

# Barriers to performing direct ophthalmoscopy by primary care physicians

Barreiras para a realização de oftalmoscopia direta por médicos de família e comunidade

*Barreras a la oftalmoscopia directa por médicos de familia y comunidad*

Lucas Zanetti Milani<sup>1</sup> , Santiago Pich<sup>2</sup> , Marcos Krahe Edelweiss<sup>1</sup> 

<sup>1</sup>Escola de Saúde Pública de Florianópolis

<sup>2</sup>Universidade Federal de Santa Catarina

## ABSTRACT

**Introduction:** Direct ophthalmoscopy is an examination performed for the diagnosis and screening of diseases of the retina, optic disc, and vitreous humor in the context of primary health care. Studies show that this practice is rarely used by primary care physicians. **Objective:** The aim of this study is to identify barriers for primary care physicians to perform ophthalmoscopy. **Methods:** This study used a qualitative methodology based on a semi-structured interview with primary care physicians with subsequent thematic analysis. **Results:** It was verified that barriers to performing direct ophthalmoscopy include difficulty in handling the ophthalmoscope and pupil dilation, little knowledge of eye anatomy, feeling of insecurity in performing and interpreting findings, perception that the examination would be better performed by a specialist, lack of training and practical experience in undergraduate program and medical residency, perception of little use or resolution, difficulty in adjusting the room environment for the examination, absence of equipment and mydriatics in health units, increase in consultation time, absence of referral flows when facing altered findings, presence of teleophthalmology services and lack of training of the multidisciplinary team. **Conclusions:** Barriers to performing ophthalmoscopy by primary care physicians include emotional, behavioral, cognitive, educational, and work-environment aspects.

**Keywords:** Family practice. Primary health care. Ophthalmoscopy. Fundus oculi.

### Corresponding author:

Lucas Zanetti Milani

E-mail: lucasmilani1@gmail.com

### Funding:

No external funding.

### Ethical approval:

CAAE 32360820.8.0000.5361

### Provenance:

Not commissioned.

### Peer review:

external.

Received: 03/03/2021.

Approved: 11/23/2021.

**How to cite:** Milani LZ, Pich S, Edelweiss MK. Barriers to performing direct ophthalmoscopy by primary care physicians. Rev Bras Med Fam Comunidade. 2022;17(44):2970. [https://doi.org/10.5712/rbmfc17\(44\)2970](https://doi.org/10.5712/rbmfc17(44)2970)



## RESUMO

A oftalmoscopia direta é um exame utilizado para diagnóstico e rastreamento de doenças da retina, do disco óptico e do humor vítreo no contexto da atenção primária à saúde. Estudos demonstram que é uma prática pouco utilizada regularmente por médicos de família e comunidade. O objetivo deste estudo é identificar barreiras para a realização da oftalmoscopia por médicos da referida especialidade. Este estudo utilizou metodologia qualitativa, baseada em entrevista semiestruturada com médicos de família e comunidade e posterior análise temática. Demonstrou-se que as barreiras para a realização de oftalmoscopia direta incluem dificuldade no manejo do oftalmoscópio e na dilatação pupilar, pouco conhecimento da anatomia ocular, sentimento de insegurança na realização e na interpretação de achados, percepção de que seria um exame mais bem realizado por um especialista, falta de formação e experiência prática na graduação e na residência médica, percepção de pouca utilidade ou resolutividade, dificuldade em adequar o ambiente para a realização do exame, ausência de aparelho e colírios midríaticos nas unidades de saúde, aumento no tempo de consulta, ausência de fluxos de encaminhamento mediante achados alterados, presença de serviços de teleoftalmologia e ausência de treinamento da equipe multiprofissional.

