3.0-9.0)
Orthokeratology for myopia correction	6.0 (2.0-9.0)	3.0 (1.0-7.0)	7.0 (3.0-9.0)	9.0 (6.3-10.0)	7.0 (3.0-9.0)	5.0 (2.0-7.0)	4.0 (0.0-8.0)	5.0 (1.0-8.0)
Daily disposable CLs for occasional wear	8.0 (7.0-10.0)	8.0 (6.0-9.0)	8.0 (6.0-9.0)	9.0 (8.0-10.0)	9.0 (7.0-10.0)	9.0 (7.0-10.0)	9.0 (8.0-10.0)	8.0 (6.0-10.0)
Diagnostic, therapeutic and bionic lenses	5.0 (2.0-7.0)	5.0 (2.0-7.0)	5.0 (2.0-7.0)	4.0 (2.0-7.0)	5.0 (2.0-7.0)	5.0 (3.0-7.0)	5.0 (1.5-8.0)	7.0 (5.0-9.0)
Cosmetic lenses	5.0 (3.0-8.0)	6.0 (3.0-9.0)	7.0 (5.0-9.0)	2.0 (1.0-4.8)	4.0 (2.0-6.0)	8.0 (6.0-10.0)	4.0 (2.0-6.0)	5.0 (3.0-8.0)
Biocompatible materials to improve comfort	8.0 (5.0-9.0)	6.0 (5.0-8.0)	7.0 (5.0-9.0)	7.5 (6.0-9.0)	8.0 (5.0-9.0)	7.0 (5.0-9.0)	8.0 (6.0-9.0)	8.0 (6.0-10.0)
Custom soft CLs to control aberrations and enhance VA	6.0 (3.0-8.0)	6.0 (3.0-8.0)	6.0 (3.0-8.0)	5.0 (2.0-7.0)	6.0 (3.0-8.0)	6.0 (4.0-8.0)	6.0 (3.0-8.0)	8.0 (6.0-10.0)

Potential Interventions

The most relevant actions perceived by practitioners as being valuable interventions were the need for constant updating of knowledge/skills and to become competent in managing CL-related complications (Median: 9/10 for both). In contrast, the use of social media marketing campaigns was less relevant to the respondents (Median: 7/10). Overall, South American practitioners seemed to value the interventions listed, expressing significantly higher aggregate interventions' scores in comparison to the other geographical areas ($p < 0.05$ for), with the exception of their African colleagues ($p > 0.05$).

Table 3. Global and regional average scores (expressed as median and interquartile range) of potential interventions in CL, on a scale from 0 (worst) to 10 (best). CL: contact lenses, DD: daily disposable

INTERVENTIONS	Global	Africa	Asia	Australasia	Europe	Middle East	North America	South America
Continuously updating knowledge/skills of practitioners	9.0 (8.0-10.0)	8.0 (7.0-10.0)	8.0 (7.0-10.0)	8.0 (7.0-8.0)	9.0 (8.0-10.0)	8.0 (7.0-10.0)	8.0 (6.5-10.0)	10.0 (9.0-10.0)
Educating the parents about children to wear CLs	8.0 (7.0-10.0)	8.0 (7.0-9.0)	8.0 (6.0-9.0)	9.0 (8.0-10.0)	9.0 (7.0-10.0)	8.0 (6.0-9.0)	8.0 (7.0-10.0)	10.0 (8.0-10.0)
Being competent in managing CL-related complications	9.0 (8.0-10.0)	8.0 (7.0-10.0)	8.0 (7.0-10.0)	9.0 (8.0-10.0)	9.0 (8.0-10.0)	8.0 (6.0-9.0)	9.0 (7.0-10.0)	10.0 (9.0-10.0)
Making CLs more affordable to patients (especially DD CLs)	8.0 (6.0-9.0)	8.0 (7.0-10.0)	8.0 (6.0-9.0)	7.0 (5.0-9.0)	7.0 (5.0-9.0)	8.0 (6.0-9.8)	7.0 (6.0-9.0)	9.0 (8.0-10.0)
Marketing CL practice on social media	7.0 (5.0-9.0)	8.0 (6.0-9.0)	8.0 (5.0-9.0)	7.0 (5.0-8.0)	7.0 (5.0-9.0)	7.0 (5.0-9.0)	7.0 (5.0-9.0)	8.0 (5.0-10.0)

