3D total body photography, a promising innovation for early skin cancer detection: scoping review

Fran Baete, Alyssa Laura Jakers, Emilie Delanoye, Nele Vande Velde, Griet Voet

Table of Contents

3D total body photography, a promising innovation for early skin cancer detection: scoping review

Fran Baete[1] MD; Alyssa Laura Jakers[1] MD; Emilie Delanoye[1] MD; Nele Vande Velde[1] MD; Griet Voet[1] MD

[1]Clinique Dermatologie Gent Clinique Dermatologie Gent Gent BE

Corresponding Author:
Griet Voet MD
Clinique Dermatologie Gent
Clinique Dermatologie Gent
Hippoliet lippensplein 24A
Gent
BE

Abstract

Background: Skin cancer is a global health concern due to its high and still increasing incidence and associated healthcare cost. Belgium is no exception as one in five people are diagnosed with skin cancer before the age of 75. A promising innovation, the VECTRA WB360, a three-dimensional total body photography system allows clinicians to objectively compare the totality of the skin on a macroscopic level on further appointments. The integrated lesion visualisation software allows automated detection, counts and assessment of skin lesions. Detailed comparison of individual lesions is possible through the attached digital dermatoscope.

Objective: This study aims to review available literature on the use of the Vectra in research and clinical settings, and to summarise the clinical utility, advantages and limitations reported for this system.

Methods: An electronic literature search was conducted on PubMed using a combination of following search terms: 3D imaging, VECTRA WB360, melanoma, non-melanoma skin cancer, their synonyms and associated entry terms.

Results: Our literature search yielded 11 relevant papers. According to multiple studies, the VECTRA WB360 images were of a high enough quality to allow on-screen diagnosis of melanoma and nonmelanoma skin cancers by dermatologists. The integrated lesion visualisation software is capable of detecting and counting naevi and distinguishing melanoma from other skin lesions with high accuracy. Integrating a convolutional neural network enhances both the sensitivity and specificity of the software. However, dermatologists achieved greater specificity and thus remained superior to machine and artificial intelligence.

Conclusions: At this time the Vectra 3D TBP provided high enough image quality to detect NMSC by a clinician remotely examining the images without the addition of dermoscopy. The longitudinal comparation of 3D TBP images has aided the detection of melanomas in research studies. The CNN for naevi classification has high accuracy and the CNN for lesion malignancy risk (DEXI) reported higher accuracy than the one used for the 2D TBP system. Despite these promising results, expert overview is still recommended, and AI should be used as a support tool.

Preprint Settings

1) Would you like to publish your submitted manuscript as preprint?

✔ **Please make my preprint PDF available to anyone at any time (recommended).**
   Please make my preprint PDF available only to logged-in users; I understand that my title and abstract will remain visible to all users.
   Only make the preprint title and abstract visible.
   No, I do not wish to publish my submitted manuscript as a preprint.

2) If accepted for publication in a JMIR journal, would you like the PDF to be visible to the public?

✔ **Yes, please make my accepted manuscript PDF available to anyone at any time (Recommended).**
   Yes, but please make my accepted manuscript PDF available only to logged-in users; I understand that the title and abstract will remain v

Yes, but only make the title and abstract visible (see Important note, above). I understand that if I later pay to participate in <a href="http
No. Please do not make my accepted manuscript PDF available to anyone. I understand that if I later pay to participate in <a href="https:/

Original Manuscript

Narrative review

Baete Fran -MD, Clinique Dermatologie Gent, Ghent, Belgium   https://orcid.org/0009-0006-4983-9415

Alyssa Laura Jakers – MD, Clinique Dermatologie Gent, Ghent, Belgium
https://orcid.org/0009-0007-4122-7470

Delanoye Emilie – MD, Clinique Dermatologie Gent, Ghent, Belgium https://orcid.org/0009-0004-2599-2285

Vande Velde Nele - MD, Clinique Dermatologie Gent, Ghent, Belgium https://orcid.org/0009-0001-2517-7756

Voet Griet - MD, Clinique Dermatologie Gent, Ghent, Belgium
https://orcid.org/0009-0006-1452-1781

Corresponding Author:
Voet Griet
Clinique Dermatologie Gent
Hippoliet Lippensplein 24A
9000 Ghent
Belgium

Email: griet.voet@dermatologiegent.be
Phone: +32 9 335 37 83

3D total body photography, a promising innovation for early skin cancer detection: scoping review

Abstract

Background: Skin cancer is a global health concern due to its high and still increasing incidence and associated healthcare cost. Belgium is no exception as one in five people are diagnosed with skin cancer before the age of 75. A promising innovation, the VECTRA WB360, a three-dimensional total body photography system allows clinicians to objectively compare the

totality of the skin on a macroscopic level on further appointments. The integrated lesion visualisation software allows automated detection, counts and assessment of skin lesions. And detailed comparison of individual lesions is possible through the attached digital dermatoscope.

Objectives: This study aims to review available literature on the use of the Vectra in research and clinical settings, and to summarise the clinical utility, advantages and limitations reported for this system.

Methods: An electronic literature search was conducted on PubMed from December 2023 - March 2024 using a combination of following search terms: 3D imaging, VECTRA WB360, melanoma, non-melanoma skin cancer, their synonyms and associated entry terms. Publications that used a device other than the Vectra WB360 were excluded, as were articles reporting on new technology without further research or without added cases. After thorough screening of the articles and removal of duplicates, 11 articles remained.

Results: Our literature search yielded 11 relevant papers, which included 2 case studies, 6 prospective and 3 retrospective studies. According to multiple studies, the VECTRA WB360 images were of a high enough quality to allow on-screen diagnosis of some melanoma and nonmelanoma skin cancers by dermatologists. Sensitivity compared to face to face examination for melanoma is unknown. The integrated lesion visualisation software is capable of detecting and counting naevi and distinguishing melanoma from other skin lesions with high accuracy, with convolutional neural network (CNN) integration further enhancing its sensitivity and specificity. However, it is important to note that no comparison to the usual standard of care was made. Also, dermatologists achieved greater specificity and thus remained superior to machine and artificial intelligence.

Conclusions: While the VECTRA 3D TBP holds substantial promise for the early detection and monitoring of skin cancer, its application cannot yet replace the expertise of trained clinicians. Although the lesion visualizer and DEXI score offer potential enhancements, they also pose risks, including a significant increase in unnecessary excisions due to lower specificity. Despite these promising results, expert overview is still recommended and superior, since there is not enough evidence yet that 3D TBP and/or AI is reliable on its own or beneficial as a support tool Given the small samples and lack of blinded trials, further studies are needed to explore and improve the diagnostic capacities of 3D TBP and the possible integration of CNN's or other AI extensions. It will also be important to examine the Vectra 360WB compared to the usual standard of care.

