Received: 13 May 2022 | Accepted: 1 July 2022 | Published online: 04 August 2022

DOI: 10.1111/opo.13034

OPO THE COLLEGE OF OPTOMETRISTS

ORIGINAL ARTICLE

Attitudes of optometrists towards artificial intelligence for the diagnosis of retinal disease: A cross-sectional mail-out survey

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Funding information
Guide Dogs NSW/ACT

Abstract

Purpose: Artificial intelligence (AI)-based systems have demonstrated great potential in improving the diagnostic accuracy of retinal disease but are yet to achieve widespread acceptance in routine clinical practice. Clinician attitudes are known to influence implementation. Therefore, this study aimed to identify optometrists' attitudes towards the use of AI to assist in diagnosing retinal disease.

Methods: A paper-based survey was designed to assess general attitudes towards AI in diagnosing retinal disease and motivators/barriers for future use. Two clinical scenarios for using AI were evaluated: (1) at the point of care to obtain a diagnostic recommendation, versus (2) after the consultation to provide a second opinion. Relationships between participant characteristics and attitudes towards AI were explored. The survey was mailed to 252 randomly selected practising optometrists across Australia, with repeat mail-outs to non-respondents.

Results: The response rate was 53% (133/252). Respondents' mean (SD) age was 42.7 (13.3) years, and 44.4% (59/133) identified as female, whilst 1.5% (2/133) identified as gender diverse. The mean number of years practising in primary eye care was 18.8 (13.2) years with 64.7% (86/133) working in an independently owned practice.

On average, responding optometrists reported positive attitudes (mean score 4.0 out of 5, SD 0.8) towards using AI as a tool to aid the diagnosis of retinal disease, and would be more likely to use AI if it is proven to increase patient access to healthcare (mean score 4.4 out of 5, SD 0.6). Furthermore, optometrists expressed a statistically significant preference for using AI after the consultation to provide a second opinion rather than during the consultation, at the point-of-care (+0.12, $p = 0.01$).

Conclusions: Optometrists have positive attitudes towards the future use of AI as an aid to diagnose retinal disease. Understanding clinician attitudes and preferences for using AI may help maximise its clinical potential and ensure its successful translation into practice.

KEYWORDS
artificial intelligence, clinical decision support, machine learning, optometrists, survey

INTRODUCTION

In 2019, the World Health Organization estimated 1.02 billion people around the world were at high risk of developing retinal disease that could lead to blindness.[1] Recently, machine learning techniques have come to the forefront of clinical decision support systems, with a landmark study demonstrating that a machine learning algorithm could detect major retinal disease with high diagnostic accuracy (area under the receiver operating characteristic curve [aROC] 0.991, 95% confidence interval [95% CI] 0.988 to 0.993).[2] Yet, the widespread acceptance of machine learning into routine clinical practice has not been achieved, likely in part due to a general misunderstanding and distrust of artificial intelligence (AI) applications.[3]

Medical professionals have highlighted their concerns about new technologies compromising existing standards of professional autonomy and independent decision-making.[4] This fear of losing control was echoed by dermatologists in a recent survey that also identified the greatest barrier to implementing AI in practice as its potential to disrupt the physician–patient relationship.[5] Meanwhile, a survey of mixed medical specialities reliant on imaging (ophthalmology, dermatology, radiology and radiation oncology) revealed a general belief that AI would improve their field of medicine in the future, particularly regarding access to disease screening and clinicians' diagnostic confidence. However, only 15.7% (48/305) of ophthalmologist respondents reported actually using AI-derived algorithms in their daily practice.[6] Interestingly, ophthalmologists believed AI would have a greater impact on optometry than upon their own speciality.[6] We are unaware of any studies that have solicited the attitudes of optometrists towards the use of AI in their daily practice.

The purpose of this survey was to identify optometrists' attitudes towards the use of AI in clinical practice to assist in diagnosing retinal disease. Two clinical scenarios were presented: the first described an instance where AI is used to obtain a likely diagnosis from an optical coherence tomography (OCT) scan at the point-of-care; the second described an instance where the clinician makes a tentative diagnosis during the examination; then, the AI is run overnight to process the patient's OCT scan and provide a second opinion the following morning.

