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Training general practitioners in melanoma diagnosis: a scoping review of the literature.

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Training general practitioners in melanoma diagnosis: a scoping review of the literature

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Abstract

Background: General practitioners (GPs) are recognized to play a key role in early melanoma detection. In order to help GPs deal with suspicious skin lesions, melanoma diagnostic training programs were developed. However, it is unclear whether these programs guarantee the acquisition of skills that will be applied by the GPs in their daily clinical practice and maintained over time.

Objectives: This scoping review aimed to examine and compare educational programs training GPs in melanoma diagnosis using clinical (naked eye) examination alone, dermoscopy alone or clinical diagnosis followed by dermoscopy and sought to inform on the long-term sustainability of the GPs' acquired skills.

Eligibility criteria: Studies eligible for inclusion evaluated educational programs teaching diagnosis of melanoma to GPs. MEDLINE, EMBASE, and Cochrane databases were searched for relevant articles between February and May 2020.

Results: Forty-five relevant articles were found assessing 31 educational programs. Most programs that improved the diagnostic accuracy and long-term performances of the GPs, i.e. increase in confidence, decrease in dermatologist referral of benign skin lesions, and improvement of the benign/malignant ratio of excised skin lesions, trained the GPs in clinical diagnosis followed by dermoscopy. To maintain the GPs' acquired performances in the long term, they provided refresher training material.

Conclusion: This review shows that studies generally report positive outcomes from the training of GPs in melanoma diagnosis. However, refresher training material seemed necessary to maintain the GPs' acquired skills. The optimal form and ideal frequency for these updates have yet to be defined.

Strengths and limitations of the review

- Systematic review conducted following the guidelines of the PRISMA-Scr (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) checklist
- It evaluates all educational programs in melanoma diagnosis for general practitioners
- Specifically, the review examines the long-term effect of the educational programs and the value providing regular refresher training sessions after the training
- This review led inevitably to some publication bias as only English language peer-reviewed articles were included.

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Contributorship statement

E. Harkemanne developed the research protocol, completed the literature search and screened the articles for inclusion, extracted the data, synthesised the findings, interpreted the results and drafted the manuscript. M. Baeck screened the articles for inclusion, extracted data and critically revised the manuscript. I. Tromme developed the protocol, independently reviewed the articles for inclusion, extracted data, interpreted the results and critically revised the manuscript. All authors approved the final version.

Data availability statement

All data relevant to the study are included in the article.

Introduction

Early melanoma detection is essential to reduce morbidity and mortality of melanoma patients.¹ Given the increased incidence of this aggressive skin cancer, primary care physicians (PCPs) are recognized to play a key role in early melanoma diagnosis.²⁻⁴ PCPs are health care professionals providing first and continuing medical care to a patient. They include general practitioners (GPs), internists, physician assistants, and registered nurses, among others. In this review, we decided to focus on GPs who take care of patients in community settings and are, in most countries, the first point of contact for any patient with a health issue.

To improve the GPs' diagnostic accuracy, educational training programs in melanoma diagnosis have been developed. At first, training courses in melanoma diagnosis were proposed using clinical (naked eye) examination alone. A systematic review⁵ published in 2011 reported on 20 studies evaluating 13 educational interventions in clinical melanoma diagnosis for PCPs. All these evaluated interventions demonstrated to improve the diagnostic accuracy and melanoma management.

Later on, educational programs including dermoscopy training were created and evaluated for primary care. So far, dermoscopy has been the most widely non-invasive *in vivo* technique used in clinical practice to assess skin tumors.⁶ It uses a handheld device, which allows observation of skin structures invisible to the naked eye. However, its sensitivity and specificity are operator-dependent (trained *vs.* untrained physicians).⁷ To note that 92% sensitivity and 95% specificity can be achieved for melanoma by a trained dermatologist using visual inspection plus *in vivo* dermoscopy.⁸ In primary care, dermoscopy has also been shown to be an effective tool for the triage of suspicious pigmented skin lesions when performed by properly trained PCPs.^{9,10} Yet, the minimum in training to reach competence is still unknown.¹¹

The previously published reviews^{5,11-14} on training programs in melanoma diagnosis for GPs focused on the content, teaching method, outcome measures and study-by-study efficacy of the evaluated educational interventions. However, they did not assess whether the GPs' acquired skills were measured in the short or long term. Yet, given the increasing burden of melanoma on general practice, it is crucial to know whether these programs are capable of teaching GPs easily applicable and sustainable skills in melanoma diagnosis and management.

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3 This scoping review aimed to examine educational programs training GPs in melanoma
4 diagnosis using clinical (naked eye) examination alone, dermoscopy alone or clinical diagnosis
5 followed by dermoscopy. It also sought to inform on the long-term sustainability of the GPs'
6 acquired skills.
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10 **Material and methods**

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14 To carry out this literature review, a scoping review seemed the most appropriate. Indeed, the
15 results from studies on educational programs on melanoma diagnosis for GPs presented with a
16 wide range of study designs and heterogeneous outcome measures, which made it impossible
17 to formally assess the quality of these studies and to conduct a meta-analysis. To conduct this
18 scoping review, the guidelines of the PRISMA-ScR (Preferred Reporting Items for Systematic
19 reviews and Meta-Analyses extension for Scoping Reviews) checklist were followed.¹⁵
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24 **Eligibility criteria**

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27 Studies eligible for inclusion in this review (Table 1) evaluated educational programs teaching
28 either clinical diagnosis of melanoma and/or diagnosis using dermoscopy, both designed
29 primarily for PCPs including GPs. Indeed, the population of interest were qualified GPs and
30 GP trainees. Studies that trained PCPs not including GPs were not eligible. Specialists and GPs
31 working in hospital settings and/or specialized clinics were excluded. Studies where no
32 participant training in melanoma diagnosis was proposed and studies evaluating exclusively
33 nonmelanoma skin cancer detection were excluded. Studies using teledermoscopy and
34 computer-aided diagnosis of melanoma were not assessed as they do not require specific
35 education in melanoma recognition by the participants. Outcomes of interest were the type of
36 educational program and the short and/or long-term evaluation of its efficacy on the GPs' skills.
37 Finally, articles not subject to peer review and written in languages other than English were not
38 taken into account.
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49 **Data sources and study selection**

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51 Literature searches were undertaken between February and May 2020. MEDLINE, EMBASE,
52 and Cochrane databases were searched for relevant articles published between 1995 and End
53 of May 2020. Studies were selected for inclusion by three authors (EH, MB, and IT), with IT
54 providing the final decision in the event of disagreement.
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3 To cover all the literature on the subject, 4 categories of terms were identified: (1) general
4 practitioners, family doctor, general medicine, family practice, primary care physicians; (2)
5 education, continuing medical education (3) melanoma, malignant melanoma, cutaneous
6 melanoma, skin neoplasms; (4) diagnosis, cancer early detection. In MEDLINE, the following
7 Medical Subject Headings (MeSH) were used: *general practitioners* OR *family practice* OR
8 *primary care physicians* OR *general medicine* AND *melanoma* AND *diagnosis*. No limits were
9 defined. In EMBASE, Emtree terms were exploded: *general practitioner*, *family doctor*,
10 *primary care*, *family physician*, *primary care physician*, *melanoma*, *diagnosis*, and *education*.
11 In the Cochrane database, the following terms were searched: *melanoma* AND *diagnosis* AND
12 *general practitioners* OR *family medicine* AND *dermoscopy*. In addition, the reference lists of
13 included studies were screened as a source of further relevant articles.
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24 **Data extraction**

25 Two authors (EH and MB) reviewed all included articles and independently collected data.
26 Extracted data included authors, year of publication, origin of the article, study design, number
27 of participating GPs, type of educational program, type of outcome measures and short- and/or
28 long-term evaluation of these outcomes. The type of educational program included training
29 content, teaching method, training duration and refresher training material (if provided). To
30 facilitate comparison with data found in previous reviews, all these data were reported into
31 categories adapted from those presented by Fee *et al.*¹⁴
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39 Table 2 gives the definition of the different categories. The training content was subdivided into
40 6 components: epidemiology, clinical diagnosis, clinical algorithm, dermoscopic diagnosis,
41 dermoscopic algorithm and management. The teaching method was considered either as live,
42 in the form of scientific literature, e-learning, or self-assessment and the refresher training
43 material specified the material available for participants to refresh their skills after the training.
44 The outcome measures were expressed either in terms of competence or in terms of
45 performance, according to the assessment approach of continuing medical education programs
46 proposed by Moore.¹⁶ Finally, since the limits between short-term and long-term evaluation of
47 a medical educational program are not standardized, arbitrary limits have been chosen based on
48 the observations made during this literature review.
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58 **Patient and Public Involvement**

59 No patient and public involvement was required for this review.
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Results

In total, 325 articles were identified from the electronic database searches, as shown in the PRISMA flowchart (Figure 1).¹⁷ At the end of the study selection process, 45 relevant articles were included in the review analysis. These articles reported on five reviews and 37 studies, which assessed 31 educational interventions.

Study designs

Thirty-seven interventional studies with a range of study designs were found: 11 randomized controlled trials (RCTs)^{9,10,26,27,18–25}, 19 diagnostic accuracy studies^{28,29,38–46,30–37}, three cohort studies^{47–49} and three case-control study.^{50–52} To note that five of the 31 trainings were assessed twice.^{22,25,27,30,47}

Four systematic reviews were identified: one on training PCPs in clinical melanoma diagnosis,⁵ two on training PCPs in dermoscopy for melanoma diagnosis,^{12,13} and one on the use of dermoscopy in primary care.¹¹ A scoping review on training PCPs in dermoscopy¹⁴ was also included. The final three articles were descriptive articles of the educational programs and study protocols.^{53–55}

Educational programs

The educational programs in melanoma diagnosis for GPs varied in terms of content, teaching method and outcome measures. The characteristics of these training programs are summarized in Table 3.

Training content

Of the 31 educational programs, 15 involved training GPs in clinical diagnosis, five in dermoscopic diagnosis alone, and 11 trained GPs in both melanoma diagnostic methods. Twelve (80%) of the clinical diagnostic training programs involved also learning of epidemiology and 11 (73%) learning of management guidelines for suspicious lesions. Only 7 (47%) programs teaching clinical diagnosis used an algorithm to teach melanoma recognition, with the ABCD(E) rule⁵⁶ (Asymmetry, uneven Borders, uneven Colors, Diameter > 6mm, and Evolution) being most commonly taught. Of the dermoscopic training programs, 12 (80%) included learning of at least one dermoscopic algorithm (Menzies' method,^{20,33,35,38} Three-point checklist,^{9,38,39} the 7-point checklist,^{10,33} TADA,^{42,45} the ABCD rule,^{33,36} BLINCK,³⁸ and

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3 pattern analysis^{33,52}). In addition, two educational programs included training on other
4 diagnostic tools, such as sequential digital dermoscopy imaging³⁵ and polaroid instant camera
5 photography.²²
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10 *Teaching method, training duration and refresher training material*

11 Live training courses and the use of educational books, posters or videos (literature) were the
12 two preferred teaching methods of clinical diagnostic training programs. Five trainings used
13 also an e-learning approach.^{25,27,29,49,51} The most common teaching method used in dermoscopic
14 training programs was live training. This approach was combined to literature and/or e-learning
15 in six programs. Three programs also used self-assessment. Overall, the teaching method did
16 not appear to have influenced the program outcomes. Duration of training varied from 75
17 minutes to 1 day. It was not specified in two studies^{28,38} and was participant dependent in six
18 studies using self-assessment methods. Six dermoscopic diagnostic training
19 programs^{26,35,36,39,47,52} and three programs in clinical diagnosis^{23,34,48} provided regular refresher
20 training material such as unlimited e-learning access or self-assessment training sessions.
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30 *Training outcomes*

31 Table 4 summarizes the outcome measures of the studies. In the selected studies, the GPs'
32 competences were generally measured in the short term while the performances of the GPs were
33 measured in the long term after the training.
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39 Eight clinical diagnostic training programs and seven dermoscopic training programs were
40 assessed only in the short term (Table 4A). For these studies, the most evaluated competences
41 were the diagnostic accuracy and the appropriate management of the GPs measured in a training
42 setting. The most evaluated performance in the short-term, measured in a clinical setting, was
43 the GPs' confidence in diagnosing melanoma. Except for two, all showed a positive impact of
44 their intervention.^{18,24} Four clinical diagnostic training programs and three dermoscopic
45 training programs were only assessed in the long term (Table 4B). The most evaluated
46 performances, measured in daily clinical practice, were the GPs' diagnostic accuracy and the
47 benign/malignant ratio of excised lesions. Three studies^{9,34,47} reported improvement of the GPs'
48 performances on melanoma diagnosis. The other studies reported none. Finally, three clinical
49 diagnostic and seven dermoscopic training programs were evaluated in the short and long term
50 (Table 4C). All training programs demonstrated to improve the GPs' competences measured in
51 a training setting in the short term, except one.²⁴ In the long term, eight
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3 trainings^{10,35,36,39,47,48,51,52} reported significant improvement of the GPs' performances for the
4 diagnosis of melanoma and benign skin lesions. This led to either a decrease in the referral rates
5 to dermatologists^{35,39,51} and/or a decrease in the ratio of benign/malignant excised skin
6 lesions.^{35,47} Among the major studies, Koelink *et al.*¹⁰ found that their dermoscopic training
7 program improved the GPs' performances up to 1.25 times greater diagnostic accuracy for skin
8 lesions including melanomas in the long term. In a French department, Grange *et al.*⁴⁸ observed
9 an impressive reduction of the incidence of advanced melanomas (Breslow thickness ≥ 3 mm)
10 during the 3-year period after their GP training campaign in clinical melanoma diagnosis. A
11 very recent study conducted by Marra *et al.*⁵¹ found that of a total of 1662 referrals, GPs trained
12 in melanoma diagnosis had a better quality of referrals than untrained GPs, leading to less
13 potentially unnecessary referrals. However, two educational programs^{25,26} were unable to
14 maintain the GPs' acquired performances in the long term.

