Received: 4 January 2023 | Accepted: 8 March 2023

DOI: 10.1111/jdv.19087

JEADV JOURNAL OF THE EUROPEAN ACADEMY OF DERMATOLOGY & VENEREOLOGY

ORIGINAL ARTICLE

Evaluation of primary care physicians' competence in selective skin tumour triage after short versus long dermoscopy training: a randomized non-inferiority trial

E. Harkemanne[1,2,3] | C. Legrand[4] | K. Sawadogo[5] | A. van Maanen[5] | K. Vossaert[6] | G. Argenziano[7] | R. Braun[8] | L. Thomas[9] | M. Baeck[1,2] | I. Tromme[1,3]

[1]Dermatology Department, Cliniques universitaires Saint-Luc, Brussels, Belgium

[2]Institute of Experimental and Clinical Research (IREC), UCLouvain, Brussels, Belgium

[3]King Albert II Cancer and Hematology Institute, Cliniques universitaires Saint-Luc, Brussels, Belgium

[4]Institute of Statistics, Biostatistics and Actuarial Sciences (ISBA/LIDAM), UCLouvain, Louvain-la-Neuve, Belgium

[5]Statistical Support Unit, King Albert II Cancer and Hematology Institute, Cliniques universitaires Saint-Luc, Brussels, Belgium

[6]Dermatologie Maldegem, private practice, Maldegem, Belgium

[7]Dermatology Unit, University of Campania Luigi Vanvitelli, Naples, Italy

[8]Dermatology Department, University Hospital Zürich, Zürich, Switzerland

[9]Dermatology Department, Lyon Cancer Research Center INSERM, Université Lyon 1, Centre Hospitalier Lyon Sud, Pierre, Bénite, France

Correspondence
Evelyne Harkemanne, Department of Dermatology, Cliniques universitaires Saint-Luc, Avenue Hippocrate, 10, B-1200 Brussels, Belgium.
Email: evelyne.harkemanne@saintluc.uclouvain.be

Funding information
Fonds De La Recherche Scientifique - FNRS

Abstract

Background: Although primary care physicians (PCPs) play a key role in skin cancer screening, their skills in detecting malignant tumours is suboptimal.

Objectives: To determine whether a short dermoscopy e-learning course (4 h) in skin tumour diagnosis for PCPs is non-inferior to a long course (12 h) in selective triage of skin lesions. Secondly, to evaluate whether regular refresher training sessions are necessary to maintain the PCPs' skills in the medium term.

Methods: A randomized 2 × 2 factorial non-inferiority trial was conducted online over an 8-month period among 233 PCPs including 126 certified general practitioners, 94 PCPs in training, and 13 occupational physicians, all without prior advanced dermoscopy training. Participants were randomized 1:1:1:1 to receive short training and mandatory refreshers ($n = 58$), short training and optional refreshers ($n = 59$), long training and mandatory refreshers ($n = 58$), or long training and optional refreshers ($n = 58$). PCPs' skills were evaluated before training (T0), immediately after training (T1) to test the non-inferiority, and after 5 months (T2) to evaluate the impact of the refreshers. The primary endpoint was the difference in the change of score after short and long training. The non-inferiority margin was set at −28%.

Results: Among the 233 randomized participants, 216 (93%) completed T1 and 197 (84.5%) completed T2. For short versus long training, the primary endpoint was 1.392 (95% CI: 0.138; 2.645) in the per-protocol population ($p < 0.001$) and 1.016 (95% CI: −0.224; 2.256) in the modified intention-to-treat population ($p < 0.001$). After training, the type of refresher showed no impact on the score ($p = 0.840$). However, PCPs who completed all refreshers showed the best mean overall score at T2 ($p < 0.001$).

Conclusions: These findings confirm that short dermoscopy e-learning is non-inferior in training PCPs to triage skin lesions compared to long training. After training, regular refreshers are important to maintain the PCPs' acquired skills over time.

INTRODUCTION

Melanoma and non-melanoma skin cancers, continue to show increasing incidence rates in white populations worldwide.[1] While most common non-melanoma skin cancers (basal cell and squamous cell carcinomas) primarily increase patient morbidity, melanoma remains the most aggressive skin cancer, significantly reducing patient survival rates in its advanced stages.[2] Primary care physicians (PCPs), particularly general practitioners (GPs), play a key role in the early detection of skin cancer.[3–5] However, PCPs' diagnostic skills for skin tumours have been shown to be suboptimal.[6–10]

Specific educational training programs,[11–14] including dermoscopy training, have demonstrated to enhance PCPs' diagnostic accuracy and management of skin cancer.[15–18] Nevertheless, dermoscopy is currently used very little by PCPs[19–21] probably due to lack of adequate training opportunities and to the long training duration required to become competent.[22–25]

In 2016, the Triage Amalgamated Dermoscopic Algorithm (TADA) was specifically created for non-experts to triage skin lesions suspicious of malignancy using dermoscopy.[26,27] In a 3-h workshop, participants first learned to identify the dermoscopic features of three common types of benign lesions and then to recognize a panel of dermoscopic criteria that raise suspicion of malignancy.[28] Short dermoscopy training has several advantages compared to long training including being less time-consuming and easier to learn. However, it is still unclear whether the PCPs' skills to triage skin lesions acquired during short training are non-inferior to those acquired during long training. In addition, some studies suggest that a key aid to maintaining or even improving skills over time may be the availability of refresher training sessions (RTS) at regular intervals after the training period.[11,27,29] In this context, we created a short TADA-inspired dermoscopy training program followed by four monthly RTS to train PCPs to effectively triage benign and malignant skin tumours.

The primary objective was to determine whether a short dermoscopy training program in skin tumour diagnosis was non-inferior to a long dermoscopy training program in terms of PCPs' skills in selective triage of skin lesions (malignant vs. benign). The secondary objective was to study the added value of regularly scheduled RTS compared to the provision of optional refresher training material on the medium-term maintenance of the PCPs' skills.

METHODS

The trial protocol is provided as Supplement S1.

Study population

Eligible participants were PCPs working in Belgium and Luxembourg including certified GPs, registered occupational physicians, and GPs and occupational physicians in training. GPs and occupational physicians who had already taken an advanced dermoscopy training (>4 h) were excluded. Recruitment was conducted from July to November 2021 and enrollment was voluntary.

Study design

The study was a monocentric, randomized, controlled, 2 × 2 factorial, non-inferiority trial conducted over an 8-month period from November 2021 to end of June 2022. The study received ethical approval from the ethics committee of the Cliniques universitaires Saint-Luc in Brussels, Belgium.

