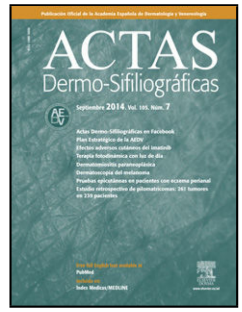
Journal Pre-proof




# Melanoma diagnosis with 3D total-body photography

A. Ferreirinha V. Farricha AL João

PII: S0001-7310(25)00105-X
DOI: https://doi.org/doi:10.1016/j.ad.2024.09.030
Reference: AD 4275

To appear in: *Actas dermosifiliograficas*

Received Date: 11 March 2024
Accepted Date: 1 September 2024

Please cite this article as: Ferreirinha A, Farricha V, João A, Melanoma diagnosis with 3D total-body photography, *Actas dermosifiliograficas* (2025), doi: https://doi.org/10.1016/j.ad.2024.09.030

**Sección: Novedades en Dermatología**

# Melanoma diagnosis with 3D total-body photography

Diagnóstico de melanoma con fotografía corporal total en 3D

**A Ferreirinha[1] , V. Farricha [2] , AL João[1]**

**Affiliations:**

[1]Dermatology and Venereology Department, Hospital de Santo António dos Capuchos, Centro Hospitalar Universitário de Lisboa Central, Alameda Santo António dos Capuchos, 1169-050, Lisbon, Portugal
[2] General Surgery Department, Instituto Português de Oncologia de Lisboa, Rua Prof. Lima Basto, 1099-023 Lisbon, Portugal

**corresponding author:**
Ana Ferreirinha (A Ferreirinha)
**E-mail:** anafcferreirinha@gmail.com

## Abstract

Skin cancer is a growing global health challenge, emphasizing the need for early detection. In recent years, 3D total-body photography has emerged as a promising tool in dermatology. This non-invasive imaging technique provides a comprehensive visual representation of a patient's skin, enabling the early detection of suspicious lesions and the surveillance of existing nevi. Despite its promising role in early melanoma detection, ongoing research is essential to validate its real-world impact and address its current limitations. Although it enhances diagnostic accuracy, this technique currently does not replace the need for a thorough examination by a dermatologist. This review provides a comprehensive overview of the most recent findings on the application of 3D total-body photography in melanoma diagnosis.

**Key words:** melanoma, 3-dimensional total-body photography, skin cancer diagnosis, total-body photography, Imágenes 3D

## Diagnóstico de melanoma con fotografía corporal total en 3D

¿Están siendo sustituidos los dermatólogos?

## Resumen

El cáncer de piel es un reto sanitario mundial cada vez mayor, que pone de relieve la necesidad de una detección precoz. En los últimos años, la fotografía 3D de cuerpo entero se ha revelado como una herramienta prometedora en dermatología. Esta técnica de imagen no invasiva proporciona una representación visual completa de la piel de un paciente, lo que permite la detección precoz de lesiones sospechosas y la vigilancia de los nevos existentes. A pesar de su prometedor papel en la detección precoz del melanoma, la investigación en curso es esencial para validar su impacto en el mundo real y abordar sus limitaciones actuales. Aunque mejora la precisión diagnóstica, esta técnica no sustituye actualmente la necesidad de un examen exhaustivo por parte de un dermatólogo. Esta revisión ofrece una visión general de los hallazgos más recientes sobre la aplicación de la fotografía 3D de cuerpo entero en el diagnóstico del melanoma.

**Palabras clave:** melanoma, fotografía corporal total tridimensional, diagnóstico del cáncer de piel, fotografía corporal total, imagen en 3D

