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ABSTRACT

Purpose: The aim of this cross-sectional study was to survey Australian optometrists regarding their attitudes towards, and knowledge of, blue light-blocking lenses designed to attenuate blue light transmission to the eye.

Methods: A 29-item survey was distributed at a major national optometry education conference and through professional networks. Respondents provided information regarding their demographics and practice modalities, knowledge about the potential effects of blue light, and attitudes towards prescribing blue light-blocking ophthalmic devices. Ordinal logistic regression analysis was performed to assess the factors that predicted optometrists' prescribing of blue light-blocking lenses.

Results: Of 372 respondents, 75.3% indicated prescribing blue light-blocking spectacle lenses in their clinical practice. Forty-four per cent of optometrists considered daily environmental exposure to blue light as a potential cause of retinal damage, and approximately half of respondents thought blue light emitted from computer screens was an important factor in causing computer vision syndrome. About half of optometrists considered placebo effects to potentially play a role, at least sometimes, in patients' experiences with blue light-blocking lenses. Most optometrists estimated that they first prescribed a blue light-blocking lens in 2016. The most common reason optometrists prescribed these devices was for patients who were computer or electronic device users (87.9%). The two main sources of information used to guide practitioners' management approaches were conference presentations and manufacturer product information. Practitioners were significantly more likely to prescribe blue light-blocking lenses if they considered blue light to cause either retinal damage (odds ratio, OR 2.28, 95%CI 1.34-3.88, *P*=0.002) or computer vision syndrome (OR 2.52, 95%CI 1.41-1.51, *P*=0.002) compared with practitioners who did not consider such factors to be relevant.

Conclusion: Prescribing trends by Australian optometrists in relation to blue light-blocking lenses reflect the inconclusive nature of several aspects of the evidence in this field. Blue light-blocking lens prescribing has increased since 2010, despite practitioners acknowledging the lack of high-quality evidence to support their use and also commonly believing that placebo effects may have a role in patient responses to these lenses. Information from this study will help inform the development of resources to guide evidence-based prescribing of blue light-blocking lens products.

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INTRODUCTION

Blue light, or short-wavelength light in the visible electromagnetic spectrum, ranges from approximately 380 to 500 nm and carries the highest amount of energy per photon.[1] Blue light exposure has been found to regulate normal biological and physiological functions, such as the circadian rhythm,[2] sleep propensity[3] and the pupillary light reflex.[4] However, high intensity blue light exposure can cause adverse effects in the retina in animals,[5,6] and has been hypothesised to cause retinal damage in humans.[7] Recently, prolonged exposure to blue light emitted from the electronic devices, such as computer and mobile phone screens, has been suggested to induce eye strain[8] (a condition referred to as computer vision syndrome - CVS), and alterations to sleep patterns with night-time exposure.[9]

Blue light-filtering devices, such as spectacle and intraocular lenses, commonly known as blue light-blocking lenses, have been introduced into ophthalmic practice, and it has been suggested that these lenses may protect the eyes from any potential adverse effects of blue light.[10,11] A number of marketing claims have been made regarding the potential benefits of blue light-blocking devices, which include alleviation of ocular discomfort and eye strain with computer use, improving sleep, and providing protection from retinal phototoxicity.[12] The potential detrimental effects of blue light have also captured the attention of the mainstream media, with reports that exposure to blue light may cause ocular discomfort,[13] retinal damage,[12] ageing of the skin,[14] prostate cancer[15] and alterations to sleep cycles.[13] Some claims made by industry regarding the potential beneficial effect(s) of blue light blocking devices are not without controversy.[16] In the United Kingdom (UK), the Advertising Standard Authority (ASA) prohibited a national press advertisement made by an optical retailer, which had publicised that blue light-blocking lens products reduced retinal damage. The ASA found it to be a "misleading advertisement", as there was insufficient clinical evidence to support the claim that blue light causes retinal damage.[17]

The optical and clinical performance of blue light-blocking spectacle lenses has been relatively understudied compared with blue light-filtering intraocular lenses.[18,19] Leung *et al.*[10] conducted a pseudo-randomised study to investigate if blue light attenuation affected visual performance and sleep quality. The study outcomes, after one month of blue light-blocking lens wear, showed no significant difference in contrast testing (with and without glare), colour discrimination, or sleep quality. However, compliance with the spectacle intervention during the study period was not assessed. More recently, a systematic review

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and meta-analysis by Lawrenson *et al*.[20] considered the potential benefits and harms of blue light-blocking spectacle lenses on visual performance, macular health, and the sleep wake cycle, and found no significant difference in any of these parameters, relative to standard (non-blue blocking) spectacle lenses. The authors concluded that high quality clinical trials are required to achieve greater clarity with regard to the potential effects of blue light-blocking lenses on ocular health, sleep patterns and eye strain.

Whether to prescribe blue light-blocking lenses in routine optometric clinical practice is still the subject of debate.[21] Currently, there are no clinical guidelines to guide practice in this area. Whether a blue light-blocking lens is prescribed (or not prescribed) by an eye care clinician may depend on the practitioner's knowledge and attitudes towards these devices. To date, no studies have assessed practitioners' attitudes towards blue light-blocking lenses and/or whether current practice patterns are consistent with the best available research evidence. Hence, the present study sought to survey Australian optometrists' knowledge, attitudes, and their prescribing patterns, as related to blue light-blocking spectacle lenses.

METHODS

This cross-sectional survey-based study was performed between May 2018 and August 2018, and involved registered Australian optometrists. Ethics approval was granted by The University of Melbourne Human Research Ethics Committee (ID #1851566), and our study complied with the Declaration of Helsinki.

Practitioner survey

The self-administered, anonymous questionnaire consisted of 29 items, developed by the study researchers (provided in *Appendix 1*). The questionnaire consisted of six main sections: (1) Practitioner demographics and practice modality; (2) Knowledge about blue light and its potential adverse ocular effects; (3) Method of diagnosis and management of computer vision syndrome (CVS); (4) Frequency of prescribing blue light-blocking lenses; (5) Blue light-blocking spectacle lens prescribing practices; and (6) Perception regarding the quality of evidence relating to the clinical application of blue light-blocking spectacle lenses. The

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questions within each section required responses that included: Yes/No; Select one option only; Select all options that apply; and five-point Likert-type scales. The questions surveyed in each section are summarised in *Table 1*.

The survey was initially piloted among five optometrists in order to assess the clarity of the questions and the time commitment required. Minor changes were made to the questionnaire based on their feedback, and the required time to complete the survey was approximately five minutes. A written statement at the beginning of the survey indicated that the questionnaire was to be completed by registered Australian optometrists only, and submission of the survey implied their consent to participate in the study.

The questionnaire was circulated both in hard copy, at the largest Australian optometry education conference (Southern Regional Congress, Melbourne, May 2018, attended by approximately 800 delegates from around Australia), and electronically via a link to the survey through relevant professional networks (Optical Prescription Spectacle Makers (OPSM) via an email invitation to 391 optometrists, and the Mivision ophthalmic publication via posting on the Mivision website), between May 2018 and August 2018. OPSM is a corporate optometry chain, with practices in Australia and New Zealand, and Mivision is a free, unrefereed ophthalmic journal distributed to subscribers in the Asia-Pacific region (www.minivision.com.au). The online version of the survey was hosted through SurveyMonkey® (www.surveymonkey.com). In the online version of the survey, respondents could not alter responses to previous questions as they progressed through the questionnaire.

