MedNEXT
Journal of Medical an Health Sciences

REVIEW ARTICLE

DOI: 10.54448/mdnt26105

Early skin cancer screening using digital dermatoscopy and artificial intelligence: a systematic review

Paulina Elizabeth Durán Mora[1,2,*], **Joffre Ivan Ponce Baque**[1,2], **Miriam Maria Delbem Bellon**[2]

[1] Durán Hospital, Pasteur and César Borja Avenue, Ambato, Ecuador.
[2] UNORTE - University Center of Northern São Paulo - Department of Dermatology, Sao Jose do Rio Preto, Sao Paulo, Brazil.

*Corresponding author: Paulina Elizabeth Durán Mora.
Durán Hospital, Pasteur and César Borja Avenue,
Ambato, Ecuador.
E-mail: pduran41@outlook.es
DOI: https://doi.org/10.54448/mdnt26105
Received: 11-28-2025; Revised: 02-02-2026; Accepted: 02-10-2026; Published: 02-12-2026; MedNEXT-id: e26105
Editor: Dr. Idiberto José Zotarelli-Filho, MSc, Ph.D., Post-Doctoral.

Abstract

Introduction: The development of computer-aided diagnostic solutions based on Artificial Intelligence (AI) has enabled the diagnosis of skin cancer. **Objective:** To discuss advances in dermatoscopic and AI-based digital image solutions for the diagnosis of skin cancer, along with some future challenges and opportunities to improve these AI systems, in order to support dermatologists and increase their ability to diagnose skin cancer. **Methods:** The systematic review guidelines of the PRISMA Platform were followed. The search was conducted from September to October 2025 in the Web of Science, Scopus, PubMed, Science Direct, SciELO, and Google Scholar databases. The quality of the studies was based on the GRADE and AMSTAR-2 instruments, and the risk of bias was adequately analyzed according to the Cochrane instrument. **Results and Conclusion:** 87 articles were found. A total of 18 articles were qualitatively evaluated, and 13 were included and developed in this systematic review study. Considering the Cochrane tool for risk of bias, the overall assessment resulted in 5 studies with a high risk of bias and 50 studies that did not meet the GRADE and AMSTAR-2 criteria. It was concluded that accumulating evidence suggests that computer-aided diagnostic systems can offer their greatest benefit as assistive systems, as studies indicate that the combination of humans and machines achieves the best results. Artificial intelligence-based diagnostic systems are capable of detecting morphological characteristics quickly, quantitatively, objectively, and reproducibly, thus providing a more objective analytical basis to complement medical expertise.

Keywords: Skin. Cancer. Diagnosis. Artificial Intelligence. Dermatoscopy.

Introduction

The development of computer-assisted diagnostic solutions based on Artificial Intelligence (AI) has enabled the diagnosis of skin cancer. With the increasing incidence of skin cancer, the low level of awareness among a growing population, and the lack of clinical expertise and adequate services, there is an immediate need for AI systems to assist physicians in this area. A large number of skin lesion datasets are publicly available, and researchers have been developing AI solutions, particularly deep learning algorithms, to distinguish between malignant and benign skin lesions in various imaging modalities, including dermatoscopic, clinical, and histopathological images [1,2].

Despite various claims that AI systems achieve greater accuracy than dermatologists in classifying different skin lesions, these systems are still in the early stages of clinical application, with regard to their ability to assist physicians in diagnosing skin cancer [2].

One of the most lethal skin diseases is melanoma. The great similarity between different skin lesions, such as melanoma and nevus, in colored skin images increases the complexity of identification and diagnosis. An automated and efficient system for early detection of skin cancer is crucial for saving lives, time, and effort. First, dermatoscopic images of the skin are obtained and subjected to a pre-processing step to remove noise and a post-processing step to enhance the image. Then, the processed image undergoes segmentation using algorithms. Features are selected based on Harris-Hawks optimization (HHO). Several classifiers are used to predict stages and evaluate the efficiency of the proposed system [3].

In this sense, if melanoma detection is performed early, melanoma is highly treatable. Early detection of skin cancer has improved significantly in recent decades, for example, with the introduction of screening in 2008 and dermatoscopy. However, visual detection of early-stage melanomas remains a challenge, as they exhibit many morphological overlaps with nevi. Therefore, there remains a great medical need to develop methods for early detection of skin cancer in order to reliably diagnose melanomas at a very early stage. Routine diagnosis for melanoma detection includes visual inspection of the entire body, often complemented by dermatoscopy, which can significantly increase the diagnostic accuracy of experienced dermatologists [4].