## Introduction

Skin cancer rates have raised over 600% among fair-skinned populations from 1940 to 2010, posing a significant public health challenge.[1,2] The most common skin cancers are squamous cell carcinoma, basal cell carcinoma, and melanoma, with melanoma being the deadliest despite accounting for only 2% of cases.[1] Early detection through regular screening and surveillance is crucial, markedly improving survival rates and reducing healthcare costs.[3] Various diagnostic methods exist, with European[4], NICE[5] and SIGN[6] guidelines emphasizing a comprehensive full-body visual examination for melanoma diagnosis. Clinical diagnosis by dermatologists has a sensitivity of approximately 70%,[4] augmented by dermoscopy,[4,5,6] achieving a 89% sensitivity and 79% specificity.[4] Dermoscopy aids in early cancer detection and reduces unnecessary biopsies,[2,7] though its efficacy varies with clinician expertise and can be time-consuming,[2] particularly with numerous nevi,[8,9] making the detection of new lesions nearly impossible. European guidelines advocate for total-body photography (TBP) with sequential digital dermoscopy (DD), enhancing detection in high-risk populations.[4] In response to this pressing health concern, new technologies have been developed to obtain a more precise and early diagnosis. Familiarity with these new non-invasive tools is crucial for healthcare providers managing skin cancer. In this review, we examine the latest research on three-dimensional total-body photography (3D-TBP), exploring its advantages and acknowledging its inherent limitations, in the quest for improved early detection and effective management of skin cancer.

## Methods

The search was conducted on october 10, 2023, using the PubMed database. The search terms employed in PubMed were "3D total-body photography". Inclusion criteria consisted of (1) papers published within the timeframe of 2010-2023 and (2) original and review papers that provided insights into 3D total-body photography, encompassing examples, novel evidence, its practical applications, and emerging protocols. Exclusion criteria encompassed (1) articles in languages other than English, Spanish or Portuguese and (2) unpublished data or conference papers/lectures. Following the application of automated filters for publication date and language, 45 articles emerged from the initial search results. Subsequently, a meticulous examination of the abstracts yielded 21 articles that conformed to the stipulated criteria. To augment the discussion of specific themes, supplementary references were handpicked through the same PubMed database, amounting to 5 additional sources. The review incorporates a total of 26 references.

**Total-Body photography**

Digital photography, a cornerstone in medicine since 1845, plays a pivotal role in dermatology, serving as a tool for documentation, monitoring, and education.[2] TBP offers a unique advantage by surveilling the entire skin surface, unlike the conventional focus on individual lesions.[7] This holistic approach enables the detection of changes in pre-existing lesions missed in initial clinical/dermoscopic exams, and consequently not captured in DD.[7] TBP also excels in identifying newly emerging lesions, critical as one-third of high-risk melanomas were linked to lesions not monitored by DD.[3,7] Recommended for screening high-risk individuals, TBP plus dermoscopy enhances diagnostic accuracy and reduces unnecessary biopsies.[3] Hornung et al.'s systematic review, encompassing 14 studies with 12,082 participants, demonstrated TBP users exhibited thinner Breslow's thickness and higher rates of in situ melanoma compared to non-users.[10] TBP employs visual light imaging and can be implemented in both two-dimensional (2D) and three-dimensional (3D) formats.

2D-TBP utilizes a single camera mounted on a frame, necessitating multiple scans to cover the entire skin surface. While cost-effective and beneficial for high-risk melanoma patients compared to standard care, it has drawbacks.[11] Capturing multiple images from various angles can be challenging, especially in patients with limited mobility, potentially resulting in overlaps or missed nevi.[12] Additionally, the process is time-consuming, taking nearly an hour per patient and requiring significant resources.[3,9,13]

3D-TBP is an innovative approach in skin cancer screening, aiming to overcome traditional TBP limitations.[3,14] Developed since 2015,[3,10] this system employs a rotating body-scanning platform with 92 high-resolution cameras and depth scanners to capture a full-body image in just one to five seconds.[1] Subsequently, it takes ten minutes to generate a detailed digital avatar and 3D-body map,[15] offering a 360-degree view of nearly the entire skin surface, excluding specific areas such as clothed regions, the hairy scalp, spaces between fingers and toes, the soles of the feet, scars, and tattoos.[16,17] This method greatly enhances the representation of curved surfaces.[16,17] Integrated software enables precise association of dermoscopic and clinical images with their exact locations on the 3D avatar, facilitating the detection of new lesions and monitoring changes over time.[3, 6,10,12,13,14] Moreover, 3D-TBP aggregates similar nevi within an individual into a "skin ecosystem," alerting healthcare providers for the presence of different pattern lesions, a phenomenon commonly known as "ugly duckling sign”.[16] This technology also enhances the evaluation of raised lesions by allowing examination from multiple angles and minimizing artifacts, as it does not apply pressure to the skin, a common issue in longitudinal dermoscopy imaging. [16](Material suplementario)