Perceived Threats

Practitioners expressed concerns regarding the availability of CLs online without practitioners' supervision and the access to CL prescriptions via digital devices (such as on-line remote exams) in absence of direct involvement of the professional (Median: 9/10 for both). Refractive surgery and the innovation of new spectacle designs, as well as the risk of infection related to CLs, were rated as less

concerning among the options proposed (Median: 5/10). Practitioners based in Europe and South America expressed equivalent levels of concern over lack of regulation in CL sales (Median: 9/10), availability of CLs online (Median: 10/10), and their prescription through digital devices (Median: 10/10, $p > 0.05$). While in other geographical areas they showed similar level of concern over those topics, slightly less concern was expressed by practitioners based in Middle East (Medians: 6, 8 and 7/10, respectively). The latter also expressed minor concern with regards to the level of competency of colleagues (Median: 6/10), which was similar to practitioners in Australasia (Median: 5.5/10) and North America (Median: 6/10) ($p > 0.05$), while higher scores were reported in South America (Median: 9/10) and in the other regions (Median: 8/10 for all remaining). The threat of infections related to CL use was indicated as less concerning in North America and Australasia (Median: 4/10 for both), in comparison with those working in South America and Middle East (for both, Median: 6/10, $p < 0.001$), as in Asia and Europe (Median: 5/10, $p < 0.005$).

Table 4. Global and regional average scores (expressed as median and interquartile range) of perceived threats to CL practice, on a scale from 0 (least concern) to 10 (most concerned), CL: contact lenses.

THREATS	Global	Africa	Asia	Australasia	Europe	Middle East	North America	South America
Lack of regulation	8.0 (6.0-10.0)	9.0 (7.0-10.0)	8.0 (5.0-10.0)	8.0 (5.0-10.0)	9.0 (7.0-10.0)	6.0 (4.3-8.0)	8.0 (7.0-10.0)	9.0 (7.0-10.0)
CLs available online without professional supervision	9.0 (7.0-10.0)	9.0 (7.0-10.0)	9.0 (7.0-10.0)	9.0 (7.0-10.0)	10.0 (8.0-10.0)	8.0 (5.0-10.0)	10.0 (8.0-10.0)	10.0 (8.0-10.0)
CL prescriptions available via digital devices	9.0 (7.0-10.0)	8.0 (6.0-10.0)	8.0 (6.0-10.0)	8.5 (7.0-10.0)	10.0 (8.0-10.0)	7.0 (5.0-9.0)	9.0 (8.0-10.0)	10.0 (7.0-10.0)
Clinics without proper instrumentation	8.0 (5.0-10.0)	8.0 (5.0-10.0)	8.0 (5.0-9.0)	7.0 (5.0-9.0)	8.0 (6.0-10.0)	7.0 (4.0-8.0)	8.0 (5.0-10.0)	9.0 (7.0-10.0)
Incompetent practitioners	8.0 (5.0-10.0)	8.0 (5.0-10.0)	8.0 (5.0-9.0)	5.5 (3.0-8.0)	8.0 (5.0-10.0)	6.0 (4.0-8.0)	6.0 (3.0-8.0)	9.0 (5.0-10.0)
Refractive surgeries	5.0 (4.0-7.0)	5.0 (4.0-6.0)	6.0 (4.0-8.0)	4.0 (2.0-6.0)	5.0 (3.0-7.0)	6.0 (5.0-8.0)	4.0 (2.0-5.0)	6.0 (5.0-8.0)
Negative myths about CL among public	6.0 (4.0-8.0)	6.0 (5.0-8.0)	6.0 (5.0-8.0)	5.0 (2.3-6.0)	6.0 (4.0-8.0)	6.0 (4.0-8.0)	4.0 (2.0-6.0)	7.0 (5.0-9.0)
Advances in spectacle industry	5.0 (3.0-7.0)	5.0 (4.0-7.0)	6.0 (5.0-8.0)	3.0 (2.0-5.0)	5.0 (2.0-6.0)	6.0 (4.0-8.0)	4.0 (2.0-5.0)	6.0 (4.0-8.0)
	8.0	7.0	7.0	8.0	8.0	6.0	8.0	8.0

Commoditization of CL (i.e. not considered as medical device)	(5.0-10.0)	(5.0-9.0)	(5.0-8.5)	(5.0-10.0)	(5.0-10.0)	(5.0-8.0)	(7.0-10.0)	(6.0-10.0)
	7.0	6.0	6.0	6.0	7.0	6.0	7.0	7.0
Dropout due to discomfort/dryness	(5.0-8.0)	(5.0-8.0)	(5.0-8.0)	(5.0-8.0)	(5.0-8.0)	(5.0-8.0)	(5.0-8.0)	(5.0-9.0)
	5.0	5.0	5.0	4.0	5.0	6.0	4.0	6.0
CL-related infections	(3.0-7.0)	(3.0-6.0)	(4.0-8.0)	(2.0-6.0)	(3.0-7.0)	(4.0-7.0)	(2.0-5.0)	(4.0-8.0)
	7.0	7.0	7.0	7.0	7.0	6.0	6.0	8.0
Unfavourable industry policies	(5.0-9.0)	(5.0-9.0)	(5.0-8.0)	(5.0-8.0)	(5.0-9.0)	(4.0-8.0)	(5.0-8.0)	(5.0-10.0)