25 **Discussion**

26 This scoping review aimed to examine educational programs training GPs in melanoma
27 diagnosis using clinical (naked eye) examination alone, dermoscopy alone or clinical diagnosis
28 followed by dermoscopy and sought to inform on the long-term sustainability of the GPs'
29 acquired skills.
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36 In total, 31 educational programs were found. Fifteen programs trained GPs in clinical diagnosis
37 alone and 16 trained GPs in dermoscopy (Table 3). Duration of training varied from 75 minutes
38 to 1 day and various teaching methods were used among live training courses, educational
39 books and e-learning. After the course, nine programs provided their participants with regular
40 refresher training material such as unlimited e-learning access or self-assessment training
41 sessions.
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48 **Types of educational programs with positive long-term outcomes**

49 Two main diagnostic training methods, clinical examination and diagnosis using dermoscopy,
50 were identified. Most reported educational programs that improved the long-term diagnostic
51 accuracy and changed the GPs' melanoma practice patterns, such as reducing the referral rates
52 to dermatologists and the benign/malignant ratio of excised skin lesions, trained their
53 participating GPs in both methods.
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3 Educational programs in clinical examination alone might have been less likely to convince
4 positive long-term outcomes than programs teaching both methods because they used less
5 powerful measures of performance. They compared, for instance, the GPs' confidence and the
6 number of total-body skin examinations performed before and after training, whereas programs
7 teaching both methods measured the GPs' diagnostic accuracy and decrease of referral rates to
8 dermatologists. Nevertheless, a very recent study conducted in the Netherlands compared the
9 quality of referral and diagnostic accuracy of GPs mostly trained in clinical melanoma diagnosis
10 alone to that of untrained GPs and demonstrated a significant better outcome by the trained
11 GPs.⁵¹
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20 To note that only one training in dermoscopy alone was found to be assessed in the long term.⁵²
21 Indeed, it is more and more common and pertinent to teach GPs in clinical examination
22 followed by dermoscopy. This teaching method is furthermore supported by a recent Cochrane
23 review,⁸ which found that dermoscopy alone was less accurate than clinical examination
24 followed by dermoscopy, for the diagnosis of melanoma.
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30 Moreover, the same Cochrane review⁸ suggested that dermoscopic algorithms were most useful
31 to train non-experts in dermoscopy. In the present review, we found that five of the programs
32 with long-term positive impact used dermoscopic algorithms to teach melanoma
33 diagnosis.^{10,35,36,39,52} These algorithms, Menzies' method,⁵⁷ the ABCD rule,⁵⁸ pattern analysis
34 and the 7-point checklist,⁵⁹ were designed at first for trained physicians and afterwards tested
35 as effective when used by nonexperts.⁶⁰ Other algorithms, such as the Three-point checklist⁶¹
36 were created directly for use by PCPs. In 2005, Dolianitis *et al.*³³ compared the performance of
37 four of these algorithms (Menzies' method, the 7-point checklist, the ABCD rule, and pattern
38 analysis) for teaching dermoscopy to untrained GPs and found similar performances for all
39 algorithms. In this review, similar observation was made among the trainings that improved the
40 GPs' performances, each using a different algorithm. Recently, a new promising 3-step
41 dermoscopic algorithm, The Triage Amalgamated Dermoscopic Algorithm (TADA), has been
42 proposed especially for GPs.⁶² Three studies already confirmed the short-term efficacy of
43 TADA in improving the GPs' melanoma diagnostic accuracy.^{42,45,63} A recent study
44 demonstrated that teaching only the first step of the TADA was already enough to improve the
45 diagnostic accuracy of untrained GPs from 76.9% to 95% for melanoma.⁴⁶ However, the long-
46 term performance of these trainings using the TADA-algorithm has not been tested yet.
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3 In the literature, the main limitation to the use of dermoscopy in general practice was reported
4 to be the large number of training hours in order to become competent.^{64,65} At this time, there
5 is no evidence on the optimal length of training, even though it has been demonstrated that
6 diagnostic accuracy of dermoscopy depends on the degree of training of the practitioner.⁶⁶ A
7 study suggested that 1 day of live training in dermoscopy was sufficient to build the confidence
8 of GPs with special interest in melanoma diagnosis.⁶⁷ Actually, we found two RCTs showing
9 sustained improvement of the diagnostic accuracy of GPs proposing a live training in
10 dermoscopy with a duration of 1 day to 10 hours, respectively.^{9,10} The long duration of training
11 in dermoscopy being a limiting factor for most GPs, it is important to keep in mind that training
12 in clinical melanoma diagnosis also showed to improve the GPs' performances while requiring
13 less training time (+/- 2.5h).^{34,48}

23 **Long-term improvement of the GPs' performances in clinical settings**

24 The GPs' performances measured in clinical settings were assessed over the long term for 15
25 educational programs: six in clinical diagnosis and nine in dermoscopic diagnosis. Ten showed
26 a positive impact on the GPs' performances measured over periods ranging from 6 to 19
27 months. Seven of these 10 trainings demonstrated sustainability of the GPs' acquired diagnostic
28 skills measured in a training setting leading to changes in real-life practice. The studies mostly
29 stated a decrease of referral rates to a dermatologist for benign skin lesions and an improvement
30 of the benign/malignant ratio of excised skin lesions. Furthermore, a decrease of the incidence
31 of advanced melanomas was shown in a French department over a 3-year period after their
32 training program in clinical melanoma diagnosis.⁴⁸ The INFORMED group³⁹ also reported an
33 increase in melanoma diagnosis during a screening program by GPs trained with their program
34 in 2016.⁶⁸ Unfortunately, two educational programs^{25,26} failed to maintain the GPs' acquired
35 performances at 1 year after the end of the training. In contrast to other dermoscopy training
36 programs, Badertscher *et al.*²⁶ used Lumio®, a polarized magnifying glass with 2x
37 magnification (10x for standard dermoscopy device) to teach dermoscopy and teledermatology
38 feedback as refresher training material. Concerning Markova *et al.*,²⁵ they chose to assess by
39 interviews of patients the number of total-body skin examinations performed but did not
40 evaluate the GPs' diagnostic accuracy.

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57 To retain acquired diagnostic skills over the long term, a recent RCT, which failed to maintain
58 the performances of trained internists at 12 months, suggested a need for "refresher sessions at
59 regular intervals".^{69,70} In this review, nine (60%) educational programs, which were evaluated
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3 in the long-term, provided refresher training material for their participating GPs. Seven of these
4 programs were successful. In 2014, Grange *et al.*⁴⁸ furnished a CD-ROM containing the
5 teaching material and sent regular information about melanoma to the GPs. The INFORMED
6 group³⁹ provided GPs with a free unlimited access to their web-based course. Menzies *et al.*³⁵
7 gave the GPs an educational textbook and an unlimited e-learning access. Grimaldi *et al.*³⁶ and
8 Youl *et al.*⁴⁷ also ensured self-assessment refresher training sessions. Marra *et al.*⁵¹ found a 10-
9 month sustainability of the diagnostic accuracy of their trained GPs and assumed that daily use
10 of the obtained knowledge during the study period achieved this effect. Only Koelink *et al.*,¹⁰
11 who evaluated the longest post-training period (19 months) demonstrating sustainability of
12 diagnostic skills, did not specify whether update training modalities were provided.
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22 However, the ideal frequency and form of these updates have never been studied. A RCT, taking
23 place in the English National Defibrillator Programme, determined that update session intervals
24 after a medical education session should not exceed 7 months to limit the loss of acquired skills
25 and maintain the participants confidence.⁷¹ In the UK, a survey among GPs with special interest
26 in dermatology stated that self-assessment learning was the most popular for refresher
27 sessions.⁶⁷ Nevertheless, they also showed that 36% of GPs using dermoscopy in their clinical
28 practice reported to never have updated their training skills. We found that the most appreciated
29 form of self-assessment updates was unlimited access to an e-learning course. In the future, this
30 craze for online training could lead to the development of smartphone applications to train GPs
31 in melanoma diagnosis. Some newly developed applications have currently been evaluated
32 among medical students⁷² and dermatology residents.⁷³ Initial results already looked very
33 promising.
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44 **Limitations**

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46 This scoping review has some limitations and led inevitably to certain publication bias. We
47 used keywords for the selection of articles and only peer-reviewed articles were included. By
48 limiting our research to English language articles, some studies may also have been missed. It
49 is also very likely that melanoma diagnostic training programs exist in unpublished forms, for
50 example in university continuing medical education programs. Moreover, we focused only on
51 studies assessing melanoma diagnostic training methods among GPs. This way, some
52 educational programs for primary care may not be mentioned in this review. Furthermore,
53 educational programs, which were not evaluated in studies, were overlooked. Finally, this
54 review covers educational programs over a 25-year period. As technology has evolved
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3 considerably since then, some teaching methods and refresher training materials have for the
4 most been overshadowed by interactive online tutorials (e-learning). This is all the truer since
5 the health crisis caused by COVID-19 has allowed this distance learning method to develop
6 very rapidly.
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10 **Conclusion**

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12 In conclusion, educational programs trained GPs in melanoma diagnosis using clinical
13 examination alone, dermoscopy alone or clinical diagnosis followed by dermoscopy. Most
14 reported programs that improved the long-term diagnostic accuracy and changed the daily-life
15 performances of the GPs, i.e. decrease in dermatologist referral of benign skin lesions, and
16 improvement of the benign/malignant ratio of excised skin lesions, trained their participating
17 GPs in both methods. The preferred teaching method was live and e-learning but the teaching
18 method did not seem to influence the GPs' acquired performances. It is important to note that
19 the educational programs that achieved to maintain long term performances of the GPs in daily
20 clinical practice included refresher training material. However, the optimal form and ideal
21 frequency of these updates have yet to be defined.
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Table 1. Inclusion and exclusion criteria for article selection

<p>Inclusion criteria:</p> <p>Articles</p> <ul style="list-style-type: none"> Articles written in English Study articles and descriptive articles of educational programs <p>Population</p> <ul style="list-style-type: none"> Qualified GPs and GP trainees working in community settings <p>Intervention</p> <ul style="list-style-type: none"> Studies evaluating educational programs in clinical (naked eye) diagnosis and/or diagnosis of melanoma using dermoscopy <p>Outcome(s)</p> <ul style="list-style-type: none"> Studies assessing the type of educational program and its short and/or the long-term efficacy on the skills acquired by the GPs
<p>Exclusion criteria:</p> <p>Articles</p> <ul style="list-style-type: none"> Articles not subject to peer review and written in languages other than English <p>Population</p> <ul style="list-style-type: none"> Studies involving specialists, medical students, non-GPs, GPs working in hospital settings and/or specialized skin cancer clinics <p>Intervention</p> <ul style="list-style-type: none"> Studies evaluating exclusively nonmelanoma skin cancer Teledermoscopy studies Studies on computer-aided diagnosis of melanoma <p>Outcome(s)</p> <ul style="list-style-type: none"> No method of measuring outcomes was ruled out

Key: GPs= general practitioners

Table 2. Definition of study categories

Criteria	Categories	Definition
Training content	Epidemiology	Background information on rates of melanoma cancer, risk factors, localization and evolution of melanomas
	Clinical diagnosis	Naked eye melanoma recognition
	Clinical algorithm	Use of a pre-existing algorithm as a learning tool to aid for clinical diagnosis
	Dermoscopic diagnosis	Recognition of melanoma using dermoscopy
	Dermoscopic algorithm	Use of an algorithm as a learning tool to aid for dermoscopic diagnosis
	Management	Determination of a plan of action for a skin lesion i.e. reassurance, follow-up, or lesion excision
Teaching method	Live	Presentation by a speaker to a group of participants
	Scientific literature	Use of educational books, posters, letters, CD-ROMs or videos
	E-learning	Interactive online tutorials including audio and visual information
	Self-assessment	Learning by the participant himself using educational material
Refresher training material	Teledermatology feedback	Feedback from a dermatologist on the image and clinical history of a suspicious lesion at a distance, using remote internet-based technologies
Outcome measures	Competences	Acquired skills, which are evaluated in a training setting on clinical and/or dermoscopic photographs of skin lesions
	Diagnostic accuracy	Ability of the participants to discriminate between melanoma and benign lesions
	Knowledge	Report of conceptual understanding
	Appropriate management	Determination of the right plan of action for a skin lesion
	Performances	Changes in real-life practice measured in a clinical setting, i.e. changes in the benign/malignant ratio of excised lesions, the number of total-body skin examinations performed, confidence of the GPs, changes in referral rates to a dermatologist, and decrease in the incidence of advanced melanomas
Evaluation	Short-term	Measurement of outcomes immediately or up to 3 months after the training
	Long-term	Measurement of outcomes at ≥ 6 months after the training

Table 3. Characteristics of educational programs in melanoma diagnosis for general practitioners

Article	Study design	Study participants	Training content						Teaching method	Training duration	Refresher training material
			Epidemiology	Clinical diagnosis	Clinical algorithm	Dermoscopic diagnosis	Dermoscopic algorithm	Management			
Marra, 2020, The Netherlands ⁵¹	Case-control study	185 (83; 102)*		X		X (optional)		X	e-learning	2h	
Sawyers, 2020, Canada ⁴⁶	DA study	33 GPs				X	TADA step-I		Live	3.5h	
Augustsson, 2019, Sweden ⁵²	Case-control study	43 GPs (27;16)*				X	Pattern analysis		Live	1-day	PDF-files of the course
Seiverling, 2019, USA ⁴⁵	DA study	59 GPs		X		X	TADA		Live	75min	
Beecher, 2018, Ireland ⁴⁴	DA study	23 GP trainees	X	X				X	Live, Literature	1h	
Secker, 2017, The Netherlands ⁴³	DA study	293 PCPs including ? GPs		X		X		X	Live, Literature and E-learning	1-day	
Rogers, 2016, USA ⁴²	DA study	16 GPs				X	TADA		Live	1-day	
Badertscher, 2011 and 2015, Switzerland ^{54,26}	RCT	78 GPs (39;39)*		X		Lumio®			Live	1-day	Teledermatology feedback
Gulati, 2015, UK ⁴⁹	Cohort study	967 GPs	X	X				X	E-learning	PD	
Koelink, 2014, The Netherlands ¹⁰	RCT	53 GPs	X	X		X	7-point checklist		Live	4h clinical diagnosis; 6h dermoscopy	

Grange, 2013, France ⁴⁸	Cohort study	398 GPs	X	X					Live, Literature	2.5h	CD-ROM+ regular information sheets
Markova, 2013, USA ²⁵ Mikkilineni, 2001 and 2002, USA ^{40,41} (Weinstock 1996) ⁵⁵	RCT DA study	46 GPs (20;26)* 7 GPs	X	X	ABCD(E)			X	E-learning Live Literature	 2h	
Eide, 2013, ³⁹ (Shaikh, 2012) ⁵³ INFORMED	DA study	54 PCPs including 9 GPs (20%)	X	X	ABCD(E) + Ugly duckling sign	X	Three-point checklist	X	E-learning, Self-assessment	2h web-based learning	Unlimited e-learning access
Bourne, 2012, Australia ³⁸	DA study	3 GPs		X		X	BLINCK Three-point checklist Menzies method		Live, Literature	UD	
Shariff, 2010, UK ³⁷	DA study	94 GPs		X					Literature	PD	
Grimaldi, 2009, Italy ³⁶	DA study	13 GPs		X		X	ABCD rule		Live, E-learning, Self-assessment	PD	Self-assessment e-learning training sessions
Menzies, 2009, Australia ³⁵	DA study	63 GPs		X		Yes + Sequential digital dermoscopy	Menzies method		Live, Literature, E-learning	2h-workshop	Unlimited e-learning access
Peuvrel, 2009, France ³⁴	DA study	210 GPs	X	X	ABCD(E)			X	Live, Literature (CD-ROM)	2h	CD-ROM
Youl, 2007, Australia ⁴⁷	Cohort study	16 GPs	X	X	ABCD(E)	X		X	Literature	PD	Self-assessment paper-based training sessions

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3	Raasch, 2000, Australia ²⁴	RCT	46 GPs (23;23)*								
4	Argenziano, 2006, Italy and Spain ⁹	RCT	73 GPs (36;37)*		X	ABCD	X	Three-point checklist	Live	1-day	
5											
6	Dolianitis, 2005, Australia ³³	DA study	35 GPs				X	Menzies method 7-point checklist ABCD rule Pattern analysis	Literature, E-learning, Self- assessment	PD	
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15											
16	Carli, 2005, Italy ³²	DA study	41 GPs	X	X	ABCD(E)		X	Live	4h	
17											
18	De Gannes, 2004, Canada ²³	RCT	27 GPs (10;17)*	X	X				Literature (Video- format)	12min	Unlimited access to the 12- minute Video
19											
20											
21	English, 2003, Australia ²²	RCT	468 GPs (245;228)*		X + Polaroid instant camera			X	Literature	>6h	
22											
23											
24	Del Mar, 1995, Australia ²¹	RCT	93 GPs (48;45)*							1h	
25											
26											
27	Brochez, 2001, Belgium ³¹	DA study	146 GPs	X	X			X	Live, Literature	2h	
28											
29	Harris, 1999 and 2001, USA ^{29,30}	DA study	232 GPs 17 GPs	X	X	ABCD 7-point Glasgow checklist		X	Literature, E-learning	1h	
30											
31											
32											
33	Westerhoff, Australia 2000 ²⁰	RCT	74 GPs				X	Menzies method	Live, Literature	1h live	
34											
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36	Bedlow, 2000, UK ²⁸	DA study	17 GPs		X				Live, Literature	UD	
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46											