Dermatoscopy (or dermoscopy) has been found to assist physicians in detecting cancer, providing greater accuracy. Computer-aided design (CAD) systems use computerized images of malignancy to diagnose melanoma and its stages. For rapid and accurate cancer treatment, CAD technologies recognize signs of the disease in a lesion. Due to the nature of this procedure, it is possible to remove a skin lesion down to the subcutaneous fat [5].

Based on this context, the present study aimed to discuss advances in dermatoscopic and AI solutions based on digital images for the diagnosis of skin cancer, along with some future challenges and opportunities to enhance these AI systems, in order to support dermatologists and increase their ability to diagnose skin cancer.

Methods

Study Design

This study followed the international model for systematic review, following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) guidelines. Available at: http://www.prisma-tatement.org/?AspxAutoDetectCookieSupport=1. Accessed on: 11/20/2025. The AMSTAR-2 (Assessment of the Methodological Quality of Systematic Reviews) methodological quality standards were also followed. Available at: https://amstar.ca/. Accessed on: 11/20/2025.

Data Sources and Research Strategy

The literature search process was conducted from September to October 2025 and was developed based on Web of Science, Scopus, Embase, PubMed, Science Direct, Scielo, and Google Scholar, using classic articles up to 2025, using the descriptors (Health Sciences Descriptors – DeCS/MeSH Terms): *"Skin. Cancer. Diagnosis. Artificial Intelligence. Dermatoscopy"*, and using the Boolean operators "and" between the descriptors (MeSH Terms) and "or" between the historical findings.

Study Quality and Risk of Bias

The quality of the studies was based on the GRADE instrument, with randomized controlled clinical trials, prospective controlled clinical trials, and systematic review and meta-analysis studies listed as the studies with the strongest scientific evidence. The risk of bias was analyzed according to the Cochrane instrument. The methodological quality of each study was interpreted according to the AMSTAR-2 instrument.

Results and Discussion

Summary of Literature Findings

87 articles were found. Initially, duplicate articles were excluded. After this process, the abstracts were evaluated, and a further exclusion was carried out, removing articles that did not include the theme of this article, resulting in 23 articles. A total of 18 articles were qualitatively evaluated, and 13 were included and developed in this systematic review study (Figure 1). Considering the Cochrane tool for risk of bias, the overall assessment resulted in 5 studies with a high risk of bias and 50 studies that did not meet the GRADE and AMSTAR-2 criteria.

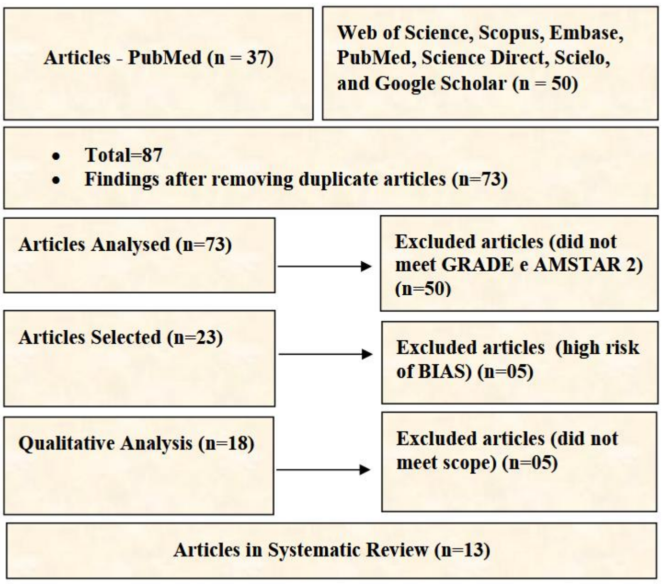

Figure 1. Flowchart and eligibility of studies. Source: Own Authorship.

Major Clinical Results

The incidence of malignant melanoma has increased exponentially in recent decades. The combination of whole-body photography (WBC) and digital dermatoscopy (DD) has improved the early detection of melanoma in previous studies. In addition, the use of artificial intelligence (AI) can enhance the diagnostic accuracy of dermatologists. The authors Hobelsberger et al. (2025) [6] evaluated the applications of AI in WBC, DD, and high-resolution dermatoscopy in clinical practice. The use of AI can improve the diagnostic accuracy of WBC, DD, and high-resolution dermatoscopy. As most studies to date have been conducted in an artificial environment, more research is needed to assess the potential use of AI in the clinical context.