**Results**

Only a few clinical trials using 3D-TBP have been conducted, indicating a need for ongoing research to fully establish its effectiveness across diverse clinical settings. However, preliminary findings and case studies suggest potential benefits, such as the ability to detect and monitor skin nevi and provide a comprehensive view of the skin surface.(Table 1)

In a single-center, retrospective, observational study conducted by Marchetti et al., patients underwent 3D-TBP within 90 days of a diagnostic melanoma skin biopsy.[18] Out of 35 patients, 23,538 skin lesions larger than 2 mm were identified, including 49 melanomas and 22489 non-melanomas. The prediction model's area under the curve was determined to be 0.94 (95% confidence interval of 0.92-0.96). When analyzing all lesions, it was observed that melanoma lesions either had the highest predicted score or ranked in the 99th percentile among all lesions for individual patients. This suggests that the 3D-TBP’s automated analysis, can effectively differentiate melanoma from other skin lesions with a high degree of accuracy.[18] This study is subject to several limitations. Firstly, the dataset was a small convenience sample obtained from a single hospital-based center, potentially limiting generalizability. There is an over-representation of individuals at higher risk of melanoma, and 3D-images from patients without a melanoma diagnosis were not included. External validation and independent dataset verification were lacking. Lastly, it is conceivable that some lesions categorized as non-melanoma in this study could, in fact, be melanomas not yet clinically recognized.[18]

Soyer et al. conducted a 3-year prospective, cohort study involving 193 participants who underwent 3D-TBP every six months for three years.[8] Among the identified lesions, 250 were marked as concerning, leading to the excision or biopsy of 138 of these lesions. Histopathological examination revealed 39 non-melanoma skin cancers and six melanomas, all of which were *in situ*. Conversely, 96 lesions were excised out of the study, with 33 revealing to be non-melanoma skin cancers. The Number Needed to Excise (NNE) was calculated as 3.0 to 1.0 (NNE 3).[8] Limitations include potential participant recruitment bias towards those interested in skin cancer screening despite a population-based approach. The 96 lesions excised out of the study should be considered as missed lesions, no specific reason for this discrepancy was identified, except that all those participants had severely photodamage, and lesions may have evolved or become more apparent between study visits. Although the study achieved 85% retention over three years, some participants were lost to follow-up.[8]

Betz-Stablein et al. concluded that it was feasible to achieve automated nevus counts, using 3D-TBP and convolutional neural networks (CNNs), with a level of agreement reasonably close to that of an expert clinician. Their study demonstrated that for lesions two millimeters or larger, the CNNs and 3D-TBP combination had a sensitivity of 79% and a specificity of 91% when compared to the gold standard provided by an expert clinician. For larger lesions (five millimeters or more), sensitivity and specificity were 84% and 91%, respectively.[17] Nonetheless, the algorithm performed poorly in people with many seborrheic keratoses, overcounting them as nevi.  Limitations included the small participant size, even if the corresponding number of test lesions was large, falling to evaluate the algorithm in different subject characteristics such as level of photodamage, Fitzpatrick skin type or gender.[17]

In a study evaluating the diagnostic performance of a phone app, dermatologists with and without the help of artificial intelligence (AI) used both 2D and 3D-TBP, and a total of 114 participants were examined, with 1204 skin lesions assessed.[19] Among these, 3D-TBP identified 39 lesions as suspicious, while dermatologists identified 9. When both methods were combined, they collectively flagged 12 lesions. Of the 61 lesions that underwent histopathological examination, 6 confirmed to be melanomas. The sensitivity of the 3D-TBP system for detecting histologically confirmed melanoma was 83%, with a specificity of 63.3%. While, dermatologists exhibited a sensitivity of 83% and a higher specificity of 92%. At the conclusion of the study, most participants reported to prefer to undergo screening conducted by dermatologists in conjunction with 3D-TBP.[19]

Cerminara et al. underscored the significance of real-world validation of AI algorithms and the potential of 3D-TBP with CNN in detecting melanoma. Their findings revealed that 3D-CNN device surpassed the performance of 2D-CNN in classifying melanocytic lesions and ensuring result reproducibility. Notably, the 3D-CNN demonstrated practical utility by achieving sensitivity levels comparable to dermatologists.[20]