For the purpose of this study, a training program divided into five training modules (#1–5) and four RTS was created (see Training program in Supplement S1). Every module was a 4-h e-learning course. The short training (ST) consisted only of module #1, designed on the basis of the TADA-method. It first summarized the most specific dermoscopic patterns of skin tumours and, secondly, focused on the detailed dermoscopic features of the most common benign skin tumours. The long training (LT) included modules #1, #2 and #3, consisting in a 12-h e-learning course based on dermoscopy courses for junior dermatologists. This training included the same content as the ST (module #1) with the addition of more detailed dermoscopic features of malignant skin tumours (module #2), of skin lesions of special sites (face, palms and soles, and nails) and the use of sequential digital dermoscopy to monitor atypical melanocytic lesions (module #3). Modules #4 and #5, which are useful for general practice but do not teach dermoscopic skin tumour diagnosis, were created to avoid biases related to different training length between the training groups. To address the first and second objectives, PCPs' skills to triage skin lesions into benign tumours (patient can be reassured) and lesions suspicious of malignancy (lesion must be treated/excised) were assessed based on dermoscopic images of skin lesions at different timepoints. The PCPs' skills were evaluated prior to randomization and training (T0), immediately after ST or LT (T1), and 5 months after the end of training (T2) to evaluate the impact of the RTS.

Before training initiation and after completing T0, eligible PCPs were randomly assigned at a 1:1:1:1 ratio to one of the four following groups (Figure 1): ST and mandatory RTS (group A), ST and optional RTS (group B), LT and mandatory RTS (group C), or LT and optional RTS (group D). At a rate of one module per month, groups C and D followed modules #1, #2, and #3 (= LT) while groups A and B took modules #4, #5, and #1 (= ST) before completing T1. After T1, all PCPs were invited to complete four RTS (one per month). For groups A and C, the RTS were mandatory, therefore, PCPs who did not complete one session would not have access to the next RTS. Whereas for groups B and D, the RTS were optional and non-completion did not limit access to the rest of the training. The four RTS were a 30-min online self-study course covering topics of module #1. The images of skin lesions used in the RTS were images of lesions already seen in module #1 as well as new (not previously presented) but similar lesions (with the same dermoscopic features). Finally, PCPs completed T2.

During the trial, PCPs were free to choose to stop the training whenever they wished to. At short-term, PCPs who did not complete T1 were considered as drop-outs and excluded from the primary analysis. PCPs who did not complete T2 were considered drop-outs for the secondary endpoint analysis at medium term.

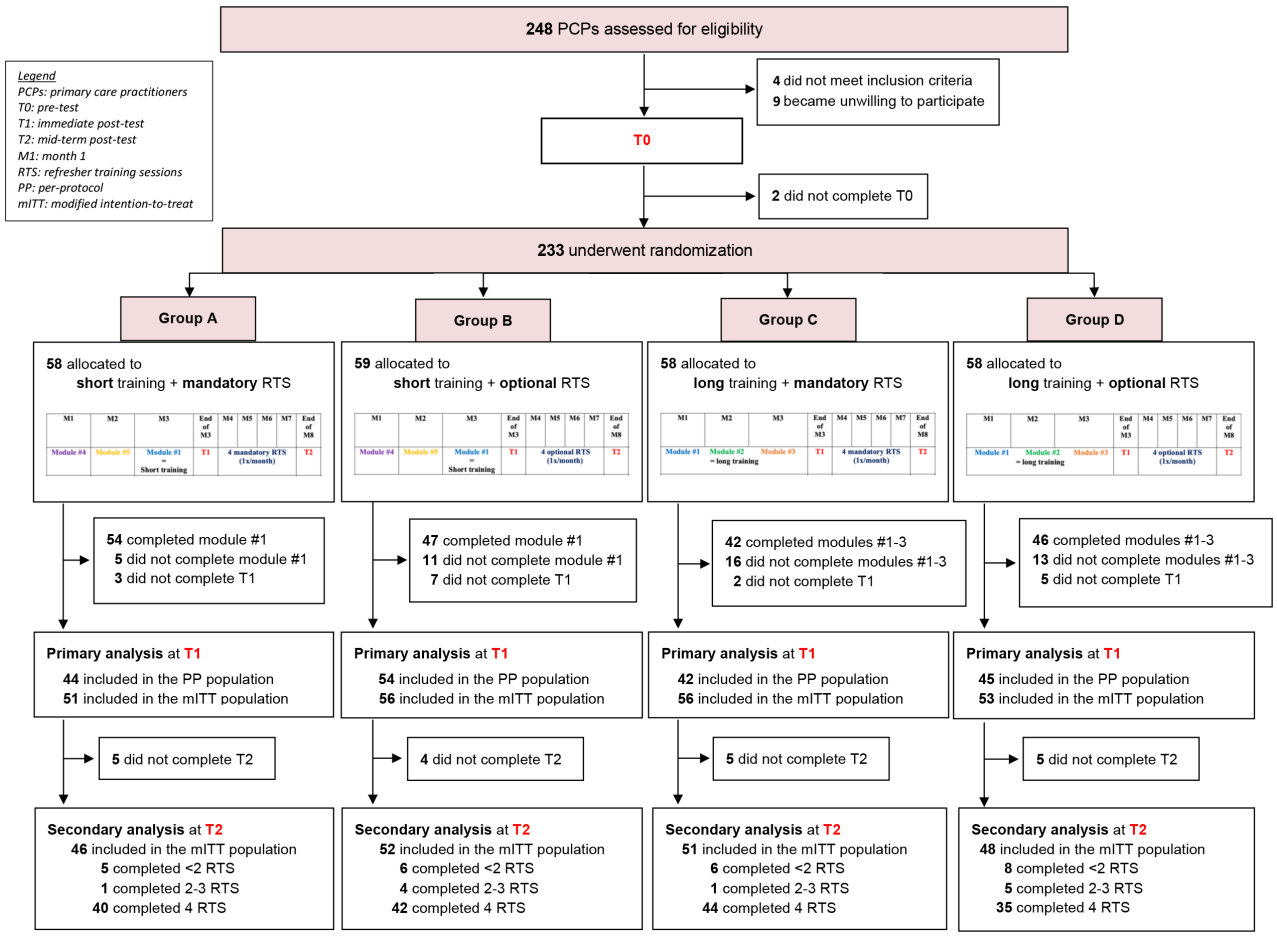

FIGURE 1 Consort diagram. M1, month 1; mITT, modified intention-to-treat; PCPs, primary care practitioners; PP, per-protocol; RTS, refresher training sessions; T0, pretest; T1, immediate posttest; T2, mid-term posttest.