**Palavras-chave:** Medicina de família e comunidade. Atenção primária à saúde. Oftalmoscopia. Fundo de olho.

## RESUMEN

**Introducción:** La oftalmoscopia directa es un examen que se utiliza para el diagnóstico y rastreo de enfermedades de la retina, el disco óptico y el humor vítreo en el contexto de la atención primaria de salud. Los estudios demuestran que es una práctica poco utilizada habitualmente por los médicos de familia y comunidad. **Objetivo:** El objetivo de este estudio es identificar barreras del porqué los médicos de familia y comunidad no realizan oftalmoscopias. **Métodos:** Esta investigación está basada en una entrevista semiestructurada con médicos de familia y comunidad con posterior análisis temático. **Resultados:** Se ha demostrado que las barreras para realizar oftalmoscopia directa incluyen dificultad en el manejo del oftalmoscopio y dilatación pupilar, poco conocimiento de la anatomía ocular, sensación de inseguridad en la realización e interpretación de los hallazgos, percepción de que sería un mejor examen por parte de un especialista, falta de formación y experiencia práctica en licenciatura y residencia médica, percepción de poco uso o resolución, dificultad para ajustar el ambiente para el examen, ausencia de aparatos y gotas midríaticas en las unidades de salud, aumento del tiempo de consulta, ausencia de flujo derivación a hallazgos alterados, presencia de servicios de teleoftalmología y falta de formación del equipo multidisciplinario. **Conclusiones:** Barreras para la oftalmoscopia directa por médicos de familia y de la comunidad incluyen aspectos emocionales, conductuales, cognitivos, educativos y del entorno laboral.

**Palabras-clave:** Medicina familiar y comunitaria. Atención primaria de salud. Oftalmoscopia. Fondo de ojo.

## INTRODUCTION

Ophthalmoscopy, also called funduscopy or fundus examination, is part of the ocular physical examination that uses a device, the ophthalmoscope or funduscope, to examine the lens, retina, optic disc, fovea, macula, retinal arteries, and retinal veins. It can be performed directly, with a manual ophthalmoscope, or indirectly, with a manual lens under the illumination of a light source.<sup>1</sup>

Ophthalmoscopy is used for screening and diagnosis of pathologies of the retina, optic disc, and vitreous humor. For instance, it is used in the screening of diabetic retinopathy in patients with type 1 or type 2 diabetes, in the evaluation of patients with glaucoma, in the screening of congenital cataracts in newborns, in the evaluation of patients with cataracts, among others. Thus, it can be performed by physicians with generalist training or by specialists in ophthalmology.<sup>1</sup>

Direct ophthalmoscopy is considered an important or essential skill for primary care physicians (PCP). The Competency-Based Curriculum for Family and Community Medicine (*Currículo Baseado em Competências para a Medicina de Família e Comunidade*) cites knowledge of the funduscopy technique as an essential skill, and funduscopy in general and funduscopy for neurological examination as a desirable skill.<sup>2</sup>

Several studies have shown that direct ophthalmoscopy is not regularly performed by PCP and that many of them have difficulty using it.<sup>3-9</sup>

A Brazilian study evaluated the use of ophthalmoscopy by physicians participating in a Latin American congress on diabetes and showed that 52% of participants had experience in performing ophthalmoscopy, and that 21.4% performed ophthalmoscopy in their patients.<sup>10</sup>

Although its importance is recognized, PCP rarely perform direct ophthalmoscopy in clinical practice. The reasons for this behavior were not addressed by Brazilian studies on the subject so far.

The objective of this research is to identify potential barriers to performing ophthalmoscopy by PCP.

## METHODS

This is an exploratory study, which used a qualitative methodology and was carried out in seven health centers in the city of Florianópolis, state of Santa Catarina, Brazil.

PCP who work in the municipal government of Florianópolis and who have a medical residency and/or specialist degree in family and community medicine were included.

PCP who had medical residency or specialization in ophthalmology were excluded.

Twelve PCP were invited and all agreed to participate in the study. The selected participants formed a convenience sampling, selected to include doctors who perform ophthalmoscopy and doctors who do not perform it, aiming at gathering several views on the topic. The identification of the PCP was performed by telephone contact or by electronic message, and all were questioned about the performance of ophthalmoscopy and the frequency with which they performed it.