Key points

- Optometrists regard artificial intelligence-based systems as exciting and promising tools to aid in the diagnosis of retinal disease.
- Optometrists are open to using artificial intelligence under different clinical scenarios, and their attitudes are not significantly influenced by most individual and workplace characteristics, including age, gender and workplace location.
- Future validation of patient-centred benefits through high-quality clinical trials may help maximise the potential of artificial intelligence in optometric practice.

METHODS

Researchers at the Centre for Eye Health (University of New South Wales, Sydney) designed and conducted a cross-sectional mail-out survey of randomly selected optometrists across Australia. The research protocol was approved by the University of New South Wales Human Research Ethics Advisory Committee (HC210014; February 2021).

Survey instrument design

The survey design was shaped by a comprehensive review of the literature. Previously published surveys evaluating healthcare professionals' attitudes towards AI were identified by searching PubMed using the following key terms: *artificial intelligence*, *clinician attitudes*, *digital health technologies* and *survey*. A list of topic areas and specific questions were then collated from these retrieved articles, with a particular focus on the work by Jungmann et al.[7] and the Allied Health Professions Australia software and digital health survey,[8] and revised into a draft instrument.

The draft survey was piloted on six optometrists from the Centre for Eye Health. Feedback was primarily directed at changing ambiguous or poorly worded items and face validity. Appropriate modifications were made until no further feedback was received. The final eight-page self-administered survey (Figure S1) was structured into four sections:

1. Section 1 contained a combination of multiple choice, multiple response and short-answer questions on participant characteristics: gender, age, work experience and workplace characteristics.
2. Section 2 solicited attitudes towards the use of advanced algorithms with properties similar to AI.
3. Section 3 presented Clinical Scenario 1 and solicited attitudes towards the use of AI. Clinical Scenario 1 described an instance where AI is used to evaluate an OCT scan and generate a diagnostic recommendation during the examination, at the 'point-of-care'.
4. Section 4 presented Clinical Scenario 2 and solicited attitudes towards the use of AI. Clinical Scenario 2 described an instance where AI is used after the examination (run overnight) to process an OCT scan and provide a 'second opinion' on diagnosis that would be available for review the following morning.

At the end of the survey, an open-ended question allowed general comments.

In Sections 2 to 4, agreement with specific statements was ranked on a 5-point Likert scale: strongly disagree (score 1); disagree (score 2); neither agree nor disagree (score 3); agree (score 4); strongly agree (score 5). Because Likert scales represent ranked categorical levels of strength of agreement or disagreement on an ordinal scale,[9] overall item responses were mapped to appropriate descriptive statements by rounding the mean of all item responses (e.g., mean score of 4.5 mapped to overall strong agreement).

Survey administration

The survey was administered using a modified version of Dillman's Total Design Method[10] to minimise response burden and increase response rate. A pre-numbered survey pack, which included a survey booklet, cover letter, information and consent form and reply-paid (stamped) return envelope, was mailed to each potential participant in February 2021. When surveys were returned, respondent numbers were recorded and removed from the mailing list. Non-respondents were recontacted through repeat mail-outs from March to June following the same procedures as the initial mail-out. Return of the survey constituted evidence of informed consent. No financial incentives were offered for completion of the survey. Participant confidentiality and anonymity were maintained throughout data collection, analysis and interpretation.

Sampling frame

Any optometrist holding 'general registration' with the Optometry Board of Australia was eligible for participation. To obtain the study sample, 252 postcodes were randomly selected (with replacement) from a complete list of Australian postcodes.[11] Each postcode was then entered into the 'Find an optometrist' function on the Optometry Australia website[12] to randomly identify the mailing addresses of potential participants. Optometry Australia is the peak professional body of optometrists in Australia with membership comprising approximately 85% of the profession.[13]

Sample size estimate

Given 5908 practising optometrists in Australia,[14] a minimum sample size of 126 participants was calculated to provide 95% certainty around a 10% margin of error on the primary outcome question soliciting attitudes towards the use of AI for diagnosing retinal disease.[15] Based on a literature-derived expectation of a 50% response rate,[10,16–19] a random sample of 252 optometrists were invited to participate in the study.