The authors Federico et al. (2025) [7] provided a comprehensive overview of how conventional and emerging diagnostic tools can be integrated into dermatological practice. A broad spectrum of diagnostic methods currently used in dermatology was examined, ranging from traditional techniques to advanced approaches such as digital dermatoscopy, reflectance confocal microscopy (RCM), optical coherence tomography (OCT), linear-field confocal OCT (LC-OCT), 3D whole-body imaging systems with AI integration, mobile applications, electrical impedance spectroscopy (EIS), and multispectral imaging. While traditional methods continue to play a crucial role, especially in resource-limited settings or for immediate bedside decision-making, modern tools significantly enhance diagnostic accuracy. Dermatoscopy and its digital evolution have improved accuracy in detecting melanoma and basal cell carcinoma. Reflectance confocal microscopy (RCM) and liquid crystal optical coherence tomography (LC-OCT) allow for near-histological visualization of skin structures, reducing the need for invasive procedures. AI-based platforms assist in lesion tracking and risk stratification, although their routine implementation requires greater clinical validation and regulatory oversight. Tools such as electrochemical impedance spectroscopy and multispectral imaging can offer additional value in complex diagnostic cases.

The authors Ruga et al. (2026) [8] presented MultiExCam, a novel multifaceted approach and explainable architecture for skin cancer detection that integrates machine learning and deep learning. Three heterogeneous datasets, from three different techniques, are used: dermatoscopic images, features extracted through deep learning techniques, and manually defined statistical features. MultiExCam demonstrates robust performance on three diverse datasets (HAM10000, ISIC, MED-NODE), achieving AUC scores of 97%, 91%, and 98%, respectively, with corresponding F1 scores of 92%, 87%, and 94%. Comprehensive ablation studies validate the importance of the preprocessing pipeline and ensemble integration, with the hybrid approach consistently outperforming benchmark deep learning models by 1 to 3 percentage points. Unlike existing compartmentalized hybrid solutions, the adaptive architecture of the MultiExCam ensemble learns customized decision strategies for individual lesions, mimicking specialized dermatological workflows that integrate multiple sources of evidence. Explainability analysis reveals clinically significant activation patterns corresponding to established diagnostic criteria, including asymmetry, border irregularity, and color variation. The architecture's ability to provide accurate classifications while explaining the prediction logic meets critical requirements for the adoption of medical AI, offering a promising foundation for clinical decision support systems in melanoma detection.

Preprocessing skin cancer images is a crucial, yet complex, challenge in the development of highly effective computerized diagnostic systems. The presence of fine lines and low image quality in skin represents a substantial challenge in the precise definition of features for automated cancer classification. Thus, the authors Khattar et al. (2025) [9] proposed a new hybrid technique, employing a fusion of Intensity Anisotropic Hair Removal (AI-HR), a Gaussian Filter, and a deep learning-based residual convolutional neural network to improve the quality of dermatoscopic images and thus perform correct diagnostic tasks. Experimental results revealed that the proposed technique successfully removes hair and noise from dermatoscopic images, resulting in better visibility of details in terms of different evaluation metrics. Furthermore, investigations were carried out to observe how the proposed preprocessing techniques help improve the segmentation and classification performance for the diagnosis of skin cancer images. Experimental results revealed an improvement in segmentation and classification results with the use of the proposed hybrid preprocessing technique. Moreover, the recommended method outperforms the most advanced preprocessing techniques in the area of skin cancer diagnosis, as demonstrated by the results of investigations carried out on the HAM10000 dataset. The results revealed that the methodology was superior in both subjective and objective assessments and has the potential to be implemented in real-time clinical settings.