Study outcomes

PCPs' acquired skills in selective triage of skin tumours into benign/malignant were assessed with three sets of similar dermoscopic images of the 25 most common skin tumours: 14 benign lesions (one dermatofibroma, one angioma, four seborrheic keratoses, six typical naevus, one subungual hematoma, and one subcorneal haemorrhage), 10 malignant lesions (five melanomas, four basal cell carcinomas, one Bowens' disease), and one actinic keratosis. Only the dermoscopic image of the lesion was presented in the tests (not including history nor clinical photograph) and each image had specific dermoscopic criteria that were taught in module #1. The images were randomly assigned to T0, T1, and T2. All study data were collected and managed using REDCap® (Research Electronic Data Capture, Vanderbilt University), a web-based survey application hosted at the Cliniques universitaires Saint-Luc.[30,31]

The primary endpoint was the difference between the mean change in PCPs' overall score immediately after the ST (T1short – T0) and the mean change in PCPs' overall score immediately after the LT (T1long – T0). For each test session, PCP's overall score was calculated on the 25 dermoscopic images of skin lesions through weighting as follows: +1 point if correct answer, +0 point if no answer given, −½ point if incorrect answer not dangerous for the patient's health (false positive), and −1 point if incorrect answer dangerous for the patient's health (false negative). The secondary endpoint was the difference between the mean change in the percentage of PCPs' correct responses for (i) all types of skin lesions, (ii) malignant, and (iii) benign lesions, immediately after the ST (T1short – T0) and the mean change in the percentage of PCPs' correct responses for the different types of skin lesions immediately after the LT (T1long – T0). The same endpoints were used for primary and secondary analyses (*see Statistical analyses below).*

Expert consensus

Prior to study initiation, four leading dermoscopy experts were called in September 2021 to reach a consensus on the validity of the following points: the 25 most frequently encountered lesions and their dermoscopic criteria, the 3X25 lesions with similar dermoscopic criteria to be included in the tests, the evidence of diagnoses for benign lesions, and the determination of the non-inferiority margin for this trial.

Statistical considerations

Considering the results of two previously trained cohorts of GPs (unpublished data), those of scientific literature[28,32–39] and the expert panel advice, a non-inferiority margin of –28% (–2.0 points/25) was chosen. Based on these results, it was computed that a sample of 216 participants was required to provide the trial with at least 90% power to detect a non-inferiority margin of –28% at a one-sided 2.5% significance level. This sample size was calculated considering two groups (ST vs. LT). In case non-inferiority was demonstrated, a superiority test of the ST was planned with an a priori superiority margin of +4 points/25. The primary analysis used to detect non-inferiority was assessed on the per-protocol (PP) population, defined as all PCPs in groups A and B who completed module #1, T0, and T1 and PCPs in groups C and D who completed modules #1–3, T0, and T1. Results were confirmed on the modified intention-to-treat (mITT) population consisting of all randomized PCPs who completed T1. The secondary analyses were performed only on the mITT population.

Participating PCPs' characteristics were summarized using counts and percentages. A Student *t*-test was used to compare mean change in PCPs' overall score between groups (*ST* vs. *LT* and *mandatory* vs. *optional RTS*). Mean changes in PCP's overall scores between T2 and T0 were compared according to the number of completed RTS using a one-way ANOVA or a Kruskal–Wallis test as appropriate with post-hoc analysis and Bonferroni correction. Apart from the primary analysis for which *p* value was one-sided with a significance level of <0.025 (non-inferiority), all other *p* values were two-sided and values <0.05 were considered statistically significant. Statistical analyses were performed using the SAS software (SAS© 9.4, SAS Institute Inc).

RESULTS

Participants

From July to November 2021, 248 PCPs were assessed for eligibility. Among them, 233 underwent randomization as follows: 58 (25.0%) in group A, 59 (25.3%) in group B, 58 (25.0%) in group C, and, 58 (25.0%) in group D. Seventeen PCPs who did not complete T1 were excluded, resulting in a primary analysis of 216 PCPs in the mITT population (see Figure 1). Of these, 157 (72.7%) were women. Table 1 shows that the PCPs' characteristics were evenly balanced among ST and LT groups. Of the 216 PCPs, only 185 (85.6%) completed their training program as expected (PP population). Afterwards, 19 PCPs did not complete T2 resulting in secondary analyses of 197 (84.5%) PCPs. In total, 36 (16.7%) participants withdrew over time.

Effectiveness outcomes

Table 2 shows the primary and secondary outcomes for 216 PCPs who completed T1. The difference in the mean change of the overall score between ST and LT (primary endpoint), was 1.392 (95% CI: 0.138–2.645) in the PP population ($p < 0.001$) and 1.016 (95% CI: −0.224–2.256) in the mITT population ($p < 0.001$), both demonstrating non-inferiority of ST over LT. The mean change in the percentage of correct answers (secondary endpoint), was not statistically significant between the training groups at 2.960 (95% CI: −1.098–7.018) in the PP population ($p = 0.152$) and 2.212 (95% CI: −1.693–6.118) in the mITT population ($p = 0.265$). The short e-learning was, therefore, shown to be non-inferior in improving PCPs' triage skills for skin lesions immediately after training with a non-inferiority margin of –28% (–2 points/25). On the other hand, our results do not allow to conclude to superiority of ST over LT given our predefined margin of superiority. Indeed, as shown on Figure 2 the lower limit of the two-sided 95% CI for difference in mean change of the overall score in the PP and mITT population did not exceed the margin of superiority of +4 points/25.

Secondary analyses

At the medium term, 197 PCPs completed T2 (Table 3). The difference in the mean change of the overall score between ST and LT was 1.302 (95% CI: −0.046–2.649) in the mITT population with a non-significant *p*-value ($p = 0.058$). The mean change in the percentage of correct answers was only significant ($p = 0.046$) for malignant lesions. There was no significant change in the mean overall score ($p = 0.841$) nor in the mean change in percentage of correct responses ($p = 0.409$; $p = 0.090$; $p = 0.860$) for all types of lesions between groups with optional ($n = 100$) and mandatory ($n = 97$) RTS. However, only 68 out of 100 participants with optional RTS completed the four sessions, while 84 out of 97 participants with mandatory RTS completed all the sessions.

In total, 80 out of 98 (81.6%) PCPs in the ST and 77 out of 99 (77.8%) PCPs in the LT attended the RTS ($p = 0.730$). Post-hoc analysis showed that the score ($p < 0.001$) and the percentage of correct answers ($p < 0.003$) were statistically better for PCPs who completed all refreshers than for PCPs who completed <2 sessions. Table 4 shows that there was a difference in the mean overall score ($p < 0.001$) and in the percentage of correct responses for all lesions ($p = 0.005$), including for malignant lesions ($p = 0.027$), between PCPs who completed ≥2 refreshers and PCPs who completed <2 sessions.

DISCUSSION

In this randomized controlled trial that evaluated whether a short dermoscopic training was non-inferior to a long training in terms of PCPs' competence in selective triage of skin tumours, the ST was shown to be non-inferior to the LT in the short and medium term. Although superiority of the ST was not demonstrated, non-inferiority was confirmed in all predefined analyses with a non-inferiority margin of –28%.

TABLE 1 Characteristics of trial participants.