Statistical analysis

Responses were analysed using appropriate descriptive statistics. Under the principles of the central limit theorem, the mean and standard deviation (SD) were used to describe continuous data and results of centred and balanced Likert scales.[20] Categorical data were described using frequencies. Univariable and multivariable linear regression were used to explore relationships between each participant characteristic reported in Section 1 of the survey as independent variables, and the primary outcome question soliciting attitudes towards the use of AI for diagnosing retinal disease.[20] Two-sided 5% significance levels were used to identify statistically significant results. A difference between Likert scales greater than one-half SD was accepted to be clinically meaningful.[21] All statistical analyses were performed using SPSS (Version 26; IBM, ibm.com).

RESULTS

Response rate

The survey was sent to the sample population in six consecutive mail-outs from February to June 2021. After the first mail-out, 42 of 252 surveys were returned; an additional 29 surveys were returned after the second mail-out, 27 after the third mail-out, 21 after the fourth mail-out, three after the fifth mail-out and 11 after the sixth mail-out. All data collection ceased 10 weeks after the final mail-out. The overall response rate was 53% (133/252). Four of these 133 returned surveys provided incomplete responses for one question each, representing an individual question completion rate from 98% (131/133) to 100% (133/133).

Respondent characteristics

The mean (SD) age of respondents was 42.7 (13.3) years. Altogether, 44.4% (59/133) of respondents reported female gender identities, 54.1% (72/133) identified as male, and 1.5% (2/133) identified as gender diverse. The mean number of years practising in primary eye care was 18.8 (13.2) years. Respondents reported seeing a mean of 12.5 (5.2) patients per day of which 2.4 (1.8) had retinal disease. An OCT was used by 75.9% (101/133) of respondents for patient care provision.

Respondents reported working in either an independently owned practice (64.7%; 86/133), a corporate practice (33.1%; 44/133) or an educational institution (2.3%; 3/133). These clinical practices were located in a major city (55.6%; 74/133), large town (12.0%; 16/133) or rural location (32.3%; 43/133). The mean number of optometrists working in each practice daily was 1.9 (1.8). Access to ophthalmology services was easy for 72.9% (97/133) of optometrists, moderate for 22.6% (30/133) and difficult for 4.5% (6/133). A computerised system for appointment booking, billing, practice management or prescribing was used by 97.0% (129/133) of practices, and the mean number of computerised systems used at each practice was 3.9 (1.5).

Table 1 summarises key respondent characteristics, and Table S1 presents additional workplace characteristics.

Attitudes towards advanced pattern recognition algorithms

Respondents reported they agreed with the statement 'In the future, I see myself using advanced pattern recognition algorithms as tools to aid the diagnosis of retinal disease', with a mean score of 4.0 (0.8) on the 5-point Likert scale. With a mean score of 3.9 (0.8), respondents also *agreed* that future use of advanced pattern recognition algorithms is 'exciting' (Table S2).

Attitudes towards artificial intelligence

Respondent optometrists reported they agreed with the statement 'In the future, I believe there will be an overall need for AI in primary eye care', with a mean score of 3.8 (0.8). Furthermore, respondents ranked increased patient accessibility to healthcare (mean score 4.4 [0.6]) and more reliable clinician diagnoses (mean score 4.3 [0.6]) as the two most important potential benefits of using AI, whilst improved cost-effectiveness (mean score 4.0 [0.8]) was ranked as the least important potential benefit.

Respondents *agreed* with the statement 'In the future, I see myself using AI if such automated processes surpass human clinician involvement in clinical decision-making', with a mean score of 3.7 (1.0). Meanwhile, respondents were neutral *(*neither agreed nor disagreed*)* towards the suggestion of limiting their use of AI if increased dependence on AI resulted in a neglect of their clinical skills (mean score 3.0 [1.0]).

Optometrists ranked the need to validate AI through high-quality clinical trials (mean score 4.1 [0.8]) and against a retinal specialist standard (mean score 4.1 [0.7]) highest, whilst validation through government approval was ranked lowest (mean score 3.4 [1.0]). Respondents also ranked using AI if most of their peers were using it (mean score 3.6 [0.9]) highest compared to if their peers advised them to (mean score 3.4 [0.8]) or if their patient requested they do (mean score 3.4 [0.9]).