Keywords: 3D total body photography; 3D total body imaging; melanoma; skin cancer; Artificial intelligence; non-melanoma skin cancer

Introduction

Skin cancers (SC) are a significant and growing global health concern. In the latest Global Cancer Statistics report, SC accounted for approximately 1.5 million of the cancer cases and around 128.000 of the cancer fatalities worldwide [1]. In Belgium accounted SC for nearly 44.000 of the new cancer diagnoses, making it the most prevalent cancer. The most common types of SC are basal cell carcinoma (BCC) with an occurrence of 73.2%, followed by squamous cell carcinoma (SCC) with 18.8% and melanoma with 8% [2]. These percentages are comparable to other countries with a predominantly fair-skinned population [1,3].

An increase in the average annual percentage change was seen for all SC types in 2018, with rates rising by 9% for BCC, 7% for SCC and 5% for melanoma. By 2030, a doubling of new diagnoses of BCC and SCC is expected. This increase is substantially higher than previous estimates based on population ageing [2].

The prognosis for most SC is rather favourable. In Belgium, an increase in the 10-year relative survival rate is seen for all types of SC since 2004 [2]. The prognosis for melanoma, however, is highly dependent on the stage at diagnosis. While the 10-year survival rate for stage 1 melanoma is nearly 100%, this decreases to 70% for stage 2, 60% for stage 3 and drops to a mere 20% for stage 4 [2,3]. The different melanoma stages respectively accounted for 76.5%, 13.3%, 5.9% and 1.4% of the new diagnoses in Belgium in 2021 [4]. Melanomas diagnosed at more advanced stages require more aggressive treatment, along with intensive monitoring and follow-up [3,5].

A Belgian cost-analysis estimated the economic burden of SC at approximately €106 million in 2014. The majority of these costs (65%) were attributed to melanoma, primarily due to the number of excisions, hospitalisations and expensive advanced treatments. If the rising incidence trend continues, it is expected that the economic burden of SC will triple and lead to a cumulative cost rise estimated at €3 billion by 2034 [2,6].

Overall, it can be said that for all SC and especially for melanoma, early diagnosis improves quality of life, reduces morbidity and mortality, but also patient anxiety and healthcare costs [7]. To optimise early detection, the 2022 European Melanoma Guideline recommends the use of total body photography (TBP) in addition to sequential digital dermoscopy imaging (SDDI) in high-risk populations. Both interventions have been proven cost-effective in multiple analyses [3,8–10].

TBP has witnessed an evolution from 2D to 3D imaging since 2015. The first commercial 3D TBP system, the VECTRA WB360 3D whole body imaging system (Canfield Scientific, Parsippany, NJ, USA), was launched in 2017 [11]. The device allows rapid and qualitative imaging through 92 cameras that simultaneously capture nearly the totality of the skin, including curved surfaces. This is followed by the construction of a 3D avatar of the individual [7,11]. Additionally, the VECTRA WB360 can be complemented by a SDDI device, dermoscopic images can be tagged to the Vectra body map. When combined, the skin surface and its existing lesions can be documented and compared at every visit [7,11–13]. Lastly, the VECTRA WB360 includes an automated lesion visualisation software that can independently identify, count and assess lesions on 3D images. This is based on several parameters, including the longest diameter, contrast, border and colour variation, hue and naevus confidence. At this time this software is available as research only tool. An on SDDI images AI generated risk score, the DEXI score, can be used to assist in the diagnosis of suspicious lesions. However, the tools regarding naevi count and the DEXI risk assessment tool for dermatoscopic images can only be used in clinical

3

trials and is not yet validated for clinical application [14–17]. The full technical details on the VECTRA WB360 can be found via Canfield Scientific [18].

With the increasing use of 3D-TBP, specifically with the Vectra WB360, it is timely to review the current literature reporting on the clinical utility, advantages and limitations of this emerging technology for skin cancer screening.

Methods

First, a PICO framework was established by the research team to explore keywords, search terms and existing systematic reviews. No similar reviews were found up to March 2024.

An electronic literature search was conducted on PubMed from December 2023 - March 2024. The search terms included 3D imaging, VECTRA WB360, melanoma, non-melanoma skin cancer, their synonyms as well as the associated entry terms (using NIH). The synonyms were linked with the OR operator while the different categories were linked with the AND operator. Since the first prototype of the 3D TBP was introduced in 2015, a 10-year filter was used. For the full search string see appendix 1. An additional electronic search was conducted to obtain data on Belgian epidemiology and healthcare costs concerning SC screening and management.

Two authors (B.F. and D.E.) independently screened the search results (698 results). For records that were considered relevant according to title and abstract screening, full-text articles were obtained. Inclusion and exclusion criteria were applied by the same two authors. Publications that used a device other than the Vectra WB360 were excluded, as were articles reporting on new technology without further research or without added cases. After thorough screening of the articles and removal of duplicates, 11 articles remained. All materials were imported to Zotero for citation management.
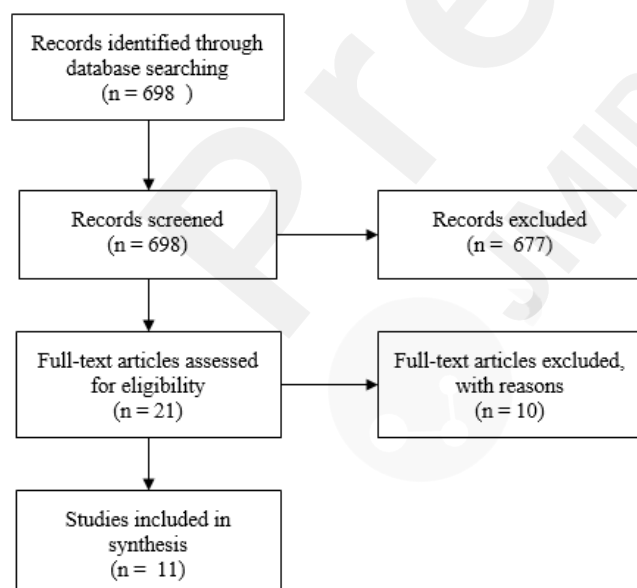

Figure 1. PRISMA Flow Diagram.

Results

Study description

Given that 3D TBP is a recent innovation, only a limited number of studies are available.

Five out of the 11 articles included in this review reported results from the Mind Your Moles (MyM) protocol by Koh et al. This was the first study to evaluate 3D TBP in context of melanocytic naevi. The study was based on the general Australian population and consisted of nearly 200 participants from different risk groups. All participants were between the age of 20 and 69 and had at least one naevus. All attended the clinic for an in-person skin examination, 3D TBP and SDDI of lesions that were suspicious or >5mm. This was repeated every six months over a period of three years with the purpose of monitoring changes in naevi [19]. These five articles included a report on the final outcomes [17], performance of the lesion visualiser [14,15,20] and study participant experiences [21]. An overview of the characteristics of the different studies can be found in Table 1.