Gerbert, 1998 and 2002, USA ^{19,27}	RCT	52 GPs (26;26)*	X	X				X	Live, Literature, E-learning	>3h	
Dolan, 1997, USA ¹⁸	RCT	82 PCPs including 16 GPs (46;36)*	X	X					Live	2h	
Girgis, 1995, Australia ⁵⁰	Case-control study	41 GPs (24;17)*	X	X				X	Live, literature	>6h	

Key: GPs=general practitioners; PCPs= primary care physicians; RCT= randomized controlled trial; DA= diagnostic accuracy; INFORMED= Internet curriculum for melanoma early detection; PD= participant dependent; UD=undisclosed; TADA=trriage amalgamated dermoscopic algorithm

*number of participants in the intervention group and control group

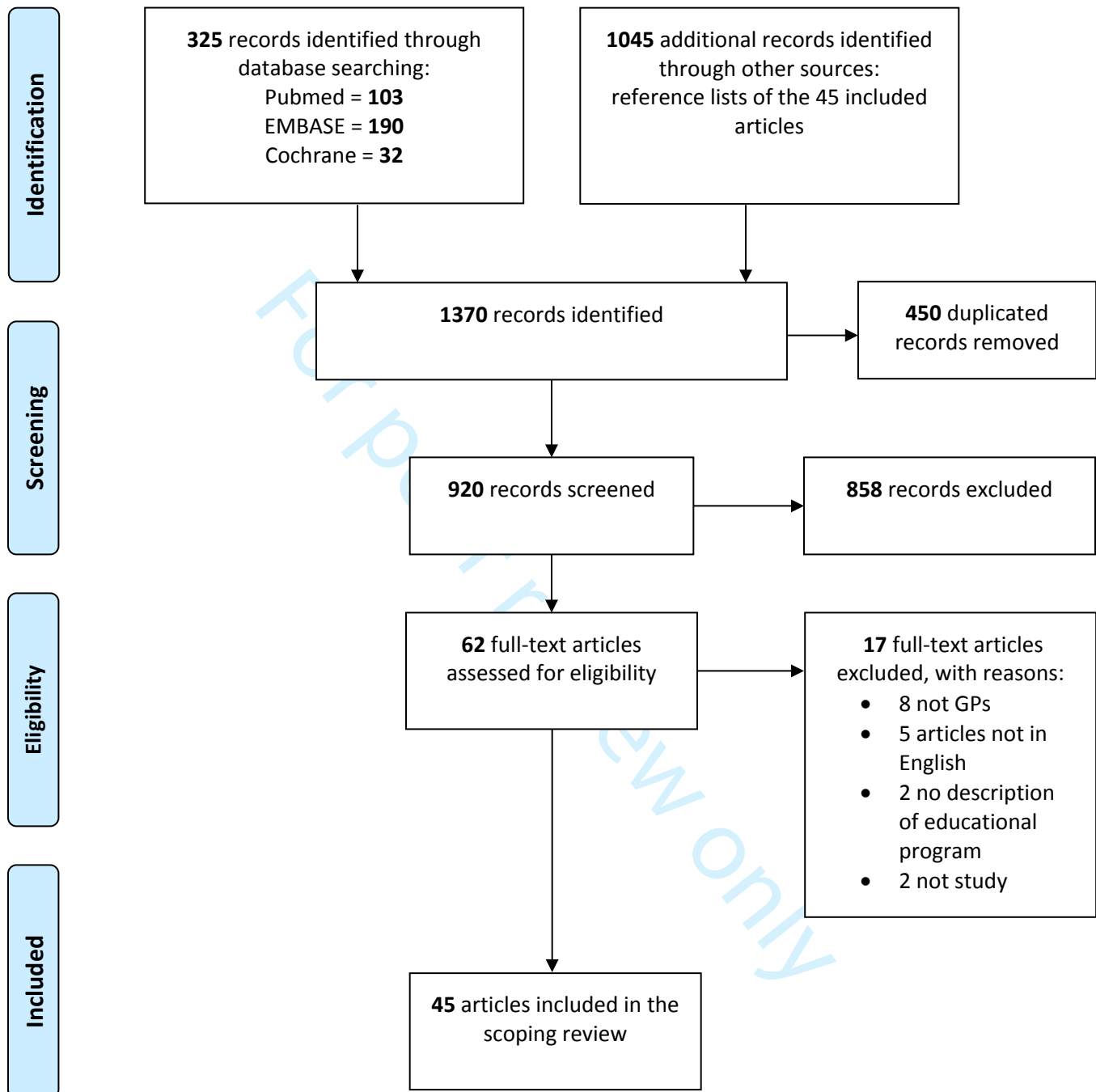
Table 4. Outcome measures of the melanoma diagnostic educational programs for general practitioners.

A. Studies with short-term outcomes												
Studies (1st author and year of publication)	Measured competence in training setting			Measured performance in clinical setting						Timing after the training		
	DA	Knowledge	AM	B/M lesion ratio	TBSE	DA	confidence	Decrease of VTM incidence	RR	immediately	at 1 month	at 3 months
Dermoscopic diagnostic training programs												
Sawyers 2020 ⁴⁶	+									X		
Seiverling 2019 ⁴⁵	+									X		
Secker 2017 ⁴³	+		+									X
Rogers 2016 ⁴²	+									X		
Bourne 2012 ³⁸	+									X		
Dolianitis 2005 ³³	+									X		
Westerhoff 2000 ²⁰	+	+								X		
Clinical diagnostic training programs												
Beecher, 2018 ⁴⁴	+	+	+							X		X
Carli 2005 ³²	+		+							X		
Mikkilineni 2001;2002 ^{32,33}		+	+		+		+			X		
Brochez 2001 ³¹	+									X		
Harris 2001 ³⁰	+	+	+				+			X		
Harris 1999 ²⁹	+	-	+				+			X		
Raasch 2000 ²⁶	-						+			3-month period		
Bedlow 2000 ²⁸	+	+								X		
Gerbert 1998;2002 ^{19,27}	+	+	+				+			X		
Dolan 1997 ¹⁸	-	+	-							X	X	

Girgis 1995 ⁵⁰	-		+					+			X		X	
B. Studies with long-term outcomes														
Studies	Measured competence in training setting			Measured performance in clinical setting							Timing after the training			
	DA	Knowledge	AM	M/B lesion ratio	TBSE	DA	Confidence	Decrease of VTM incidence	RR					
Dermoscopic diagnostic training programs														
Shariff 2010 ³⁷						-						at 11 months		
Youl 2007 ⁴⁷				+		+						6-month period		
Argenziano 2006 ⁹						+					+	16-month period		
Clinical diagnostic training programs														
Gulati 2015 ⁴⁹						-	+					8-month period		
Peuvrel 2009 ³⁴			+				+					15-month period		
De Gannes 2004 ²³	-	-	-									at 6 months		
English 2003 ²²				-								21-month period		
Del Mar 1995 ²¹				+								24-month period		
C. Studies with short and long-term outcomes														
Studies	Measured competence in training setting			Timing after the training		Measured performance in clinical setting						Timing after the training		
	DA	Knowledge	AM	Immediately after	at 1-3 months	B/M lesion ratio	TBSE	DA	Confidence	Decrease of VTM incidence	RR			
Dermoscopic diagnostic training programs														
Augustsson 2019 ⁵²	+			X								at 6 months (here competence measure)		
Badertsche r2015 ²⁶	+			X				-	+			at 12 months		
Koelink 2014 ¹⁰	+		+	X				+	+			at 8 months	at 12 months	at 19 months
Eide 2013 ³⁹	+	+	+	X				+	+		+	at 6 months		

1 2 3 4 5 6 7 8	Youl 2007 ⁴⁶ Raasch 2000 ²⁴	-					+		+				6-month period
9 10 11 12 13	Grimaldi 2009 ³⁶ Menzies 2009 ³⁵	+			X	X			+				6-month period
14	Clinical diagnostic training programs												
15 16 17 18 19 20 21 22 23 24 25	Marra, 2020 ⁵¹ Grange 2013 ⁴⁸ Markova 2013 ²⁵ Mikkilineni 2001; 2002 ^{40,41}	+				X			+	+		+	at 10 months 3-year period at 12 months

26 *Key: DA= diagnostic accuracy; AM=appropriate management; TBSE= total body skin examination; B/M=benign/malignant; VTM= very thick melanomas; RR=*
 27 *decrease in dermatologist referral rates for benign lesions and increase in referral rates for malignant lesions*
 28 *'+'= statistically significant improvement; '-'= no statistically significant improvement*

Figure 1. PRISMA flowchart of study selection process¹⁷

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	N.A.
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	5
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	5-6
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	6
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	6
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	Table 2
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	5



SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	6
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Figure 1
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Table 3
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	N.A.
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Table 3
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	7-8
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	9-10-11
Limitations	20	Discuss the limitations of the scoping review process.	12
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	13
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	1

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169:467–473. doi: [10.7326/M18-0850](https://doi.org/10.7326/M18-0850).



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Training general practitioners in melanoma diagnosis: a scoping review of the literature

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Abstract

Background: General practitioners (GPs) play a key role in early melanoma detection. In order to help GPs deal with suspicious skin lesions, melanoma diagnostic training programs have been developed. However, it is unclear whether these programs guarantee the acquisition of skills that will be applied by the GPs in their daily clinical practice and maintained over time.

Objectives: This scoping review aimed to examine and compare educational programs designed to train GPs in melanoma diagnosis using clinical (naked eye) examination alone or dermoscopy +/- clinical examination, and sought to inform on the long-term sustainability of the GPs' acquired skills.

Eligibility criteria: Studies eligible for inclusion evaluated educational programs for teaching diagnosis of melanoma to GPs. MEDLINE, EMBASE, and Cochrane databases were searched for relevant articles from 1995 to May 2020.

Results: Forty-five relevant articles were found assessing 31 educational programs. Most programs that improved the diagnostic accuracy and long-term performances of the GPs i.e., increase in confidence, decrease in dermatologist referral of benign skin lesions, and improvement of the benign/malignant ratio of excised skin lesions, trained the GPs in clinical diagnosis followed by dermoscopy. To maintain long-term performances, these programs provided refresher training material.

Conclusion: This review shows that studies generally report positive outcomes from the training of GPs in melanoma diagnosis. However, refresher training material seemed necessary to maintain the acquired skills. The optimal form and ideal frequency for these updates have yet to be defined.

Strengths and limitations of the review

- Systematic review conducted following the guidelines of the PRISMA-ScR (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) checklist.
- It thoroughly evaluates educational programs on melanoma diagnosis for general practitioners.
- Specifically, the review examines the long-term effect of the educational programs and the value of providing regular refresher training sessions after the training.
- This review led inevitably to some publication bias as only English language peer-reviewed articles were included.

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Contributorship statement

E. Harkemanne developed the research protocol, completed the literature search and screened the articles for inclusion, extracted the data, synthesised the findings, interpreted the results and drafted the manuscript. M. Baeck screened the articles for inclusion, extracted data and critically revised the manuscript. I. Tromme developed the protocol, independently reviewed the articles for inclusion, extracted data, interpreted the results and critically revised the manuscript. All authors approved the final version.

Data availability statement

All data relevant to the study are included in the article.

Introduction

Early melanoma detection is essential to reduce morbidity and mortality of melanoma patients.¹ Given the increased incidence of this aggressive skin cancer, primary care physicians (PCPs) play a key role in early melanoma diagnosis.²⁻⁴ PCPs include a number of health care professionals who provide first and continuing medical care to a patient. In this review, we focus on GPs who take care of patients in community settings and are, in most countries, the first point of contact for any patient with a health issue.

To improve the diagnostic accuracy of melanoma by GPs, specific educational training programs have been developed. At first, training courses focused on melanoma diagnosis by clinical (naked eye) examination alone. A systematic review⁵, published in 2011, reported on 20 studies that evaluated 13 educational interventions in clinical melanoma diagnosis for PCPs. All the evaluated interventions improved diagnostic accuracy and melanoma management. Later, educational programs that included dermoscopy training were created and were then evaluated for primary care. To date, dermoscopy has been the most widely non-invasive *in vivo* technique used in clinical practice to assess skin tumors.⁶ It involves the use of a handheld device which allows the observation of skin structures invisible to the naked eye. However, the sensitivity and specificity of the technique are operator-dependent (trained vs. untrained physicians).⁷ Ninety-two percent sensitivity and 95% specificity can be achieved for melanoma diagnosis by a trained dermatologist combining visual inspection and *in vivo* dermoscopy.⁸ In primary care, dermoscopy has also been shown to be an effective tool for the triage of suspicious pigmented skin lesions when performed by properly trained PCPs.^{9,10} Yet, the minimum training required to reach competence is still unknown.¹¹

Previously published reviews^{5,11-14} on training programs in melanoma diagnosis for GPs focused on the content, teaching method, outcome measures and study-by-study efficacy of the evaluated educational interventions. However, they did not assess whether the GPs' acquired skills were measured in the short or long term. Yet, given the increasing burden of melanoma on general practice, it is crucial to know whether these programs are capable of teaching GPs easily applicable and sustainable skills in melanoma diagnosis and management. This scoping review aimed to explore educational programs training GPs in melanoma diagnosis using clinical (naked eye) examination alone and diagnosis using dermoscopy +/- clinical examination. Educational programs were examined with regard to training content, teaching

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3 method, training duration, availability of refresher training material, and outcome measures.
4 This review also specifically sought to inform on the long-term sustainability of the skills
5 acquired during these training programs.
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9 **Material and methods**

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11 To carry out this literature review, a scoping review seemed the most appropriate. Indeed, the
12 results from studies on educational programs on melanoma diagnosis for GPs presented with a
13 wide range of study designs and heterogeneous outcome measures, which made it impossible
14 to formally assess the quality of these studies and to perform a meta-analysis. To conduct this
15 scoping review, the framework developed by Arksey and O'Malley,¹⁵ subsequently refined by
16 Levac,¹⁶ and the guidelines of the PRISMA-ScR¹⁷ (Preferred Reporting Items for Systematic
17 reviews and Meta-Analyses extension for Scoping Reviews) checklist were followed.
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25 **Eligibility criteria**

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27 Studies eligible for inclusion in this review (Table 1) evaluated educational programs teaching
28 either clinical diagnosis of melanoma and/or diagnosis using dermoscopy +/- clinical
29 examination and designed primarily for PCPs including GPs. The population of interest
30 included qualified GPs and GP trainees. Specialists and GPs working in hospital settings and/or
31 specialized clinics were excluded. Studies that included training programs for PCPs other than
32 GPs were not eligible. Studies where no participant training in melanoma diagnosis was
33 proposed and studies evaluating exclusively non-melanoma skin cancer detection were also
34 excluded. Studies evaluating teledermoscopy and computer-aided diagnosis of melanoma were
35 not assessed as they do not require specific education in melanoma recognition by the
36 participants. Only studies assessing the type of educational program and its short and/or the
37 long-term efficacy on the skills acquired by the GPs were included. Finally, only peer-reviewed
38 and English language articles were included.
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49 **Data sources and study selection**

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51 MEDLINE, EMBASE, and Cochrane databases were searched for relevant articles published
52 from 1995 to May 2020. Studies were selected for inclusion by three authors (EH, MB, and IT),
53 with IT providing the final decision in the event of disagreement. The studies were not assessed
54 for bias, as the risk of bias assessment was reported as not applicable to scoping reviews in the
55 2018 PRISMA-ScR guidelines.¹⁷
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To extensively cover the literature on the subject, four categories of terms were identified: (1) general practitioners, family doctor, general medicine, family practice, primary care physicians; (2) education, continuing medical education; (3) melanoma, malignant melanoma, cutaneous melanoma, skin neoplasms; (4) diagnosis, and cancer early detection. In MEDLINE, the following Medical Subject Headings (MeSH) were used: *general practitioners OR family practice OR primary care physicians OR general practice AND melanoma AND diagnosis*. No limits were defined. In EMBASE, Emtree terms were exploded: *general practitioner, family doctor, primary care, family physician, primary care physician, melanoma, diagnosis, and education*. In the Cochrane database, the following terms were searched: *melanoma AND diagnosis AND general practitioners OR family medicine AND dermoscopy* (see Supplementary Table 1 for search strategies). In addition, the reference lists of included studies were screened as a source of further relevant articles.