Sample size

A sample size calculation[22] determined that for a total population of ~5500 Australian optometrists, a sample of 360 responses was required to achieve a representative response with a margin error of ±5% and confidence level of 95%.

Data analysis

Results from the online responses were exported from SurveyMonkey into a Microsoft Excel 2016 spreadsheet (www.microsoft.com), and were collated with the manually entered responses from the hard copy surveys, for analysis. Survey responses were not included if

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the respondent had completed the survey before, was currently practising outside of Australia, or omitted more than two questions.

Statistical analysis was performed using IBM SPSS® statistics software version 21.0 (https://www.ibm.com/analytics/spss-statistics-software). As manufacturer information regarding the amount of blue light attenuation was available online for only two products – Essilor Crizal Prevencia and Essilor Eyezen (www.essilor.com/en)[23,24] - for other products, information reported in the literature was used.[10]

Univariate and multivariate ordinal logistic regression analyses were performed to assess if the following factors influenced a practitioner's self-reported prescribing of blue light-blocking spectacle lenses: belief that blue light causes retinal damage or CVS; accurate knowledge of the wavelengths of blue light; belief about whether high quality evidence supports the efficacy of blue-blocking lenses for managing CVS; belief that placebo effects have a role in patient experiences with blue-blocking lenses; principal type of work; and years of optometric practicing experience. A P value of less than 0.05 defined statistical significance.

RESULTS

Response rate

Survey responses were received from 326 optometrists (out of ~800 attendees) who attended the optometry education conference (response rate: 41%). For the online version of the survey, 139 optometrists (OPSM, n=94; Mivision, n=45) responded. The response rate from e-mail invitations sent to optometrists practicing at OPSM was 16.4%. For Mivision, as the survey link was posted on a webpage, the true response rate could not be estimated. After screening for the inclusion/exclusion criteria (detailed in the Methods section), data from 56 (17.2%) responders from the education conference and 37 (26.6%) responders (OPSM, n=30; Mivision, n=7) from the online survey were excluded. Overall, 372 surveys were included in the analysis.

Practitioner demographics

Respondents' demographics are summarised in *Table 2*. Most respondents worked in corporate (47.7%) or independent practice (41.4%). Respondents' years of optometric

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practice experience ranged from less than one year to greater than 21 years. On average, respondents worked 33 hours per week in optometric practice, and the majority (78.5%) were endorsed to prescribe scheduled topical therapeutic medications. Survey responses were received from optometrists practicing in all states and territories of Australia, distributed as: Victoria (54.2%), New South Wales (15.3%), Queensland (10.9%), Western Australia (8.7%), Australian Capital Territory (3.0%), South Australia (2.5%), Tasmania (2.7%), and the Northern Territory (2.7%).

Practitioners' perceptions and knowledge of blue light and its ocular effects

Overall, 44.1% optometrists considered daily exposure to blue light to be a cause retinal damage, with remaining respondents responding that they either did not consider daily blue light exposure to cause retinal damage (21.5%) or that they were unsure of its retinal effects (34.4%). Similarly, approximately half of optometrists nominated blue light emitted from computer screens as a cause of CVS. Almost one-third of respondents were unsure of the association between blue light and CVS, and 17% did not consider blue light to be a cause of CVS. The majority of practitioners (96.0%) identified spectacle lenses as a method for attenuating blue light transmission to the eye, followed by changing the internal setting of electronic devices (81.5%), adding a filter attachment to screens (75.6%), sunglasses (55.1%), intraocular lenses (47.3%), downloadable software (37.1%), contact lenses (32.5%), and other devices (3.0%).

Figure 1A summarises the environmental sources that practitioners considered to be clinically important with respect to their level of blue light emission. Mobile phones (77.3%) were considered most important, followed by tablets (68.9%) and the sun (57.8%). In total, 208 respondents (56.4%) correctly identified the wavelength range of blue light (400–500 nm) in the electromagnetic spectrum. In assessing practitioners' perceptions towards the role of blue light in influencing visual and physiological functions (*Figure 1B*), 90.0% of respondents nominated blue light to be important for regulating sleep patterns, followed by colour vision (40.0%), and contrast sensitivity (30.0%).

Practitioners' clinical practice patterns relating to the management of computer vision syndrome and prescription of blue-blocking lens products

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Figure 2 summarises practitioners' methods for diagnosing and managing CVS. Most optometrists considered patient symptoms (87.4%) to be important for diagnosing CVS, followed by specific history questions about computer use or related visual tasks (82.8%), and binocular vision assessment (72.0%). The majority of respondents (86.8%) nominated the use of a spectacle lens correction to manage CVS, followed by advice on visual hygiene (83.6%), and prescription of ocular lubricants (78.5%). In terms of the primary practice personnel member involved in making recommendations about spectacle lens materials and/or coatings to patients, 71.7% of respondents nominated the optometrist, followed by the dispensing optician (27.7%) and receptionist/other staff member (0.6%).

Figure 3 shows optometrists' frequency of prescribing, or making recommendations with respect to, blue light-blocking spectacle and intraocular lenses, respectively. Four out of five practitioners were found to have never recommended blue light-blocking intraocular lenses to their patients undergoing cataract surgery. On assessing practitioners' reasons for not recommending blue light-blocking intraocular lenses, 68.8% reported it to be the role of ophthalmologists to select the intraocular lens product, 31.3% were not aware of these lenses, and 9.9% considered these lenses to not be clinically justified. Less than 1% of practitioners never examined cataract patients in their clinical practice.

In total, 280 practitioners (75.3%) self-reported recommending blue light-blocking spectacle lenses in their clinical practice, and 92 practitioners (24.7%) reported never prescribing these lenses. The most common reasons for not prescribing blue light-blocking lenses were a perception that they were not clinically justified (54.4%), lack of availability in the respondents' clinical practice (34.8%), and lack of awareness about these products (9.8%).

Practitioners' clinical practice patterns relating to blue light-blocking spectacle lenses

On average, in the 12 months preceding the survey, 30% of spectacle lens products prescribed by practitioners were estimated to be blue light-blocking lenses. In terms of the patient age ranges these products were prescribed to, 92.9% of optometrists commonly prescribed blue light-blocking lenses to patients aged between 21-40 years, 62.9% to those aged between 11-20 years, 58.9% to those aged between 41-60 years, and 23.9% to those aged 60 and above. Only 19.6% of practitioners prescribed blue light-blocking lenses to patients aged between 0-10 years.

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The most common year when practitioners prescribed their first blue light-blocking lens product was 2016 (33.1%), followed by 2017 (32.3%). About 3% of respondents indicated beginning to prescribe blue light-blocking lenses prior to 2010.