Respondent optometrists were neutral towards the need to inform patients about the use of AI (mean score 3.4 [0.9]) and the need to inform patients of all AI-derived results related to their care (mean score 3.3 [0.9]). Respondents were also neutral towards clinicians bearing sole medicolegal responsibility over the use of AI rather than developers of the AI, with a mean score of 3.1 (1.0).

Tables 2 and S3 present complete results of attitudes towards AI. General respondent comments regarding the use of AI are listed in Table S4.

TABLE 1 Key respondent characteristics

Variable	Result
Gender	
Male	54.1% (72/133)
Female	44.4% (59/133)
Gender diverse	1.5% (2/133)
Age (years)	
Mean (SD)	42.7 (13.3)
Median (range)	42 (24–76)
Years practising in primary eye care	
Mean (SD)	18.8 (13.2)
Workplace location	
Major city	55.6% (74/133)
Large town	12.0% (16/133)
Rural location	32.3% (43/133)
Main work setting	
Independent practice	64.7% (86/133)
Corporate practice	33.1% (44/133)
Educational institution	2.3% (3/133)
Public hospital	0% (0/133)
Private hospital	0% (0/133)
Community health centre	0% (0/133)
Form of medical record system used	
Electronic	85.7% (114/133)
Paper-based	14.3% (19/133)
Number of computerised systems used	
Mean (SD)	3.9 (1.5)

Abbreviation: SD, standard deviation.

Influence of clinical scenario

After reading Clinical Scenario 1, respondents *agreed* with the statement 'In the future, I see myself using AI as a tool to aid the diagnosis of retinal disease' with a mean score of 4.0 (0.8). After reading Clinical Scenario 2, agreement with the same statement significantly increased to a mean score of 4.1 (0.7). The mean difference between clinical scenarios was 0.12 with a 95% CI around the difference of 0.03 to 0.21 (p = 0.01). However, because the magnitude of this change (0.12) was not greater than ½ SD (0.26), we cannot claim this difference to be clinically meaningful.

Respondents also *agreed* that in the future, AI might be used as a learning tool to improve clinician diagnostic abilities. After reading Clinical Scenario 1, the mean score response to this statement was 4.0 (0.7), and after reading Clinical Scenario 2, the mean score was 4.1 (0.7). The mean difference between clinical scenarios was 0.06 with a 95% CI of −0.03 to 0.15 (p = 0.20). Similarly, respondents

TABLE 2 Attitudes towards artificial intelligence

Question number and statement	Ranked score, mean (SD)	% (*n*/*N*) selected each category				
		1	2	3	4	5
AI and Clinicians: In the future, I see myself using AI …						
3.16 If such automated processes surpass human clinician involvement in clinical decision-making	3.7 (1.0)	3.0 (4/133)	9.8 (13/133)	20.3 (27/133)	51.1 (68/133)	15.8 (21/133)
3.17 As its increased use to aid the diagnosis of retinal disease excites me	3.9 (0.8)	0.8 (1/133)	3.0 (4/133)	24.8 (33/133)	48.9 (65/133)	22.6 (30/133)
3.18 If increased dependence on AI will not result in a relative neglect of my clinical skills	3.0 (1.0)	6.8 (9/133)	24.8 (33/133)	40.6 (54/133)	21.1 (28/133)	6.8 (9/133)
AI and Patients: For me to use AI in the future, it is necessary to …						
3.19 Inform patients about its use	3.4 (0.9)	0.8 (1/133)	15.8 (21/133)	35.3 (47/133)	39.1 (52/133)	9.0 (12/133)
3.20 Inform patients of all AI-derived results related to their care	3.3 (0.9)	2.3 (3/133)	18.0 (24/133)	36.8 (49/133)	36.8 (49/133)	6.0 (8/133)
AI and Conformity: In the future, I see myself using AI if …						
3.21 My peers advise me to do so	3.4 (0.8)	3.0 (4/133)	9.0 (12/133)	33.8 (45/133)	50.4 (67/133)	3.8 (5/133)
3.22 Most of my peers are using it	3.6 (0.9)	3.0 (4/133)	8.3 (11/133)	24.8 (33/133)	57.1 (76/133)	6.8 (9/133)
3.23 My patient requests that I do	3.4 (0.9)	3.0 (4/133)	10.5 (14/133)	33.8 (45/133)	46.6 (62/133)	6.0 (8/133)
AI Responsibilities						
3.24 In the future, I see myself using AI if clinicians bear sole medicolegal responsibility for the patient diagnosis. (Note: at the other end of the scale, developers of the AI bear sole medicolegal responsibility for the patient diagnosis)	3.1 (1.0)	5.3 (7/133)	23.3 (31/133)	35.3 (47/133)	31.6 (42/133)	4.5 (6/133)