Information was collected through individual semi-structured interviews, which had a script of open-ended questions consistent with the objectives of the study (Table 1). The interviews were recorded with the aid of electronic equipment (smartphone), live, at the health center, or remotely via online video call. The interviews were carried out between June and August 2020 by one of the authors. Subsequently,

**Table 1.** Structure of the interviews.

<b>Presentation of the study, its objectives and methods</b>
<b>Request to fill in the informed consent form</b>
Questions
1. What do you know about ophthalmoscopy?
2. Do you own an ophthalmoscope? Do you use it on a daily basis? Do you use mydriatics?
3. In what everyday situations at the health unit do you use/would you use it?
4. What is your experience using the ophthalmoscope?
5. What is the most difficult thing about using the ophthalmoscope?
6. What is your level of confidence in performing an ophthalmoscopy? And in interpreting the results?
7. What are the difficulties in performing ophthalmoscopy in the daily routine of the health unit?
8. In your opinion, what is the importance of ophthalmoscopy in the daily routine of the health unit?
9. Several surveys demonstrate that non-ophthalmologist physicians do not perform ophthalmoscopy on a daily basis. In your opinion, why does this happen?
10. What kind of training have you received on this topic (undergraduate, residency programs)?
11. Would you be interested in receiving training on the topic? Would you be interested in using it on a daily basis? Do you see importance in this?
12. In your opinion, who should do the ophthalmoscopy (family doctor, ophthalmologist)?
13. What benefits do you see for the patient in performing ophthalmoscopy in the health unit? And what harms?

they were also transcribed by the same author and subjected to thematic analysis of the content and the integrative synthesis of the results according to Bardin's technique.<sup>11</sup> The content of the interviews was grouped according to the following categories: emotional barriers, behavioral barriers, cognitive barriers, work environment barriers, and learning barriers.

A pilot test with the participation of three PCP was previously carried out for eventual corrections in the formulation of the questions. The information collected in the pilot test was not included in the study, and the physicians who participated in it were not part of the sample.

This research was approved by the Ethics Committee on Research Involving Human Beings of Hospital Infantil Joana de Gusmão/Secretaria de Estado da Saúde de Santa Catarina [Santa Catarina State Health Department] (SES-SC) and all participants signed an informed consent form prior to the interviews. Data from this research will not be shared with third parties and no patient or community member participated in the planning or performance of the research.

## RESULTS

A total of 12 PCP were interviewed. Of them, two had an ophthalmoscope and only one daily performed ophthalmoscopy. Nine of the participants were men (75%) and three were women (25%). They had from three to 21 years of experience in the field of primary health care. Six were preceptors of the residency in family and community medicine and one was a university professor.

Participants reported several situations in which they would perform the fundus examination. These include ophthalmologic (eye pain, visual impairment, ocular foreign body), neurologic (headache, focal neurologic deficits) and systemic (hypertensive urgency, meningitis) complaints. As a screening test, the fundus examination would be used in the evaluation of congenital cataracts in newborns and diabetic and hypertensive retinopathy in hypertensive and/or diabetic patients.

Six participants reported ophthalmoscope handling as a difficulty. The ability to handle the device with both hands, to know the indication to use the green and red lights, and to find the ideal focus and distance were some of the reported difficulties. The indication of pupil dilation and even the examination without pharmacological mydriasis were also reported as difficulties. In addition, some participants reported that they would need greater knowledge of eye anatomy and greater ability to discriminate the different structures of the retina, aspects that they deemed essential for the interpretation of the exam findings.

*"The most difficult thing is pupil dilation. [...] The dexterity with both hands, the difficulty in closing one eye and looking with the other while having to work with different hands."* Participant 11.

Insecurity in doing the examination and in interpreting its findings was mentioned as a barrier to its performance. The causes of this insecurity include lack of experience in performing the examination on a daily basis and the perception that it is an unusual examination to be performed in their daily routine and with a low prevalence of altered findings. In addition, the perception that the evaluation of the Fundus oculi performed by PCP does not have the same sensitivity as that performed by ophthalmologists was reported. One participant reported the impression that the assessment of eye disorders, in general, should be done by an ophthalmologist.

*"Nose, mouth, and eye belong to the specialist."* Participant 2.