Data extraction

Two authors (EH and MB) reviewed all included articles and independently collected data. Extracted data included authors, year of publication, origin of the article, study design, number of participating GPs, type of educational program, type of outcome measures and short- and/or long-term evaluation of these outcomes. The type of educational program included training content, teaching method, training duration and refresher training material (if provided). To facilitate comparison with data found in previous reviews, all these data were reported into categories adapted from those presented by Fee *et al.*¹⁴

Table 2 gives the definition of the different categories. The training content was subdivided into six components: epidemiology, clinical diagnosis, clinical algorithm, dermoscopic diagnosis, dermoscopic algorithm and management. The teaching method was considered either as live, in the form of scientific literature, e-learning, or self-assessment. The refresher training material specified the material available for participants to refresh their skills after the training. The outcome measures were expressed either in terms of competence or in terms of performance, according to the assessment approach of continuing medical education programs proposed by Moore.¹⁸ Finally, since the limits between short-term and long-term evaluation of a medical educational program are not standardized, arbitrary limits have been chosen based on the observations made during this literature review.

Patient and Public Involvement

No patient and public involvement was required for this review.

Results

In total, 325 articles were identified from the electronic database searches, as shown in the PRISMA flowchart¹⁹ (Figure 1). At the end of the study selection process, 45 relevant articles, which assessed 31 educational interventions, were included in the review analysis.

Study designs

Thirty-six interventional studies with a range of study designs were found: 11 randomized controlled trials (RCTs)^{9,10,20-29}, 19 diagnostic accuracy studies^{30-39,40-48}, three cohort studies⁴⁹⁻⁵¹ and three case-control studies.⁵²⁻⁵⁴ Five of the 31 training programs were assessed twice.^{22,23,26,30,42}

Four systematic reviews were identified: one on the training of PCPs in clinical melanoma diagnosis,⁵ two on the training of PCPs in dermoscopy for melanoma diagnosis,^{12,13} and one on the use of dermoscopy in primary care.¹¹ A scoping review on the training of PCPs in dermoscopy¹⁴ was also included. The final three articles were descriptive articles of the educational programs and study protocols.⁵⁵⁻⁵⁷

Educational programs

The educational programs in melanoma diagnosis for GPs varied in terms of content, teaching method and outcome measures. The characteristics of these training programs are summarized in Table 3.

Training content

Of the 31 educational programs, 15 involved the training of GPs in clinical diagnosis, five involved dermoscopic diagnosis alone, and 11 involved the training of GPs in both of these melanoma diagnostic methods. Twelve (80%) of the clinical diagnostic training programs also involved learning of epidemiology and 11 (73%) learning of management guidelines for suspicious lesions. Only seven (47%) programs teaching clinical diagnosis used an algorithm to teach melanoma recognition, with the ABCD(E) rule⁵⁸ (Asymmetry, uneven Borders, uneven Colors, Diameter > 6mm, and Evolution) being most commonly taught. Of the dermoscopic

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3 training programs, 12 (80%) included learning of at least one dermoscopic algorithm (Menzies'
4 method,^{24,35,37,40} Three-point checklist,^{9,40,41} the 7-point checklist,^{10,35} TADA,^{44,47} the ABCD
5 rule,^{35,38} BLINCK,⁴⁰ and pattern analysis^{35,53}). The Menzies' method,⁵⁹ the ABCD rule,⁶⁰
6 pattern analysis and the 7-point checklist⁶¹ were designed originally for trained physicians, and
7 were later tested as effective when used by non-experts.⁶² Other algorithms, such as the Three-
8 point checklist⁶³ and the Triage Amalgamated Dermoscopic Algorithm (TADA)⁴⁴ were initially
9 created for use by PCPs. In addition, two educational programs included training on other
10 diagnostic tools, such as sequential digital dermoscopy imaging³⁷ and polaroid instant camera
11 photography.²⁶
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20 *Teaching method, training duration and refresher training material*

21 Live training courses and the use of educational books, posters or videos (literature) were the
22 two preferred teaching methods of clinical diagnostic training programs. Five training programs
23 also used an e-learning approach.^{25,28,30,51,54} The most common teaching method used in
24 dermoscopic training programs was live training. This approach was combined with literature
25 and/or e-learning in six programs. Three programs also used self-assessment. Overall, the
26 teaching method did not appear to have influenced the program outcomes. Duration of training
27 varied from 75 minutes to 1 day, was not specified in two studies^{31,40}, and was participant
28 dependent in six studies using self-assessment methods. Six dermoscopic diagnostic training
29 programs^{29,37,38,41,49,53} and three programs in clinical diagnosis^{27,36,50} provided regular refresher
30 training material such as unlimited e-learning access or self-assessment training sessions.
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41 *Training outcomes*

42 Table 4 summarizes the outcome measures of the studies. In the selected studies, the GPs'
43 competences were generally measured in the short term and their performances measured in the
44 long term after the training.
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50 Eight clinical diagnostic training programs and seven dermoscopic training programs only
51 assessed the short-term efficacy of their program (Table 4A). For these studies, the competences
52 most often evaluated were diagnostic accuracy and appropriate management measured in a
53 training setting. The most evaluated short-term performance, measured in a clinical setting, was
54 the GPs' confidence in diagnosing melanoma. With the exception of two studies, all showed a
55 positive impact of their intervention.^{21,23} Four clinical diagnostic training programs and three
56 dermoscopic training programs (one teaching dermoscopy alone⁵³) only assessed long-term
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3 performances (Table 4B). The most evaluated long-term performances, measured in daily
4 clinical practice, were the GPs' diagnostic accuracy and the benign/malignant ratio of excised
5 lesions. Three studies^{9,36,49} reported improvement of the GPs' performances in melanoma
6 diagnosis. The other studies reported no improvement.
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11 Finally, three clinical diagnostic and seven dermoscopic training programs assessed the short-
12 and long-term outcome of their training (Table 4C). Except for one,²³ all these training
13 programs demonstrated improvement of the GPs' competences, measured in a training setting
14 in the short term. In the long term, eight training programs^{10,37,38,41,49,50,53,54} reported significant
15 improvement of the GPs' performances for the diagnosis of melanoma and benign skin lesions.
16 This led to either a decrease in the referral rates to dermatologists^{37,41,54} and/or a decrease in the
17 ratio of benign/malignant excised skin lesions.^{37,49} Among the major studies, Koelink *et al.*¹⁰
18 found that their dermoscopic training program improved the GPs' long-term performances with
19 up to 1.25 times greater diagnostic accuracy for skin lesions including melanomas. In a French
20 department, Grange *et al.*⁵⁰ observed an impressive reduction of the incidence of advanced
21 melanomas (Breslow thickness ≥ 3 mm) during the 3-year period after their GP training
22 campaign in clinical melanoma diagnosis. A very recent study by Marra *et al.*,⁵⁴ assessing 1662
23 referrals, reported better quality of referrals by GPs trained in melanoma diagnosis than by
24 untrained GPs, potentially leading to less unnecessary referrals. However, two educational
25 programs^{28,29} were unable to maintain the GPs' acquired performances in the long term.
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39 **Discussion**

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41 This scoping review aimed to explore educational programs training GPs in melanoma
42 diagnosis using clinical (naked eye) examination alone and diagnosis using dermoscopy +/-
43 clinical examination. Educational programs were examined with regard to training content,
44 teaching method, training duration, availability of refresher training material, and outcome
45 measures. This review also specifically sought to inform on the long-term sustainability of the
46 skills acquired during these training programs.
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52 **Types of educational programs with positive long-term outcomes**

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54 Most reported educational programs that improved long-term diagnostic accuracy and changed
55 GPs' melanoma practice patterns trained their participating GPs in dermoscopy combined with
56 clinical diagnosis. This teaching method is supported by a recent Cochrane review⁸ in which
57 dermoscopy alone was found to be less accurate than clinical examination followed by
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3 dermoscopy for the diagnosis of melanoma. The Cochrane review results also suggested that
4 dermoscopic algorithms were the most useful method to train non-experts in dermoscopy. In
5 our review, we found that five of the programs with long-term positive impact used
6 dermoscopic algorithms to teach melanoma diagnosis.^{10,37,38,41,53}
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11 Unfortunately, the substantial number of training hours necessary to become competent in
12 dermoscopy is the main reported factor limiting its use in general practice.^{64,65} At this time,
13 there is no evidence on the optimal length of training, even though it has been demonstrated
14 that diagnostic accuracy of dermoscopy depends on the degree of training of the practitioner.⁶⁶
15 One study suggested that 1 day of live training in dermoscopy was sufficient to build the
16 confidence of GPs with special interest in melanoma diagnosis.⁶⁷ We found two RCTs that
17 demonstrated sustained improvement of GPs' diagnostic accuracy, both of which proposed live
18 training in dermoscopy over 1 day or 10 hours.^{9,10} Because the duration of training in
19 dermoscopy is a limiting factor for most GPs, it is important to keep in mind that training in
20 clinical melanoma diagnosis has also been shown to improve the GPs' performances while
21 requiring less training time (in this review, a mean duration of 2.5 hours was observed for
22 clinical diagnostic training programs).^{36,50}
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34 However, we found that educational programs teaching dermoscopy have been more likely to
35 assure positive long-term outcomes than programs teaching clinical examination alone. One of
36 the reasons could be that the latter used measures of performance such as GPs' confidence level
37 and number of total-body skin examinations performed before and after training, which did not
38 reflect GPs' diagnostic ability in clinical practice. On the one hand, measuring the confidence
39 of GPs is more useful in assessing the quality of a training program than in assessing skills
40 acquired by participants. From a pedagogical point of view, participants feel more confident
41 when they know how to use the teaching content in daily practice.¹⁸ On the other hand, the
42 number of total-body skin examinations performed may be useful in measuring GPs' awareness
43 of skin tumours, but not for evaluation of GPs' diagnostic skills.
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53 **Long-term improvement of the GPs' performances in clinical settings**

54 The GPs' long-term performances measured in clinical settings were assessed for 15
55 educational programs: six in clinical diagnosis and nine in dermoscopic diagnosis. Ten showed
56 a positive impact on the GPs' performances measured over periods ranging from 6 to 19
57 months. The most frequent observations were a decrease of referral rates to dermatologists for
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3 benign skin lesions and an improvement of the benign/malignant ratio of excised skin lesions.
4 The INFORMED group⁴¹ reported an increase in melanoma diagnosis during a screening
5 campaign by GPs trained with their program in 2016.⁶⁸ Furthermore, a decrease of the incidence
6 of advanced melanomas was shown in a French department over a 3-year period after their
7 training program in clinical melanoma diagnosis.⁵⁰ Unfortunately, two educational
8 programs^{28,29} failed to maintain the GPs' acquired performances at 1 year after the end of the
9 training. The reasons might be that Markova *et al.*²⁸ chose to assess the number of total-body
10 skin examinations performed but did not evaluate the GPs' diagnostic accuracy and that
11 Badertscher *et al.*²⁹ trained their GPs to use Lumio®, a polarized magnifying glass with 2x
12 magnification instead of a standard dermoscopy device (10x magnification).
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22 To retain acquired diagnostic skills over the long term, results of a recent RCT suggested the
23 need for “refresher sessions at regular intervals”.^{69,70} In our review, nine (60%) educational
24 programs evaluated in the long-term provided refresher training material. Seven of these
25 programs were successful. In 2014, Grange *et al.*⁵⁰ produced a CD-ROM containing their
26 teaching material and sent regular information about melanoma to the GPs. The INFORMED
27 group⁴¹ provided GPs with a free unlimited access to their web-based course. Menzies *et al.*³⁷
28 gave participating GPs an educational textbook and an unlimited e-learning access. Grimaldi *et*
29 *al.*³⁸ and Youl *et al.*⁴⁹ also ensured self-assessment refresher training sessions. Marra *et al.*⁵⁴
30 found a 10-month sustainability of the diagnostic accuracy of their trained GPs and assumed
31 that daily use of the obtained knowledge during the study period achieved this effect. Only
32 Koelink *et al.*,¹⁰ who evaluated the longest post-training period (19 months) and who
33 demonstrated sustainability of diagnostic skills, did not specify whether update training
34 modalities were provided.
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46 However, the ideal frequency and form of updates have never been studied. An RCT, taking
47 place in the English National Defibrillator Programme, determined that update session intervals
48 after a medical education session should not exceed 7 months to limit the loss of acquired skills
49 and maintain the participants confidence.⁷¹ In the UK, a survey among GPs with special interest
50 in dermatology stated that self-assessment learning was the most popular for refresher
51 sessions.⁶⁷ Nevertheless, they also showed that 36% of GPs that use dermoscopy in their clinical
52 practice reported to have never updated their training skills. We found that the most appreciated
53 form of self-assessment updates was the unlimited access to an e-learning course. In the future,
54 this enthusiasm for online training could lead to the development of smartphone applications to
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3 train GPs in melanoma diagnosis. Some newly developed applications have currently been
4 evaluated among medical students⁷² and dermatology residents.⁷³ Initial results already looked
5 very promising.
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8 9 **Limitations**

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11 This scoping review has some limitations and led inevitably to certain publication biases. We
12 used keywords for the selection of articles and only peer-reviewed articles were included. By
13 limiting our research to English language articles, some studies may also have been missed. It
14 is also very likely that melanoma diagnostic training programs exist in unpublished forms, for
15 example in university continuing medical education programs. Moreover, we focused only on
16 studies assessing melanoma diagnostic training methods among GPs. Therefore, we may have
17 failed to mention some educational programs for primary care in this review. Furthermore,
18 educational programs which were not evaluated in studies were overlooked. Finally, this review
19 covers educational programs over a 25-year period. As technology has evolved considerably
20 over this time, some teaching methods and refresher training materials have been overshadowed
21 by interactive online tutorials (e-learning) - all the more so with the health crisis caused by
22 COVID-19 during which distance learning methods have developed very rapidly.
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34 **Conclusion**