Note: Reported extent to which respondents agreed or disagreed with statements concerning the relationship between artificial intelligence, clinicians and patients, the use of artificial intelligence due to conformity, and associated medicolegal responsibilities. Allowable responses were as follows: strongly disagree (score 1), disagree (score 2), neither agree nor disagree (score 3), agree (score 4) and strongly agree (score 5).

Abbreviations: SD, standard deviation; AI, artificial intelligence.

agreed they were 'excited' by future increased use of AI to diagnose retinal disease (Clinical Scenario 1 mean score 3.9 [0.8] vs. Clinical Scenario 2 mean score 3.9 [0.8]). The mean difference between the clinical scenarios was −0.02 with a 95% CI of −0.10 to 0.05 ($p = 0.55$; see Tables 3 and S5).

Advanced pattern recognition versus artificial intelligence

To determine the influence of alternative terminology on respondents' attitudes towards AI, Section 2 Question 2.1 'In the future, I see myself using advanced pattern recognition algorithms as tools to aid the diagnosis of retinal disease' was presented similar to statements under Clinical Scenario 1 and Clinical Scenario 2, which used the term 'AI' instead of 'advanced pattern recognition algorithms'. Agreement with Question 2.1 did not differ significantly from that of the corresponding 'AI' statement under Clinical Scenario 1 (mean difference – 0.01, 95% CI −0.09 to 0.07, $p = 0.85$); however, agreement with Question 2.1 was significantly different to the corresponding 'AI' statement under Clinical Scenario 2 (mean difference 0.11, 95% CI 0.02 to 0.21, $p = 0.02$). Nevertheless, because the magnitude of this difference (0.11) was not greater than ½ SD (0.27), we cannot claim this difference to be clinically meaningful (see Table 4).

TABLE 3 Influence of clinical scenarios

Question number and statement	Ranked score, mean (SD)		Difference (95% CI)	Significance (p)
	Clinical scenario 1	Clinical scenario 2		
3.1 vs. 4.1 In the future, I see myself using AI as a tool to aid the diagnosis of retinal disease	3.95 (0.76)	4.08 (0.67)	0.12 (0.03 to 0.21)	0.01
3.2 vs. 4.2 In the future, I see myself using AI as a learning tool to improve my own diagnostic abilities	3.99 (0.71)	4.05 (0.66)	0.06 (−0.03 to 0.15)	0.20
3.17 vs. 4.3 Increased use of AI to aid the diagnosis of retinal disease excites me	3.89 (0.81)	3.87 (0.80)	−0.02 (−0.10 to 0.05)	0.55

Note: Comparison of responses to statements concerning the use of artificial intelligence under Clinical Scenario 1 versus Clinical Scenario 2.
Abbreviations: AI, artificial intelligence; CI, confidence interval; SD, standard deviation.

TABLE 4 Attitudes towards advanced pattern recognition algorithms versus artificial intelligence

Question number and statement	Ranked score, mean (SD)		Difference (95% CI)	Significance (p)
	Advanced pattern recognition algorithms	AI		
Clinical Scenario 1				
2.1 vs. 3.1 In the future, I see myself using (advanced pattern recognition algorithms/AI) as a tool to aid the diagnosis of retinal disease	3.96 (0.78)	3.95 (0.76)	−0.01 (−0.09 to 0.07)	0.85
2.2 vs. 3.17 Increased use of (advanced pattern recognition algorithms/AI) to aid the diagnosis of retinal disease excites me	3.89 (0.80)	3.89 (0.81)	0.01 (−0.09 to 0.10)	0.87
Clinical Scenario 2				
2.1 vs. 4.1 In the future, I see myself using (advanced pattern recognition algorithms/AI) as a tool to aid the diagnosis of retinal disease	3.96 (0.78)	4.1 (0.7)	0.11 (0.02 to 0.21)	0.02
2.2 vs. 4.3 Increased use of (advanced pattern recognition algorithms/AI) to aid the diagnosis of retinal disease excites me	3.89 (0.80)	3.9 (0.8)	−0.02 (−0.11 to 0.08)	0.75