The following were the main reasons for prescribing blue light blocking spectacle lenses: the patient is a computer or electronic device user (87.9%); the patient has symptoms of CVS (75.4%); the patient specifically requests these lenses (72.9%); practitioner belief that the lenses act as a general safety measure against harmful effects of blue light (38.2%); and because these lenses are an important revenue stream (12.1%).

Figure 4A summarises the sources of information and/or evidence respondents used to guide their clinical decision-making regarding blue light-blocking lenses. Conference presentations (50%) and manufacturer product information (47.5%) were the major sources. Published research papers were nominated by 43.2% of the respondents and systematic reviews were selected by 15.8% of practitioners. The most commonly prescribed blue light-blocking lens brands (*Figure 4B*) were Essilor Crizal Prevencia (72.1%), Essilor Eyezen (32.5%), and Hoya Blue Control lenses (30.7%). As shown in *Figure 5*, there was a major divergence between practitioner's perceptions regarding the degree of blue light filtered by each lens brand compared with the actual amount filtered, with practitioners typically overestimating the percentage of attenuation.

Practitioners' perceptions regarding the efficacy and evidence for blue light-blocking lenses

Most practitioners (53%) considered placebo effects to play a role at least 'sometimes' in patients' experiences with blue light-blocking lens products (*Figure 6A*). Practitioners were fairly evenly divided in terms of their beliefs as to whether advertisements for blue-blocking products provided an accurate representation of the risks associated with blue light exposure (*Figure 6B*). About half of respondents thought that the quality of evidence supporting the use of blue light-blocking lenses for managing CVS was low (49.1%), with others believing there was moderate evidence (40.1%) or no published evidence (7.1%). Few (3.8%) believed there was high quality evidence.

Predictive factors for prescribing blue light-blocking spectacle lenses

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Table 3 summarises the predictive factors for optometrists prescribing blue light-blocking spectacle lenses. In univariate analysis, practitioners were significantly more likely to prescribe these lenses if they considered blue light to cause either retinal damage (odds ratio, OR 3.67, 95% CI 2.23 to 6.03, $P \leq 0.001$) or CVS (OR 4.59, 95% CI 2.69 to 7.84, $P \leq 0.001$). Practitioners were significantly less likely to prescribe blue light-blocking lenses if they considered the quality of published evidence for their use in managing CVS to be "low" (OR 0.44, 95% CI: 0.21 to 0.93, $P = 0.031$). Likewise, the likelihood of prescribing blue light blocking lenses systematically declined as the practitioners' belief that they worked via placebo increased. All of these factors, except for the association between published evidence quality and prescribing, were also significant in the multivariate analysis (*Table 2*). As no association was found between practitioners' tendency to prescribe blue light-blocking lenses and their response accuracy to selecting the wavelength range of blue light in the electromagnetic spectrum, principal type of optometric practice or years of optometric experience, these variables were not included in the multivariate analysis.

DISCUSSION

This is the first study to analyse the knowledge, attitudes and practice patterns of optometrists towards prescribing devices that attenuate the transmission of blue light. The survey achieved a representative response rate for Australian optometrists, including those practicing in all states and territories, with a diverse range of clinical experience and practice modalities. Notably, 75% of optometrists indicated that they recommend blue light-blocking spectacle lenses to their patients. Furthermore, respondents estimated that ~30% of spectacle lens products prescribed in the 12-month period preceding the survey had blue light-filtering properties, with most recalling that they first prescribed this type of lens in 2016. Together, these findings indicate that prescribing of these products is highly prevalent within the Australian optometric profession, particularly over the past two years.

We found that 40% of respondents considered daily blue light exposure to be a cause of retinal damage. The rationale for blue light-inducing retinal injury derives primarily from animal model and cell culture studies,[5,6] where retinal changes have been reported following

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exposure to high intensity blue light. More recently, O'Hagan *et al.*[25] investigated blue light exposure from electronic devices, such as computer screens and mobile phones, and noted that the amount of blue light emitted from these devices was almost 1000-fold less than the levels in natural daylight. Blue light emissions from electronic devices are also well within the international safety exposure limits defined by the International Commission on Non-ionising Radiation Protection (ICNIRP).[26] It is therefore interesting that more survey respondents (77%) considered mobile phones as a clinically important environmental source of blue light, compared with emissions from sunlight (58% of respondents). Currently, the potential for environmental blue light exposure to cause retinal phototoxicity in humans is unproven, and whether findings from animal studies are transferable to humans remains questionable.[27]

Although 50% of optometrists nominated blue light from computer screens as a cause of CVS, there is a paucity of literature to corroborate this perception. Patient symptoms were most commonly used to assess CVS, with few practitioners (4%) using validated CVS questionnaires. As described by Downie *et al.*,[28] in the context of dry eye disease, this may be due to a lack of practitioner knowledge about the availability of validated symptom surveys, poor understanding of their usefulness compared with standard history taking and/or the perception that questionnaires may be time consuming to perform in clinical practice. Most respondents nominated spectacle lens corrections as their preferred method for managing CVS; other common strategies were visual hygiene and ocular lubricants. With regard to the role of blue light-blocking spectacle lenses in alleviating symptoms of eye strain associated with computer use, the evidence for their efficacy is relatively poor, and any potential mechanism of action remains unknown.[20] This is consistent with most practitioners considering a placebo effect to contribute to the clinical performance of these devices in at least some patients (*Figure 6*), and that such beliefs were associated with lower prescribing rates (*Table 2*).

Whilst we acknowledge the limitation that self-reporting may not reflect actual practice, as described by Theodossiades *et al.*[29] (2012) with respect to glaucoma clinical testing, the two main reasons cited by practitioners for prescribing blue light-blocking lenses were if the patient was a computer/electronic device user or had symptoms of CVS. About one in eight

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respondents also nominated these lenses to be an important revenue stream. This latter finding is not unexpected, given that optometry (as a profession) relies substantially on the revenue derived from the sale of optical appliances, including all forms of spectacles and contact lenses.

The majority (~90%) of respondents considered blue light to be important for regulating sleep patterns. Ostrin *et al.*[3] reported improvements in subjective sleep quality (by ~24 minutes/night) and an increase in night time melatonin levels with evening wear of blue light blocking lenses, in 21 healthy participants. However, these results should be interpreted with caution, and with acknowledgement of the potential contribution of a placebo effect, as the study was an open-label single-arm trial, and thus the participants might have been aware of the expected clinical outcomes. It is important to consider the magnitude of the placebo response when prescribing blue light-blocking lenses, as in a real-world clinical scenario, expectation from the patient and/or motivation from the clinician may contribute to placebo effects.[30] This effect has been well explored in the psychological domain, where it has been shown that a clinician's choice of words to frame the expected effect(s) of an intervention can strongly influence the level of placebo response.[31]

Regarding the source(s) of information used by the practitioners to inform their blue light-blocking spectacle lens prescribing practices, half of respondents nominated using information from conference presentations. Similar results have been reported in the context of guiding clinical decision making in other areas of optometric practice, including dry eye disease and age-related macular degeneration.[28,32-34] These findings emphasise the need for continuing education to be founded on rigorous evidence, to ensure the appropriate translation of research findings into clinical practice. There are currently no clinical guidelines available for prescribing blue light-blocking lenses. Of the low percentage (4%) of optometrists who indicated that they did use clinical guidelines to inform their prescribing practices, this may reflect a desire to be seen as practicing within the scope of any presumed guidelines (despite not actually doing so) and/or considering other information (e.g., manufacturer product information) as guidelines. Nearly half of respondents relied on manufacturer product information to guide their clinical decision-making. As described by Suttle,[35] in her recent editorial, such information should be interpreted with caution due to the

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potential for bias and/or a reliance on anecdotal reports (such as patient testimonials) rather than rigorous research evidence.