Regarding published clinical cases, we found three examples.
Grochulska et al. investigated the potential of 3D-TBP in enhancing sequential dermoscopy imaging and, in some cases, supporting or even replacing clinical assessments.[14] The study focused on three specific skin lesions, which were selected intentionally for educational purposes and to showcase the experience of integrating 3D-imaging into clinical practice. The results of the study indicated that 3D-TBP offers the capability to detect new skin lesions and contributes to providing a contextual understanding of individual lesion dermoscopy images.[14]

Erdmann et al. introduced sequential 3D-TBP, for a melanoma patient with widespread skin metastases undergoing treatment with immune checkpoint antibodies, followed by

BRAF/MEK inhibition.[21] The sequential 3D-TBP provided a visual record of the changes in this case. Immunotherapy resulted in the progression of epidermotropic metastases, whereas subsequent BRAF/MEK inhibition revealed a regression of these lesions. This approach offered valuable insights into the patient's treatment response, demonstrating the potential of 3D-TBP in therapeutic monitoring.[21]

Wallingford et al. highlighted the significance of 3D-TBP in lesion localization in their case study.[22] They focused on a patient harboring a homozygous MITF E318K mutation, who had been diagnosed with six primary melanomas. The main goal was to leverage 3D-TBP to highlight genotype-phenotype correlations. In this specific case, they discovered melanoma sites in areas with mild or no sun damage, and observed a high number of large and atypical nevi in regions with minimal sun damage. This observation led to the conclusion that, in this particular case, there was no apparent correlation between melanoma development or nevus density and the severity of sun damage.[22]

Ongoing research in this field is actively being pursued.[3,23] Currently, ACEMID (Australian Cancer of the Skin and Melanoma Image Database) is conducting a prospective cohort study involving 15,000 participants across Australia. This study utilizes 3D-TBP for melanoma imaging and diagnosis, aiming to collect comprehensive data on personal information, immunological profiles, genetics, and clinical risk factors, to develop and validate protocols for melanoma detection.[24]

Regarding patient opinion, we found three examples.
A 3-year prospective cohort study involving adults aged 20-70 evaluated participants' experiences with 3D-TBP for nevi surveillance.[13] Participants underwent biannual skin examinations by a clinician and 3D-TBP with dermoscopy.[13] Of the 149 participants surveyed at 18- and 36-months, a majority (69.1% at 18-months, 69.8% at 36-months) expressed trust in the imaging process. Most participants reported being very comfortable or comfortable with the technology (92.6% at 18-months, 94% at 36-months) and almost all participants were willing to pay for this service, with few expressing unwillingness (6.7%).[13] Participants valued 3D-TBP for providing an accurate baseline and tracking skin changes over time.[13] Some participants concerns included the technology's ability to detect suspicious lesions, digital privacy, cost, and travel requirements. Some participants (13,4%) expressed discomfort with being in their underwear and feeling exposed during the imaging process. Despite these issues, nearly all participants expressed interest in using 3D-TBP if it became commercially available.[13] Overall, participants demonstrated a high level of engagement, as they wanted to discuss the images with their doctors, underscoring the importance placed on the doctor-patient relationship.

Similarly, a cross-sectional survey was conducted, targeting 1056 adults living in both metropolitan and rural areas of Australia, assessing their perceptions regarding 3D-TBP. An overwhelming majority (95%) indicated that they would be willing to consider using 3D-TBP if it were to become commercially available. Furthermore, most participants

(94%) expressed confidence in the technology's effectiveness for identifying suspicious skin lesions, and 90% perceiving it as a mean to reduce skin cancer-related anxiety.[25] However, 84% identified potential barriers, such as concerns about cost, accessibility, technology confidence and digital security. [25]

Another study involving 39 participants within a virtual consumer forum, observed that as the potential sensitivity of images increased, a growing number of participants expressed concerns about sharing such data. Participants were increasingly reluctant to share images on public platforms and for business-related purposes, including uses in social media, public databases, and AI applications. In contrast, participants exhibited greater aise with sharing for clinical or research purposes.[26]