Note: Comparison of responses to statements that used the term 'advanced pattern recognition algorithms' against responses to identical statements that used the term 'AI' under Clinical Scenario 1 and Clinical Scenario 2.
Abbreviations: AI, artificial intelligence; CI, confidence interval; SD, standard deviation.

Factors influencing attitudes towards artificial intelligence

Of all respondent characteristics, the number of computerised systems used in the workplace was the only variable significantly (b = 0.12, $p = 0.004$) associated with a stronger positive belief in the future use of AI to aid in diagnosing retinal disease. Factors that were not significantly associated with attitudes towards AI included gender ($p = 0.33$), age ($p = 0.88$), work experience ($p = 0.83$), workplace location ($p = 0.75$) and setting ($p = 0.96$), number of patients seen ($p = 0.32$), number of working optometrists ($p = 0.57$), level of accessibility to ophthalmology services ($p = 0.29$), and rural vs. urban location ($p = 0.47$). Table S6 presents complete results.

DISCUSSION

We conducted a mail-out survey of practising optometrists in Australia to explore their attitudes towards using AI to assist in the diagnosis of retinal disease. With random selection from the target population and a 53% response rate from the sampling frame, it is reasonable to conclude that our results are representative of practising optometrists in Australia within a 10% margin of error.[22] Results of our survey indicated that, on average, optometrists have positive attitudes towards the future use of AI for diagnosing retinal disease, especially if using AI can increase patient access to healthcare. Interestingly, optometrists expressed a preference for using AI after a patient consultation to obtain a second opinion, as opposed to during a patient consultation to generate a diagnostic recommendation.

Artificial intelligence

The term 'artificial intelligence' describes any automated system that aims to reproduce human-like learning and achieve human-level performance in complex situations.[23] Early AI systems used fuzzy logic or common logistic regression to mimic learning;[23] however, AI has since evolved such that modern systems employ greater numbers of mathematical operations chained together in a deeply layered network of functions, for example, pattern recognition algorithms used for facial recognition in cameras. Certain applications of AI are already being used routinely in healthcare, from robotic surgery to AI-enhanced speech recognition software appealing to physicians who prefer dictation to typing.[24] However, interpretation of diagnostic images to support clinical decision-making is the area where AI holds the most promise.[25] In eye care, AI has been applied to colour fundus photography for the automated detection of diabetic retinopathy with excellent accuracy (aROC 0.991, 95% CI 0.99 to 0.93).[2] Systems utilising OCT have also outperformed human experts in diagnosing multiple retinal pathologies including choroidal neovascularisation (aROC 0.993), drusen (aROC 0.974) and macular holes (aROC 0.999).[26] Yet, only 15.7% of ophthalmologists are using AI daily in their clinical practice.[6] There are no published data on the frequency of AI use by optometrists. With the role of AI is constantly expanding, clinician attitudes towards AI have become key in driving the acceptance and uptake of these new technologies.[4,27]

Attitudes towards artificial intelligence in clinical practice

A survey of 487 pathologists from 54 countries found that many were interested or excited about the integration of AI tools (73.3%), which they regarded as a means to increase diagnostic efficiency (71.7%).[28] Moreover, 57% of dermatologists stated they would use an AI tool to help diagnose skin lesions in clinic and up to 77.3% believed that AI will improve their field of practice.[5,6,29,30] Such views have also been shared among radiologists/radiation oncologists (69.5%) and ophthalmologists (73.4%).[6] Therefore, the use of AI for diagnostic purposes appears to be well-received among clinicians from medical specialities reliant on imaging.