Table 1. Characteristics of publications derived from the Mind Your Moles protocol

	Soyer et al. [17]	Jayasinghe et al. [20]	Betz-Stablein, Koh et al. [15]	Betz-Stablein, D'Alessandro et al. [14]	Horsham et al. [21]
Country	Australia	Australia	Australia	Australia	Australia
Year of publication	2023	2023	2022	2022	2022
Study design	Prospective population-based cohort study	Prospective population-based cohort study	Retrospective population-based cohort study	Retrospective population-based cohort study	Prospective population-based cohort study
Population type	General population	General population	General population	General population	General population
Data collection	2016/12 – 2020/02	2016/12 – 2020/02	2016/12 – 2020/02	2016/12 – 2020/02	2016/12 – 2020/02
Number of participants	164	156	20 selected out of 163 total body images	92 total	149
Male/female	Male: 58% Female: 42%	Male: 63% Female: 37%	Male: 61% Female: 59%	Training Male: 62% Female: 48% Testing Male: 50% Female: 50%	Male: 63.1% Female: 36.9%
Median age (range)	Not reported [18-70]	55y [23-70]	57y [25-72]	Training 55y [23-69] Testing 57y [37-67]	55y [23-70]
Number of training and testing images	Not applicable	Not applicable	14 training 6 testing	82 training 10 testing	Not applicable
Number of lesions	250	Not reported	Training 882 cherry angioma 168,180 non-angiomas	62,610	Not applicable

5

			Testing 334 cherry angioma 56,515 non-angiomas	Training 57.742 > 2mm 5,106 naevi 52,636 non-naevi Testing 4.868 > 2mm 520 naevi 4,348 non-naevi	
Automated count	No	Yes	Yes	Yes	Not applicable
Lesion type	Suspicious lesions for MSC and NMSC	Naevus	Cherry angioma	Naevus	Not applicable
Clinical examination	Yes by study clinician	Yes	20 participants	10 test participants	Yes
Use of 3D TBP	3y FU 6m intervals	3y FU 6m intervals	One time No follow-up	One time No follow-up	3y FU 6m intervals
Fitzpatrick Type	1-4	1-4	1-4	1-4	1-4
SDDI of lesions	Yes when suspicious OR >5mm	No	No	No	Not applicable
Histopathology	234 lesions	No	No	No	Not applicable
Lesion visualiser	No	Yes >2mm AND <100 naevi	Yes >1mm >2mm	No	Not applicable
CNN	No	No	No	Yes >2mm AND >5mm	Not applicable
Conclusion	3D TBP results in diagnosis of a high number of NMSC and their precursors in the general population.	3D TBP is an objective tool for automated naevus count.	Angioma detection and counts are possible with 3D TBP.	Objective naevus detection and counts are possible with 3D TBP CNN.	Majority is content, +/- 50% sees barrier

The six remaining studies included participants at higher risk of either having or acquiring SC instead of the general population. With the exception of one case study series which included two high-risk patients and one participant from the MyM study [12]. Aside from the MyM study and a case report by Rayner et al, all other studies employed one-time imaging using the VECTRA WB360 [11,16,22–24]. An overview of the characteristics of the studies not derived from the Mind Your Moles protocol can be found in Table 2.

Multiple studies used SDDI but often chose different criteria for inclusion of (pigmented) lesions. For example, Cerminara et al. and Jahn et al. included all lesions >3mm, while Soyer et al. opted for lesions >5mm. In every study suspicious lesions were captured regardless of their size [16,17,23]. Two studies evaluated the efficacy of the lesion visualiser [20,24]. Two more recent studies investigated whether the addition of AI, in the form of convolutional neural network (CNN), could improve the performance of the

6

current software [14,15]. And one study looked at the CNN on SDDI level, namely the DEXI score [16]. Furthermore, some studies explored participant experience when using the VECTRA WB360 [21,23]. Others were a case series and a clinical perspective with a case report [11,12] Lastly, but important to mention, all studies included participants with fairer skin types (Fitzpatrick I to IV).

Table 2. Characteristics of publications not derived from the Mind Your Moles protocol

	Hobelsberger et al. [22]	Marchetti et al. [24]	Grochulska et al. [12]	Rayner et al. [11]	Cerminara et al. [16]	Jahn et al. [23]
Country	Germany	USA	Australia	Australia	Switzerland	Switzerland
Year of publication	2023	2023	2021	2018	2023	2022
Study design	Prospective cohort study	Single centre retrospective observational study	Case series	Case report	Prospective single centre observational cohort study	Prospective single centre comparative observational cohort study
Population type	Patients with suspicious lesions for NMSC	High risk population	2 cases from high-risk population and 1 general population	High risk	High risk population	High risk population
Data collection	2021/04 – 2022/06	2015/07 – 2021/10	2017/01 – 2020/10	2016/05 – 2017/02	2021/01 – 2021/08	2021/01 – 2021/06
Number of participants	129	35	3	1	143	114
Male/female	Male: 60% Female: 40%	Male: 66% Female: 34%	Male: 67% Female: 33%	Female: 100%	Male: 52% Female: 48%	Male: 49% Female: 51%
Median age [range]	77y [42-91]	64y [26-89]	67y [48-71]	50y	56y [22-85]	59y [22-85]
Number of lesions	182	23,538 49 MSC 22,489 others	3	1	1,690	1,204
Automated count	No	Yes	No	No	Yes	Not reported
Lesion type	NMSC	MSC	Naevus	MSC	Naevus	Naevus
Clinical examination	Yes	No	Not reported	Not reported	Yes	yes
Use of 3D TBP	One time No FU	One time No FU	Fu after 5-12 months	Fu after 3 and 9 months	One time No FU	One time No FU
Fitzpatrick Type	1-3	"White patients"	Not reported	Not reported	1-4	1-4
SDDI of lesions	No	No	Yes, of suspicious lesion	Yes, of suspicious lesions	Yes, of suspicious lesions OR	Yes, of suspicious lesions OR

7

					>3mm	>3mm
Histopathology	158 lesions	43 melanomas	2 lesions	1 lesion	75 lesions	61 lesions
Lesion visualiser	No	Yes, lesions >2mm	No	No	Not reported	Not reported
CNN	No	No	No	No	Yes	Yes
Conclusion	Diagnostic accuracy for 3D TBP is slightly lower than for dermoscopy in NMSC diagnosis.	3D TBP software for automated analysis has a high accuracy to differ MSC from other skin lesions	3D TBP is a valuable tool alongside dermoscopy to assist clinicians	3D TBP and SDDI can potentially increase the diagnostic accuracy in melanoma screening	Dermatologists are more accurate than dermatoscopic CNN included in 3D TBP and 2D TBP. The novel DEXI score on 3D-CNN device outperformed the 2D-CNN and achieved comparable sensitivity with dermatologists	Patients rate 3D TBP as trustworthy

Utility of the VECTRA WB360

On screen assessment by a clinician

Two studies compared histopathological outcomes to diagnoses made on-screen on 3D TBP images by dermatologists. In the first study, a clinician based their clinical diagnosis on the 3D TBP images combined with SDDI of different types of lesions [17]. The second study didn't use SDDI and solely included lesions that were suspicious for non-melanoma skin cancer (NMSC) [22].