The authors Lindsay et al. (2025) [10] compared the costs and health effects of whole-body three-dimensional (3D) photography (TDP) and sequential digital dermatoscopy (SDDI) versus standard care for the early detection of melanoma. This pre-specified cost-effectiveness analysis, using data from a randomized clinical trial (n = 309) with 2 years of follow-up, was conducted at a research hospital in Brisbane, Australia, and adopted a health system perspective. It included adults aged 18 years or older at high risk of developing primary or subsequent melanoma. The intervention group received standard care, in addition to clinical skin examinations performed by resident physicians at baseline and at 6, 12, 18, and 24 months, with review of 3D TDP -SDDI images by a teledermatologist. The control group continued to receive standard care and answered online questionnaires every 6 months. Public health costs, costs paid directly by patients, the number of excisions of benign and malignant skin tumors, and quality-adjusted life years (QALYs) were collected. Skin biopsies, excisions, histopathological analyses, and their respective costs were collected using administrative data from health plans. Quality of life was assessed using the EuroQol-5D-5L questionnaire. The study included 314 participants (mean age [SD], 51.6 [12.8] years; 194 women [62%]) who completed all study procedures (158 in the intervention group and 156 in the control group). Compared to the control group, participants in the intervention group had fewer melanoma excisions, more keratinocyte carcinomas and benign excisions, and more biopsies. Over 24 months, the average costs per person (analyzed in Australian dollars and converted to US dollars) for the intervention group were $1708 (95% CI, $1455-$1961) versus $763 (95% CI, $655-$870) for the control group, representing an incremental cost of $945 (95% CI, $738-$1157) for implementing the intervention. Total quality-adjusted life years (QALYs) per person were similar for the intervention (1.84; 95% CI, 1.82-1.86) and control (1.84; 95% CI, 1.83-1.86) groups.

The authors Fischman et al. (2025) [11] conducted a multicenter, retrospective study on AI diagnosis of basal cell carcinoma (BCC). Traditional methods, which use clinical and dermatoscopic imaging, often rely on biopsies and histology for final validation. Non-invasive techniques, such as liquid crystal optical coherence tomography (LC-OCT), which allow for "digital biopsies," are promising alternatives, but are still underutilized due to the expertise required. The development of Artificial Intelligence (AI) algorithms is a promising approach to assist dermatologists in diagnosis and support the wider adoption of these technologies. Thus, these authors presented a real-time AI assistant for BCC diagnosis with LC-OCT, which is, to date, the only real-time AI model encompassing all dermatological imaging modalities. This study aimed to quantify the effectiveness of the model when used by dermatologists with different levels of experience and to compare its performance with traditional methods and unassisted LC-OCT. A total of 43 dermatologists answered a two-round questionnaire about 200 BCC lesions with doubtful diagnoses. Diagnoses were initially made based on biopsy and dissection (B&D) images and then randomized using single-layer optical coherence tomography (LC-OCT) or AI-assisted LC-OCT. AI-assisted LC-OCT significantly improved dermatologists' diagnostic performance in detecting BCC (a 25.8-point increase in sensitivity and a 16.8-point increase in specificity compared to biopsy and dissection), particularly benefiting those with less LC-OCT experience, effectively bridging a two-year experience gap. These results highlight the potential for wider clinical adoption through AI assistance and reinforce its promise in reducing the need for invasive procedures and improving patient outcomes.

It was also observed that the authors Menzies et al. (2023) [12] tested in clinical practice whether there is equivalence between AI algorithms and physicians for the diagnosis and treatment of pigmented skin lesions. These authors developed a multicenter, prospective, diagnostic clinical trial, including specialist and non-specialist physicians, as well as patients, from two tertiary referral centers in Australia and Austria. Eligible patients were between 18 and 99 years old and had a modified Fitzpatrick skin phototype I-III; those in the diagnostic trial were undergoing routine excision or biopsy of one or more suspicious pigmented lesions with a diameter greater than 3 mm, and those in the treatment trial had full-body photographs obtained between 1 and 4 years before diagnosis. Two AI tools for mobile devices were used, with a simple optical accessory: a novel 7-class AI algorithm and the AI algorithm from the International Skin Imaging Collaboration (ISIC), previously tested in a large study with online readers. The gold standard for excised lesions in the diagnostic trial was histopathological examination; in the clinical management trial, the gold standard was a descending hierarchy based on histopathological examination, comparison of baseline whole-body photographs, digital monitoring, and telediagnosis. Thus, the accuracy of diagnostic and management decisions by experts and laypersons was compared using the two AI tools. The possible decisions in the clinical management trial were hospital discharge, biopsy, or monitoring for 3 months. Monitoring decisions were considered equivalent to hospital discharge (scenario A) or biopsy of malignant lesions (scenario B). The diagnostic study included 172 suspicious pigmented lesions (84 malignant) from 124 patients, and the management study included 5696 pigmented lesions (18 malignant) from the whole body in 66 high-risk patients. Diagnoses from the 7-class AI algorithm were equivalent to expert diagnoses (absolute accuracy difference of 1.2% [95% CI -6.9 to 9.2]) and significantly superior to novice diagnoses (21.5% [13.1 to 30.0]). Diagnoses from the ISIC AI algorithm were significantly inferior to expert diagnoses (-11.6% [-20.3 to -3.0]), but significantly superior to novice diagnoses (8.7% [-0.5 to 18.0]). An AI algorithm that proved superior in experimental studies was significantly inferior to expert diagnoses in a real-world setting, suggesting that caution is needed when extrapolating results from experimental studies to clinical practice.