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36 In conclusion, educational programs trained GPs in melanoma diagnosis using clinical
37 examination alone or dermoscopy +/- clinical diagnosis. Most reported programs that improved
38 the long-term diagnostic accuracy and changed routine performances of the GPs (i.e., decrease
39 in dermatologist referral of benign skin lesions, and improvement of the benign/malignant ratio
40 of excised skin lesions), trained their participating GPs in both diagnostic methods. The
41 preferred teaching methods were live and e-learning but the teaching method did not seem to
42 influence the GPs' acquired performances. It is important to note that the educational programs
43 that achieved long term sustainability of GPs' performances in daily clinical practice provided
44 refresher training material. However, the optimal form and ideal frequency of these updates
45 have yet to be defined.
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For peer review only

Table 1. Inclusion and exclusion criteria for article selection

<p>Inclusion criteria:</p> <p>Articles</p> <ul style="list-style-type: none"> Articles written in English Study articles and descriptive articles of educational programs <p>Population</p> <ul style="list-style-type: none"> Qualified GPs and GP trainees working in community settings <p>Intervention</p> <ul style="list-style-type: none"> Studies evaluating educational programs in clinical (naked eye) diagnosis and/or diagnosis of melanoma using dermoscopy <p>Outcome(s)</p> <ul style="list-style-type: none"> Studies assessing the type of educational program and its short and/or the long-term efficacy on the skills acquired by the GPs
<p>Exclusion criteria:</p> <p>Articles</p> <ul style="list-style-type: none"> Articles not subject to peer review and written in languages other than English <p>Population</p> <ul style="list-style-type: none"> Studies involving specialists, medical students, non-GPs, GPs working in hospital settings and/or specialized skin cancer clinics <p>Intervention</p> <ul style="list-style-type: none"> Studies evaluating exclusively nonmelanoma skin cancer Teledermoscopy studies Studies on computer-aided diagnosis of melanoma <p>Outcome(s)</p> <ul style="list-style-type: none"> No method of measuring outcomes was ruled out

Key: GPs= general practitioners

Table 2. Definition of study categories

Criteria	Categories	Definition
Training content	Epidemiology	Background information on rates of melanoma cancer, risk factors, localization and evolution of melanomas
	Clinical diagnosis	Naked eye melanoma recognition
	Clinical algorithm	Use of a pre-existing algorithm as a learning tool to aid for clinical diagnosis
	Dermoscopic diagnosis	Recognition of melanoma using dermoscopy
	Dermoscopic algorithm	Use of an algorithm as a learning tool to aid for dermoscopic diagnosis
	Management	Determination of a plan of action for a skin lesion i.e. reassurance, follow-up, or lesion excision
Teaching method	Live	Presentation by a speaker to a group of participants
	Scientific literature	Use of educational books, posters, letters, CD-ROMs or videos
	E-learning	Interactive online tutorials including audio and visual information
	Self-assessment	Learning by the participant himself using educational material
Refresher training material	Teledermatology feedback	Feedback from a dermatologist on the image and clinical history of a suspicious lesion at a distance, using remote internet-based technologies
Outcome measures	Competences	Acquired skills, which are evaluated in a training setting on clinical and/or dermoscopic photographs of skin lesions
	Diagnostic accuracy	Ability of the participants to discriminate between melanoma and benign lesions
	Knowledge	Report of conceptual understanding
	Appropriate management	Determination of the right plan of action for a skin lesion
	Performances	Changes in real-life practice measured in a clinical setting, i.e. changes in the benign/malignant ratio of excised lesions, the number of total-body skin examinations performed, confidence of the GPs, changes in referral rates to a dermatologist, and decrease in the incidence of advanced melanomas
Evaluation	Short-term	Measurement of outcomes immediately or up to 3 months after the training
	Long-term	Measurement of outcomes at ≥ 6 months after the training

Table 3. Characteristics of educational programs in melanoma diagnosis for general practitioners

Article	Study design	Study participants	Training content						Teaching method	Training duration	Refresher training material
			Epidemiology	Clinical diagnosis	Clinical algorithm	Dermoscopic diagnosis	Dermoscopic algorithm	Management			
author, year, location ^{ref}											
Marra, 2020, The Netherlands ⁵⁴	Case-control study	185 (83; 102)*		X		X (optional)		X	e-learning	2h	
Sawyers, 2020, Canada ⁴⁸	DA study	33 GPs				X	TADA step-I		Live	3.5h	
Augustsson, 2019, Sweden ⁵³	Case-control study	43 GPs (27;16)*				X	Pattern analysis		Live	1-day	PDF-files of the course
Seiverling, 2019, USA ⁴⁷	DA study	59 GPs		X		X	TADA		Live	75min	
Beecher, 2018, Ireland ⁴⁶	DA study	23 GP trainees	X	X				X	Live, Literature	1h	
Secker, 2017, The Netherlands ⁴⁵	DA study	293 PCPs including ? GPs		X		X		X	Live, Literature and E-learning	1-day	
Rogers, 2016, USA ⁴⁴	DA study	16 GPs				X	TADA		Live	1-day	
Badertscher, 2011 and 2015, Switzerland ^{56,29}	RCT	78 GPs (39;39)*		X		Lumio®			Live	1-day	Teledermatology feedback
Gulati, 2015, UK ⁵¹	Cohort study	967 GPs	X	X				X	E-learning	PD	
Koelink, 2014, The Netherlands ¹⁰	RCT	53 GPs	X	X		X	7-point checklist		Live	4h clinical diagnosis; 6h dermoscopy	
Grange, 2013, France ⁵⁰	Cohort study	398 GPs	X	X					Live, Literature	2.5h	CD-ROM+ regular

											information sheets
Markova, 2013, USA ²⁸	RCT	46 GPs (20;26)*			ABCD(E)				E-learning		
Mikkilineni, 2001 and 2002, USA ^{42,43} (Weinstock 1996) ⁵⁷	DA study	7 GPs	X	X				X	Live Literature	2h	
Eide, 2013, ⁴¹ (Shaikh, 2012) ⁵⁵ INFORMED	DA study	54 PCPs including 9 GPs (20%)	X	X	ABCD(E) + Ugly duckling sign	X	Three-point checklist	X	E-learning, Self-assessment	2h web-based learning	Unlimited e-learning access
Bourne, 2012, Australia ⁴⁰	DA study	3 GPs		X		X	BLINCK Three-point checklist Menzies method		Live, Literature	UD	
Shariff, 2010, UK ³⁹	DA study	94 GPs		X					Literature	PD	
Grimaldi, 2009, Italy ³⁸	DA study	13 GPs		X		X	ABCD rule		Live, E-learning, Self-assessment	PD	Self-assessment e-learning training sessions
Menzies, 2009, Australia ³⁷	DA study	63 GPs		X		Yes + Sequential digital dermoscopy	Menzies method		Live, Literature, E-learning	2h-workshop	Unlimited e-learning access
Peuvrel, 2009, France ³⁶	DA study	210 GPs	X	X	ABCD(E)			X	Live, Literature (CD-ROM)	2h	CD-ROM
Youl, 2007, Australia ⁴⁹ Raasch, 2000, Australia ²³	Cohort study RCT	16 GPs 46 GPs	X	X	ABCD(E)	X		X	Literature	PD	Self-assessment paper-based training sessions

		(23;23)*									
Argenziano, 2006, Italy and Spain ⁹	RCT	73 GPs (36;37)*		X	ABCD	X	Three-point checklist		Live	1-day	
Dolianitis, 2005, Australia ³⁵	DA study	35 GPs				X	Menzies method 7-point checklist ABCD rule Pattern analysis		Literature, E-learning, Self-assessment	PD	
Carli, 2005, Italy ³⁴	DA study	41 GPs	X	X	ABCD(E)			X	Live	4h	
De Gannes, 2004, Canada ²⁷	RCT	27 GPs (10;17)*	X	X					Literature (Video-format)	12min	Unlimited access to the 12-minute Video
English, 2003, Australia ²⁶	RCT	468 GPs (245;228)*		X + Polaroid instant camera				X	Literature	>6h	
Del Mar, 1995, Australia ²⁰	RCT	93 GPs (48;45)*								1h	
Brochez, 2001, Belgium ³³	DA study	146 GPs	X	X				X	Live, Literature	2h	
Harris, 1999 and 2001, USA ^{30,32}	DA study	232 GPs 17 GPs	X	X	ABCD 7-point Glasgow checklist			X	Literature, E-learning	1h	
Westerhoff, Australia 2000 ²⁴	RCT	74 GPs				X	Menzies method		Live, Literature	1h live	
Bedlow, 2000, UK ³¹	DA study	17 GPs		X					Live, Literature	UD	
Gerbert, 1998 and 2002, USA ^{22,25}	RCT	52 GPs (26;26)*	X	X				X	Live, Literature, E-learning	>3h	

Dolan, 1997, USA ²¹	RCT	82 PCPs including 16 GPs (46;36)*	X	X					Live	2h	
Girgis, 1995, Australia ⁵²	Case-control study	41 GPs (24;17)*	X	X				X	Live, literature	>6h	

Key: GPs=general practitioners; PCPs= primary care physicians; RCT= randomized controlled trial; DA= diagnostic accuracy; INFORMED= Internet curriculum for melanoma early detection; PD= participant dependent; UD=undisclosed; TADA=trriage amalgamated dermoscopic algorithm

**number of participants in the intervention group and control group*

For peer review only

Table 4. Outcome measures of the melanoma diagnostic educational programs for general practitioners.

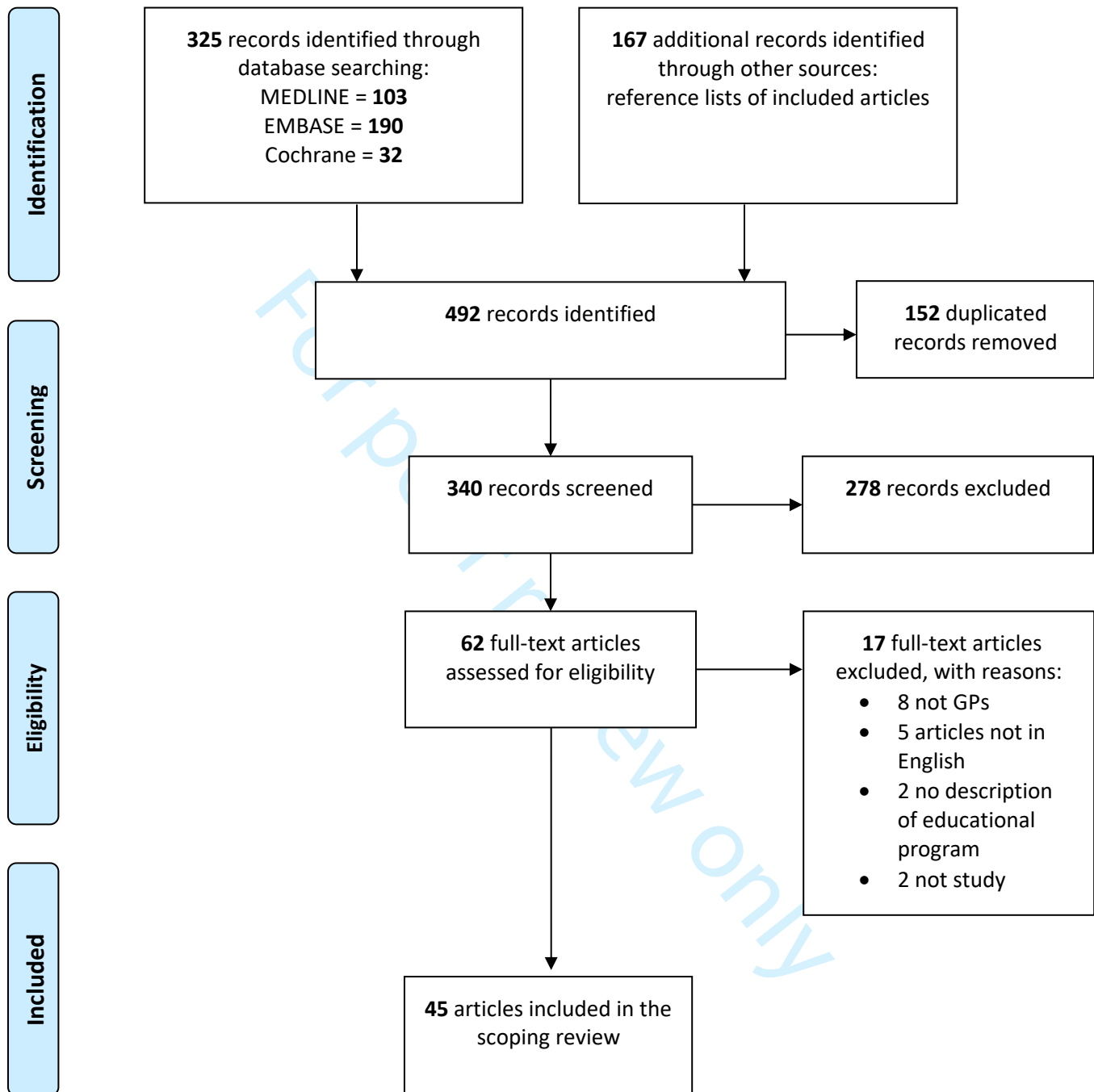
A. Studies with short-term outcomes												
Studies	Measured competence in training setting			Measured performance in clinical setting						Timing after the training		
(1st author and year of publication)	DA	Knowledge	AM	B/M lesion ratio	TBSE	DA	confidence	Decrease of VTM incidence	RR	immediately	at 1 month	at 3 months
Dermoscopic diagnostic training programs												
Sawyers 2020 ⁴⁸	+									X		
Seiverling 2019 ⁴⁷	+									X		
Secker 2017 ⁴⁵	+		+									X
Rogers 2016 ⁴⁴	+									X		
Bourne 2012 ⁴⁰	+									X		
Dolianitis 2005 ³⁵	+									X		
Westerhoff 2000 ²⁴	+	+								X		
Clinical diagnostic training programs												
Beecher, 2018 ⁴⁶	+	+	+							X		X
Carli 2005 ³⁴	+		+							X		
Mikkilineni 2001;2002 ^{42,43}		+	+		+		+			X		
Brochez 2001 ³³	+									X		
Harris 2001 ³²	+	+	+				+			X		
Harris 1999 ³⁰	+	-	+				+			X		
Raasch 2000 ²³	-						+			3-month period		
Bedlow 2000 ³¹	+	+								X		
Gerbert 1998;2002 ^{22,25}	+	+	+				+			X		
Dolan 1997 ²¹	-	+	-							X	X	
Girgis 1995 ⁵²	-	+					+			X		X

B. Studies with long-term outcomes														
Studies	Measured competence in training setting			Measured performance in clinical setting						Timing after the training				
	DA	Knowledge	AM	M/B lesion ratio	TBSE	DA	Confidence	Decrease of VTM incidence	RR					
Dermoscopic diagnostic training programs														
Shariff 2010 ³⁹						-					at 11 months			
Youl 2007 ⁴⁹				+		+					6-month period			
Argenziano 2006 ⁹						+				+	16-month period			
Clinical diagnostic training programs														
Gulati 2015 ⁵¹						-	+				8-month period			
Peuvrel 2009 ³⁶		+					+				15-month period			
De Gannes 2004 ²⁷	-	-	-								at 6 months			
English 2003 ²⁶						-					21-month period			
Del Mar 1995 ²⁰						+					24-month period			
C. Studies with short and long-term outcomes														
Studies	Measured competence in training setting			Timing after the training		Measured performance in clinical setting					Timing after the training			
	DA	Knowledge	AM	Immediately after	at 1-3 months	B/M lesion ratio	TBSE	DA	Confidence	Decrease of VTM incidence	RR			
Dermoscopic diagnostic training programs														
Augustsson 2019 ⁵³	+			X								at 6 months (here competence measure)		
Badertscher 2015 ²⁹	+			X				-	+			at 12 months		
Koelink 2014 ¹⁰	+		+	X				+	+			at 8 months	at 12 months	at 19 months
Eide 2013 ⁴¹	+	+	+	X				+	+		+	at 6 months		
Youl 2007 ⁴⁹						+		+				6-month period		
	-				3-month period									

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Raasch 2000 ²³												
Grimaldi 2009 ³⁸	+			X	X			+				6-month period
Menzies 2009 ³⁷	+		+	X			+				+	6-month period
Clinical diagnostic training programs												
Marra, 2020 ⁵⁴	+				X			+	+		+	at 10 months
Grange 2013 ⁵⁰	+	+		X						+		3-year period
Markova 2013 ²⁸							-					at 12 months
Mikkilineni 2001; 2002 42,43		+	+	X								

Key: DA= diagnostic accuracy; AM=appropriate management; TBSE= total body skin examination; B/M=benign/malignant; VTM= very thick melanomas; RR= decrease in dermatologist referral rates for benign lesions and increase in referral rates for malignant lesions
 + = significant improvement; - = no significant improvement
 To note that Shariff et al.³⁷ and Peuvrel et al.³⁴ provided only descriptive statistics of their study results. For the other studies, a P-value < 0.05 was considered significant, except for Grimaldi et al.³⁶ (P-value < 0.001).