The first study, conducted from 2016 until 2020 in Australia, was based on the MyM protocol. A senior dermatologist used teledermatology for assessment and diagnosis of lesions. This involved the use of 3D TBP imaging and SDDI of lesions that were suspicious or >5mm. Fifty-six percent of participants (108/193) received a referral for cryotherapy, topical treatment, further clinical examination, biopsy or excision. Of those with a referral for biopsy or excision, 85% visited their practitioner and underwent the recommended management. This accounted for a total of 138 lesions which were histopathologically examined. Thirty-seven of the 61 lesions that were clinically suspicious for skin malignancy were histopathologically confirmed. Eight of the 77 lesions that seemed clinically benign, turned out to be malignant after histopathological examination. The conclusion was that 3D TBP resulted in the diagnosis of mostly NMSC (BCC n=36 and SCC n=3 vs melanoma n=6) and their precursors (n=25) in the general population. The reported number needed to excise (NNE) was 3.0/1.0 [17].

The second study was a German prospective cohort study conducted between 2021 and 2022. They included 129 patients who had a clinically suspicious lesion for NMSC and had not yet undergone a biopsy. All patients underwent a clinical examination followed by examination by dermoscopy and 3D TBP. The 3D TBP images were interpreted separately by another clinician who was blinded to the results in dermoscopy. Both clinicians, in clinic and on screen, gave a specific diagnosis for 182 suspicious lesions and

8

their grade of certainty for said diagnosis. The diagnoses made in-person and on-screen were compared to the histopathological results of 158 lesions. They concluded that compared to clinical examination with dermoscopy, 3D-TBP had lower sensitivity for BCC (73% vs 79%, p= 0.727), higher sensitivity for SCC (81% vs 74%, p=0.727), and lower sensitivity for in-situ SCC (0% vs 33%, p=0.125). Specificity of 3D TBP was lower than that of dermoscopy for BCC (77% vs 82%, p=0.581) and for SCC (75% vs 84%, p=0.063), and higher specificity for in-situ SCC (97% vs 94%; p=0.344). However, the differences in sensitivity and specificity were not statistically significant. The diagnostic accuracy increased when the clinician was more certain of their diagnosis [22].

Lastly on-screen naevus vs non naevus identification was compared to in-clinic identification by the same clinician in 10 test participants. This was examined in a broader study (cf. infra) which was also based on the MyM protocol. The overall agreement was 90% and the Cohen's kappa was 0.45 indicating a moderate agreement between both methods [14].

Utility of the Lesion Visualiser and added convolutional neural network

Only one American study conducted by Marchetti et al. investigated the use of imaging processing techniques on 3D TBP images. They found that the lesion characteristics provided in the lesion visualiser software, could be used to detect melanoma and accurately distinguish between melanoma and other benign dermal lesions. This proof-of-concept study retrospectively investigated 35 patients who were diagnosed with at least one melanoma and had available 3D TBP imaging captured within 90 days prior to their histopathological diagnosis. This accounted for a total of 43 histopathologically confirmed melanomas, 29 in situ and 14 invasive.

The different prediction model variables and their individual ability to distinguish melanoma from non-melanoma were examined based on their AUC (area under the curve). The variables can be categorized into size (area, diameter), colour (asymmetry, variation, lesion vs non-lesion contrast), border (jaggedness, asymmetry) and anatomic site. The Vectra DermaGraphix software detected 22,538 lesions, all >2mm. All lesions without histopathologic diagnosis of melanoma within 90 days after 3D-imaging were classified as non-melanoma (22,489 lesions). The other 49 lesions were labelled as melanoma lesions. In a patient level analysis, the prediction model-based probability for each lesion was ranked from lowest to highest. Of the melanoma lesions, 7 (14%) had the highest predicted score among all lesions for an individual patient, 7 (14%) were in the 99th percentile, 12 (25%) in the 98th percentile, 12 (25%) in the 90–97th percentiles and 11 (22%) in the 60-89th percentiles. Of the lesions that scored below the 90th percentile, 85% were incorrectly segmented. Five melanomas were recognized as two or more distinct lesions by the software, and one was not detected.

The 15 variable prediction model achieved an AUC of 0.94, indicating that it has a great prediction power. The segmentation of lesions was a notable limitation for the accuracy of the software. The research group further concluded that using a model-based threshold associated with 95% sensitivity for melanoma detection, the model could reduce the number of lesions requiring clinical examination by 75% [24].

Efficiency of added convolutional neural network

The next three studies revealed how a CNN can improve the diagnostic accuracy of the existing system to aid clinicians in the assessment of skin lesions. A CNN is a form

9

artificial intelligence used primarily for image recognition and processing due to its ability to recognize patterns. However, it is not possible to compare these studies or CNN's since they were engineered, trained and tested following different protocols [14,15,20].

Two of these studies were published by Betz-Stablein et al. and were derived from the MyM protocol in the general population. One study trained a CNN on 14 3D-TBP images and tested it on 6 3D-TBP images. This CNN was used to detect, localise and count cherry angiomas and thus distinguish them from other skin lesions. The study population and methodology can be found in figure 2. A clinician identified all cherry angiomas on 20 participants, these where then split 60:40 into a training and test set. The algorithm achieved a sensitivity of 87% and a specificity of 99% and was able to perform the requested task [15].
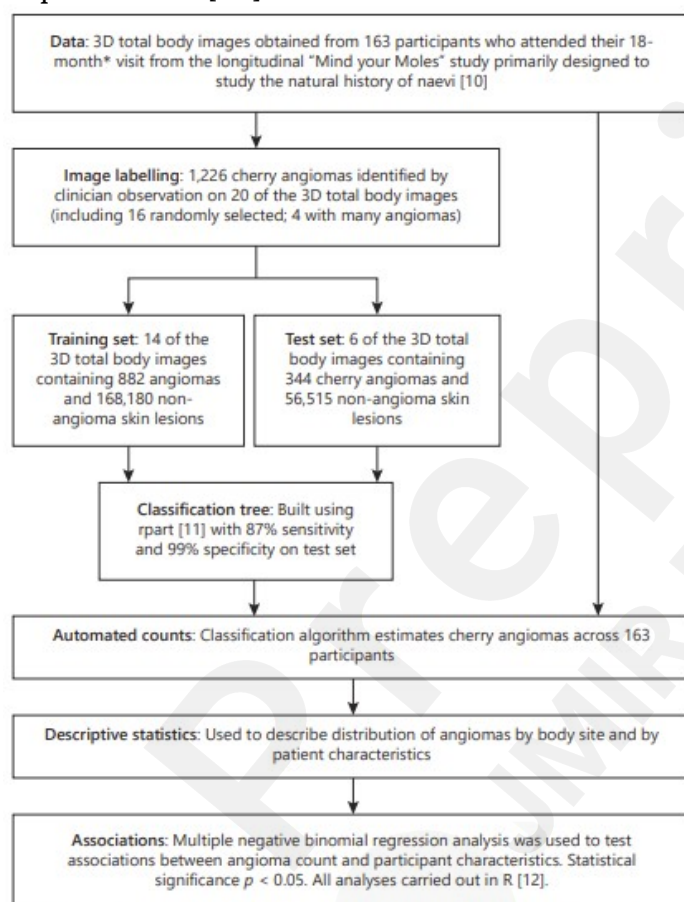