Finally, a systematic review study summarized the current evidence on Whole-body photography for the early detection of melanoma. A total of 14 studies published between 1997 and 2020, with a total sample size of n = 12,082 (range 100 to 4,692), were included in the qualitative analysis. Individuals undergoing transbronchial biopsy (TBB) showed a trend toward lower Breslow thickness and a higher proportion of melanomas in situ compared to those without TBB. The number needed to excise a melanoma ranged from 3:1 to 14.3:1 and was better for newly emerging lesions than for those previously screened. The included studies were considered to have methodologically uncertain concerns, with specific deficiencies in the domains of "flow and timing" and "reference standard". The use of TBB may improve the early detection of melanoma in high-risk populations. Future studies are needed to reduce heterogeneity in the definition of phenotypic risk factors and in the technical implementation of TBB. Image analysis derived from 3D TBB systems and digital dermatoscopy, assisted by artificial intelligence, can further enhance the early detection of melanoma [13].

Limitations

Visual detection of early-stage melanomas remains a challenge, as they exhibit many morphological overlaps with nevi. There remains a great medical need to develop methods for early detection of skin cancer to reliably diagnose melanomas at a very early stage. More randomized clinical trials are needed.

Conclusion

It was concluded that evidence is accumulating that computer-aided diagnostic systems can offer their greatest benefit as assistive systems, since studies indicate that the combination of humans and machines achieves the best results. Artificial intelligence-based diagnostic systems are capable of detecting morphological characteristics quickly, quantitatively, objectively, and reproducibly, thus providing a more objective analytical basis to complement medical expertise.

CRediT

Author contributions: **Conceptualization-** Paulina Elizabeth Durán Mora, Joffre Ivan Ponce Baque, Miriam Maria Delbem Bellon; **Investigation-** Paulina Elizabeth Durán Mora, Joffre Ivan Ponce Baque; **Methodology-** Paulina Elizabeth Durán Mora, Joffre Ivan Ponce Baque; **Project administration-** Paulina Elizabeth Durán Mora; Supervision- Miriam Maria Delbem Bellon; **Writing - original draft-** Paulina Elizabeth Durán Mora, Joffre Ivan Ponce Baque, Miriam Maria Delbem Bellon; **Writing-review & editing-** Paulina Elizabeth Durán Mora, Joffre Ivan Ponce Baque, Miriam Maria Delbem Bellon.

Acknowledgment

Not applicable.

Ethical Approval

Not applicable.

Informed Consent

Not applicable.

Funding

Not applicable.

Data Sharing Statement

No additional data are available.

Conflict of Interest

The authors declare no conflict of interest.

Similarity Check

It was applied by Ithenticate@.

Application of Artificial Intelligence (AI)

Not applicable.

Peer Review Process

It was performed.