Our survey showed on average, optometrists have positive attitudes towards the future use of AI, with a mean score of 4.0 (0.8) and 78.2% agreeing/strongly agreeing with its use as a tool to evaluate clinical images and subsequently aid the diagnosis of retinal disease. Respondents were also excited at its increased use in clinical practice (mean score 3.9 [0.8]) and believed there will be a need for AI in primary eye care (mean score 3.8 [0.8]). This indicates that optometrists are not only receptive to AI but also highly anticipate its use. Indeed, Scheetz et al.[6] found that ophthalmologists considered the impact of AI on the workforce would be greater for optometrists than for general medical practitioners or their own profession. With high expectations for the future role of AI in optometric practice, the positive clinician attitudes demonstrated in this study are encouraging for its clinical adoption.

Validation of patient-centred benefits

The motivation behind AI lies in its potential to offer objective analysis to guide clinical diagnosis, simultaneously enabling higher capacity and lower cost healthcare.[31] Ophthalmologists and dermatologists perceived improved access to disease screening as the greatest advantage to AI use,[6] alongside enhanced clinical efficiency and quicker diagnosis.[5] In line with these works, our survey found that optometrists were most optimistic about the potential for AI to increase patient accessibility to healthcare (mean score 4.4 [0.6]) and enhance diagnostic reliability (mean score 4.3 [0.6]). Time savings, better accuracy and cost-effectiveness were also highly valued. Convincing evidence validating these benefits will likely promote the clinical adoption of AI.

Randomised controlled clinical trials are considered the gold standard for evidence generation.[3] Optometrists in our survey ranked the conduct of higher quality randomised controlled trials as the most important requirement in the validation of AI with a mean score of 4.1 (0.8), followed by demonstration of AI's accuracy against the standard of retinal specialists (mean score 4.1 [0.7]). Researchers should incorporate these design expectations into future validation studies. Interestingly, optometrists were neutral towards AI validation via government approval, rating it as the least important requirement (mean score 3.4 [1.0]). In 2018, the United States Food and Drug Administration approved the IDx-DR system for the autonomous detection of diabetic retinopathy, becoming the first AI algorithm to receive government approval in any field of medicine.[32] Although this is regarded in research as a major milestone for the clinical application of AI, such government approval does not appear to significantly influence optometrists' willingness to use AI.

Using artificial intelligence in specific clinical scenarios

Clinicians are known to adopt clinical decision support systems judiciously depending on social and environmental factors.[33,34] Thus, optometrists' attitudes towards AI may vary depending on the specific circumstances in which it is being used. Kawamoto et al.[35] conducted a large systematic review of 70 randomised controlled trials evaluating clinical decision support systems, and identified the provision of recommendations at the time and location of decision-making as one of four independent predictors of improved clinical practice (p = 0.03), defined by patient outcomes or process measures. Yet in our survey, greater positive attitudes were conveyed towards using AI after the consultation to provide a second opinion rather than during the consultation to provide a diagnostic recommendation at the point-of-care. Despite being statistically significant (p = 0.009), this finding was not clinically meaningful, defined by a difference between Likert scores greater than one-half SD. The 95% CI around the mean difference indicated no clinically meaningful effect even at the upper limit. Therefore, optometrists are open to using AI under both clinical scenarios and do not indicate a meaningful preference for the timing of its use after the consultation or at the point-of-care. The positive attitude towards using AI after the consultation aligns with optometrists' agreement with the need for AI to fit into the clinical workflow (mean score 4.2 [0.6]) since using a supplementary diagnostic tool at the point-of-care may be time-consuming and interruptive, traits found to be least favoured by clinicians.[36]

Artificial intelligence and the human clinician

As with the introduction of any new technology, the incorporation of AI in medicine may have unintended consequences.[37] Clinician loss of control to AI has been labelled a priority potential risk to its use.[5,6] Only 46% of dermatologists supported machine-derived diagnosis, this opinion rising to 64% for the use of AI in an assistive role to enhance, but not replace, human intelligence.[5] An international survey reported few physicians (20.3%) approved of AI tools taking a dominant role over humans in diagnostic decision-making.[28] In contrast, optometrists in our survey intended to use AI even if it surpassed human clinician involvement in clinical decision-making (mean score 3.7 [1.0]). However, overreliance on technology may lead to automation bias and deskilling in clinicians by reducing their ability to independently interpret detectable signs and symptoms.[37,38] Optometrists remained neutral (mean score 3.0 [1.0]) towards limiting their use of AI if increased dependence on AI caused a neglect in their clinical skills. At the same time, respondents asserted: 'AI I see as an adjunct but diagnosis ultimately lies with the practitioner' and 'Optometry is based on personable relationships…[AI] detracts from this', emphasising the value placed on the human physician–patient relationship.[5] Early efforts to help optometrists establish a healthy relationship with AI will ensure the potential of this transformative set of technologies is fully realised. Proactive education on the intended role of AI as a support system may ease anxiety and increase awareness of its benefits.