Figure 2. Study population and methodology. Adapted from [15]**.**

In the second study by Betz-Stablein et al., a CNN was trained on 82 participants (57,742 lesions >2mm; 5,106 naevi vs 52,636 non-naevi lesions) and tested on 10 participants (4,868 lesions >2mm; 520 naevi vs 4,348 non-naevi lesions). An overview of the methodology can be found in figure 3. This CNN was used to detect and count naevi (both >2mm and >5mm). The counts were compared to the in-clinic counts of a senior dermatologist (ground truth) and to on-screen counts of 3 expert clinicians on 3D TBP images. Non-naevi lesions were mainly solar lentigines, seborrhoeic keratoses or angiomas. The sensitivity of the 3D TBP CNN increased when only lesions >5mm were included (79% for >2mm vs 84% for >5mm). The specificity stayed identical regardless

10

of the diameter (91% for >2mm and >5mm). Comparing the CNN with the in-clinic assessment by the dermatologist resulted in a Cohen's kappa of 0.56, indicating moderate agreement for naevi ≥2 mm, and substantial agreement (0.72) for naevi ≥5 mm. The agreement was lower when participants had numerous seborrheic keratoses due to an overestimation of the number of naevi by the CNN [14]. Using the findings of the previous study a smaller study by Jayasinghe et al. utilised the VECTRA WB360 system to automatically count naevi >2mm in 124 participants who had <100 naevi. Manual counts were used for the 32 participants with > 100 naevi or >50 seborrhoeic keratosis. Their aim was to assess how naevi change during adulthood [20].
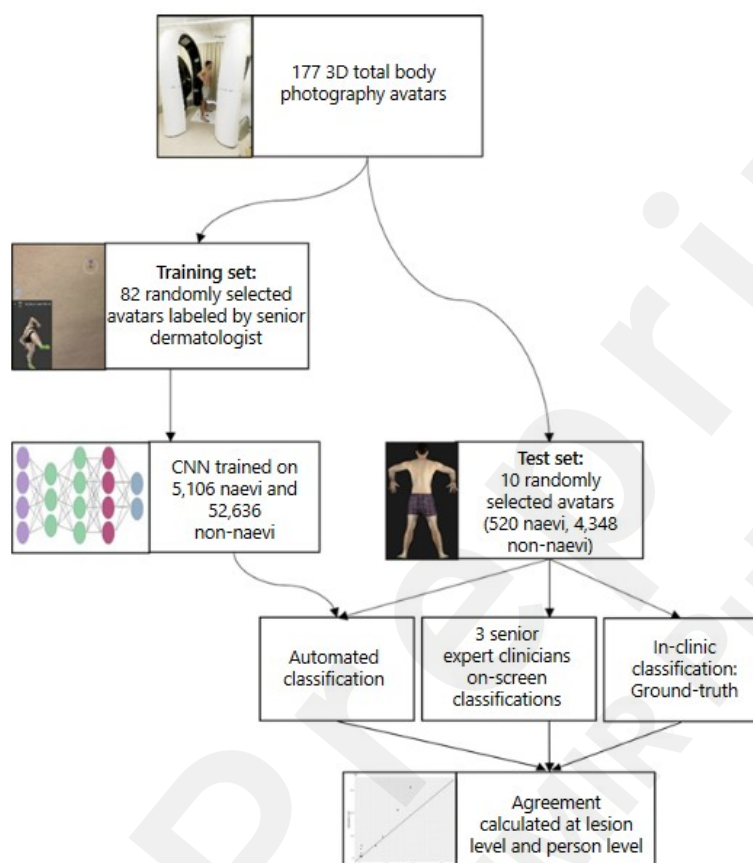
Figure 3. Methodology. Adapted from [14]**.**

In a third study from a Swiss research group led by Cerminara et al., two different CNN's used on SDDI images were compared. Their objective was to examine the capabilities of AI in a real-world setting. In total 1,690 pigmented lesions in 143 participants at a high-risk of melanoma were used. All participants first underwent routine skin cancer screening, including dermoscopy conducted by a dermatologist, who provided a dichotomous diagnosis (malignant versus benign) for each pigmented skin lesion. Patients then underwent TBP with both a 3D (VECTRA WB360) and 2D (2D-FotoFinder-ATBM) imaging system. After this melanocytic lesions ≥3mm and smaller suspicious lesions identified by dermatologists were captured with SDDI. The diagnostic accuracy of the CNN used on the SDDI images on the 3D TBP (DEXI score) and the CNN used on the SDDI images on the 2D TBP (FotoFinders Moleanalyzer Pro) were compared to clinical diagnoses of dermatologists and to histopathological examinations. They found

11

that when histopathological outcomes were used as a ground truth (75 lesions), dermatologists (without the aid of a CNN) achieved the highest specificity (92.3%). Second were dermatologists aided by a CNN (86.2%) and third a CNN without human interference (64.6% for 3D CNN and 40% for 2D CNN). However, the sensitivity of dermatologist, dermatologist + CNN and the 3D CNN was identical (both 90%). It was concluded that 3D TBP CNN was superior to 2D TBP CNN (in both sensitivity and specificity).

This study also included a sub-analysis in which the repetition rate of both CNN's was tested. The 3D TBP CNN had a higher repetition rate (0.89) than the 2D TBP CNN (0.79). In conclusion, the 3D CNN outperformed 2D CNN in the classification of melanocytic lesions and in the reproducibility of the scores. Although the 3D CNN demonstrated great scores, dermatologist continue to achieve higher specificity [16].