About The License©

References

1. Ragab M, Choudhry H, Al-Rabia MW, Binyamin SS, Aldarmahi AA, Mansour RF. Early and accurate detection of melanoma skin cancer using hybrid level set approach. Front Physiol. 2022 Dec 5;13:965630. doi: 10.3389/fphys.2022.965630.
2. Goyal M, Knackstedt T, Yan S, Hassanpour S. Artificial intelligence-based image classification methods for diagnosis of skin cancer: Challenges and opportunities. Comput Biol Med. 2020 Dec;127:104065. doi: 10.1016/j.compbiomed.2020.104065.
3. Arif M, Philip FM, Ajesh F, Izdrui D, Craciun MD, Geman O. Automated Detection of Nonmelanoma Skin Cancer Based on Deep Convolutional Neural Network. J Healthc Eng. 2022 Feb 10;2022:6952304. doi: 10.1155/2022/6952304. Retraction in: J Healthc Eng. 2023 Oct 11;2023:9836063. doi: 10.1155/2023/9836063.
4. Jutzi T, Krieghoff-Henning EI, Brinker TJ. Künstliche Intelligenz auf dem Vormarsch – Hohe Vorhersage-Genauigkeit bei der Früherkennung pigmentierter Melanome [The Rise of Artificial Intelligence - High Prediction Accuracy in Early Detection of Pigmented Melanoma]. Laryngorhinootologie. 2023 Jul;102(7):496-503. German. doi: 10.1055/a-1949-3639.
5. Ragab M, Choudhry H, Al-Rabia MW, Binyamin SS, Aldarmahi AA, Mansour RF. Early and accurate detection of melanoma skin cancer using hybrid level set approach. Front Physiol. 2022 Dec 5;13:965630. doi: 10.3389/fphys.2022.965630.
6. Hobelsberger S, Seitz AT. Künstliche Intelligenz-Einsätze in der Ganzkörperfotografie, Videodermatoskopie und High-resolution-Dermatoskopie [Artificial intelligence in total body photography, digital dermoscopy and high-resolution dermoscopy]. Dermatologie (Heidelb). 2025 Nov;76(11):677-682. German. doi: 10.1007/s00105-025-05570-5.
7. Federico S, Cassalia F, Mazza M, Del Fiore P, Ferrera N, Malvehy J, Trilli I, Rivas AC, Cazzato G, Ingravallo G, Ardigò M, Piscazzi F. Advancements in Diagnosis of Neoplastic and Inflammatory Skin Diseases: Old and Emerging Approaches. Diagnostics (Basel). 2025 Aug 20;15(16):2100. doi: 10.3390/diagnostics15162100.
8. Ruga T, Caroprese L, Vocaturo E, Zumpano E. MultiExCam: A multi approach and explainable artificial intelligence architecture for skin lesion classification. Comput Methods Programs Biomed. 2026 Jan;273:109081. doi: 10.1016/j.cmpb.2025.109081.
9. Khattar S, Kaur R, Kumar A. DeepHybrid-CNN: A hybrid approach for pre-processing of skin cancer images. Comput Med Imaging Graph. 2025 Sep;124:102611. doi: 10.1016/j.compmedimag.2025.102611.
10. Lindsay D, Soyer HP, Janda M, Whiteman DC, Osborne S, Finnane A, Caffery LJ, Collins LG. Cost-Effectiveness Analysis of 3D Total-Body Photography for People at High Risk of Melanoma. JAMA Dermatol. 2025 May 1;161(5):482-489. doi: 10.1001/jamadermatol.2025.0219.
11. Fischman S, Viel T, Perrot JL, Pérez-Anker J, Suppa M, Cinotti E, Lenoir C, Orte Cano C, Welzel J, Schuh S, Sattler EC, Del Marmol V, Rubegni P, Dragotto M, Cioppa V, Falcinelli F, Cappilli S, Challe S, Tavernier C, Malvehy J, Tognetti L; LC-OCT Reviewers Consortium. AI-assisted basal cell carcinoma diagnosis with LC-OCT: A multicentric retrospective study. J Eur Acad Dermatol Venereol. 2025 Oct 19. doi: 10.1111/jdv.70099.
12. Menzies SW, Sinz C, Menzies M, Lo SN, Yolland W, Lingohr J, Razmara M, Tschandl P, Guitera P, Scolyer RA, Boltz F, Borik-Heil L, Herbert Chan H, Chromy D, Coker DJ, Collgros H, Eghtedari M, Corral Forteza M, Forward E, Gallo B, Geisler S, Gibson M, Hampel A, Ho G, Junez L, Kienzl P, Martin A, Moloney FJ, Regio Pereira A, Ressler JM, Richter S, Silic K, Silly T, Skoll M, Tittes J, Weber P, Weninger W, Weiss D, Woo-Sampson P, Zilberg C, Kittler H. Comparison of humans versus mobile phone-powered artificial intelligence for the diagnosis and management of pigmented skin cancer in secondary care: a multicentre, prospective, diagnostic, clinical trial. Lancet Digit Health. 2023 Oct;5(10):e679-e691. doi: 10.1016/S2589-7500(23)00130-9.
13. Hornung A, Steeb T, Wessely A, Brinker TJ, Breakell T, Erdmann M, Berking C, Heppt MV. The Value of Total Body Photography for the Early Detection of Melanoma: A Systematic Review. Int J Environ Res Public Health. 2021 Feb 10;18(4):1726. doi: 10.3390/ijerph18041726.

MetaScience Press
The Best Science
https://zotarellifilhoscientificworks.com/