Figure 1. PRISMA flowchart of study selection process¹⁷

Supplementary Table 1: Search strategies

Database	Search query	Limits	Filters	Results	Date
EMBASE	('general practitioner'/exp OR 'gp (general practitioner)' OR 'family doctor' OR 'family physician' OR 'general practitioner' OR 'general practitioners' OR 'physicians, family' OR 'physicians, primary care' OR 'practitioner, general' OR 'primary care doctor' OR 'primary care physician' OR 'primary care physicians') AND ('education'/exp OR 'education' OR 'self-evaluation programmes' OR 'self-evaluation programs' OR 'training support') AND ('melanoma'/exp OR 'malignant melanoma' OR 'melanoma' OR 'nevi and melanomas' OR 'naevi and melanomas') AND ('diagnosis'/exp OR 'diagnosis' OR 'diagnostic tool')	none	none	190	4 May 2020
MEDLINE	"('General Practitioners'[MeSH Terms] OR 'General Practice'[MeSH Terms] OR 'Family Practice'[MeSH Terms] OR 'physicians, primary care'[MeSH Terms]) AND 'Melanoma'[MeSH Terms] AND 'Diagnosis'[MeSH Terms]"	none	none	103	27 April 2020
Cochrane Library	melanoma in Title Abstract Keyword AND diagnosis in Title Abstract Keyword AND general practitioner in Title Abstract Keyword OR family medicine in Title Abstract Keyword AND dermoscopy in Title Abstract Keyword (Word variations have been searched)	none	none	32	28 April 2020

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	N.A.
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	5
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	5-6
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	6
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	6
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	Table 2
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	5



SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	6
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Figure 1
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Table 3
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	N.A.
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Table 3
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	7-8
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	9-10-11
Limitations	20	Discuss the limitations of the scoping review process.	12
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	13
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	1

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169:467–473. doi: [10.7326/M18-0850](https://doi.org/10.7326/M18-0850).



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Training general practitioners in melanoma diagnosis: a scoping review of the literature

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Abstract

Background: General practitioners (GPs) play a key role in early melanoma detection. In order to help GPs deal with suspicious skin lesions, melanoma diagnostic training programs have been developed. However, it is unclear whether these programs guarantee the acquisition of skills that will be applied by GPs in their daily clinical practice and maintained over time.

Objectives: This scoping review aimed to examine and compare educational programs designed to train GPs in melanoma diagnosis using clinical (naked eye) examination alone or dermoscopy +/- clinical examination, and sought to inform on the long-term sustainability of the GPs' acquired skills.

Eligibility criteria: Studies eligible for inclusion evaluated educational programs for teaching diagnosis of melanoma to GPs. MEDLINE, EMBASE, and Cochrane databases were searched for relevant articles from 1995 to May 2020.

Results: Forty-five relevant articles were found assessing 31 educational programs. Most programs that improved the diagnostic accuracy and long-term performances of the GPs i.e., increase in confidence, decrease in dermatologist referral of benign skin lesions, and improvement of the benign/malignant ratio of excised skin lesions, trained the GPs in clinical diagnosis followed by dermoscopy. To maintain long-term performances, these programs provided refresher training material.

Conclusion: This review shows that studies generally report positive outcomes from the training of GPs in melanoma diagnosis. However, refresher training material seemed necessary to maintain the acquired skills. The optimal form and ideal frequency for these updates have yet to be defined.

Strengths and limitations of the review

- Systematic review conducted following the guidelines of the PRISMA-ScR (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews) checklist.
- It thoroughly evaluates educational programs on melanoma diagnosis for general practitioners.
- Specifically, the review examines the long-term effect of the educational programs and the value of providing regular refresher training sessions after the training.
- This review led inevitably to some publication bias as only English language peer-reviewed articles were included.

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Contributorship statement

E. Harkemanne developed the research protocol, completed the literature search and screened the articles for inclusion, extracted the data, synthesised the findings, interpreted the results and drafted the manuscript. M. Baeck screened the articles for inclusion, extracted data and critically revised the manuscript. I. Tromme developed the protocol, independently reviewed the articles for inclusion, extracted data, interpreted the results and critically revised the manuscript. All authors approved the final version.

Data availability statement

All data relevant to the study are included in the article.

Introduction

Early melanoma detection is essential to reduce morbidity and mortality of melanoma patients.¹ Given the increased incidence of this aggressive skin cancer, primary care physicians (PCPs) play a key role in early melanoma diagnosis.²⁻⁴ PCPs include a number of health care professionals who provide first and continuing medical care to a patient. In this review, we focus on GPs who take care of patients in community settings and are, in most countries, the first point of contact for any patient with a health issue.

To improve the diagnostic accuracy of melanoma by GPs, specific educational training programs have been developed. At first, training courses focused on melanoma diagnosis by clinical (naked eye) examination alone. A systematic review⁵, published in 2011, reported on 20 studies that evaluated 13 educational interventions in clinical melanoma diagnosis for PCPs. All the evaluated interventions improved diagnostic accuracy and melanoma management. Later, educational programs that included dermoscopy training were created and were then evaluated for primary care. To date, dermoscopy has been the most widely non-invasive *in vivo* technique used in clinical practice to assess skin tumors.⁶ It involves the use of a handheld device which allows the observation of skin structures invisible to the naked eye. However, the sensitivity and specificity of the technique are operator-dependent (trained vs. untrained physicians).⁷ Ninety-two percent sensitivity and 95% specificity can be achieved for melanoma diagnosis by a trained dermatologist combining visual inspection and *in vivo* dermoscopy.⁸ In primary care, dermoscopy has also been shown to be an effective tool for the triage of suspicious pigmented skin lesions when performed by properly trained PCPs.^{9,10} Yet, the minimum training required to reach competence is still unknown.¹¹

Previously published reviews^{5,11-14} on training programs in melanoma diagnosis for GPs focused on the content, teaching method, outcome measures and study-by-study efficacy of the evaluated educational interventions. However, they did not assess whether the GPs' acquired skills were measured in the short or long term. Yet, given the increasing burden of melanoma on general practice, it is crucial to know whether these programs are capable of teaching GPs easily applicable and sustainable skills in melanoma diagnosis and management. This scoping review aimed to explore educational programs training GPs in melanoma diagnosis using clinical (naked eye) examination alone and diagnosis using dermoscopy +/- clinical examination. Educational programs were examined with regard to training content, teaching

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3 method, training duration, availability of refresher training material, and outcome measures.
4 This review also specifically sought to inform on the long-term sustainability of the skills
5 acquired during these training programs.
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9 **Material and methods**

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11 To carry out this literature review, a scoping review seemed the most appropriate research
12 method. Indeed, the studies we identified, which provided evidence on the efficacy of
13 educational programs in melanoma diagnosis for GPs, showed a wide range of study designs
14 and heterogeneous outcome measures. This observation made it impossible to formally assess
15 the quality of these studies and to perform a meta-analysis leading to a narrative synthesis of
16 our research results. To conduct this scoping review, the framework developed by Arksey and
17 O'Malley,¹⁵ subsequently refined by Levac,¹⁶ and the guidelines of the PRISMA-ScR¹⁷
18 (Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping
19 Reviews) checklist were followed.
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29 **Eligibility criteria**

30 Studies eligible for inclusion in this review (Table 1) evaluated educational programs teaching
31 either clinical diagnosis of melanoma and/or diagnosis using dermoscopy +/- clinical
32 examination and designed primarily for PCPs including GPs. The population of interest
33 included qualified GPs and GP trainees. Specialists and GPs working in hospital settings and/or
34 specialized clinics were excluded. Studies that included training programs for PCPs other than
35 GPs were not eligible. Studies where no participant training in melanoma diagnosis was
36 proposed and studies evaluating exclusively non-melanoma skin cancer detection were also
37 excluded. Studies evaluating teledermoscopy and computer-aided diagnosis of melanoma were
38 not assessed as they do not require specific education in melanoma recognition by the
39 participants. Only studies assessing the type of educational program and its short and/or the
40 long-term efficacy on the skills acquired by the GPs were included. Finally, only peer-reviewed
41 and English language articles were included.
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52 **Data sources and study selection**

53 MEDLINE, EMBASE, and Cochrane databases were searched for relevant articles published
54 from 1995 to May 2020. Studies were selected for inclusion independently by three authors
55 (EH, MB, and IT), with IT providing the final decision in the event of disagreement. The studies
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3 were not assessed for bias, as the risk of bias assessment was reported as not applicable to
4 scoping reviews in the 2018 PRISMA-ScR guidelines.¹⁷
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8 To extensively cover the literature on the subject, four categories of terms were identified: (1)
9 general practitioners, family doctor, general medicine, family practice, primary care physicians;
10 (2) education, continuing medical education; (3) melanoma, malignant melanoma, cutaneous
11 melanoma, skin neoplasms; (4) diagnosis, and cancer early detection. In MEDLINE, the
12 following Medical Subject Headings (MeSH) were used: *general practitioners OR family*
13 *practice OR primary care physicians OR general practice AND melanoma AND diagnosis*.
14 No limits were defined. In EMBASE, Emtree terms were exploded: *general practitioner, family*
15 *doctor, primary care, family physician, primary care physician, melanoma, diagnosis, and*
16 *education*. In the Cochrane database, the following terms were searched: *melanoma AND*
17 *diagnosis AND general practitioners OR family medicine AND dermoscopy* (see
18 Supplementary Table 1 for search strategies). In addition, the reference lists of included studies
19 were screened as a source of further relevant articles.
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30 **Data extraction**

31 Two authors (EH and MB) reviewed all included articles and independently collected data.
32 Extracted data included authors, year of publication, origin of the article, study design, number
33 of participating GPs, type of educational program, type of outcome measures and short- and/or
34 long-term evaluation of these outcomes. The type of educational program included training
35 content, teaching method, training duration and refresher training material (if provided). To
36 facilitate comparison with data found in previous reviews, all these data were reported into
37 categories adapted from those presented by Fee *et al.*¹⁴
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46 Table 2 gives the definition of the different categories. The training content was subdivided into
47 six components: epidemiology, clinical diagnosis, clinical algorithm, dermoscopic diagnosis,
48 dermoscopic algorithm and management. The teaching method was considered either as live,
49 in the form of scientific literature, e-learning, or self-assessment. The refresher training material
50 specified the material available for participants to refresh their skills after the training. The
51 outcome measures were expressed either in terms of competence or in terms of performance,
52 according to the assessment approach of continuing medical education programs proposed by
53 Moore.¹⁸ Finally, since the limits between short-term and long-term evaluation of a medical
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educational program are not standardized, arbitrary limits have been chosen based on the observations made during this literature review.

Patient and Public Involvement

No patient and public involvement was required for this review.

Results

In total, 325 articles were identified from the electronic database searches, as shown in the PRISMA flowchart (Figure 1).¹⁹ At the end of the study selection process, 45 relevant articles, which assessed 31 educational interventions, were included in the review analysis.

Study designs

Thirty-six interventional studies with a range of study designs were found: 11 randomized controlled trials (RCTs)^{9,10,20–25,26–29}, 19 diagnostic accuracy studies^{30–35,36–40,41–48}, three cohort studies^{49–51} and three case-control studies.^{52–54} Five of the 31 training programs were assessed twice.^{25,26,28,32,49}

Four systematic reviews were identified: one on the training of PCPs in clinical melanoma diagnosis,⁵ two on the training of PCPs in dermoscopy for melanoma diagnosis,^{12,13} and one on the use of dermoscopy in primary care.¹¹ A scoping review on the training of PCPs in dermoscopy¹⁴ was also included. The final three articles were descriptive articles of the educational programs and study protocols.^{55–57}

Educational programs

The educational programs in melanoma diagnosis for GPs varied in terms of content, teaching method and outcome measures. The characteristics of these training programs are summarized in Table 3.

Training content

Of the 31 educational programs, 15 involved the training of GPs in clinical diagnosis, five involved dermoscopic diagnosis alone, and 11 involved the training of GPs in both of these melanoma diagnostic methods. Twelve (80%) of the clinical diagnostic training programs also involved learning of epidemiology and 11 (73%) learning of management guidelines for

suspicious lesions. Only seven (47%) programs teaching clinical diagnosis used an algorithm to teach melanoma recognition, with the ABCD(E) rule⁵⁸ (Asymmetry, uneven Borders, uneven Colors, Diameter > 6mm, and Evolution) being most commonly taught. Of the dermoscopic training programs, 12 (80%) included learning of at least one dermoscopic algorithm (Menzies' method,^{24,35,37,40} Three-point checklist,^{9,40,41} the 7-point checklist,^{10,35} TADA,^{44,47} the ABCD rule,^{35,38} BLINCK,⁴⁰ and pattern analysis^{35,54}). The Menzies' method,⁵⁹ the ABCD rule,⁶⁰ pattern analysis and the 7-point checklist⁶¹ were designed originally for trained physicians, and were later tested as effective when used by non-experts.⁶² Other algorithms, such as the Three-point checklist⁶³ and the Triage Amalgamated Dermoscopic Algorithm (TADA)⁴⁴ were initially created for use by PCPs. In addition, two educational programs included training on other diagnostic tools, such as sequential digital dermoscopy imaging³⁷ and polaroid instant camera photography.²⁶

Teaching method, training duration and refresher training material

Live training courses and the use of educational books, posters or videos (literature) were the two preferred teaching methods of clinical diagnostic training programs. Five training programs also used an e-learning approach.^{25,28,30,51,53} The most common teaching method used in dermoscopic training programs was live training. This approach was combined with literature and/or e-learning in six programs. Three programs also used self-assessment. Overall, the teaching method did not appear to have influenced the program outcomes. Duration of training varied from 75 minutes to 1 day, was not specified in two studies^{31,40}, and was participant dependent in six studies using self-assessment methods. Six dermoscopic diagnostic training programs^{29,37,38,41,49,54} and three programs in clinical diagnosis^{27,36,50} provided regular refresher training material such as unlimited e-learning access or self-assessment training sessions.