Reported advantages of 3D TBP

The main reported advantage of the VECTRA WB360 system is the comfortable, rapid and non-invasive acquisition of high-resolution images that are used to create a 3D representation of the patient. This allows clinicians to assess and objectively compare the totality of the skin surface over time. This is especially important in melanoma screening, given that the evolution and appearance of new moles and lesions are important for the early detection of (de novo) SC [8,12–15,21]. By this, dermatologists know which naevi they should be aware of and should be carefully examined with dermatoscopy. The attached dermatoscope and the lesion visualisation software allow integration and assessment of dermoscopy images onto the 3D avatar. This enables detailed and objective comparison of individual lesions. Although even without SDDI, the resolution of the 3D images is high enough to see important changes in lesions, especially when >5mm. This is also shown in the publication of Grochulska et al. where in one case a lesion showed asymmetric changes and in a second case a new lesion appeared [12].

When the consumer experience was explored in two studies, they concluded that 94% of participants find 3D TBP a comfortable examination and 98% would recommend it. The majority of participants has a high acceptability and confidence in the new technology and they also rapport a reduction in melanoma-related anxiety [21,23].

Other reported potential benefits of the system include: AI-assisted assessment of lesions in the future, introduction of automated, standardised and timesaving naevus counts, increase in diagnostic confidence in clinicians and further evolution of teledermatology with a potential decrease in waiting lists as a result [11,14].

Reported limitations of 3D TBP

Despite being presented as having the potential to be a great innovation, 3D TBP holds significant shortcomings. The most inconvenient one being the absence of visualisation of the foot soles, scalp and parts of the genital region in general [11,22]. In different trials, a small number of pigmented lesions were not detected or appeared as erythema on the 3D TBP images [22,24]. It is important to note that despite the current resolution of the images, the system is not able to replace a dermatological examination [11,22].

The algorithm performed poorly on participants with many seborrhoeic keratoses, however this population can easily be identified in clinic and flagged for manual counts [14]. There is also a possibility that 3D TBP increased the NNE due to a more prompt decision to perform a biopsy or excision when changes are seen, particularly in the younger population where changes are rather common and insignificant [11].

12

In the consumer experience study by Horsham et al., 6.7% of the participants stated that they would not pay for 3D TBP examination and 2% would not recommend it. They also found that 50% of the study population remarked obstacles, mainly concerning the (digital) privacy, the high cost, a lack of trust to detect and monitor small lesions [21].

Lastly, for clinicians, an important disadvantage is the practical and logistical implications of the VECTRA WB360. The system takes up a great amount of space and needs specialised IT management and maintenance, leading to a high cost [11].

Ongoing studies

Three protocols centred around 3D TBP were found on the online databases. However, no results were found up to March 2024.

The first is a new prospective population-based cohort study protocol by the Australian research team of MyM. They want to investigate whether 3D TBP can be used for melanoma imaging and diagnosis on 15.000 participants from the general population. An implementation of a CNN, a cost-analysis and consumer experience are also included [25]. The second protocol was released in 2019 and is by the same Australian research group under Primiero et al. This is the only two arm randomised controlled trial (RCT) protocol in a high-risk melanoma cohort, in which they compare standard clinical care to 3D TBP with SSDI. [13]. Another promising protocol for a RCT in high-risk patients (so called IMAGE-trial) was published by Yan et al. This study will compare the proportion of false positives and false negatives with standard clinical examination and 2D TBP and 3D TBP (with the VECTRA.WB360). Both arms will include the use of SDDI on suspicious lesions and up to 20 lesions >4mm. Furthermore, they will also assess economic impact, health-related quality of life and diagnostic performance [26].

Discussion

This review provides an overview on the current experience, outcomes, advantages and limitations of 3D TBP with the VECTRA WB360 in a mainly fair-skinned population (Australia and Europe). Currently, SC is the most diagnosed form of cancer in Belgium and the incidence of both melanoma and NMSC is increasing, as well as the cost of SC management. Given these trends, it is crucial to explore innovative methods for early skin cancer detection and more efficient, time-saving follow-up strategies. Also, with the increasing use of 3D TBP, it is timely to explore the reported outcomes to date.

While the heterogeneity of study designs restricted a quantitative analysis of results, a scoping synthesis found agreeance over general outcomes and conclusions. The VECTRA WB360 shows significant promise for mapping and monitoring the evolution of the skin surface and individual lesions through additional SDDI. This system not only allows new lesions to be detected but also enables objective comparison of pre-existing lesions (on a macroscopic and a dermoscopic level). Research shows that despite the lower resolution of 3D TBP than dermatoscopy it is suitable to detect changes in lesions, however dermoscopy is still generally required to diagnose a suspected melanoma. All these tools are enabling and facilitating teledermatology.

The lesion visualizer was examined in only three studies, where it was used to differentiate melanoma from benign lesions and to count naevi and cherry angiomas [14,15,24]. The most significant limitation so far is its inaccurate segmentation of melanoma. In the study by Marchetti et al., 11% of melanoma's (5 out of 44) were incorrectly segmented, raising concerns that some melanomas could be missed. Additionally, the study suggests that using a model-based threshold associated with 95%

13

sensitivity for melanoma detection could reduce the number of lesions requiring clinical examination by 75% [24]. However, this remains a hypothesis that has yet to be validated. If confirmed this could be particularly useful in clinical practice. In the study by Betz-Stablein et al., the Cohen's Kappa of the CNN based count to the gold standard clinical count was 0.56, indicating that while the lesion visualizer can provide an estimate of naevi numbers, it is not reliable for tracking the development of new naevi [14]. Furthermore, it should be noted that in another study by Betz-Stablein et al. only one individual labelled cherry angiomas on 20 participants, which does not provide sufficient evidential strength [15]. While counting cherry angiomas could demonstrate the lesion visualizer's ability to differentiate between cherry angiomas and naevi, which is important for the naevus count, its clinical utility remains limited. In the future addition of CNN may improve efficiency by identifying new and changing lesions for closer inspection, this can prove to be particularly useful for people with many naevi. It may also be used as a tool for imaging technicians to flag which lesions are important to take additional dermoscopy images of for further review by a dermatologist.

Only one study looked at the DEXI score which is available as a research tool only on SDDI images. When using the histology as ground truth the dermatologist, dermatologist + AI and the DEXI score all had the same sensitivity of 90%. The specificity of the dermatologist is the highest at 92,31%, then dermatologist + AI at 86,15% and finally DEXI score with 64,62% [16]. All methods have the same chance of missing lesions, but the difference lies in labelling benign lesions as malignant. This shows that the use of DEXI score alone would lead to a lot more excisions which weren't necessary in the first place. It should be noted that more patients were examined by beginner dermatologists than seniors. In a clinical setting it is also not feasible to take dermatoscopic images of all the naevi of a patient.