We found substantial discrepancy between practitioners' knowledge of the percentage of blue light filtered by different lens products and the actual amount of blue light attenuation. Although the cause of this discrepancy is not clear, it may reflect that manufacturers do not routinely provided precise information about the lens transmission characteristics. It is also not unreasonable that a practitioner might consider that a relatively large reduction in blue light transmission might be required to substantially modulate any ill-effects of blue light exposure, as these lenses are claimed to do.[12] This might partly explain why optometrists overestimated the level of blue blocking capacity of these lenses, compared with the typically low amount of blue light attenuation (around 20%, or 0.1 log units) achieved. A further consideration is that blue light represents a range of wavelengths, and so quantifying transmittance via a single number is potentially ambiguous.

Our study provides valuable insight into the current knowledge and attitude of Australian optometrists, as related to prescribing blue light-blocking spectacle lenses. The findings suggest that, in recent years, the trend of prescribing blue light-blocking lenses has increased, despite practitioners acknowledging the lack of high quality evidence to support their use and also commonly believing that placebo effects may play a role in patient responses to these lenses. In clinical practice, spectacle lenses are selected based on a variety of factors that are not necessarily related to their blue light-blocking properties – such as availability, cost, and optical properties – and so it might be that modern lens forms are selected in spite of their blue light-blocking effects, rather than because of them. Unfortunately, an assessment of these other factors was beyond the scope of our current study. Our results do, however, clearly highlight where knowledge about the properties and efficacy of blue light-blocking lenses can be improved, which may help in forming guidelines for evidence-based prescribing of blue light-blocking lenses and informing future education programs for eye care practitioners.

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DISCLOSURE: The authors report no conflicts of interest and have no proprietary interest in any of the materials mentioned in this article.

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REFERENCES

1. Sliney DH. What is light? The visible spectrum and beyond. *Eye (Lond)* 2016; 30: 222-229.

2. Dijk DJ & Archer SN. Light, sleep, and circadian rhythms: together again. *PLoS Biol* 2009; 7: e1000145.

3. Ostrin LA, Abbott KS & Queener HM. Attenuation of short wavelengths alters sleep and the ipRGC pupil response. *Ophthalmic Physiol Opt* 2017; 37:440-450.

4. Kardon R, Anderson SC & Damarjian TG, *et al*. Chromatic pupil responses: preferential activation of the melanopsin-mediated versus outer photoreceptor-mediated pupil light reflex. *Ophthalmology* 2009;116: 1564-1573.

5. Noell WK, Walker VS, Kang BS & Berman S. Retinal damage by light in rats. *Invest Ophthalmol* 1966; 5: 450-473.

6. Ham WT Jr, Ruffolo JJ Jr, Mueller HA, Clarke AM & Moon ME. Histologic analysis of photochemical lesions produced in rhesus retina by short-wave-length light. *Invest Ophthalmol Vis Sci* 1978;17: 1029-1035.

7. Wu, J, Seregard S & Algvere, PV. Photochemical damage of the retina. *Surv Ophthalmol* 2006; 51: 461-481.

8. Sheppard AL & Wolffsohn JS. Digital eye strain: prevalence, measurement and amelioration. *BMJ Open Ophthalmol* 2018; 3: e000146.

9. Dijk DJ & Archer SN. Light, sleep, and circadian rhythms: together again. *PLoS Biol* 2009; 7: e1000145.

10. Leung TW, Li RW & Kee CS. Blue-light filtering spectacle lenses: optical and clinical performances. *PLoS One* 2017; 12: e0169114.

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11. Henderson BA & Grimes KJ. Blue-blocking IOLs: a complete review of the literature. *Surv Ophthalmol* 2010; 55: 284-289.

12. Website: 'Blue Light Exposed', Available from: http://www.bluelightexposed.com/; accessed 16 October 2018.

13. Website: 'Prevent Blindness', Available from: https://www.preventblindness.org/blue-light-and-your-eyes/; accessed 16 October 2018.

14. Website: 'Health', Available from: https://www.health.com/skin-cancer/blue-light-skincare-protection/; accessed on 16 October 2018.

15. Website: 'Men'sHealth', Available from: https://www.menshealth.com/health/a20087180/prostate-cancer-blue-light-smartphones/; accessed on 16 October 2018.

16. Byrne S. 3 Blue blockers put to the test. Consumer Reports. 2016. Accessed 16 October 2018. Available at: https://www.consumerreports.org/eyeglass-stores/3-blue-blockers-put-to-the-test/

17. United Kingdom Advertising Standards Authority (ASA). ASA Ruling on Boots Professional Services Ltd t/a Boots Opticians Ltd. 2015. Accessed 16 October 2018. Available at: https://www.asa.org.uk/rulings/boots-professional-services-ltd-a15-293200.html/

18. Downie LE, Busija L & Keller PR. Blue-light filtering intraocular lenses (IOLs) for protecting macular health. *Cochrane Database Syst Rev* 2018 May 22;5:CD011977.

19. Downie LE, Wormald R & Evans J, *et al*. Analysis of a systematic review about blue light-filtering intraocular lenses for retinal protection: understanding the limitations of the evidence. *JAMA Ophthalmol* 2019. Feb 21. doi: 10.1001/jamaophthalmol.2019.0019. [Epub ahead of print]

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20. Lawrenson JG, Hull CC & Downie LE. The effect of blue-light blocking spectacle lenses on visual performance, macular health and the sleep-wake cycle: a systematic review of the literature. *Ophthalmic Physiol Opt* 2017; 37: 644-654.

21. Downie LE. Blue-light filtering ophthalmic lenses: to prescribe, or not to prescribe?. *Ophthalmic Physiol Opt* 2017; 37: 640-643.

22. Bartlett JE, Kotrlik JW & Higgins CC. Organisational research: determining appropriate sample size in survey research. *Inf Technol Learn Perform J* 2001; 19: 43–50.

23. Website: 'essilorusa', Available from: https://www.essilorusa.com/content/dam/essilor-redesign/product resources/crizal/Crizal%20Prevencia+%20ECP%20Sales%20Aid.pdf/; Accessed on 18 November 2018.

24. Website: 'essilorusa', Available from: https://www.essilorusa.com/products/eyezen/blue-light-filter-technology/; Accessed on 18 November 2018.

25. O'Hagan JB, Khazova M & Price LL. Low-energy light bulbs, computers, tablets and the blue light hazard. *Eye (Lond)* 2016; 30: 230-233.

26. International Commission on Non-ionizing Radiation Protection. Guidelines on limits of exposure to incoherent visible and infrared radiation. *Health Phys* 2013; 105: 74–96.