Training outcomes

Table 4 summarizes the outcome measures of the studies. In the selected studies, the GPs' competences were generally measured in the short term and their performances measured in the long term after the training.

Eight clinical diagnostic training programs and seven dermoscopic training programs only assessed the short-term efficacy of their program (Table 4A). For these studies, the competences most often evaluated were diagnostic accuracy and appropriate management measured in a training setting. The most evaluated short-term performance, measured in a clinical setting, was

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3 the GPs' confidence in diagnosing melanoma. With the exception of two studies, all showed a
4 positive impact of their intervention.^{21,23} Four clinical diagnostic training programs and three
5 dermoscopic training programs (one teaching dermoscopy alone⁵⁴) only assessed long-term
6 performances (Table 4B). The most evaluated long-term performances, measured in daily
7 clinical practice, were the GPs' diagnostic accuracy and the benign/malignant ratio of excised
8 lesions. Three studies^{9,36,49} reported improvement of the GPs' performances in melanoma
9 diagnosis. The other studies reported no improvement.

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12 Finally, three clinical diagnostic and seven dermoscopic training programs assessed the short-
13 and long-term outcome of their training (Table 4C). Except for one,²³ all these training
14 programs demonstrated improvement of the GPs' competences, measured in a training setting
15 in the short term. In the long term, eight training programs^{10,37,38,41,49,50,53,54} reported significant
16 improvement of the GPs' performances for the diagnosis of melanoma and benign skin lesions.
17 This led to either a decrease in the referral rates to dermatologists^{37,41,53} and/or a decrease in the
18 ratio of benign/malignant excised skin lesions.^{37,49} Among the major studies, Koelink *et al.*¹⁰
19 found that their dermoscopic training program improved the GPs' long-term performances with
20 up to 1.25 times greater diagnostic accuracy for skin lesions including melanomas. In a French
21 department, Grange *et al.*⁵⁰ observed an impressive reduction of the incidence of advanced
22 melanomas (Breslow thickness ≥ 3 mm) during the 3-year period after their GP training
23 campaign in clinical melanoma diagnosis. A very recent study by Marra *et al.*,⁵³ assessing 1662
24 referrals, reported better quality of referrals by GPs trained in melanoma diagnosis than by
25 untrained GPs, potentially leading to less unnecessary referrals. However, two educational
26 programs^{28,29} were unable to maintain the GPs' acquired performances in the long term.

27 28 29 **Discussion**

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32 This scoping review aimed to explore educational programs training GPs in melanoma
33 diagnosis using clinical (naked eye) examination alone and diagnosis using dermoscopy +/-
34 clinical examination. Educational programs were examined with regard to training content,
35 teaching method, training duration, availability of refresher training material, and outcome
36 measures. This review also specifically sought to inform on the long-term sustainability of the
37 skills acquired during these training programs.

Types of educational programs with positive long-term outcomes

Most reported educational programs that improved long-term diagnostic accuracy and changed GPs' melanoma practice patterns trained their participating GPs in dermoscopy combined with clinical diagnosis. This teaching method is supported by a recent Cochrane review⁸ in which dermoscopy alone was found to be less accurate than clinical examination followed by dermoscopy for the diagnosis of melanoma. The Cochrane review results also suggested that dermoscopic algorithms were the most useful method to train non-experts in dermoscopy. In our review, we found that five of the programs with long-term positive impact used dermoscopic algorithms to teach melanoma diagnosis.^{10,37,38,41,54}

Unfortunately, the substantial number of training hours necessary to become competent in dermoscopy is the main reported factor limiting its use in general practice.^{64,65} At this time, there is no evidence on the optimal length of training, even though it has been demonstrated that diagnostic accuracy of dermoscopy depends on the degree of training of the practitioner.⁶⁶ One study suggested that 1 day of live training in dermoscopy was sufficient to build the confidence of GPs with special interest in melanoma diagnosis.⁶⁷ We found two RCTs that demonstrated sustained improvement of GPs' diagnostic accuracy, both of which proposed live training in dermoscopy over 1 day or 10 hours.^{9,10} Because the duration of training in dermoscopy is a limiting factor for most GPs, it is important to keep in mind that training in clinical melanoma diagnosis has also been shown to improve the GPs' performances while requiring less training time (in this review, a mean duration of 2.5 hours was observed for clinical diagnostic training programs).^{36,50}

However, we found that educational programs teaching dermoscopy have been more likely to assure positive long-term outcomes than programs teaching clinical examination alone. One of the reasons could be that the latter used measures of performance such as GPs' confidence level and number of total-body skin examinations performed before and after training, which did not reflect GPs' diagnostic ability in clinical practice. On the one hand, measuring the confidence of GPs in their own ability to diagnose melanoma is more useful in assessing the quality of a training program than evaluating skills acquired by participants. From a pedagogical point of view, participants feel more confident when they know how to use the teaching content in daily practice but this does not define their true diagnostic competence.¹⁸ On the other hand, the number of total-body skin examinations performed may be useful in measuring GPs' awareness of skin tumours, but not for evaluation of GPs' diagnostic skills.

Long-term improvement of the GPs' performances in clinical settings

The GPs' long-term performances measured in clinical settings were assessed for 15 educational programs: six in clinical diagnosis and nine in dermoscopic diagnosis. Ten showed a positive impact on the GPs' performances measured over periods ranging from 6 to 19 months. The most frequent observations were a decrease of referral rates to dermatologists for benign skin lesions and an improvement of the benign/malignant ratio of excised skin lesions. The INFORMED group⁴¹ reported an increase in melanoma diagnosis during a screening campaign by GPs trained with their program in 2016.⁶⁸ Furthermore, a decrease of the incidence of advanced melanomas was shown in a French department over a 3-year period after their training program in clinical melanoma diagnosis.⁵⁰ Unfortunately, two educational programs^{28,29} failed to maintain the GPs' acquired performances at 1 year after the end of the training. The reasons might be that Markova *et al.*²⁸ chose to assess the number of total-body skin examinations performed but did not evaluate the GPs' diagnostic accuracy and that Badertscher *et al.*²⁹ trained their GPs to use Lumio®, a polarized magnifying glass with 2x magnification instead of a standard dermoscopy device (10x magnification).

To retain acquired diagnostic skills over the long term, results of a recent RCT suggested the need for “refresher sessions at regular intervals”.^{69,70} In our review, nine (60%) educational programs evaluated in the long-term provided refresher training material. Seven of these programs were successful. In 2014, Grange *et al.*⁵⁰ produced a CD-ROM containing their teaching material and sent regular information about melanoma to the GPs. The INFORMED group⁴¹ provided GPs with a free unlimited access to their web-based course. Menzies *et al.*³⁷ gave participating GPs an educational textbook and an unlimited e-learning access. Grimaldi *et al.*³⁸ and Youl *et al.*⁴⁹ also ensured self-assessment refresher training sessions. Marra *et al.*⁵³ found a 10-month sustainability of the diagnostic accuracy of their trained GPs and assumed that daily use of the obtained knowledge during the study period achieved this effect. Only Koelink *et al.*,¹⁰ who evaluated the longest post-training period (19 months) and who demonstrated sustainability of diagnostic skills, did not specify whether update training modalities were provided.

However, the ideal frequency and form of updates have never been studied. An RCT, taking place in the English National Defibrillator Programme, determined that update session intervals after a medical education session should not exceed 7 months to limit the loss of acquired skills and maintain the participants confidence.⁷¹ In the UK, a survey among GPs with special interest

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3 in dermatology stated that self-assessment learning was the most popular for refresher
4 sessions.⁶⁷ Nevertheless, they also showed that 36% of GPs that use dermoscopy in their clinical
5 practice reported to have never updated their training skills. We found that the most appreciated
6 form of self-assessment updates was the unlimited access to an e-learning course. In the future,
7 this enthusiasm for online training could lead to the development of smartphone applications to
8 train GPs in melanoma diagnosis. Some newly developed applications have currently been
9 evaluated among medical students⁷² and dermatology residents.⁷³ Initial results already looked
10 very promising.
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18 Finally, the variability of refresher training material provided in the educational programs and
19 the heterogeneity of outcome measures did not allow more robust conclusions to be drawn on
20 the most beneficial training modality for sustainable improvements in GPs' diagnostic skills.
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23 **Limitations**

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27 This scoping review has some limitations and led inevitably to certain publication biases. We
28 used keywords for the selection of articles and only peer-reviewed articles were included. By
29 limiting our research to English language articles, some studies may also have been missed. It
30 is also very likely that melanoma diagnostic training programs exist in unpublished forms, for
31 example in university continuing medical education programs. Moreover, we focused only on
32 studies assessing melanoma diagnostic training methods among GPs. Therefore, we may have
33 failed to mention some educational programs for primary care in this review. Furthermore,
34 educational programs which were not evaluated in studies were overlooked. Finally, this review
35 covers educational programs over a 25-year period. As technology has evolved considerably
36 over this time, some teaching methods and refresher training materials have been overshadowed
37 by interactive online tutorials (e-learning) - all the more so with the health crisis caused by
38 COVID-19 during which distance learning methods have developed very rapidly.
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50 **Conclusion**

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52 In conclusion, educational programs trained GPs in melanoma diagnosis using clinical
53 examination alone or dermoscopy +/- clinical diagnosis. Most reported programs that improved
54 the long-term diagnostic accuracy and changed routine performances of the GPs (i.e., decrease
55 in dermatologist referral of benign skin lesions, and improvement of the benign/malignant ratio
56 of excised skin lesions), trained their participating GPs in both diagnostic methods. The
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3 preferred teaching methods were live and e-learning but the teaching method did not seem to
4 influence the GPs' acquired performances. It is important to note that the educational programs
5 that achieved long term sustainability of GPs' performances in daily clinical practice provided
6 refresher training material. However, no conclusions on the most beneficial training modality
7 to sustainably improve GPs' diagnostic skills could be drawn given the heterogeneity of
8 outcome measures and study designs. Therefore, the optimal form and ideal frequency of these
9 updates have yet to be defined.
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For peer review only

Table 1. Inclusion and exclusion criteria for article selection

<p>Inclusion criteria:</p> <p>Articles</p> <ul style="list-style-type: none"> Articles written in English Study articles and descriptive articles of educational programs <p>Population</p> <ul style="list-style-type: none"> Qualified GPs and GP trainees working in community settings <p>Intervention</p> <ul style="list-style-type: none"> Studies evaluating educational programs in clinical (naked eye) diagnosis and/or diagnosis of melanoma using dermoscopy <p>Outcome(s)</p> <ul style="list-style-type: none"> Studies assessing the type of educational program and its short and/or the long-term efficacy on the skills acquired by the GPs
<p>Exclusion criteria:</p> <p>Articles</p> <ul style="list-style-type: none"> Articles not subject to peer review and written in languages other than English <p>Population</p> <ul style="list-style-type: none"> Studies involving specialists, medical students, non-GPs, GPs working in hospital settings and/or specialized skin cancer clinics <p>Intervention</p> <ul style="list-style-type: none"> Studies evaluating exclusively nonmelanoma skin cancer Teledermoscopy studies Studies on computer-aided diagnosis of melanoma <p>Outcome(s)</p> <ul style="list-style-type: none"> No method of measuring outcomes was ruled out

Key: GPs= general practitioners

Table 2. Definition of study categories

Criteria	Categories	Definition
Training content	Epidemiology	Background information on rates of melanoma cancer, risk factors, localization and evolution of melanomas
	Clinical diagnosis	Naked eye melanoma recognition
	Clinical algorithm	Use of a pre-existing algorithm as a learning tool to aid for clinical diagnosis
	Dermoscopic diagnosis	Recognition of melanoma using dermoscopy
	Dermoscopic algorithm	Use of an algorithm as a learning tool to aid for dermoscopic diagnosis
	Management	Determination of a plan of action for a skin lesion i.e. reassurance, follow-up, or lesion excision
Teaching method	Live	Presentation by a speaker to a group of participants
	Scientific literature	Use of educational books, posters, letters, CD-ROMs or videos
	E-learning	Interactive online tutorials including audio and visual information
	Self-assessment	Learning by the participant himself using educational material
Refresher training material	Teledermatology feedback	Feedback from a dermatologist on the image and clinical history of a suspicious lesion at a distance, using remote internet-based technologies
Outcome measures	Competences	Acquired skills, which are evaluated in a training setting on clinical and/or dermoscopic photographs of skin lesions
	Diagnostic accuracy	Ability of the participants to discriminate between melanoma and benign lesions
	Knowledge	Report of conceptual understanding
	Appropriate management	Determination of the right plan of action for a skin lesion
	Performances	Changes in real-life practice measured in a clinical setting, i.e. changes in the benign/malignant ratio of excised lesions, the number of total-body skin examinations performed, confidence of the GPs, changes in referral rates to a dermatologist, and decrease in the incidence of advanced melanomas
Evaluation	Short-term	Measurement of outcomes immediately or up to 3 months after the training
	Long-term	Measurement of outcomes at \geq 6 months after the training

Table 3. Characteristics of educational programs in melanoma diagnosis for general practitioners

Article	Study design	Study participants	Training content						Teaching method	Training duration	Refresher training material
			Epidemiology	Clinical diagnosis	Clinical algorithm	Dermoscopic diagnosis	Dermoscopic algorithm	Management			
author, year, location ^{ref}											
Marra, 2020, The Netherlands ⁵³	Case-control study	185 (83; 102)*		X		X (optional)		X	e-learning	2h	
Sawyers, 2020, Canada ⁴⁸	DA study	33 GPs				X	TADA step-I		Live	3.5h	
Augustsson, 2019, Sweden ⁵⁴	Case-control study	43 GPs (27;16)*				X	Pattern analysis		Live	1-day	PDF-files of the course
Seiverling, 2019, USA ⁴⁷	DA study	59 GPs		X		X	TADA		Live	75min	
Beecher, 2018, Ireland ⁴⁶	DA study	23 GP trainees	X	X				X	Live, Literature	1h	
Secker, 2017, The Netherlands ⁴⁵	DA study	293 PCPs including ? GPs		X		X		X	Live, Literature and E-learning	1-day	
Rogers, 2016, USA ⁴⁴	DA study	16 GPs				X	TADA		Live	1-day	
Badertscher, 2011 and 2015, Switzerland ^{56,29}	RCT	78 GPs (39;39)*		X		Lumio®			Live	1-day	Teledermatology feedback
Gulati, 2015, UK ⁵¹	Cohort study	967 GPs	X	X				X	E-learning	PD	
Koelink, 2014, The Netherlands ¹⁰	RCT	53 GPs	X	X		X	7-point checklist		Live	4h clinical diagnosis; 6h dermoscopy	

Grange, 2013, France ⁵⁰	Cohort study	398 GPs	X	X					Live, Literature	2.5h	CD-ROM+ regular information sheets
Markova, 2013, USA ²⁸ Mikkilineni, 2001 and 2002, USA ^{42,43} (Weinstock 1996) ⁵⁷	RCT DA study	46 GPs (20;26)* 7 GPs	X	X	ABCD(E)			X	E-learning Live Literature	2h	
Eide, 2013, ⁴¹ (Shaikh, 2012) ⁵⁵ INFORMED	DA study	54 PCPs including 9 GPs (20%)	X	X	ABCD(E) + Ugly duckling sign	X	Three-point checklist	X	E-learning, Self-assessment	2h web-based learning	Unlimited e-learning access
Bourne, 2012, Australia ⁴⁰	DA study	3 GPs		X		X	BLINCK Three-point checklist Menzies method		Live, Literature	UD	
Shariff, 2010, UK ³⁹	DA study	94 GPs		X					Literature	PD	
Grimaldi, 2009, Italy ³⁸	DA study	13 GPs		X		X	ABCD rule		Live, E-learning, Self-assessment	PD	Self-assessment e-learning training sessions
Menzies, 2009, Australia ³⁷	DA study	63 GPs		X		Yes + Sequential digital dermoscopy	Menzies method		Live, Literature, E-learning	2h-workshop	Unlimited e-learning access
Peuvrel, 2009, France ³⁶	DA study	210 GPs	X	X	ABCD(E)			X	Live, Literature (CD-ROM)	2h	CD-ROM
Youl, 2007, Australia ⁴⁹	Cohort study	16 GPs	X	X	ABCD(E)	X		X	Literature	PD	Self-assessment paper-based training sessions