## Discussion

The integration 3D-TBP represents a significant advancement in skin cancer screening. While there may still be a lack of scientific evidence, the aforementioned studies demonstrate several distinct advantages. Firstly, it enables remote assessment and diagnosis through teledermatology,[14] proving particularly valuable during pandemic situations like COVID-19, where in-person examinations can be challenging. Secondly, 3D-TBP facilitates comprehensive monitoring of the entire skin surface, enhancing surveillance, the detection of new lesions and the monitoring treatment responses.[14,21] It offers a less time-consuming and more accurate approach, thereby offering cost-effective benefits, especially in early skin cancer detection, which can significantly improve prognosis for high-risk individuals.[18] Lastly, this technology is generally well-received and has the potential to promote ongoing preventive behaviors and self-skin checks.[11,26] While 3D-TBP offers significant potential, it has notable limitations. Patient movement during scanning can cause misalignment and surface offsets, affecting accuracy.[1] Moreover, it cannot effectively monitor lesions in specific body areas such as the genital, acral, scalp regions, and within body folds.[14] In younger populations with evolving benign nevi, biopsy efficiency may be compromised.[11] Additionally, 3D-TBP could misidentify hyperpigmented non-melanocytic lesions, like seborrheic keratosis, as melanocytic lesions.[17] It may also struggle to detect hypopigmented or amelanotic melanomas lacking typical dark pigmentation.[11] The machine's size, along with costs, complexities in technology management and data storage, may limit its widespread availability for commercial use.[13] Despite high-resolution 3D-images, integrating dermoscopy and dermatologist expertise remains crucial for accurate interpretation.[14] (Material suplementario)

## Conclusion

In summary, 3D-TBP when combined with advancements in artificial intelligence, offers a unique insight into the skin's biological ecosystem and holds the potential to significantly enhance the early detection of skin cancer, reduce appointment times, and lower healthcare costs. However, it is important to note that there is still a lack of substantial data to firmly establish its real-world impact on dermatological care. To validate these findings further research is warranted, encompassing larger, higherquality, and more representative 3D-imaging datasets. On the other hand, many individuals would still prefer the traditional approach of a clinician. In conclusion, this imaging system enhances diagnostic accuracy but cannot currently replace a comprehensive examination by a dermatologist.

Table 1 - Current evidence on 3D total-body photography

| Study reference | Study type and objective | Number of participants | Main findings | |
|---|---|---|---|---|
| | | | Results | Limitations |
| Marchetti MA, Nazir ZH, anda JK, et al., 2023.[18] | Single-center, retrospective, observational with the aim of determinate if melanoma can be distinguished from other skin lesions with 3DTBP | 35 patients, 23538 lesions | Automated analysis of 3D TBP, can differentiate melanoma from other lesions with high degree of accuracy. | Small sample size. Single-center. Over-representation of individuals with high risk of melanoma. 3D images from patients without melanoma diagnosis were not included. Lesions categorized as non-melanoma could, in fact, be melanomas. |
| Soyer HP, O'Hara M, V. Silva C, et al., 2023.[8] | Prospective, cohort, with the aim of to improving understanding in epidemiology and natural history of melanocytic naevi and melanoma | 193 participants, 250 concerning lesions | Provides data on the high number of non-melanoma skin cancers Informs about implementation of 3D TBP into clinical practice NNE of 3:1 | Bias in participant recruitment Missed lesions. Participants lost to follow-up. |
| Betz-Stablein B, D'Alessandro | Experimental study, to test if automated, reproducible | Training CNN 82 subjects, 57742 lesions and testing | Automated nevus counts with a level of agreement | Poorly performance in people with many |