Primary care physicians' characteristics	No. (%) Short training ($n = 107$)	Long training ($n = 109$)	Total ($n = 216$)
Professional status			
General practitioner	63 (58.9%)	57 (52.3%)	120 (55.6%)
General practice trainee	41 (38.3%)	46 (42.2%)	87 (40.2%)
Occupational health practitioner	3 (2.8%)	6 (5.5%)	9 (4.2%)
Gender			
Female	78 (72.9%)	79 (72.5%)	157 (72.7%)
Male	29 (27.1%)	30 (27.5%)	59 (27.3%)
Age			
25–35 years	75 (70.1%)	69 (63.3%)	144 (66.7%)
36–45 years	17 (15.9%)	26 (23.9%)	43 (19.9%)
46–55 years	10 (9.3%)	5 (4.6%)	15 (6.9%)
56–65 years	4 (3.7%)	7 (6.4%)	11 (5.1%)
>65 years	1 (1.0%)	2 (1.8%)	3 (1.4%)
Country of clinical practice			
Belgium	81 (75.7%)	80 (73.4%)	161 (74.5%)
Luxembourg	26 (24.3%)	29 (26.6%)	55 (25.5%)
Workplace			
Urban area	41 (38.3%)	42 (38.5%)	83 (38.4%)
Suburban area	38 (35.5%)	37 (33.9%)	75 (34.7%)
Rural area	28 (26.2%)	30 (27.5%)	58 (26.9%)
Years of practice			
≤3 years	39 (36.4%)	47 (43.1%)	86 (39.8%)
4–10 years	41 (38.3%)	27 (24.8%)	68 (31.5%)
>10 years	16 (15.0%)	23 (21.1%)	39 (18.1%)
>20 years	11 (10.3%)	12 (11.0%)	23 (10.6%)
Frequency of clinical whole-body skin examinations performed			
<1×/month	56 (52.3)	56 (51.4)	112 (51.9)
Once a month	28 (26.2)	28 (25.7)	56 (25.9)
1×/week to 1×/month	20 (18.7)	19 (17.4)	39 (18.1)
Once a week	3 (2.8)	2 (1.8)	5 (2.3)
>1×/week	0 (0.0)	4 (3.7)	4 (1.9)
Frequency of incidentally discovered suspicious skin lesions			
<1×/month	30 (28.8)	30 (27.5)	60 (27.8)
Once a month	46 (43.0)	51 (46.8)	97 (44.9)
1×/week to 1×/month	27 (25.2)	26 (23.9)	53 (24.5)
Once a week	4 (3.7)	2 (1.8)	6 (2.8)
>1×/week	0 (0.0)	0 (0.0)	0 (0.0)
Frequency of patients seeking medical advice for a suspicious skin lesion as primary reason for consultation			
<1×/month	59 (55.1)	57 (52.3)	116 (53.7)
Once a month	29 (27.1)	31 (28.4)	60 (27.8)
1×/week to 1×/month	16 (15.0)	18 (16.5)	34 (15.7)
Once a week	3 (2.8)	1 (0.9)	4 (1.9)
>1×/week	0 (0.0)	2 (1.8)	2 (0.9)

(Continues)

TABLE 1 (Continued)

	No. (%)		
Primary care physicians' characteristics	**Short training (*n* = 107)**	**Long training (*n* = 109)**	**Total (*n* = 216)**
Frequency of patients seeking medical advice for a suspicious skin lesion as secondary reason for consultation			
<1×/month	29 (27.1)	20 (18.3)	49 (22.7)
Once a month	27 (25.2)	41 (37.6)	68 (31.5)
1×/week to 1×/month	39 (36.4)	32 (29.4)	71 (32.9)
Once a week	6 (5.6)	11 (10.1)	17 (7.9)
>1×/week	6 (5.6)	5 (4.6)	11 (5.1)
When faced with a suspicious skin lesion, I			
Always feel uncomfortable	91 (85.0)	92 (84.4)	183 (84.7)
Often feel uncomfortable	8 (7.5)	9 (8.3)	17 (7.9)
Sometimes feel uncomfortable	4 (3.7)	3 (2.8)	7 (3.2)
Usually feel comfortable	2 (1.9)	1 (0.9)	3 (1.4)
Always feel comfortable	2 (1.9)	4 (3.7)	6 (2.8)
Referral to dermatologist or biopsy/excision performed within the last year			
<1×/month	49 (45.8)	50 (45.9)	98 (45.4)
Once a month	27 (25.2)	36 (33.0)	63 (29.2)
1×/week to 1×/month	28 (26.2)	20 (18.3)	48 (22.2)
Once a week	1 (0.9)	1 (0.9)	2 (0.9)
>1×/week	2 (1.9)	2 (1.8)	4 (1.9)
Number of suspicious skin lesions personally diagnosed in the last year			
No carcinoma	45 (42.1)	56 (51.4)	101 (46.8)
One carcinoma	26 (24.3)	18 (16.5)	44 (20.4)
2–5 carcinomas	32 (29.9)	29 (26.6)	61 (28.2)
5–10 carcinomas	3 (2.8)	4 (3.7)	7 (3.2)
>10 carcinomas	1 (0.9)	2 (1.8)	3 (1.4)
No melanoma	85 (79.4)	90 (82.6)	175 (81.0)
One melanoma	18 (16.8)	16 (14.7)	34 (15.7)
>1 melanoma	4 (3.7)	3 (2.8)	7 (3.2)

Several ST courses in dermoscopy have already shown to improve diagnostic accuracy for skin tumours in inexperienced users.[36,38–42] However, the present study is the first to compare the skills acquired after a short dermoscopy training program and after a long training program. Hence, ST was shown to provide acceptable short- and medium-term competence in skin tumour triage with significant benefits. In addition to accommodating PCPs' busy work schedules, short trainings appeal to a wider audience than long trainings that probably target only the most motivated PCPs. As a result, a larger number of PCPs could be properly trained to perform lesion-directed screening, which has previously shown to improve skin cancer detection.[43–45] This reduces unnecessary referrals to a dermatologist and/or biopsy for benign skin tumours,[46] while management of malignancies is significantly accelerated.[47] Moreover, increased detection of early-stage skin tumours could reduce burden and costs for treatments of advanced tumour stages.[48,49]

The mean change in the medium-term overall score of PCPs who completed all RTS was better than for those who completed less than 2 RTS. This finding is consistent with two recent studies that demonstrated that spaced learning increased the participants skills in dermoscopy.[50,51] Surprisingly, however, in this study 72.6% PCPs attended 100% of the RTS (77% in the mandatory and 68% in the optional groups), showing that participation was independent of whether they were optional or mandatory. One explanation may be that the training raised PCPs' awareness for the importance of early detection of skin malignancies and the need to maintain skills over time. Scheduling regular RTS can be a valuable aid since they allow for repetition and essential knowledge retention.[52] Furthermore, test-based learning with instant corrective feedback (as we used in RTS) proved to be very effective in improving knowledge[53,54] and are highly appreciated by learners.[55,56]

Recently, Tran et al. proposed an expert-approved list of key dermoscopic features of skin tumours to be taught in training

TABLE 2 Differences in PCPs' skills immediately after short and long training by per-protocol (PP) and modified intention-to-treat (mITT) analyses.