27. Margrain TH, Boulton M, Marshall J & Sliney DH. Do blue light filters confer protection against age-related macular degeneration? *Prog Retin Eye Res* 2004; 23: 523-531.

28. Downie LE, Keller PR & Vingrys AJ. An evidence-based analysis of Australian optometrists' dry eye practices. *Optom Vis Sci* 2013; 90: 1385-1395.

Author Manuscript

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29. Theodossiades J, Myint J, Murdoch IE, Edgar DF & Lawrenson JG. Does optometrists' self-reported practice in glaucoma detection predict actual practice as determined by standardised patients? *Ophthalmic Physiol Opt* 2012; 32:234-241.

30. Benedetti F. How the doctor's words affect the patient's brain. *Eval Health Prof* 2002; 25: 369-386.

31. Benedetti F. Placebo and the new physiology of the doctor-patient relationship. *Physiol Rev* 2013; 93: 1207-1246.

32. Xue AL, Downie LE, Ormonde SE & Craig JP. A comparison of the self-reported dry eye practices of New Zealand optometrists and ophthalmologists. *Ophthalmic Physiol Opt* 2017; 37:191-201.

33. Downie LE, Rumney N, Gad A, Keller PR, Purslow C & Vingrys AJ. Comparing self-reported optometric dry eye clinical practices in Australia and the United Kingdom: is there scope for practice improvement? *Ophthalmic Physiol Opt* 2016; 36:140-151.

34. Downie LE & Keller PR. The self-reported clinical practice behaviors of Australian optometrists as related to smoking, diet and nutritional supplementation. *PLoS One* 2015; 10: e0124533.

35. Suttle CM. Marketing and anecdotal evidence should not guide the delivery of optometric interventions. *Ophthalmic Physiol Opt* 2019; 39:63-65.

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FIGURE LEGENDS

Figure 1. (A) Percentage of respondents who considered each source to emit clinically important levels of blue light. LCD, Liquid Crystal Display computer screen; LED, Light Emitting Diode light source; E-reader, Electronic-reader; CRT, Cathode Ray Tube; O-LED, Organic Light Emitting Diode screen. (B) Percentage of respondents who considered blue light to play an important role for each function.

Figure 2. (A) Assessment methods used to diagnose computer vision syndrome (CVS). (B) Use of treatment options for managing CVS.

Figure 3. Self-reported frequency of prescribing, or making recommendations with respect to, blue light-blocking spectacle, and intraocular lenses, respectively.

Figure 4. (A) Percentage of respondents who nominated each source of information and/or evidence for guiding their clinical decision-making in relation to prescribing blue light-blocking lenses. (B) Percentage of respondents who selected each brand as the primary type of blue light-blocking spectacle lens they prescribe in clinical practice.

Figure 5. Box and whiskers plot showing the comparison between practitioners' perceptions about the percentage of blue light filtered by different lens products, relative to the degree of filtering specified in the relevant product information or literature (Leung *et al.*[10]). The box and whiskers plot denotes the minimum, the 25th percentile, the median, the 75th percentile, and the maximum. The grey cross denotes the amount of blue light filtered by the lens brands, as per the product information and that reported in the literature. Only products with a response rate of ≥10% are shown.

Figure 6. (A) Percentage of respondents who selected each frequency regarding the perceived role of placebo effects in patients' experiences with blue blocking spectacle lenses. (B) Percentage of respondents who selected each level of agreement in relation to the statement: "Advertisements for blue-blocking products provide an accurate representation of the risks associated with blue light exposure."

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Table 1. Summary of the survey categories and questions

Question category	Questions surveyed
Practitioners demographics and practice modality	(1) Gender (2) Forced choice (yes/no) selection of whether their optometry training was completed in Australia (3) Year of optometry graduation (4) Forced choice (yes/no) selection of endorsement to prescribe scheduled ocular therapeutics (5) Average number of hours worked per week (6) Principal type of work (i.e., academic, Independent practice, corporate practice, hospital clinic, refractive surgery clinic, public health clinic, other) (7) Postcode of principal place of practice (8) Forced choice selection (yes/no) to whether they have completed this survey before
Knowledge of blue light and its potential ocular effects	(1) Forced choice (yes/no/not sure) selection to whether they considered daily environmental exposure to blue light to cause retinal damage (2) Selection of an unrestricted number of responses from eight options of their perception with regard to currently-available methods to block the transmission of blue light (3) Selection of an unrestricted number of responses from 11 options regarding what sources they considered clinically important in terms of the level of blue light emission (4) Forced choice selection, from four options in 100nm ranges, to nominate the wavelength range of blue light in the electromagnetic spectrum (5) Selection of an unrestricted number of responses, from six options of visual and physiological functions, for which parameters blue light is considered important
CVS diagnosis and management	(1) Forced choice (yes/no/not sure) selection of their perception about whether blue light emitted from computer screens can cause CVS (2) Selection of an unrestricted number of responses from nine options regarding the clinical tests considered to be important in assessment of CVS (3) Selection of an unrestricted number of responses from eight options regarding the treatment options used to manage CVS
Frequency of prescribing blue light blocking	(1) Forced choice (dispensing optician/optometrists/receptionist or other staff) selection for who is primarily responsible for recommending spectacle lens materials and/or coating(s) to patients in their practice (2) Selecting the frequency of recommending blue blocking intraocular lenses, when

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lenses	referring a patient for cataract surgery, on a five-step Likert scale (3) Selecting the frequency of recommending blue blocking spectacle lenses to patients, on a five-step Likert scale
Blue light blocking spectacle lens prescribing practices	(1) Open answer response to estimate the year when they prescribed their first blue blocking spectacle lens product (2) Estimating the percentage of spectacle lenses prescribed in the past 12 months that had a blue blocking filter, using a visual analogue scale ranging from 0 to 100% (3) Selecting the patient age group(s) (from five categories) to which they commonly prescribed blue blocking spectacle lenses (4) Unrestricted number of selections from six options for the reasons for prescribing blue blocking spectacle lenses (5) Unrestricted number of selections from eight options for the information and/or evidence sources used to guide their clinical decision making with regards to prescribing blue blocking lenses (6) Unrestricted number of selections from different brands of blue blocking lenses prescribed in their clinical practice (7) Force choice selection to nominate the brand of blue blocking lens (from nine options), most commonly prescribed in their clinical practice
Perceptions towards the evidence relating to blue light blocking spectacle lenses	(1) Forced choice selection (strongly disagree/disagree/neither agree nor-disagree/agree/strongly agree) to indicate their level of agreement with the following statement: "Advertisements for blue-blocking products provide an accurate representation of the risks associated with blue light exposure" (2) Forced choice selection (Never/occasionally/sometimes/mostly/always)) to indicate if they consider placebo effects to play a role in patient experiences with blue blocking lenses (3) Forced choice selection (low/moderate/high/there is no published evidence) to indicate their perception of the quality of evidence available for supporting the efficacy of blue blocking lenses for management of CVS

CVS, Computer Vision Syndrome

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Table 2. Summary of participant demographics