| | | | | |
|---|---|---|---|---|
| B, Koh U, et al., 2022.[17] | naevus counts were possible through the combination of CNN and 3D TBP | 10 subjects; 4868 lesions | reasonably close to an expert clinician | seborrheic keratoses Small sample size |
| Jahn AS, Navarini AA, Cerminara SE, et al., 2022.[19] | Prospective, single-center, comparative observational cohort study, with the aim of evaluating the diagnostic performance of a phone app, dermatologists with and without the help of AI used both 2D and 3D TBP | 114 patients, 1204 lesions | Same sensibility of 3D TBP but less specificity compared to dermatologists in diagnosis of melanoma | Photos not taken by patients Number of melanomas relatively low in this study. Bias of preselected patients at higher risk of melanoma. |
| Cerminara SE, Cheng P, Kostner L, et al., 2023.[20] | Single-center, prospective observational study, with the aim of investigating the performance 3D TBP, 2D TBP and dermatologist in the early detection of melanoma in individuals at high risk of melanoma | 143 participants | 3D CNN is superior in classifying melanocytic lesions compared with 2D CNN. 3D CNN have sensitivity levels comparable to dermatologists. | Low specificity of CNNs Reproducibility of automatic naevi count were not possible. |
| Grochulska K, Betz-Stablein | Series of cases, demonstrating 3D TBP | Three cases | Capability in detection of new skin | Selected intentionally cases for |

| | | | | |
|---|---|---|---|---|
| B, Rutjes C, et al., 2022.[14] | enhanced lesion analysis alongside traditional dermoscopy | | lesions. Provides a holistic assessment. | educational purposes |
| Erdmann M, Heinzerling L, Schuler G, Berking C, Schliep S., 2021.[21] | Clinical case, using 3D TBP in monitoring response therapy | One case | Positive potential of 3D TBP in monitoring the response to therapy. | Algorithm inclusions may not detect lesions of clinical relevance. Cover areas of the body. |
| Wallingford CK, Maas EJ, Howard A, et al., 2023.[22] | Clinical case, using 3D TBP in lesion localization | One case | Genotype–phenotype correlations | Single case |
| Horsham C, O'Hara M, Sanjida S, et al., 2022.[13] | Population-based longitudinal prospective study, aim to describe the experiences of participants who underwent 3D TBP and dermoscopy every 6 months for 3-years | 149 participants | Most patients completely trusted, were very comfortable and were willing to pay a fee for 3D TBP. | Concerns about the ability to detect and monitor suspicious lesions, digital privacy, cost, and travel requirements. |
| Hona TWPT, Horsham C, Silva C V., et al., 2023.[25] | Transverse study of adults living in Australian metropolitan and rural areas, aiming to assess perceptions 3D TBP | 1056 participants | More than 90% would be willing to use, trust and think 3D TBP reduces anxiety. | 84% had concerns about the cost, accessibility, availability, and digital security. |

| | | | | |
|---|---|---|---|---|
| Horsham C, Janda M, Kerr M, Soyer HP, Caffery LJ., 2023.[26] | Transverse study that investigated the factors that determine consumers' comfort and willingness to share 3D TBP | 39 participants | Greater aise with sharing for clinical or research purposes | Concerns about digital security |

AUC, area under the curve; CI, confidence interval; CNN, convolutional neural networks; NNE, Number Needed to Excise; AI, artificial intelligence; TBP, total-body photography