Outcome	PCPs' scores on 25 images of skin lesions[a] Short training Average diff. [T1 short – T0] *PP: n* = 98 *mITT: n* = 107	Long training Average diff. [T1 long – T0] *PP: n* = 87 *mITT: n* = 109	Difference[b] Average diff.[T1 short – T0] – Long training Average diff. [T1 long – T0] (95% CI)	*p* value
Primary outcome: Mean change in the overall score /25 (± SD)				
PP (primary analysis)	9.40 (±4.40)	8.10 (±4.22)	1.392 (0.138; 2.645)	*<0.001*[c]
mITT	8.90 (±4.97)	7.90 (±4.26)	1.016 (−0.224; 2.256)	*<0.001*[c]
Secondary outcome: Mean change in percentage (%) of correct answers (± SD)[d]				
PP (primary analysis)				
All lesions	30.00% (±14.80)	27.10% (±12.95)	2.960 (−1.098; 7.018)	0.152
Malignant lesions	35.30% (±19.42)	30.50% (±18.60)	4.740 (−0.793; 10.273)	0.093
Benign lesions	25.90% (±19.25)	24.40% (±19.71)	1.563 (−4.096; 7.222)	0.586
mITT				
All lesions	28.60% (±16.12)	26.30% (±12.85)	2.212 (−1.693; 6.118)	0.265
Malignant lesions	33.50% (±20.04)	29.50% (±19.57)	3.951 (−1.361; 9.264)	0.144
Benign lesions	24.70% (±20.56)	23.90% (±19.10)	0.846 (−4.476; 6.168)	0.754

Abbreviations: 95% CI, 95% confidence interval; diff, difference; mITT, modified intention-to-treat population; PP, per-protocol population; SD, standard deviation.

[a]For the first two columns, a positive difference means a higher score at T1 than at T0.

[b]For third column, a positive difference means a greater improvement in score between T1 and T0 for short training participants than for long training participants.

[c]For the primary outcome: *p* value <0.025 is statistically significant.

[d]For the secondary outcome, *p* value <0.05 is statistically significant.

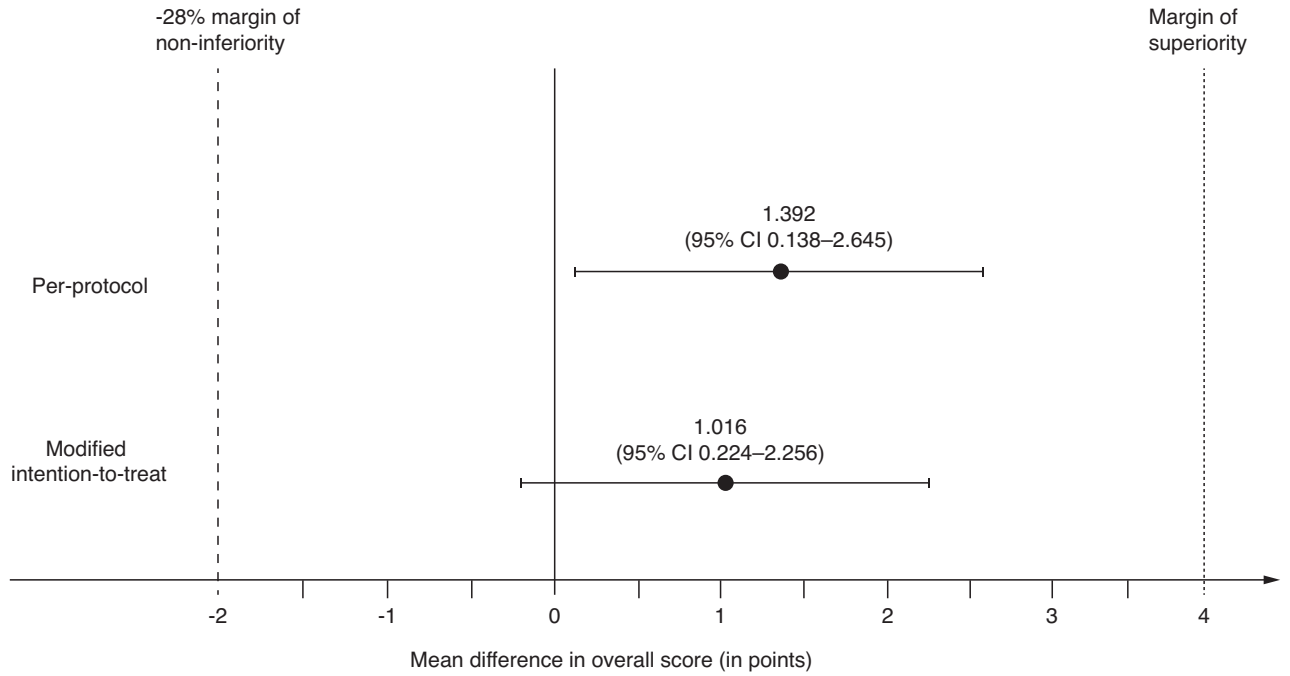

FIGURE 2 Non-inferiority diagram. This diagram shows the results of the primary endpoint, which was the difference between the mean change in PCPs' overall score immediately after the short training (T1short – T0) and the mean change in PCPs' overall score immediately after the long training (T1long – T0). Non-inferiority was demonstrated in the per-protocol population and confirmed in the modified intention-to treat population with 95% confidence intervals significantly above the non-inferiority margin of –28% (–2 points/25). However, the short training was not superior to the long training as the lower limit of both confidence intervals did not exceed the margin of superiority.

TABLE 3 Differences in PCPs' skills at medium-term after short versus long training ± refresher sessions by modified intention-to-treat analyses.

	PCPs' change in competence on 25 images of skin lesions			
Secondary analyses	**Short training Average diff. [T2 short – T0]** ***n*** **= 98**	**Long training Average diff. [T2 long – T0]** ***n*** **= 99**	**Difference Average diff. [T2 short – T0]– Average diff. [T2 long – T0] (95% CI)**	***p*** **Value**
Mean change in the overall score /25 (±SD)	9.90 (±4.93)	8.60 (±4.66)	1.302 (– 0.046; 2.649)	0.058
Mean change in the percentage (%) of correct responses (±SD)				
All lesions	31.30% (±15.73)	28.40% (±14.03)	2.942 (–1.245; 7.130)	0.167
Malignant lesions	34.40% (±18.52)	28.90% (±19.75)	5.490 (0.109; 10.872)	*0.046**
Benign lesions	28.90% (±20.87)	27.90% (±20.13)	0.941 (– 4.820; 6.702)	0.748
	Optional refresher ***n*** **= 100**	**Mandatory refresher** ***n*** **= 97**	**Difference Average diff.[*T2 opt* – *T0*] – Average diff.[*T2 man* – *T0*] (95% CI)**	***p*** **value**
Mean change in the overall score /25 (±SD)	9.14 (±4.51)	9.28 (±5.16)	−0.138 (−1.498; 1.222)	0.841
Mean change in the percentage (%) of correct responses (±SD)				
All lesions	28.96% (±13.74)	30.72% (±16.10)	−1.762 (−5.963; 2.440)	0.409
Malignant lesions	29.36% (±17.04)	34.02% (±21.21)	−4.658 (−10.056; 0.740)	0.090
Benign lesions	28.64% (±20.94)	28.13 (±20.04)	0.514 (−5.248; 6.277)	0.860

Abbreviations: 95% CI, 95% confidence interval; PCPs, primary care practitioners; SD, standard deviation.
*p value <0.05 is statistically significant.