Discussion

The strength of this survey lies in its global reach and the number of responses received from a variety of CL markets. The survey was sent to CL practitioners across the globe. The responses received reflect that CLs are mainly prescribed by optometrists [82.1% (n = 1977)] in most countries. The information can provide a solid base for devising future strategies to support CL practitioners worldwide and to inform the CL industry. As the survey was developed and administered before the COVID-19 pandemic, no questions specific to COVID-19 and its impact were included.

The views of practitioners involved in CL fitting were collected from 72 Countries around the world with the intention of establishing what facets of CL practice were perceived to be most relevant. The majority of responders were optometrists, of which 3 out of 4 worked in clinical practices, either in independent practices or local and national retail chains. The inclusive nature of the survey does not allow the response rate to be determined, but the high level of response compared to other practitioner surveys [13] suggests good coverage and engagement; bias from open surveys may arise from more engaged individuals responding, skewing the data, and this could have impacted both the threats and opportunities identified. However, the, GLMM analysis revealed that the differences of scores attributed to opportunities, interventions and threats across the geographical areas reported are genuine and not the result of artefacts related to demographics sampling differences. The regional classification was based on the geographical location. One of the limitations of the survey was the number of responses received from various countries were not proportional to their population. Hence a median value might be skewed to those countries in a region where the response rate was disproportionately higher. However, scaling responses according to population size would ignore other factors such as current CL usage and totally negate the contribution of smaller countries, so was

not applied. The response rate is much lower in countries such as the USA than expected perhaps due to the methods of advertisement employed; there were no respondents from Japan, perhaps due to a language barrier, while other countries were very engaged such as Spain. Within regions, median income can vary significantly and this could impact eye care practitioners reflection on opportunities and threats such on the use of multifocal lenses. However, there are other factors that could influence attitudes such as cultural, regulatory/legal and environmental, hence why the data has been analysed by region.

Opportunities

In recent years the CL market has seen an influx of new products and advances in CL technologies. Respondents to the survey seem to have understood the opportunity new products provided and assigned highest scores to potential opportunities offered by daily disposable lenses, new biocompatible materials, multifocal CLs for presbyopia and CL management of myopia control. [3, 14, 15]. This indicates that practitioners do see newer types of CLs, innovation in CL industry and products as an opportunity to increase CL recommendation to a wider population. However, identifying opportunities and needs does not directly translate to changes in practice, with the need for further education often cited as a reason for a lack of engagement [13].

Type of CL. The use of DD CLs was evaluated highly by practitioners worldwide, despite the question asked specifically relating to occasional wear. The use of DD CLs has been constantly increasing in recent years[7], which may be related to , the fast adaptation in neophytes [16], fewer complications resulting from the reduced usage of CL cases and care regimens [17], and the reduction of clinical [18] and subclinical [19] adverse ocular reactions. Some of the adverse reactions are related to CL storage cases and care regimens neither of which are necessary with compliant DD lens use.

In addition, silicone hydrogel CLs [20], soon after they were introduced into the market, gained prominent positioning in the sector, now accounting for almost two thirds of the DD CL market [7] [21]. To date, the safest mode of CL wear reported is DD CLs [22], and they are reputed as the best

option by practitioners in terms of safety and comfort. The perceived higher cost is the main barrier to increased DD prescribing [23], which has been acknowledged in this survey, with the need to make CLs more affordable to patients, especially DD CLs. However, occasional use of DD CLs can compensate for the more expensive unit price [24, 25]. Hence, occasional use of DD CLs in addition to regular use provides immense opportunities for expanding the CL market in the near future and leads us to surmise that DD CL wear will dominate the market share [7].

Contact Lens (CL) materials to improve comfort. A major issue leading to CL discontinuation is ocular discomfort and dryness during CL wear [26] which was perceived, by survey respondents, as a potential threat to future CL practice (Global median: 7/10). Accordingly, practitioners acknowledged the benefits offered by new biocompatible materials that reduce discomfort (Global Median: 8/10). CL associated discomfort is multifactorial and is associated with patient related as well as CL related factors. Although it has been reported that CL-related discomfort can be associated with geometrical characteristics and mobility of CLs, as well as the material [27, 28, 29], lens surface lubricity and a low modulus appear to be key in optimising lens material-related comfort [30, 31].