Factors influencing attitudes towards artificial intelligence

Previous studies identified men carried a more optimistic outlook on the integration of AI into clinical practice.[28,29,39] Surveys of the general public have noted a greater reluctance in accepting AI among those aged 55 and older.[40,41] Larger radiology practices, in terms of the number of working clinicians, were more likely to use AI than smaller practices.[42] Yet in our study, neither gender, age nor the number of working optometrists were significantly associated with attitudes towards the future use of AI. Indeed, the only characteristic to significantly influence optometrists' attitudes was the number of computerised systems used in the workplace (b = 0.12, p = 0.004), where a greater number of computerised systems was associated with a more positive attitude towards AI. Clinicians may be more willing to use AI if they are already exposed to other computer-based technologies in the workplace.

Strengths and limitations

A major strength of this study was the high overall response rate of 53%.[22] Our use of random sampling permitted a balanced sample with minimal bias in participant selection. The number of participants selected from each state/territory was proportionate to the number of practising optometrists, and these proportions were maintained in the number of responses received from each state/territory, allowing for geographic representation of Australian optometrists. We chose to use membership with Optometry Australia to identify our sampling frame. This membership comprises a large majority of practising optometrists in Australia, and omission of non-members is unlikely to significantly affect our ability to generalise to this target population. The survey design did impose limitations on the scope of response options, though this was somewhat mitigated by the inclusion of the open-ended question allowing further comments at the end.

CONCLUSIONS

Understanding clinician attitudes towards AI serve as a foundation for its implementation into clinical practice. In this survey, Australian optometrists demonstrated positive attitudes towards using AI to assist in diagnosing retinal disease. There was no clinically meaningful preference for AI to provide a diagnostic recommendation at the point-of-care or a second opinion after the consultation. Nevertheless, to achieve widespread uptake, future studies should aim to verify the patient-centred benefits of AI alongside efforts to help optometrists establish a healthy relationship with the new technology.

AUTHOR CONTRIBUTIONS

Sharon Ho: Conceptualization (lead); data curation (lead); formal analysis (equal); investigation (lead); methodology (lead); project administration (lead); resources (equal); software (equal); validation (equal); visualization (equal); writing – original draft (lead); writing – review and editing (lead). **Gordon S Doig:** Conceptualization (supporting); data curation (supporting); formal analysis (equal); funding acquisition (equal); methodology (supporting); resources (supporting); supervision (equal); validation (equal); writing – review and editing (equal). **Angelica Ly:** Conceptualization (supporting); funding acquisition (equal); methodology (equal); resources (equal); supervision (equal); validation (equal); writing – review and editing (supporting).

ACKNOWLEDGEMENTS

SH is supported by a Centre for Eye Health/Guide Dogs NSW/ACT Higher Degree Research Postgraduate Award; AL reports grants from Novartis Australia and the Australian Human Rights Institute; GSD reports grants from the Australian National Health and Medical Research Council, the Australian Human Rights Institute, Fresenius Kabi Deutschland GmbH and Baxter Healthcare Australia, and speakers' honoraria from Fresenius Kabi Deutschland GmbH, Baxter Healthcare Australia, Nestlé Healthcare and Nutricia Pharmaceutical (Wuxi) outside the submitted work. The funders had no role in the study design, data collection and analysis or preparation of the manuscript. Open access publishing facilitated by University of New South Wales, as part of the Wiley - University of New South Wales agreement via the Council of Australian University Librarians.

CONFLICT OF INTEREST

No other disclosures were reported.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Ho S, Doig GS, Ly A. Attitudes of optometrists towards artificial intelligence for the diagnosis of retinal disease: A cross-sectional mail-out survey. *Ophthalmic Physiol Opt*. 2022;42:1170–1179. https://doi.org/10.1111/opo.13034