Characteristic	Number of responses (%)
Gender (*n* = 372)	
Male	162 (43.5)
Female	209 (56.2)
Other	1 (0.3)
Therapeutically endorsed (*n* = 372)	
Yes	292 (78.5)
No	80 (21.5)
Principal type of optometric practice (*n* = 367)	
Academic	23 (6.3)
Private (Independent practice)	152 (41.4)

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Corporate practice	175 (47.7)
Hospital clinic	1 (0.3)
Refractive surgery clinic	2 (0.5)
Public health clinic	7 (1.9)
Other	7 (1.9)
Years of optometric practice (*n* = 372)	
0-5 years	114 (30.7)
6-10 years	58 (15.6)
11-15 years	42 (11.3)
16-20 years	29 (7.8)
> 21 years	129 (34.7)

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Table 3. Predictive factors for optometrists prescribing blue light blocking spectacle lenses

Factors	Univariate analysis	Multivariate analysis

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	OR (95% CI)	P value	OR (95% CI)	P value
Blue light causes retinal damage				
No	Ref		Ref	
Yes	3.67 (2.23 – 6.03)	**<0.001**	2.28 (1.34 – 3.88)	**0.002**
Not sure	1.70 (1.02 – 2.83)	**0.040**	1.54 (0.89 – 2.66)	0.119
Wavelength of blue light				
Incorrect	Ref			
Correct	1.40 (0.96 – 2.02)	0.077		
Blue light causes CVS				
No	Ref		Ref	
Yes	4.59 (2.69 – 7.84)	**<0.001**	2.52 (1.41 – 4.50)	**0.002**
Not sure	1.59 (0.90 – 2.78)	0.108	1.32 (0.73 – 2.37)	0.354
What do you think is the quality of evidence supporting the efficacy of blue blocking lenses for management of CVS				
No published evidence	Ref		Ref	
Low	0.44 (0.21 – 0.93)	**0.031**	0.47 (0.22 – 1.00)	0.050
Moderate	1.52 (0.72 – 3.23)	0.272	1.12 (0.51 – 2.44)	0.784
High	2.68 (0.82 – 8.74)	0.102	1.40 (0.42 – 4.74)	0.586
Practice type^				
Corporate	Ref			
Independent	0.81 (0.55 – 1.20)	0.294		
Experience				
0 – 10 years	Ref			
11 -20 years	1.20 (0.73 – 1.98)	0.469		
>20 years	1.15 (0.76 – 1.73)	0.504		
Do you think placebo effect could play a role in patient experiences with blue blocking lenses				

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Never	Ref		Ref	
Occasionally	0.28 (0.10 – 0.80)	**0.017**	0.34 (0.12 – 1.00)	**0.049**
Sometimes	0.14 (0.05 – 0.39)	**<0.001**	0.25 (0.09 – 0.71)	**0.009**
Mostly	0.06 (0.02 – 0.18)	**<0.001**	0.16 (0.05 – 0.50)	**0.002**
Always	0.09 (0.02 – 0.39)	**0.001**	0.18 (0.04 – 0.81)	**0.025**

CVS, Computer Vision Syndrome.

^For principal type of optometric practice, academia, hospital clinic, public health clinic, refractive surgery clinic and others were not included as the samples were less than 25 in each of the category.

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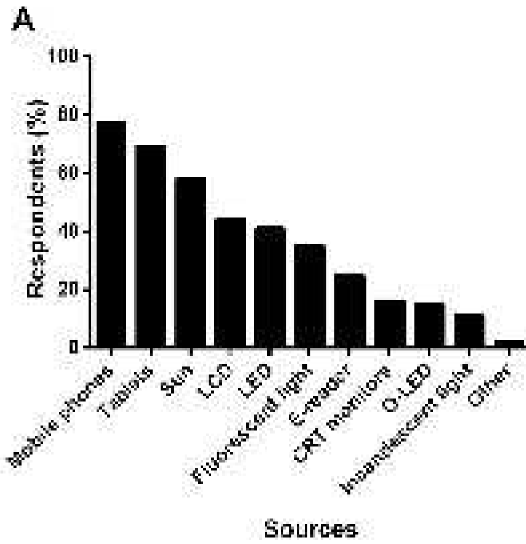

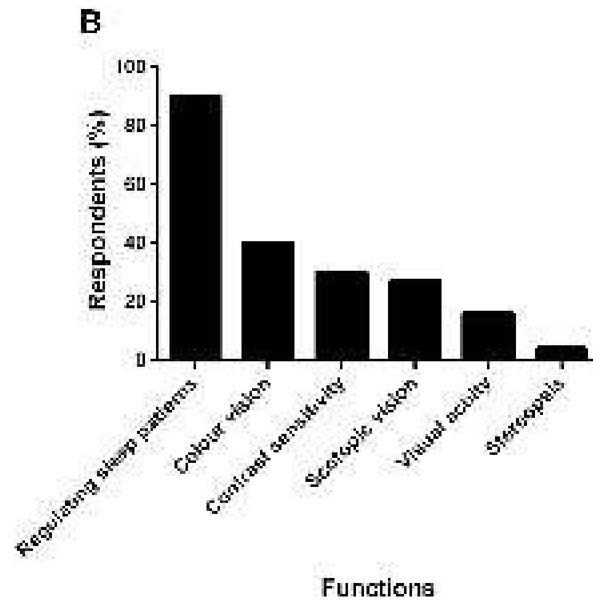

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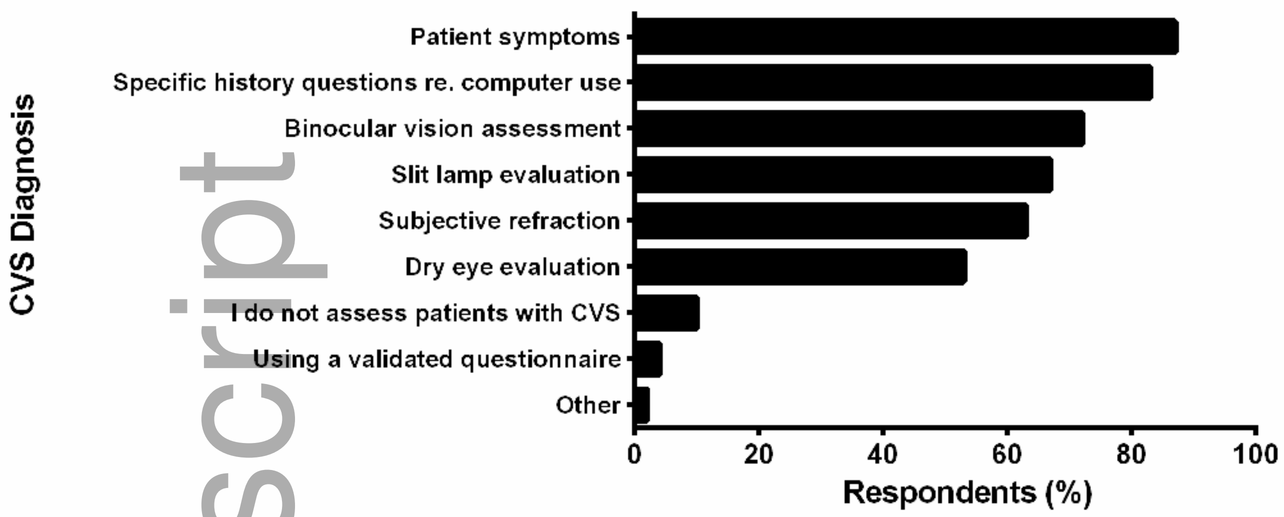