TABLE 4 Differences in PCPs' skills at midterm (T2) based on the number of refresher sessions completed.

	PCPs' change in competence on 25 images of skin lesions (T2–T0)			
Secondary analyses	**<2 sessions** ***n*** **= 28**	**2–3 sessions** ***n*** **= 12**	**4 sessions (total)** ***n*** **= 157**	***p*** **Value**
Mean change in the overall score /25 (±SD)	5.52 (±5.41)	9.67 (±6.83)	9.83 (±4.25)	*<0.001**
Mean change in the percentage (%) of correct responses (±SD)				
All lesions	21.43 (±18.32)	33.33 (±22.58)	31.06 (±13.08)	*0.005**
Malignant lesions	21.43 (±20.29)	32.58 (±24.96)	33.41 (±18.19)	*0.027**
Benign lesions	21.43 (±23.00)	33.93 (±29.07)	29.21 (±19.04)	0.256
	95% CI			
Post-hoc comparison with Bonferroni corrections	**<2 sessions versus 2–3 sessions**	**<2 sessions versus 4 sessions**	**2–3 sessions versus 4 sessions**	
Mean change in the overall score /25	[−0.86; 6.74]	[2.03; 6.60][a]	[−3.17; 3.50]	
Mean Change in the percentage (%) of correct responses				
All lesions	[−0.26; 24.07]	[2.39; 16.86][a]	[−12.84; 8.29]	
Malignant lesions	[−4.63; 26.93]	[2.60; 21.36][a]	[−12.86; 14.53]	

Abbreviations: 95% CI, 95% confidence interval; PCPs, primary care practitioners; SD, standard deviation.
*p value <0.05 is statistically significant.
[a]Indicates a significant confidence interval at a 5% level.

programs for PCPs.[57] We found that all of the core dermoscopic features proposed in their fundamental list of basic skills required to selectively triage benign and malignant skin lesions are taught in the ST. In the same line of thought, we deliberately excluded from the ST skin tumours that do not present specific dermoscopic features or that are difficult to diagnose using dermoscopy, such as adnexal tumours. Indeed, these tumours are primarily diagnosed by clinical examination. Therefore,

the present ST provides consensus-derived clinical skills with corrective learner feedback and measures outcomes such as competency/attitude using consensus validated instruments as recently recommended by Posada et al.[58]

To tackle the burden of skin cancers, it is essential that a large number of PCPs are trained in the early recognition of skin malignancies. To ensure that PCPs acquire basic knowledge in skin tumour diagnosis, such a short dermoscopy training could be taught to medical school students, as suggested by Cyr et al.[59] However, it is to be feared that the training content will be quickly forgotten if not combined with regular use of dermoscopy in clinical practice and refreshing sessions. In this context, active learning RTS to improve the acquired skills over time may be part of continuing medical education.[29] In the meantime, further studies are needed to assess the effectiveness of such training programs in real life.

Nevertheless, the question arises as to whether or not LT should be discontinued. This study found that in the medium-term, recognition of malignant lesions was better after ST than after LT. This may be because PCPs who completed the LT were overwhelmed with information overload that may have drowned out essential knowledge, whereas the ST was more "straightforward" and taught only the key messages for recognition of the most common skin malignancies. Another hypothesis is that PCPs who attended the LT became overconfident after completing modules #1–3 and did not complete the RTS reviewing the malignancy criteria for skin tumours, considering them redundant. However, the difference in the number of participants from the LT and ST, who attended the RTS, was not significant. Finally, the LT may discourage more PCPs to finish the course or even from taking it because of its longer duration. However, the ST was not shown to be superior to the LT. Therefore, in our opinion, the LT should continue to be taught to dermatologists and PCPs specializing in skin cancer diagnosis.

Limitations

Our study has some limitations. Firstly, because participation was voluntary, perhaps only PCPs interested in skin cancer diagnosis attended the training and completed the tests. Another potential selection bias is that we accepted participation of PCPs who had previously completed a short dermoscopy training (<4 h). However, this only involved 5/216 (2.3%) participants. Secondly, only the diagnosis of the most common skin tumours and their most common dermoscopic criteria were taught and evaluated in the tests. Diagnosis of some rare malignant tumours can probably be missed by PCPs during skin examinations. Thirdly, none of the images used in the tests were from patients with skin of colour. Skin cancers are less common in these patients, but their prognosis is often poor due to late diagnosis. However, although not tested, some skin tumours found in dark-skinned patients, namely acro-lentiginous melanomas and pigmented basal cell carcinomas, were included in the ST. Fourthly, the tests were conducted online in an open-book format. However, this evaluation method seemed to be the closest to real-life practice where physicians have access to their books and colleagues' opinions when evaluating a suspicious skin lesion. Finally, this study assessed the PCPs' triaging skills solely in a training setting. When measured on photographs, the skills do not always reflect the PCPs' performance in their daily clinical practice.

CONCLUSION

In this randomized controlled non-inferiority trial, a short dermoscopy e-learning course proved to be non-inferior to long training in improving PCPs' competence in selective triage of skin tumours (benign/malignant). This finding confirms that a 4-h online dermoscopy training can be effective to improve early-stage skin cancer detection. Less time-consuming and to-the-point programs may favour PCP participation in dermoscopy training, thereby increasing skin malignancy detection and reducing overall patient morbi-mortality. Finally, spaced test-based refresher training sessions appear to maintain or even increase the skills acquired by PCPs over time.

ACKNOWLEDGEMENTS

The authors thank all the primary care physicians that kindly participated in this study as well as Dr. Kelly Nelson, M.D. F.A.A.D, from the MD Anderson Cancer Center of the University of Texas for her enlightened advice on the trial protocol. We also thank Dr. Mariana Andrade, M.D., who provided editorial assistance.

FUNDING INFORMATION

FNRS Grant entitled Medical Doctor Applicant to an MSc and a PhD [CSD].

CONFLICT OF INTEREST STATEMENT

None.

DATA AVAILABILITY STATEMENT

The data that support the findings of this study are available from the corresponding author upon reasonable request.

ETHICS STATEMENT

The study received ethical approval from the ethics committee of the Cliniques universitaires Saint-Luc (CUSL) in Brussels, Belgium.

ORCID

E. Harkemanne https://orcid.org/0000-0001-9936-9868
G. Argenziano https://orcid.org/0000-0003-1413-8214
L. Thomas https://orcid.org/0000-0003-1995-2434
M. Baeck https://orcid.org/0000-0003-0499-7939

REFERENCES

1. Garbe C, Keim U, Gandini S, Amaral T, Katalinic A, Hollezcek B, et al. Epidemiology of cutaneous melanoma and keratinocyte cancer in white populations 1943–2036. Eur J Cancer. 2021;152:18–25.