Four participants reported great skill in using the ophthalmoscope on a daily basis, which was developed during their undergraduate and residency training programs and throughout their professional work in emergency care clinics, health centers, or hospitals. The opportunity to perform the exam in

practice during internships in the areas of ophthalmology, neurology, pediatrics, and internal medicine during the undergraduate program, medical internship, or medical residency was mentioned as important for maintaining this practice throughout their professional activities.

*“During the ophthalmology internship, I did more than 120 eye fundus examinations under the supervision of a professor. That was more than enough to learn how to perform the exam and have confidence.”* Participant 5

Two participants stated that the examination would be of little or no importance on a daily basis, as they perceive that it would bring little resolution to the case or would not change the conduct in most situations, valuing other symptoms or signs in the patient’s assessment. However, the other participants said that it is an important examination in the evaluation of acute or chronic conditions, as it would facilitate access to consultations with ophthalmologists, carry out the screening of urgent cases, and increase the bond with the patients, considering that they would feel as being completely evaluated.

*“I perform ophthalmoscopy many times because patients feel completely examined, they say that the doctor even examined the back of their eye. [...] I can even diagnose a cataract, but I do not think that it will make much difference in everyday life. It is better to refer them to the ophthalmologist.”* Participant 6.

Moreover, the interviewees reported that, as it is an operator-dependent examination, the quality of the evaluation could suffer interference, and more advanced and sensitive technologies should be chosen to perform the same evaluation such as digital retinography. Nevertheless, all participants stated that PCP should perform ophthalmoscopy as part of their daily activities, as do other focal specialists or generalists (ophthalmologists, cardiologists, pediatricians, neurologists, endocrinologists, among others).

*“As I knew that I could refer [the patients] to the teleophthalmology service [...], I ended up failing to learn how to use the device. But now that I have moved to a city where there is no such service, I think it is important to learn [how to handle it].”* Participant 3

All participants reported having used the device at least once during their training, and this experience is generally restricted to the period of undergraduate program or medical residency. Six physicians reported having had greater immersion in the practice due to internships in ophthalmology or neurology. Conversely, the other professionals had experience with it during medical residency, following the guidance of their preceptors or through individual study based on their own interests. However, most of them mentioned a significant lack of training during their education, whether at the undergraduate program or at residency. The predominance of theoretical approaches in favor of practical experiences under the supervision of teachers or preceptors was reported. Nonetheless, all participants (with the exception of one) reported interest in learning more about the subject and in adding this skill to their clinical practice after theoretical-practical training under supervision.

*“It is not difficult to use the ophthalmoscope itself. The thing is knowing patterns, performing the exam several times, getting experience from the smallest changes.”* Participant 12

Some aspects related to the environment of the health center were mentioned as barriers to performing indirect ophthalmoscopy, including difficulty darkening the exam room, absence of ophthalmoscope and mydriatics in health units, and the low quality of devices when available. The high price for acquiring the device was also mentioned as an obstacle by two participants.

The time aspect was pointed out as a difficulty by the majority (ten out of twelve) of the participants. Among the aspects, the need for extra time in the consultation to explain the examination to the patients, perform pupil dilation, and perform the procedure was indicated as a difficulty in the face of the increasing demands and healthcare pressure from health units, which may require prior scheduling for performing

the examination. Nevertheless, two participants with more practice in the technique did not report the time aspect as a difficulty for the procedure.

*“I have to prioritize certain things because of the great demand we have at the unit. That is why I gradually abandoned ophthalmoscopy.”* Participant 6

*“Time itself is not a barrier, because the exam can be quickly done in a few minutes.”* Participant 11.

Furthermore, aspects related to health management were also reported, for instance: the lack of referral flows due to altered findings and the fact that there are no demands on the part of local authorities regarding the examination. In addition, the lack of training by the multidisciplinary team to assist in the procedure was also mentioned as a barrier.

Participants listed as a potential benefit to patients the possibility of excluding serious diseases, avoiding unnecessary referrals, expediting necessary referrals, and increasing the bond with the patient. As harms, they reported that the inexperience in performing the exam could lead to false-positive or false-negative results, in addition to the fact that the examination could increase the consultation time and cause photophobia, nausea, or discomfort to patients due to the physical proximity to the doctor. The use of mydriatics was mentioned as potential harm, given the possibility of causing temporary visual impairment or eventually inducing acute glaucoma.