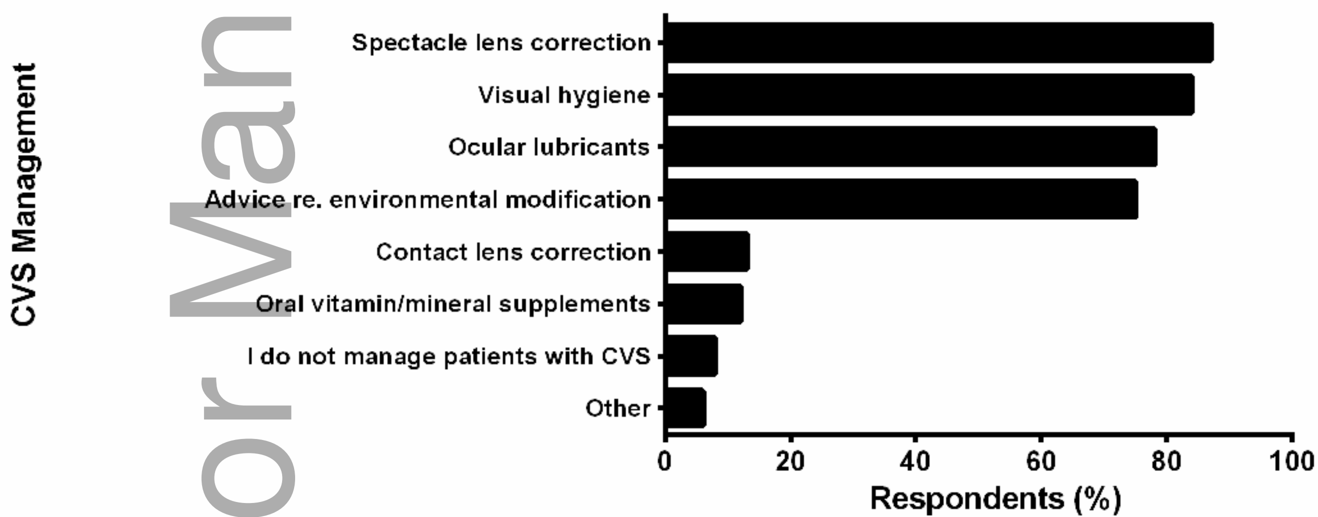

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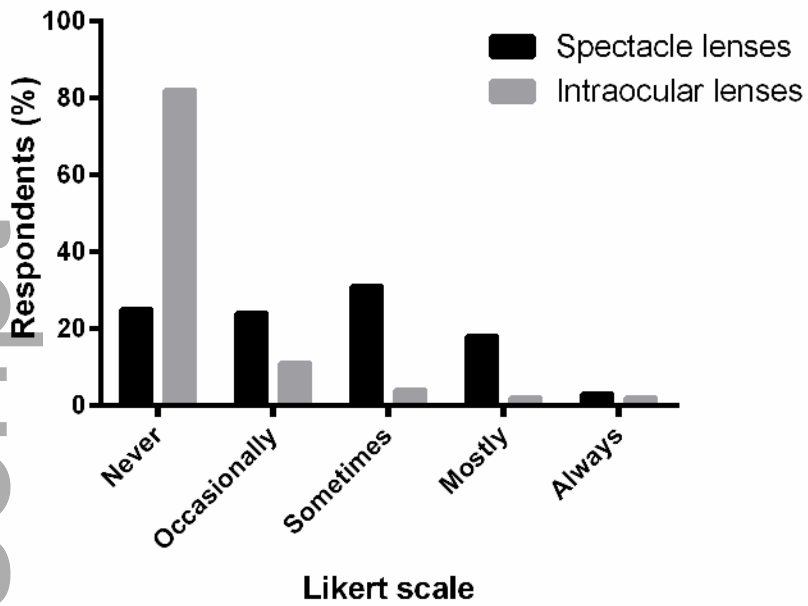

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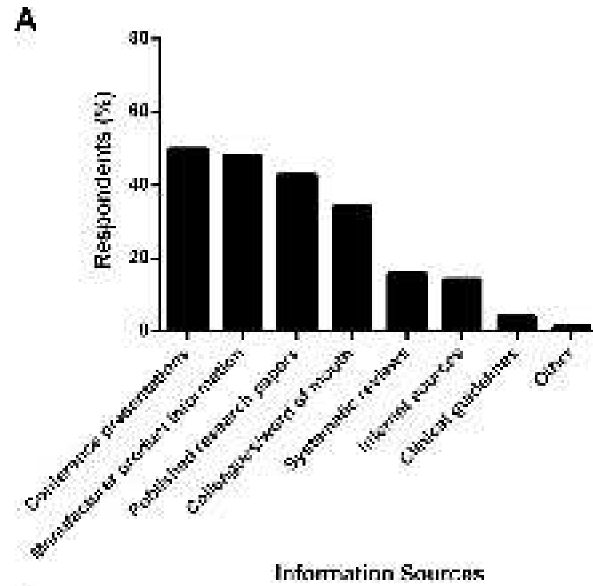