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Raasch, 2000, Australia ²³	RCT	46 GPs (23;23)*																																																							
Argenziano, 2006, Italy and Spain ⁹	RCT	73 GPs (36;37)*		X	ABCD	X		Three-point checklist		Live	1-day																																														
Dolianitis, 2005, Australia ³⁵	DA study	35 GPs					X	Menzies method 7-point checklist ABCD rule Pattern analysis		Literature, E-learning, Self-assessment	PD																																														
Carli, 2005, Italy ³⁴	DA study	41 GPs	X	X	ABCD(E)				X	Live	4h																																														
De Gannes, 2004, Canada ²⁷	RCT	27 GPs (10;17)*	X	X						Literature (Video-format)	12min	Unlimited access to the 12-minute Video																																													
English, 2003, Australia ²⁶	RCT	468 GPs (245;228)*								X	Literature	>6h																																													
Del Mar, 1995, Australia ²⁰	RCT	93 GPs (48;45)*		X + Polaroid instant camera							1h																																														
Brochez, 2001, Belgium ³³	DA study	146 GPs	X	X					X	Live, Literature	2h																																														
Harris, 1999 and 2001, USA ^{30,32}	DA study	232 GPs 17 GPs	X	X	ABCD 7-point Glasgow checklist				X	Literature, E-learning	1h																																														
Westerhoff, Australia 2000 ²⁴	RCT	74 GPs					X	Menzies method		Live, Literature	1h live																																														
Bedlow, 2000, UK ³¹	DA study	17 GPs		X						Live, Literature	UD																																														

Gerbert, 1998 and 2002, USA ^{22,25}	RCT	52 GPs (26;26)*	X	X				X	Live, Literature, E-learning	>3h	
Dolan, 1997, USA ²¹	RCT	82 PCPs including 16 GPs (46;36)*	X	X					Live	2h	
Girgis, 1995, Australia ⁵²	Case-control study	41 GPs (24;17)*	X	X				X	Live, literature	>6h	

Key: GPs=general practitioners; PCPs= primary care physicians; RCT= randomized controlled trial; DA= diagnostic accuracy; INFORMED= Internet curriculum for melanoma early detection; PD= participant dependent; UD=undisclosed; TADA=trriage amalgamated dermoscopic algorithm
 *number of participants in the intervention group and control group

Table 4. Outcome measures of the melanoma diagnostic educational programs for general practitioners.

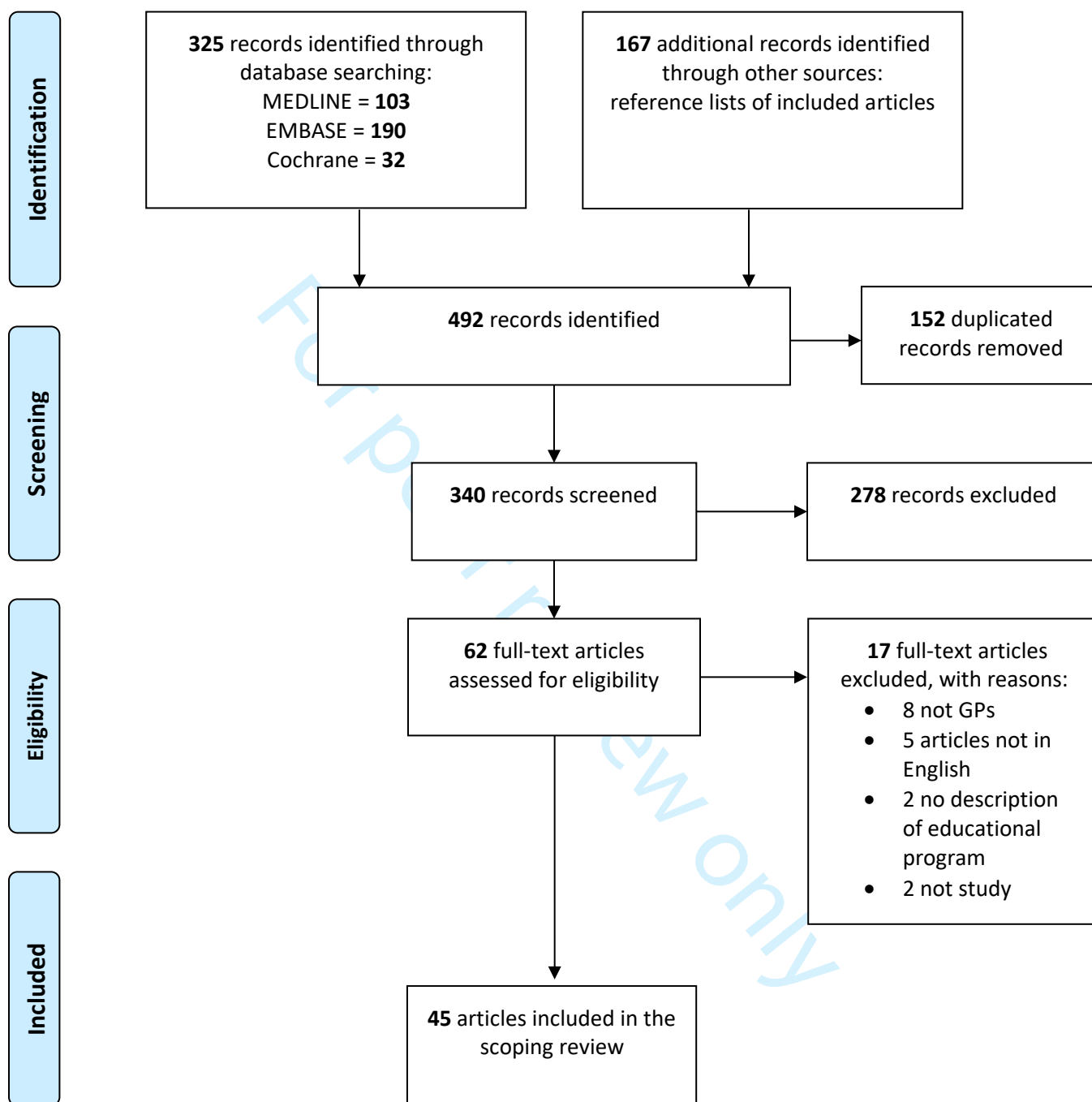
A. Studies with short-term outcomes												
Studies	Measured competence in training setting			Measured performance in clinical setting						Timing after the training		
(1st author and year of publication)	DA	Knowledge	AM	B/M ratio	TBSE	DA	confidence	Decrease of VTM incidence	RR	immediately	at 1 month	at 3 months
Dermoscopic diagnostic training programs												
Sawyers 2020 ⁴⁸	+									X		
Seiverling 2019 ⁴⁷	+									X		
Secker 2017 ⁴⁵	+		+									X
Rogers 2016 ⁴⁴	+									X		
Bourne 2012 ⁴⁰	+									X		
Dolianitis 2005 ³⁵	+									X		
Westerhoff 2000 ²⁴	+	+								X		
Clinical diagnostic training programs												
Beecher, 2018 ⁴⁶	+	+	+							X		X
Carli 2005 ³⁴	+		+							X		
Mikkilineni 2001;2002 ^{42,43}		+	+		+		+			X		
Brochez 2001 ³³	+									X		
Harris 2001 ³²	+	+	+				+			X		
Harris 1999 ³⁰	+	-	+				+			X		
Raasch 2000 ²³	-						+			3-month period		
Bedlow 2000 ³¹	+	+								X		
Gerbert 1998;2002 ^{22,25}	+	+	+				+			X		
Dolan 1997 ²¹	-	+	-							X	X	

1 2 3 4 5 6 7 8	Youl 2007 ⁴⁹						+		+				6-month period
9	Raasch 2000 ²³	-											3-month period
10	Grimaldi 2009 ³⁸	+			X	X			+				6-month period
11	Menzies 2009 ³⁷	+		+	X		+					+	6-month period
12	Clinical diagnostic training programs												
13	Marra, 2020 ⁵³	+				X			+	+		+	at 10 months
14	Grange 2013 ⁵⁰	+	+		X							+	3-year period
15	Markova 2013 ²⁸								-				at 12 months
16	Mikkilineni 2001; 2002 ^{42,43}		+	+	X								

Key: DA= diagnostic accuracy; AM=appropriate management; TBSE= total body skin examination; B/M=benign/malignant; VTM= very thick melanomas; RR= decrease in dermatologist referral rates for benign lesions and increase in referral rates for malignant lesions

+ = significant improvement; - = no significant improvement

To note that Shariff et al.³⁷ and Peuvrel et al.³⁴ provided only descriptive statistics of their study results. For the other studies, a P-value < 0.05 was considered significant, except for Grimaldi et al.³⁶ (P-value < 0.001).

Figure 1. PRISMA flowchart of study selection process¹⁷

Supplementary Table 1: Search strategies

Database	Search query	Limits	Filters	Results	Date
EMBASE	('general practitioner'/exp OR 'gp (general practitioner)' OR 'family doctor' OR 'family physician' OR 'general practitioner' OR 'general practitioners' OR 'physicians, family' OR 'physicians, primary care' OR 'practitioner, general' OR 'primary care doctor' OR 'primary care physician' OR 'primary care physicians') AND ('education'/exp OR 'education' OR 'self-evaluation programmes' OR 'self-evaluation programs' OR 'training support') AND ('melanoma'/exp OR 'malignant melanoma' OR 'melanoma' OR 'nevi and melanomas' OR 'naevi and melanomas') AND ('diagnosis'/exp OR 'diagnosis' OR 'diagnostic tool')	none	none	190	4 May 2020
MEDLINE	"('General Practitioners'[MeSH Terms] OR 'General Practice'[MeSH Terms] OR 'Family Practice'[MeSH Terms] OR 'physicians, primary care'[MeSH Terms]) AND 'Melanoma'[MeSH Terms] AND 'Diagnosis'[MeSH Terms]"	none	none	103	27 April 2020
Cochrane Library	melanoma in Title Abstract Keyword AND diagnosis in Title Abstract Keyword AND general practitioner in Title Abstract Keyword OR family medicine in Title Abstract Keyword AND dermoscopy in Title Abstract Keyword (Word variations have been searched)	none	none	32	28 April 2020

Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews (PRISMA-ScR) Checklist

SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
TITLE			
Title	1	Identify the report as a scoping review.	1
ABSTRACT			
Structured summary	2	Provide a structured summary that includes (as applicable): background, objectives, eligibility criteria, sources of evidence, charting methods, results, and conclusions that relate to the review questions and objectives.	2
INTRODUCTION			
Rationale	3	Describe the rationale for the review in the context of what is already known. Explain why the review questions/objectives lend themselves to a scoping review approach.	4
Objectives	4	Provide an explicit statement of the questions and objectives being addressed with reference to their key elements (e.g., population or participants, concepts, and context) or other relevant key elements used to conceptualize the review questions and/or objectives.	4
METHODS			
Protocol and registration	5	Indicate whether a review protocol exists; state if and where it can be accessed (e.g., a Web address); and if available, provide registration information, including the registration number.	N.A.
Eligibility criteria	6	Specify characteristics of the sources of evidence used as eligibility criteria (e.g., years considered, language, and publication status), and provide a rationale.	5
Information sources*	7	Describe all information sources in the search (e.g., databases with dates of coverage and contact with authors to identify additional sources), as well as the date the most recent search was executed.	5-6
Search	8	Present the full electronic search strategy for at least 1 database, including any limits used, such that it could be repeated.	6
Selection of sources of evidence†	9	State the process for selecting sources of evidence (i.e., screening and eligibility) included in the scoping review.	6
Data charting process‡	10	Describe the methods of charting data from the included sources of evidence (e.g., calibrated forms or forms that have been tested by the team before their use, and whether data charting was done independently or in duplicate) and any processes for obtaining and confirming data from investigators.	6
Data items	11	List and define all variables for which data were sought and any assumptions and simplifications made.	Table 2
Critical appraisal of individual sources of evidence§	12	If done, provide a rationale for conducting a critical appraisal of included sources of evidence; describe the methods used and how this information was used in any data synthesis (if appropriate).	5



SECTION	ITEM	PRISMA-ScR CHECKLIST ITEM	REPORTED ON PAGE #
Synthesis of results	13	Describe the methods of handling and summarizing the data that were charted.	6
RESULTS			
Selection of sources of evidence	14	Give numbers of sources of evidence screened, assessed for eligibility, and included in the review, with reasons for exclusions at each stage, ideally using a flow diagram.	Figure 1
Characteristics of sources of evidence	15	For each source of evidence, present characteristics for which data were charted and provide the citations.	Table 3
Critical appraisal within sources of evidence	16	If done, present data on critical appraisal of included sources of evidence (see item 12).	N.A.
Results of individual sources of evidence	17	For each included source of evidence, present the relevant data that were charted that relate to the review questions and objectives.	Table 3
Synthesis of results	18	Summarize and/or present the charting results as they relate to the review questions and objectives.	7-8
DISCUSSION			
Summary of evidence	19	Summarize the main results (including an overview of concepts, themes, and types of evidence available), link to the review questions and objectives, and consider the relevance to key groups.	9-10-11
Limitations	20	Discuss the limitations of the scoping review process.	12
Conclusions	21	Provide a general interpretation of the results with respect to the review questions and objectives, as well as potential implications and/or next steps.	13
FUNDING			
Funding	22	Describe sources of funding for the included sources of evidence, as well as sources of funding for the scoping review. Describe the role of the funders of the scoping review.	1

JBI = Joanna Briggs Institute; PRISMA-ScR = Preferred Reporting Items for Systematic reviews and Meta-Analyses extension for Scoping Reviews.

* Where *sources of evidence* (see second footnote) are compiled from, such as bibliographic databases, social media platforms, and Web sites.

† A more inclusive/heterogeneous term used to account for the different types of evidence or data sources (e.g., quantitative and/or qualitative research, expert opinion, and policy documents) that may be eligible in a scoping review as opposed to only studies. This is not to be confused with *information sources* (see first footnote).

‡ The frameworks by Arksey and O'Malley (6) and Levac and colleagues (7) and the JBI guidance (4, 5) refer to the process of data extraction in a scoping review as data charting.

§ The process of systematically examining research evidence to assess its validity, results, and relevance before using it to inform a decision. This term is used for items 12 and 19 instead of "risk of bias" (which is more applicable to systematic reviews of interventions) to include and acknowledge the various sources of evidence that may be used in a scoping review (e.g., quantitative and/or qualitative research, expert opinion, and policy document).

From: Tricco AC, Lillie E, Zarin W, O'Brien KK, Colquhoun H, Levac D, et al. PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Ann Intern Med.* 2018;169:467–473. doi: [10.7326/M18-0850](https://doi.org/10.7326/M18-0850).



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