2. Saginala K, Barsouk A, Sukumar Aluru J, Rawla P, Barsouk A. Alexander epidemiology of melanoma. Med Sci. 2021;9:63.
3. Grange F, Barbe C, Mas L, Granel-Brocard F, Lipsker D, Aubin F, et al. The role of general practitioners in diagnosis of cutaneous melanoma: a population-based study in France. Br J Dermatol. 2012;167:1351–9.
4. van Rijsingen MCJ, van Bon B, van der Wilt GJ, Lagro-Janssen ALM, Gerritsen MJP. The current and future role of general practitioners in skin cancer care: an assessment of 268 general practitioners. Br J Dermatol. 2014;170:1366–8.
5. Jones OT, Ranmuthu CKI, Hall PN, Funston G, Walter FM. Recognising skin cancer in primary care. Adv Ther. 2020;37:603–13.
6. Oliveria SA, Heneghan MK, Cushman LF, Ughetta EA, Halpern AC. Skin cancer screening by dermatologists, family practitioners, and internists: barriers and facilitating factors. Arch Dermatol. 2011;147:39–44.
7. Offidani A, Simonetti O, Bernardini ML, Alpagut A, Cellini A, Bossi G. General Practitioners' accuracy in diagnosing skin cancers. Dermatology. 2002;205:127–30.
8. van Rijsingen MCJ, Hanssen SCA, Groenewoud JMM, van der Wilt GJ, Gerritsen MJP. Referrals by general practitioners for suspicious skin lesions: the urgency of training. Acta Derm Venereol. 2014;94:138–41.
9. Garrido AQ, Wainstein AJA, Brandão MPA, de Vasconcellos Santos FA, Bittencourt FV, Ledsham C, et al. Diagnosis of cutaneous melanoma: the gap between the knowledge of general practitioners and dermatologists in a Brazilian population. J Cancer Educ. 2020;35:819–25.
10. Harkemanne E, Duyver C, Leconte S, Bugli C, Thomas L, Baeck M, et al. Melanoma diagnostic practices of French-speaking Belgian general practitioners and the prospective study of their pigmented skin lesion diagnostic accuracy and management. J Cancer Educ. 2020;36:1316–24.
11. Jones OT, Jurascheck LC, van Melle MA, Hickman S, Burrows NP, Hall PN, et al. Dermoscopy for melanoma detection and triage in primary care: a systematic review. BMJ Open. 2019;9:e027529.
12. Fee JA, McGrady FP, Rosendahl C, Hart ND. Training primary care physicians in Dermoscopy for skin cancer detection: a scoping review. J Cancer Educ. 2020;35:643–50.
13. Harkemanne E, Baeck M, Tromme I. Training general practitioners in melanoma diagnosis: a scoping review of the literature. BMJ Open. 2021;11:e043926.
14. Brown AE, Najmi M, Duke T, Grabell DA, Koshelev MV, Nelson KC. Skin cancer education interventions for primary care providers: a scoping review. J Gen Intern Med. 2022;37:2267–79.
15. Kittler H, Pehamberger H, Wolff K, Binder M. Diagnostic accuracy of dermoscopy. Lancet Oncol. 2002;3:159–65.
16. Argenziano G, Puig S, Zalaudek I, Sera F, Corona R, Alsina M, et al. Dermoscopy improves accuracy of primary care physicians to triage lesions suggestive of skin cancer. J Clin Oncol. 2006;24:1877–82.
17. Koelink CJL, Vermeulen KM, Kollen BJ, de Bock GH, Dekker JH, Jonkman MF, et al. Diagnostic accuracy and cost-effectiveness of dermoscopy in primary care: a cluster randomized clinical trial. J Eur Acad Dermatology Venereol. 2014;28:1442–9.
18. Gonna N, Tran T, Bassett RL, Farris DP, Nelson KC. Sensitivity and specificity for skin cancer diagnosis in primary care providers: a systematic literature review and meta-analysis of educational interventions and diagnostic algorithms. J Cancer Educ. 2022;37:1563–72.
19. Morris J, Alfonso S, Hernandez N, Fernandez MI. Use of and intentions to use dermoscopy among physicians in the United States. Dermatol Pract Concept. 2017;7:7–16.
20. Williams NM, Marghoob AA, Seiverling E, Usatine R, Tsang D, Jaimes N. Perspectives on Dermoscopy in the primary care setting. J Am Board Fam Med. 2020;33:1022–4.
21. Pokhrel PK, Helm MF, Greene A, Helm LA, Partin M. Dermoscopy in primary care. Prim Care Clin off Pract. 2022;49:99–118.
22. Chappuis P, Duru G, Marchal O, Girier P, Dalle S, Thomas L. Dermoscopy, a useful tool for general practitioners in melanoma screening: a nationwide survey. Br J Dermatol. 2016;175:744–50.
23. Jones OT, Jurascheck LC, Utukuri M, Pannebakker MM, Emery J, Walter FM. Dermoscopy use in UK primary care: a survey of GPs with a special interest in dermatology. J Eur Acad Dermatology Venereol. 2019;33:1706–12.
24. Fee JA, McGrady FP, Hart ND. Dermoscopy use in primary care: a qualitative study with general practitioners. BMC Prim Care. 2022;23:47.
25. Cantisani C, Ambrosio L, Cucchi C, et al. Melanoma detection by non-specialists: an untapped potential for triage? Diagnostics. 2022;12:10–5.
26. Rogers T, Marino ML, Dusza SW, Bajaj S, Usatine RP, Marchetti MA, et al. A clinical aid for detecting skin cancer: the triage amalgamated dermoscopic algorithm (TADA). J Am Board Fam Med. 2016;29:694–701.
27. Susong JR, Ahrns HT, Daugherty A, Marghoob AA, Seiverling EV. Evaluation of a virtual basic dermatology curriculum for dermoscopy by using the triage amalgamated dermoscopic algorithm for novice dermoscopists. J Am Acad Dermatol. 2020;83:590–2.
28. Seiverling EV, Ahrns HT, Greene A, Butt M, Yélamos O, Dusza SW, et al. Teaching benign skin lesions as a strategy to improve the triage amalgamated dermoscopic algorithm (TADA). J Am Board Fam Med. 2019;32:96–102.
29. Harkemanne E, Duyver C, Leconte S, Sawadogo K, Baeck M, Tromme I. Short- and long-term evaluation of general Practitioners' competences after a training in melanoma diagnosis: refresher training sessions may Be needed. J Cancer Educ. 2021;26:1–14.
30. Harris PA, Taylor R, Thielke R, Payne J, Gonzalez N, Conde JG. Research electronic data capture (REDCap)-a metadata-driven methodology and workflow process for providing translational research informatics support. J Biomed Inform. 2009;42:377–81.
31. Harris PA, Taylor R, Minor BL, Elliott V, Fernandez M, O'Neal L, et al. The REDCap consortium: building an international community of software platform partners. J Biomed Inform. 2019;95:103208.
32. Westerhoff K, McCarthy WH, Menzies SW. Increase in the sensitivity for melanoma diagnosis by primary care physicians using skin surface microscopy. Br J Dermatol. 2000;143:1016–20.
33. Raasch BA, Hays R, Buettner PG. An educational intervention to improve diagnosis and management of suspicious skin lesions. J Contin Educ Health Prof. 2000;20:39–51.
34. Eide MJ, Asgari MM, Fletcher SW, Geller AC, Halpern AC, Shaikh WR, et al. Effects on skills and practice from a web-based skin cancer course for primary care providers. J Am Board Fam Med. 2013;26:648–57.
35. Badertscher N, Tandjung R, Senn O, Kofmehl R, Held U, Rosemann T, et al. A multifaceted intervention: no increase in general practitioners' competence to diagnose skin cancer (minSKIN) - randomized controlled trial. J Eur Acad Dermatology Venerol. 2015;29:1493–9.
36. Robinson JK, Jain N, Marghoob AA, McGaghie W, MacLean M, Gerami P, et al. A randomized trial on the efficacy of mastery learning for primary care provider melanoma opportunistic screening skills and practice. J Gen Intern Med. 2018;33:855–62.
37. Augustsson A, Paoli J. Effects of a 1-day training course in Dermoscopy among general practitioners. Dermatol Pract Concept. 2019;9:195–9.
38. Sawyers EA, Wigle DT, Marghoob AA, Blum A. Dermoscopy training effect on diagnostic accuracy of skin lesions in Canadian family medicine physicians using the triage amalgamated Dermoscopic algorithm. Dermatol Pract Concept. 2020;10:e2020035.
39. De Bedout V, Williams N, Muñoz A, Londoño AM, Munera M, Naranjo N, et al. Skin cancer and Dermoscopy training for primary care physicians: a pilot study. Dermatol Pract Concept. 2021;11:e2021145.
40. Chevolet I, Hoorens I, Janssens A, Speeckaert R, van Geel N, van Maele G, et al. A short dermoscopy training increases diagnostic performance in both inexperienced and experienced dermatologists. Australas J Dermatol. 2015;56:52–5.
41. Seiverling E, Ahrns H, Stevens K, Ayers L, Nussinow T, Dorr G, et al. Dermoscopic lotus of learning: implementation and dissemination of