Multifocal CLs. In recent years, there have been many new multifocal CLs that have augmented the interest in practitioners and their presbyopic patients. Nonetheless, although increased, the percentage of multifocal CL fittings was found to be a relatively small part of the CL market [6, 7], if compared to the percentage of the population who can benefit from presbyopia corrections and may consider CLs as an alternative option to spectacles. The highest scores occurred in the regions with the oldest median ages, being , Europe and North America (for both, Median score: 9/10), whose population median ages have been estimated respectively as 42.5 and 38.6 years [32], indicating that approximately half of the population may be included in the presbyopic age range. This suggests that in those areas there may be a greater opportunity to increase the market share of multifocal CL dispensed. Vision is a critical factor with CL wearing presbyopes [9, 10], so astigmatism must be fully corrected and regular contact kept with the patient after fitting to ensure vision is optimised [34] [35]. Aesthetic benefits have been identified as a major reason for CL wear [36] [37], suggesting that the correction of presbyopia through CL-based approaches (e.g. multifocal CLs, conventional/modified

monovision) can be considered as a suitable option also for emmetropic presbyopes who may prefer not to wear spectacles.

Myopia Management. The opportunity offered by the CL management of myopia progression was positively evaluated by practitioners. During recent years, there has been a dramatic increase in interest in this topic, in light of the evidence suggesting that specific types of CL design can slow/reduce the progression of myopia [38, 39]. However, while it has been advocated to discard single vision CLs in favour of more effective peripheral defocusing optics specifically designed for myopia control [40], almost two thirds of suitable wearers were still prescribed with single vision spectacles and/or CLs still, with increased costs and inadequate information being cited as main deterrent [13]. Geographical variations in the evaluation of this potential opportunity may be based on differences in myopia prevalence across the world and also on regional product availability, such as availability of orthokeratology and myopic control approved soft lenses. African practitioners did not score myopia management as a potential opportunity, presumably as they deal with one of the lowest prevalence of myopia in school children in the world, and they may be more focused on the large portion of undiscovered refractive errors in children [41]. Lower rates of myopia prevalence in school children, and the high proportion of uncorrected refractive errors were identified also in Middle East [42] [43] [44] and South America [45] [46], which explains the similarity of opportunity noted by practitioners. The management of myopia control with CLs was positively evaluated by Asian practitioners (Median: 7/10). Nonetheless, it could be assumed that the score was as high in other areas due to the differences in myopia prevalence within Asia, including both countries with high (e.g. China 65% [46] and South Korea 52% [48]) and relatively lower prevalence (e.g. India 13% [49] and Indonesia 33% [50]). European and North American practitioners expressed comparable high scores on this potential opportunity (Median: 8/10), while characterized, apart from national variability across regions, by analogous myopia prevalence (42.7% [51] vs 42.2% [52]), [2]. In Australasia, although the prevalence of myopia is not among the highest globally, [53], myopia management by CLs was considered a great opportunity (Median: 9/10) by practitioners. This can be attributed to higher awareness among practitioners and also due to increased continuing education programs for practitioners on myopia management. Thus, in conjunction with the estimates on increasing myopia

prevalence in the forthcoming decades [2], data depicted the need to develop new approaches to myopia management, for example, by educating parents about myopia management with CLs (Median: 8/10).

Orthokeratology for myopia correction. Orthokeratology is considered to be an effective, relatively safe and well accepted correction modality to compensate for myopia [54, 55]. Nonetheless, the distribution of this type of fitting has been attributed to a reduced group of practitioners devoted to orthokeratology mainly for myopia control and mostly based in Europe and Australasia [56][57]. This study showed that orthokeratology was considered a more valuable opportunity in regions where this modality was already well established.

Coloured CLs. The opinions about the coloured/cosmetic CLs were extremely varied across geographical areas. Practitioners in Middle East viewed coloured CL as more of an opportunity (Median: 8/10), followed by Asia (Median: 7/10). In contrast, Australasian practitioners were very sceptical about this opportunity (Median: 2/10), confirming that these types of CLs are appreciated depending on the geographical region, population demographics and the culture as reported earlier [58]. Noticeably, practitioners in North America (Median: 4/10) reported cosmetic CLs are more connected to non-legal purchase, in particular via online sources, and as linked to the development of CL-related complication, despite the FDA and professional bodies regulating this type of CLs [59].