## DISCUSSION

Different barriers to performing direct ophthalmoscopy were demonstrated. Cognitive and behavioral aspects included difficulty in handling the device, finding the ideal focus, and performing the exam without pharmacological mydriasis as well as lack of knowledge of eye anatomy.

Emotional aspects were also mentioned, such as feelings of insecurity in performing and interpreting the exam, which result from little practical experience in daily life, and the impression that the examination would be better performed by a specialist. Other feelings were verified, such as the impression of causing harm due to false-positives and false-negatives and low resolution, and the idea that there would be more sensitive technologies such as retinography.

Some studies have shown that the confidence for performing the exam is, indeed, low.<sup>12,13</sup> A survey from Ireland assessed ophthalmology knowledge and ophthalmic skills among Irish PCP and showed that 40% feel confident in identifying an optic disc abnormality; 20% in monitoring patients with diabetic retinopathy; 94% have an ophthalmoscope; and 66% feel confident in using it.<sup>14</sup> Although the authors have studied a population in which almost all participants had the device, the research corroborates the findings of the present study by demonstrating the lack of confidence in interpreting the findings.

Some studies have shown that the performance of direct ophthalmoscopy by PCP seems to have similar precision to that performed by optometrists or ophthalmologists.<sup>15,16</sup> This is in line with the reports of some participants, who stated that the ability of the PCP would be inferior to that of specialists.

One study suggests that direct ophthalmoscopy should be abandoned and replaced with more technological methods such as digital retinography.<sup>17</sup> In addition, an investigation carried out in Brazil demonstrated the feasibility of using a portable handheld smartphone-based retinal camera as a resource for tracking diabetic retinopathy in primary care, associated with a telemedicine service.<sup>18</sup> This corroborates the report of some participants in this research regarding the use of telemedicine as an alternative to direct ophthalmoscopy.



Aspects related to training, such as lack of supervised practices during the undergraduate program or medical residency, were listed as barriers. A British study showed that the teaching of ophthalmoscopy in undergraduate and residency programs in family and community medicine is quite deficient.<sup>19</sup> However, other studies have shown that short training courses can contribute to the acquisition of this skill,<sup>20,21</sup> or even more extensive training.<sup>22</sup>

Organizational aspects, such as difficulty in darkening the office, absence of ophthalmoscope and mydriatics, high price for purchasing the device, need for longer consultation time to perform the procedure in view of the concern with increasing demands, and healthcare pressure in the units, were also mentioned as barriers. A study from China evaluated the availability of equipment in primary healthcare clinics in several regions and found that 57% of clinics did not have an ophthalmoscope.<sup>23</sup>

Healthcare aspects, such as the absence of referral flows and demands by local authorities, lack of team training to perform the examination, and the presence of ophthalmic screening and telemedicine services were also mentioned.

Only one study directly assessed barriers to performing direct ophthalmoscopy. In this Australian study, which used a quantitative methodology, barriers to performing ophthalmoscopy were considered to be the time required for its performance, patients not wanting to have their pupils dilated for the exam, fear of causing acute glaucoma after mydriasis, lack of confidence in detecting abnormalities, and the absence of mydriatics in the clinic. Not knowing what to do when finding alterations, not having insurance reimbursement, or not having an ophthalmoscope in the unit were not deemed as obstacles.<sup>24</sup> In comparison, the present study corroborates the time required for performing the examination, the lack of confidence in identifying abnormalities, and the absence of mydriatics as barriers to ophthalmoscopy.

## CONCLUSION

This study showed that difficulty in handling the ophthalmoscope and pupil dilation, little knowledge of eye anatomy, feelings of insecurity in performing and interpreting findings, and the perception that the exam would be better performed by a specialist act as barriers to performing direct ophthalmoscopy in the context of primary health care. In addition, lack of training and practical experience in undergraduate program and medical residency, perception of little usefulness or resolution of the exam, difficulty adapting the environment to perform the exam, absence of the device and mydriatics in health units are also influencing factors. Furthermore, an increase in consultation time, absence of referral flows in the face of altered findings, presence of teleophthalmology services, and lack of training of the multiprofessional team were also reported as barriers to performing ophthalmoscopy by PCP.