a multimodal Dermoscopy curriculum for primary care. J Med Educ Curric Dev. 2021;8:238212052198998.
42. Jones SM, Walker H, Maitland C. A dermoscopy training program for Victorian GPs to improve skin cancer prevention and detection. Public Heal Res Pract. 2022;32:1–5.
43. Brochez L, Verhaeghe E, Bleyen L, Naeyaert JM. Diagnostic ability of general practitioners and dermatologists in discriminating pigmented skin lesions. J Am Acad Dermatol. 2001;44:979–86.
44. Hoorens I, Vossaert K, Pil L, Boone B, de Schepper S, Ongenae K, et al. Total-body examination vs lesion-directed skin cancer screening. JAMA Dermatol. 2016;152:27–34.
45. Mylle S, Verhaeghe E, Van Coile L, Van de Maele B, Hoorens I, Brochez L. Lesion-directed screening to optimize skin cancer detection in dermatology practice: an observational study. J Eur Acad Dermatology Venereol. 2021;35:1309–14.
46. Seiverling EV, Stevens K, Dorr G, Prentiss MA, Stoddard H, Houk L, et al. Impact of multimodal dermatoscopy training on skin biopsies by primary care providers. J Am Acad Dermatol. 2022;87:1119–21.
47. Marra E, van Rijsingen MCJ, Alkemade JAC, Groenewoud JMM, Hueskes KF, Nij Bijvank CHM, et al. The effect of a dermato-oncologic training program on the diagnostic skills and quality of referrals for suspicious skin lesions by general practitioners. Br J Dermatol. 2021;184:538–44.
48. Tromme I, Legrand C, Devleesschauwer B, Leiter U, Suciu S, Eggermont A, et al. Melanoma burden by melanoma stage: assessment through a disease transition model. Eur J Cancer. 2016;53:33–41.
49. Mulder EEAP, Smit L, Grünhagen DJ, Verhoef C, Sleijfer S, van der Veldt AAM, et al. Cost-effectiveness of adjuvant systemic therapies for patients with high-risk melanoma in Europe: a model-based economic evaluation. ESMO Open. 2021;6:100303.
50. Boespflug A, Guerra J, Dalle S, Thomas L. Enhancement of customary dermoscopy education with spaced education e-learning: a prospective controlled trial. JAMA Dermatol. 2015;151:847–53.
51. Seiverling EV, Li D, Stevens K, Cyr P, Dorr G, Ahrns H. Distance learning and spaced review to complement dermoscopy training for primary care. Dermatol Pract Concept. 2021;11:e2021030.
52. Mcevoy MD, Fowler LC, Robertson A, Gelfand BJ, Fleming GM, Miller B, et al. Comparison of two learning modalities on continuing medical education consumption and knowledge acquisition: a pilot randomized controlled trial. J Educ Perioper Med. 2021;23:E668.
53. Feldman M, Fernando O, Wan M, Martimianakis MA, Kulasegaram K. Testing test-enhanced continuing medical education: a randomized controlled trial. Acad Med. 2018;93:S30–6.
54. Armson H, Roder S, Wakefield JEKT. Toward practice-based continuing education protocols: using testing to help physicians update their knowledge. J Contin Educ Health Prof. 2020;40:248–56.
55. Youhasan P, Raheem S. Technology enabled formative assessment in medical education: a pilot study through Kahoot. Educ Med J. 2019;11:23–9.
56. Desy JR, Reed DA, Wolanskyj AP. Milestones and millennials: a perfect pairing—competency-based medical education and the learning preferences of generation Y. Mayo Clin Proc. 2017;92:243–50.
57. Tran T, Cyr PR, Verdieck A, Lu MD, Ahrns HT, Berry EG, et al. Expert consensus Statement on proficiency standards for Dermoscopy education in primary care. J Am Board Fam Med. 2023;36:25–38.
58. Posada EL, Lauck KC, Tran T, Krause KJ, Nelson KC. Educational interventions to support primary care provider performance of diagnostic skin cancer examinations: a systematic literature review. J Cancer Educ. 2022;18:1–10.
59. Cyr PR, Craig W, Ahrns H, Stevens K, Wight C, Seiverling E. Teaching skin cancer detection to medical students using a Dermoscopic algorithm. PRiMER. 2021;5:6.

SUPPORTING INFORMATION

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

How to cite this article: Harkemanne E, Legrand C, Sawadogo K, van Maanen A, Vossaert K, Argenziano G, et al. Evaluation of primary care physicians' competence in selective skin tumour triage after short versus long dermoscopy training: a randomized non-inferiority trial. J Eur Acad Dermatol Venereol. 2023;00:1–11. https://doi.org/10.1111/jdv.19087