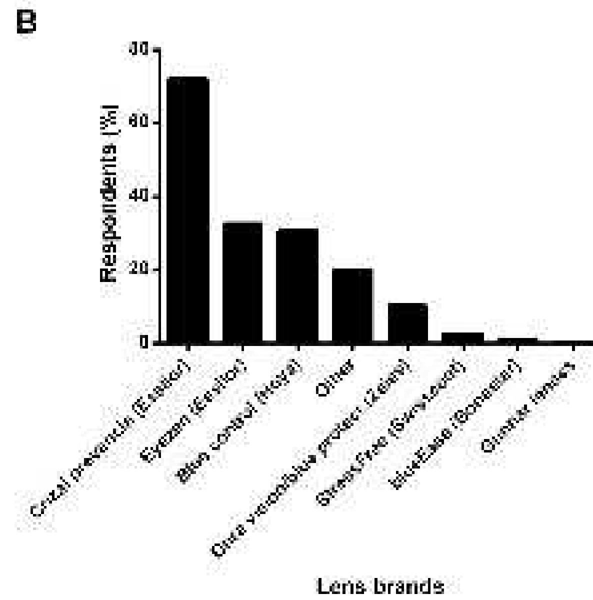

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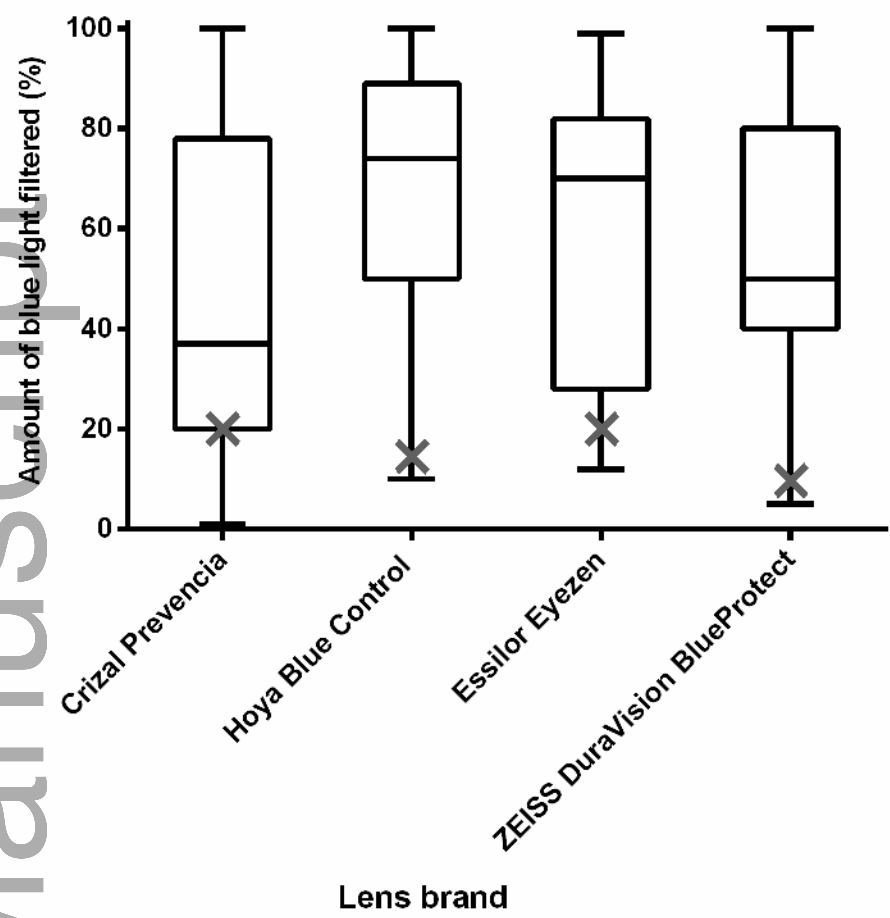

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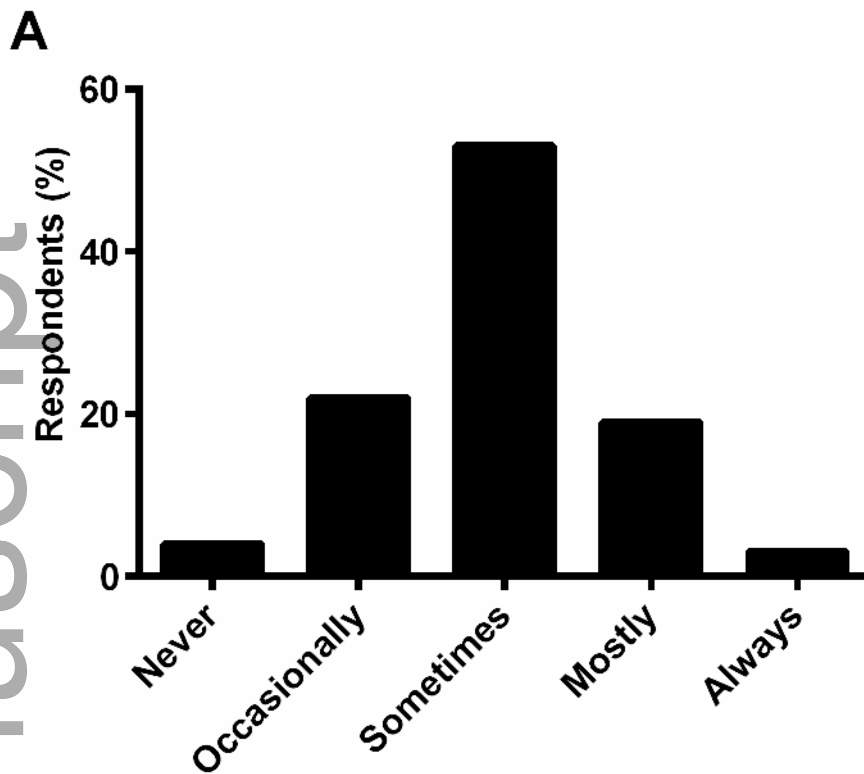

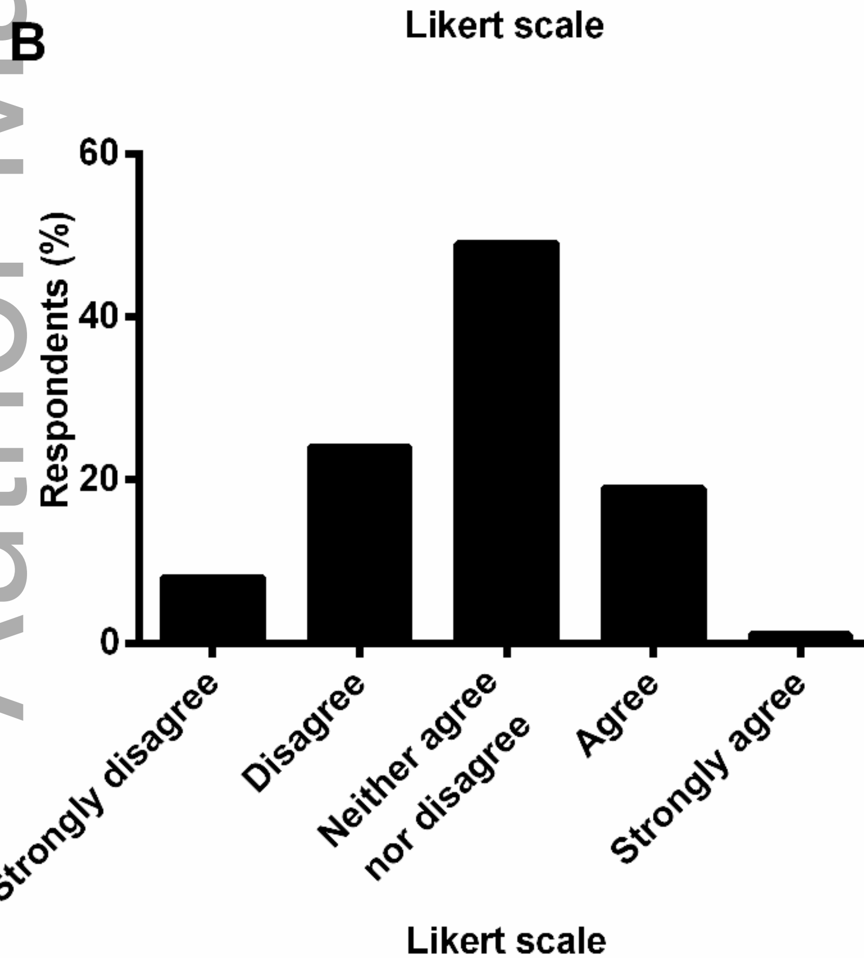

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