The limitations of this study are an initial and exploratory approach to the topic of direct ophthalmoscopy by PCP in Brazil and the limited availability of professionals with experience in using the ophthalmoscope to participate in the investigation. Nevertheless, the findings may contribute to the construction of knowledge on the subject, and especially to indicate the need for Continuing Education for PCP, aiming to equip them for the practice of direct ophthalmoscopy in primary health care, considering the relevance of the procedure in the context of public health.

## CONFLICT OF INTERESTS

Nothing to declare.

## AUTHORS' CONTRIBUTIONS

LZM: Project administration, Conceptualization, Data curation, Writing – original draft, Writing – review & editing, Investigation, Methodology, Funding acquisition, Resources, Software, Validation, Visualization. SP: Project administration, Formal analysis, Conceptualization, Writing – review & editing, Methodology, Supervision, Validation, Visualization. MKE: Project administration, Formal analysis, Conceptualization, Writing – review & editing, Methodology, Supervision, Validation, Visualization.

## REFERENCES

- Palay DA, Krachmer JH. Primary care ophthalmology. 2<sup>nd</sup> ed. Philadelphia: Elsevier; 2005.
- Sociedade Brasileira de Medicina de Família e Comunidade. Currículo baseado em competências para medicina de família e comunidade. Sociedade Brasileira de Medicina de Família e Comunidade; 2015. [cited on Oct. 01, 2020]. Available at: [http://www.sbmfc.org.br/wp-content/uploads/media/Curriculo%20Baseado%20em%20Competencias\(1\).pdf](http://www.sbmfc.org.br/wp-content/uploads/media/Curriculo%20Baseado%20em%20Competencias(1).pdf)
- Carlsson AM, ten Hove MW, Stockl F. Direct ophthalmoscopic examination of the eyes: does a mydriatic agent help with diagnosis? *Can Fam Physician* 2006;52(8):958-9. PMID: 17273497
- Fry M, Wilson GA. Scope for improving congenital cataract blindness prevention by screening of infants (red reflex screening) in a New Zealand setting. *J Paediatr Child Health* 2005;41(7):344-6. <https://doi.org/10.1111/j.1440-1754.2005.00628.x>
- Kraft SK, Marrero DG, Lazaridis EN, Fineberg N, Qiu C, Clark Jr CM. Primary care physicians' practice patterns and diabetic retinopathy. Current levels of care. *Arch Fam Med* 1997;6(1):29-37. <https://doi.org/10.1001/archfam.6.1.29>
- Leese GP, Broadbent DM, Harding SP, Vora JP. Detection of sight-threatening diabetic eye disease. *Diabet Med* 1996;13(10):850-3. [https://doi.org/10.1002/\(SICI\)1096-9136\(199610\)13:10<850::AID-DIA167>3.0.CO;2-E](https://doi.org/10.1002/(SICI)1096-9136(199610)13:10<850::AID-DIA167>3.0.CO;2-E)
- Dickson PR, McCarty CA, Keeffe JE, Baxter R, Harper CA, Taylor HR. Diabetic retinopathy: examination practices and referral patterns of general practitioners. *Med J Aust* 1996;164(6):341-4. <https://doi.org/10.5694/j.1326-5377.1996.tb122049.x>
- Smith AF. Current and possible screening practices for diabetic retinopathy by general practitioners: new evidence from a pilot survey of Oxfordshire general practitioners. *Ophthalmic Epidemiol* 1995;2(3):129-35. <https://doi.org/10.3109/09286589509057094>
- Kamien M, Ward AM, Mansfield F, Fatovich B, Mather C, Anstey K. Management of type 2 diabetes in Western Australian metropolitan general practice. *Diabetes Res Clin Pract* 1994;26(3):197-208. [https://doi.org/10.1016/0168-8227\(94\)90061-2](https://doi.org/10.1016/0168-8227(94)90061-2)