Although initial results show potential, the VECTRA system cannot yet be used without clinician supervision. At present the software and AI tools can't replace a trained clinician's skin examination. In het future could AI be used as a support tool during a skin exam to help the dermatologists with their clinical decision-making process Especially the lack of specificity, compared to dermatologists seen in multiple studies needs to be addressed. It is likely that imaging resolution and technology will improve in time, and new CNNs such as lesion classifiers are likely to be next. These developments can strengthen the specificity and the accuracy, and the system will potentially become a more efficient and reliable tool for skin cancer screening and other tasks. But before this can become a widely implemented tool its safety, cost effectiveness and added value to the standard of care must be proven. The AI tool is so new that long-term health outcomes cannot yet be discussed.

It should be noted that 5 out of the 11 studies were based on the same study protocol and participants [14,15,17,20,21]. This makes the available research population less diverse. Moreover, including only 200 participants for a population-based study is remarkably low, especially in a large country with a high prevalence of SC like Australia. Also, no control group was available which makes the results of these studies less robust. A control group is essential when evaluating new technologies. This allows for a comparison to the usual standard of care and to evaluate any added benefits.

The study by Soyer et al. concludes that 3D total body imaging results in diagnosis of a high number of keratinocyte cancers [17]. However, this finding is unsurprising, as keratinocyte skin cancers are the most common type and are diagnosed more frequently than melanoma. Additionally, the lack of a control group makes it unclear whether this approach resulted in a higher detection rate compared to standard care. Another

14

limitation is that the study does not specify who the study clinicians are. The decision on which lesions are clinically suspicious and therefore referred for tele review by an experienced dermatologist, was left to these clinicians. If they were less experienced or lacked training in dermosocopy, it is possible that certain lesions were missed. Furthermore, the study reports that 8 clinically benign lesions turned out to be malignant. Of these seven were first diagnosed as actinic keratosis and one as a naevus. It remains unclear why excision or biopsy was recommended for these lesions. Was there already diagnostic uncertainty, or were other factors influencing these decisions?

The publications which were not part of the MyM protocol also included few patients [11,12,16,22–24]. One showed a clinical example and was speculative about the future and another was a more illustrative case series , this doesn't bring an added value to the proof of safety and efficiency of the new technology [11,12]. The study by Hobelsberger et al. also had several limitations. Firstly there was only one clinician who did the interpretation of the 3D images and another who did the clinical examination [22]. When the interpretations of only two individuals are compared does the study say a lot about the differences between the methods or does it say more about the diagnostic skills of the clinicians? Bigger studies with more clinicians are needed to give more representative results. Secondly the authors mention that it is important to minimize the number of missed lesions, for this a high sensitivity is needed. Currently the sensitivity and specificity of diagnosis of NMSC on a 3D image is lower than that of clinical examination aided by dermatoscopy, although not statistically significant. This may result in a greater number of missed lesions. Of course, we should also consider that this study is used in a setting of teledermatology. It is often quicker and more straightforward to do an in-person examination instead of looking at the whole skin on a 3D image, but this is not always possible.

Because the available research is limited and heterogeneous it will be important to perform further studies. A new study with a bigger cohort that tests the DEXI-score of naevi should also be done. At the present only one study examines this, which is not enough to prove the accuracy of AI. The distribution between beginner and senior dermatologists in the studies should be even. To test the capabilities of CNN furthermore, a study in which sequential 3D TBP at 1, 2 and 3 years is performed to detect new and altered naevi by the CNN can be done. New and possibly changed naevi should also be checked by a dermatologist. A margin of error can be determined. New studies should also include randomized controlled trails to further examine the Vectra WB360 potential in a real-world clinical setting. A lot of promising potential benefits are mentioned by the researchers like increased diagnostic confidence and decrease of benign/malignant ratio but at the moment these all are not validated. Also, the impact on survival rates and morbidity needs to be examined to prove the real-world impact of the system. It will be also important to compare examinations aided by the Vectra WB360 to the normal standard of care to see if it brings an added value.

Possible obstacles for the wider implementation of 3D TBP could relate to high cost of the system and thus the imaging sessions (for both clinicians and patients), medico-legal arrangements, difficulties in terms of privacy legislation (GDPR for Europe), unsuitability for people with certain disabilities/medical conditions and the consumers view on new technology.

In conclusion, while it is important to embrace new technologies, their adoption must be approached with appropriate caution and critical evaluation. Though the system may allow faster detection of malignancies, relying solely on AI risk assessment tools may

15

lead to lesions being incorrectly assumed as suspicious due to change detection, particularly in the younger population where naevus changes are frequent and typically benign. This could result in unnecessary biopsies and excisions and consequently in increasing costs and patient anxiety and/or discomfort. Therefore, it is important to make decisions about treatment and excision in the context of the whole patient, and not just the Vectra images. Further clinical trials, including all Fitzpatrick skin types and a wide range of lesion sizes, are necessary to prove the clinical relevance and the autonomy of the VECTRA WB360.

Conclusion

In this review, the current knowledge, outcomes, advantages and disadvantages of 3D TBP with the VECTRA WB360 and the integrated lesion visualization software are presented. While the VECTRA 3D TBP holds substantial promise for the early detection and monitoring of skin cancer, its application cannot yet replace the expertise of trained clinicians. Although the lesion visualizer and DEXI score offer potential enhancements, they also pose risks, including a significant increase in unnecessary excisions due to lower specificity. Despite these promising results, expert overview is still recommended and superior, since there is not enough evidence yet that 3D TPB and/or AI is reliable on its own or beneficial as a support tool. Given the small samples and lack of blinded trails, further studies are needed to explore and improve the diagnostic capacities of 3D TBP and the possible integration of CNN's or other AI extensions. It will also be important to examine the Vectra 360WB compared to the usual standard of care.