**Bibliography:**


1. Szczypiński PM, Sprawka K. Orthorectification of skin nevi images by means of 3d model of the human body. *Sensors*. 2021;21(24).
2. Soglia S, Pérez-Anker J, Lobos Guede N, Giavedoni P, Puig S, Malvehy J. Diagnostics Using Non-Invasive Technologies in Dermatological Oncology. *Cancers (Basel)*. 2022;14(23).
3. Rutjes C, Torrano J, Soyer HP. A 3D total-body photography research network: the Australian experiment. *Hautarzt*. 2022;73(3):236-240.
4. Garbe C, Amaral T, Peris K, et al. European consensus-based interdisciplinary guideline for melanoma. Part 1: Diagnostics: Update 2022. *Eur J Cancer*. 2022;170:236-255.
5. NICE guideline. 2019 surveillance of melanoma: assessment and management (NICE guideline NG14). *Natl Inst Heal Care Excell (NICE);*. 2024;(July 2022).
6. NHS Scotland. SIGN 146 Cutaneous melanoma. *Scottish Intercoll Guidel Netw*. 2017;1(1):5-25.
7. Adler, Nikki R. et al. Methods of melanoma detection and of skin monitoring for individuals at high risk of melanoma: New Australian clinical practice guidelines. *Med J Aust*. 2019;210(1):41-47.
8. Soyer HP, O'Hara M, V. Silva C, et al. Skin cancer excisions and histopathology outcomes when following a contemporary population-based cohort longitudinally with 3D total-body photography. *Ski Heal Dis*. 2023;3(2):1-9.
9. Lee KJ, Janda M, Stark MS, Sturm RA, Soyer HP. On Naevi and Melanomas: Two Sides of the Same Coin? *Front Med*. 2021;8(February):1-8.
10. Hornung A, Steeb T, Wessely A, et al. The value of total body photography for the early detection of melanoma: A systematic review. *Int J Environ Res Public Health*. 2021;18(4):1-17.
11. Rayner JE, Laino AM, Nufer KL, et al. Clinical perspective of 3D total body photography for early detection and screening of melanoma. *Front Med*. 2018;5(MAY):1-6.
12. Reiter O, Musthaq S, Kurtansky NR, et al. Suggested methodology for longitudinal evaluation of nevi based on clinical images. *Ski Res Technol*. 2022;28(1):71-74.
13. Horsham C, O'Hara M, Sanjida S, et al. The Experience of 3D Total-Body Photography to Monitor Nevi: Results from an Australian General Population-Based Cohort Study. *JMIR Dermatology*. 2022;5(2):1-12. doi:10.2196/37034
14. Grochulska K, Betz-Stablein B, Rutjes C, et al. The Additive Value of 3D Total Body Imaging for Sequential Monitoring of Skin Lesions: A Case Series. *Dermatology*. 2022;238(1):12-17.
15. Koh U, Janda M, Aitken JF, et al. 'Mind your Moles' study: protocol of a prospective cohort study of melanocytic naevi. *BMJ Open*. 2018;8(9):1-6.

16. Janda M, Peter Soyer H. Describing the Skin Surface Ecosystem Using 3D Total Body Photography. *Dermatology*. 2022;238(1):1-3.

17. Betz-Stablein B, D'Alessandro B, Koh U, et al. Reproducible Naevus Counts Using 3D Total Body Photography and Convolutional Neural Networks. *Dermatology*. 2022;238(1):4-11.

18. Marchetti MA, Nazir ZH, Nanda JK, et al. 3D Whole-body skin imaging for automated melanoma detection. *J Eur Acad Dermatology Venereol*. 2023;37(5):945-950.

19. Jahn AS, Navarini AA, Cerminara SE, et al. Over-Detection of Melanoma-Suspect Lesions by a CE-Certified Smartphone App: Performance in Comparison to Dermatologists, 2D and 3D Convolutional Neural Networks in a Prospective Data Set of 1204 Pigmented Skin Lesions Involving Patients' Perception. *Cancers (Basel)*. 2022;14(15).

20. Cerminara SE, Cheng P, Kostner L, et al. Diagnostic performance of augmented intelligence with 2D and 3D total body photography and convolutional neural networks in a high-risk population for melanoma under real-world conditions: A new era of skin cancer screening? *Eur J Cancer*. 2023;190.

21. Erdmann M, Heinzerling L, Schuler G, Berking C, Schliep S. Monitoring skin metastases during immuno- and targeted therapy using total-body 3D photography. *J Eur Acad Dermatology Venereol*. 2021;35(1):e61-e63.

22. Wallingford CK, Maas EJ, Howard A, et al. MITF E318K: A rare homozygous case with multiple primary melanoma. *Pigment Cell Melanoma Res*. 2023.

23. Primiero CA, McInerney-Leo AM, Betz-Stablein B, et al. Evaluation of the efficacy of 3D total-body photography with sequential digital dermoscopy in a high-risk melanoma cohort: Protocol for a randomised controlled trial. *BMJ Open*. 2019;9(11):1-9.

24. Koh U, Cust AE, Fernández-Peñas P, et al. ACEMID cohort study: protocol of a prospective cohort study using 3D total body photography for melanoma imaging and diagnosis. *BMJ Open*. 2023;13(9):e072788.

25. Hona TWPT, Horsham C, Silva C V., et al. Consumer views of melanoma early detection using 3D total-body photography: cross-sectional survey. *Int J Dermatol*. 2023;62(4):524-533.

26. Horsham C, Janda M, Kerr M, Soyer HP, Caffery LJ. Consumer perceptions on privacy and confidentiality in dermatology for 3D total-body imaging. *Australas J Dermatol*. 2023;64(1):118-121.