- Preti RC, Saraiva F, Trein Junior JA, Takahashi WY, Silva MER. How much information do medical practitioners and endocrinologists have about diabetic retinopathy? *Clinics (Sao Paulo)* 2007;62(3):273-8. <http://doi.org/10.1590/S1807-59322007000300011>
- Bardin L. *Análise de Conteúdo*. São Paulo: Edições 70; 2011.
- Özkurt ZG, Balsak S, Çamçi MS, Bilgen K, Katran İH, Aslan A, et al. Approach of family physicians to pediatric eye screening in Diyarbakır. *Turkish J Ophthalmol* 2019;49(1):25-9. <http://doi.org/10.4274/tjo.galenos.2018.10829>
- Basilious A, Cheng J, Buys YM. Comparison of glaucoma knowledge and referral practices among family physicians with ophthalmologists' expectations. *Can J Ophthalmol* 2015;50(3):202-8. <http://doi.org/10.1016/j.jcjo.2015.01.006>
- Gibson C, Roche E. A survey of general practitioners' knowledge and perceived confidence with clinical ophthalmology. *Ir Med J* 2014;107(6):173-5. PMID: 24988833
- Gill JM, Cole DM, Lebowitz HM, Diamond JJ. Accuracy of screening for diabetic retinopathy by family physicians. *Ann Fam Med* 2004;2(3):218-20. <http://doi.org/10.1370/afm.67>
- Verma L, Prakash G, Tewari HK, Gupta SK, Murthy GVS, Sharma N. Screening for diabetic retinopathy by non-ophthalmologists: an effective public health tool. *Acta Ophthalmol Scand* 2003;81(4):373-7. <http://doi.org/10.1034/j.1600-0420.2003.00004.x>
- Owens DR, Gibbins RL, Lewis PA, Wall S, Allen JC, Morton R. Screening for diabetic retinopathy by general practitioners: ophthalmoscopy or retinal photography as 35 mm colour transparencies? *Diabet Med* 1998;15(2):170-5. [http://doi.org/10.1002/\(SICI\)1096-9136\(199802\)15:2<170::AID-DIA518>3.0.CO;2-H](http://doi.org/10.1002/(SICI)1096-9136(199802)15:2<170::AID-DIA518>3.0.CO;2-H)
- Queiroz MS, Carvalho JX, Bortoto SF, Matos MR, Cavalcante CGD, Andrade EAS, et al. Correction to: diabetic retinopathy screening in urban primary care setting with a handheld smartphone-based retinal camera. *Acta Diabetol* 2021;58(1):127. <http://doi.org/10.1007/s00592-020-01599-1>
- Shuttleworth GN, Marsh GW. How effective is undergraduate and postgraduate teaching in ophthalmology? *Eye* 1997;11:744-50. <https://doi.org/10.1038/eye.1997.189>
- Bukhari AA. The clinical utility of eye exam simulator in enhancing the competency of family physician residents in screening for diabetic retinopathy. *Saudi Med J* 2014;35(11):1361-6. PMID: 25399213
- Jackson C, Jong I, Glasson W. Royal Australian College of Ophthalmologists and Royal Australian College of General Practitioners National GP Eye Skills Workshops: colleges and divisions reskilling general practice. *Clin Experiment Ophthalmol* 2000;28(5):347-9. <https://doi.org/10.1046/j.1442-9071.2000.00337.x>



22. Jansen JJ, Grol RP, Van Der Vleuten CP, Scherpbier AJ, Crebolder HF, Rethans JJ. Effect of a short skills training course on competence and performance in general practice. *Med Educ* 2000;34(1):66-71. <https://doi.org/10.1046/j.1365-2923.2000.00401.x>
23. Wong WCW, Jiang S, Ong JJ, Peng M, Wan E, Zhu S, et al. Bridging the gaps between patients and primary care in China: a nationwide representative survey. *Ann Fam Med* 2017;15(3):237-45. <https://doi.org/10.1370/afm.2034>
24. McCarty CA, Taylor KI, Keeffe JE. Management of diabetic retinopathy by general practitioners in Victoria. *Clin Exp Ophthalmol* 2001;29(1):12-6. <https://doi.org/10.1046/j.1442-9071.2001.00359.x>