Diagnostic, therapeutic, and bionic lenses. Innovative uses of CLs have been proposed, including devices able to monitor health biomarkers (intraocular pressure, glucose level) and ocular drug delivery [60]. For the latter, different delivery modalities have been evaluated [61] and, despite current limits, ocular drug delivery through CLs was still considered promising. Similar results were found in a recent study in the UK, where almost 60% of the responders (mainly pharmacists) stated that they would prescribe/dispense CLs to treat ocular disease [62]. In examining the scores received in this survey (Global median: 5/10), it is important to note that professionals responding from different countries held various scopes of practice - often not including diagnosis and pharmacological management of ocular pathologies - and that opportunity may have been considered to be outside their scope of practice.

Managing irregular corneas and custom soft CLs to control aberrations and enhance VA. Products such as those to manage irregular corneas, orthokeratology for myopia correction alone and custom aberration-control designed soft CLs can all be considered to be specialty CLs that require specific knowledge and experience [62, 63], as well as additional equipment in a clinical settings [64]. Due to varying level of education and practice of professionals in this global survey, it can be assumed that practitioners perceived limitations to these options and did not view the opportunities very highly. Aside from the partial and diverse regulations typical of the emerging field [65], this could be explained by the level of education in the region, availability of equipment and practice standards in specific countries.

Threats

Regulatory and perception. Despite the bright future delineated by practitioners linked to DD and multifocal CLs, the fear of losing control over CL fitting due to unregulated sale of CL online was perceived as a major threat. There are high and widespread (with the exception of a few regional differences) levels of concern regarding the availability of CLs online and their prescription via digital devices without practitioner involvement or supervision (Median: 9/10 for both). To similar extent, there are concerns about the lack of regulation in CL sales and the commoditization of CLs (Median: 8/10 for both), while the presence of negative myths about CL among the public appeared less worrying to practitioners (Median: 6/10). The unregulated supply of CLs with associated lower levels of compliance and lack of after-care visits can result in a higher risk of CL related complications. [66-72]

CL-related complications. While ECPs rated competence in managing CL-related complications as an opportunity (Median: 9/10), contact lens complications are common and remain a concern. These complications, very different in their severity, also differ in their frequency[73], and ECPs are more concerned with discomfort/dryness, (Median: 7/10) than CL-related infection (Median: 5/10), perhaps because they deal with it often and it can result in dropout.

Quality of service and competitors. In general, practitioners revealed a similar degree of scepticism about the quality of service offered in CL practice because of inadequacy of instrumentation and level of competencies of their colleagues (Median: 8/10), assuming that both can affect CL practice. Interestingly, practitioners have not reported major menacing challenge to CL practice by either refractive surgery or innovations in new spectacle design (Median: 5/10 for both). While for the latter, mutual benefit has been demonstrated to CL and spectacle business segment in implementing the two correction modalities [74], noticeably refractive surgery was not seen as a competitor for CL market. The results of this survey will help the practitioners understand the opportunities available to proactively recommend CL to patients in their country/region and to use the opportunities to increase the number of CL wearers globally. Results of this study also help the CL industry to develop strategies for better CL penetration as it provides information on both the opportunities and the threats perceived by CL practitioners.

Conclusions

Practitioners all around the globe recognised the multifaceted nature of CL practice and indicated potential areas of expansion of their CL practice. Overall, the most appealing opportunities for CL practice growth were identified in the occasional use of DD CLs, the innovations in CL materials to reduce CL discomfort, the application of multifocal CLs for presbyopia correction, and the management of myopia control with CLs. In addition, practitioners strongly expressed the desire to develop and update their professional knowledge and skills, in particular regarding the management of CL-related complications. The lack of regulation in CL sales, especially online, seems to be a constant threat. The insights from this study can be used to design targeted strategies to enhance the CL practice across the globe and in specific geographical areas.

Acknowledgements

The survey was conducted with the support of many associations and individuals devoted to CL education and practice around the world. In particular- International Association of Contact Lens

Educators (IACLE), British Contact Lens Association (BCLA), College of Optometrists (UK), Centre for Ocular Research and Education (CORE), Contact Lens Spectrum, Cornea & Contact Lens Society Australia (CCLSA), Spanish General Council of the Colleges of Opticians-Optometrists, Stuti Misra, John Swallow, Connie Tsung, Sabastian Marx, Augustine Nti, Bismark Owusu-Afryie, and Manish Mathur.

The survey was not funded by any external entity. The authors as well as the associations involved had no financial interest or conflicts in the project.

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