Conflicts of interest

Clinique Dermatologie Ghent owns and commercially uses the Vectra WB360

Abbreviations

AI: artificial intelligence
AUC: area under the curve
BCC: basal cell carcinoma
CNN: convoluted neural network
MyM: Mind Your Moles

NMSC: non-melanoma skin cancer
NNE: number needed to excise
RCT: randomised controlled trial
SC: skin cancers
SCC: squamous cell carcinoma
SSDI: sequential digital dermoscopy imaging
TBP: total body photography

Appendix 1

("3D total body photography" OR "Vectra WB360" OR "3D whole body" OR "Three-dimensional" OR "Three dimensional" OR "Imaging, Three-dimensional" OR ("Imaging, Three-Dimensional"[MESH])) AND ("Skin neoplasms" OR "melanoma" OR ("Melanoma/diagnosis"[MESH]) OR ("Melanoma"[Mesh]) OR ("Skin Neoplasms"[Mesh]))

17

References

1.   Bray F, Laversanne M, Sung H, Ferlay J, Siegel RL, Soerjomataram I, Jemal A. Global cancer statistics 2022: GLOBOCAN estimates of incidence and mortality worldwide for 36 cancers in 185 countries. CA A Cancer J Clinicians 2024 May;74(3):229–263. doi: 10.3322/caac.21834

2.   Boonen B, Goossens M, De Schutter H, van Walle L. Huidkanker in België. Stichting tegen Kanker; 2021.

3.   Garbe C, Amaral T, Peris K, Hauschild A, Arenberger P, Basset-Seguin N, Bastholt L, Bataille V, Marmol V del, Dréno B, Fargnoli MC, Forsea A-M, Grob J-J, Höller C, Kaufmann R, Kelleners-Smeets N, Lallas A, Lebbé C, Lytvynenko B, Malvehy J, Moreno-Ramirez D, Nathan P, Pellacani G, Saiag P, Stratigos AJ, Akkooi ACJV, Vieira R, Zalaudek I, Lorigan P. European consensus-based interdisciplinary guideline for melanoma. Part 1: Diagnostics: Update 2022. European Journal of Cancer Elsevier; 2022 Jul 1;170:236–255. PMID:35570085

4.   Melanoma Cancer Fact Sheet. Belgian Cancer Registry; 2021.

5.   Gershenwald JE, Scolyer RA, Hess KR, Sondak VK, Long GV, Ross MI, Lazar AJ, Faries MB, Kirkwood JM, McArthur GA, Haydu LE, Eggermont AMM, Flaherty KT, Balch CM, Thompson JF, for members of the American Joint Committee on Cancer Melanoma Expert Panel and the International Melanoma Database and Discovery Platform. Melanoma staging: Evidence-based changes in the American Joint Committee on Cancer eighth edition cancer staging manual. CA: A Cancer Journal for Clinicians 2017;67(6):472–492. doi: 10.3322/caac.21409

6.   Pil L, Hoorens I, Vossaert K, Kruse V, Tromme I, Speybroeck N, Brochez L, Annemans L. Burden of skin cancer in Belgium and cost-effectiveness of primary prevention by reducing ultraviolet exposure. Prev Med 2016 Dec;93:177–182. PMID:27713103

7.   Mahumud RA, Janda M, Soyer HP, Fernández-Peñas P, Mar VJ, Morton RL. Assessing the value of precision medicine health technologies to detect and manage melanoma. Med J Aust 2022 Sep 4;217(6):275–278. PMID:36057953

8.   Salerni G, Carrera C, Lovatto L, Puig-Butille JA, Badenas C, Plana E, Puig S, Malvehy J. Benefits of total body photography and digital dermatoscopy ("two-step method of digital follow-up") in the early diagnosis of melanoma in patients at high risk for melanoma. J Am Acad Dermatol 2012 Jul;67(1):e17-27. PMID:21683472

9.   Truong A, Strazzulla L, March J, Boucher KM, Nelson KC, Kim CC, Grossman D. Reduction in nevus biopsies in patients monitored by total body photography. J Am Acad Dermatol 2016 Jul;75(1):135-143.e5. PMID:26947450

10. Watts CG, Cust AE, Menzies SW, Mann GJ, Morton RL. Cost-Effectiveness of Skin Surveillance Through a Specialized Clinic for Patients at High Risk of Melanoma. J Clin Oncol 2017 Jan;35(1):63–71. PMID:28034073

11. Rayner JE, Laino AM, Nufer KL, Adams L, Raphael AP, Menzies SW, Soyer HP. Clinical Perspective of 3D Total Body Photography for Early Detection and Screening of

18

Melanoma. Front Med (Lausanne) 2018;5:152. PMID:29911103

12. Grochulska K, Betz-Stablein B, Rutjes C, Chiu FP-C, Menzies SW, Soyer HP, Janda M. The Additive Value of 3D Total Body Imaging for Sequential Monitoring of Skin Lesions: A Case Series. Dermatology 2022;238(1):12–17. PMID:34380140

13. Primiero CA, McInerney-Leo AM, Betz-Stablein B, Whiteman DC, Gordon L, Caffery L, Aitken JF, Eakin E, Osborne S, Gray L, Smithers BM, Janda M, Soyer HP, Finnane A. 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 British Medical Journal Publishing Group; 2019 Nov 1;9(11):e032969. PMID:31712348

14. Betz-Stablein B, D'Alessandro B, Koh U, Plasmeijer E, Janda M, Menzies SW, Hofmann-Wellenhof R, Green AC, Soyer HP. Reproducible Naevus Counts Using 3D Total Body Photography and Convolutional Neural Networks. Dermatology 2022;238(1):4–11. PMID:34237739

15. Betz-Stablein B, Koh U, Edwards HA, McInerney-Leo A, Janda M, Soyer HP. Anatomic Distribution of Cherry Angiomas in the General Population. Dermatology 2022;238(1):18–26. PMID:34293748

16. Cerminara SE, Cheng P, Kostner L, Huber S, Kunz M, Maul J-T, Böhm JS, Dettwiler CF, Geser A, Jakopović C, Stoffel LM, Peter JK, Levesque M, Navarini AA, Maul LV. 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 Sep;190:112954. PMID:37453242

17. Soyer HP, O'Hara M, V Silva C, Horsham C, Jayasinghe D, Sanjida S, Schaider H, Aitken J, Sturm RA, Prow T, Menzies SW, Janda M. Skin cancer excisions and histopathology outcomes when following a contemporary population-based cohort longitudinally with 3D total-body photography. Skin Health Dis 2023 Apr;3(2):e216. PMID:37013120

18. Canfield Scientific. Technical idetails VECTRA WB360. Available from: https://www.canfieldsci.com/imaging-systems/vectra-wb360-imaging-system/

19. Koh U, Janda M, Aitken JF, Duffy DL, Menzies S, Sturm RA, Schaider H, Betz-Stablein B, Prow T, Soyer HP, Green AC. "Mind your Moles" study: protocol of a prospective cohort study of melanocytic naevi. BMJ Open 2018 Sep 19;8(9):e025857. PMID:30232117

20. Jayasinghe D, Koh U, Plasmeijer EI, Menzies SW, Aitken JF, Soyer HP, Janda M, Green AC, Betz-Stablein B. The dynamic nature of naevi in adulthood: prospective population-based study using three-dimensional total-body photography. Br J Dermatol 2023 Feb 22;188(3):437–439. PMID:36763731

21. Horsham C, O'Hara M, Sanjida S, Ma S, Jayasinghe D, Green AC, Schaider H, Aitken JF, Sturm RA, Prow T, Soyer HP, Janda M. The Experience of 3D Total-Body Photography to Monitor Nevi: Results From an Australian General Population-Based Cohort
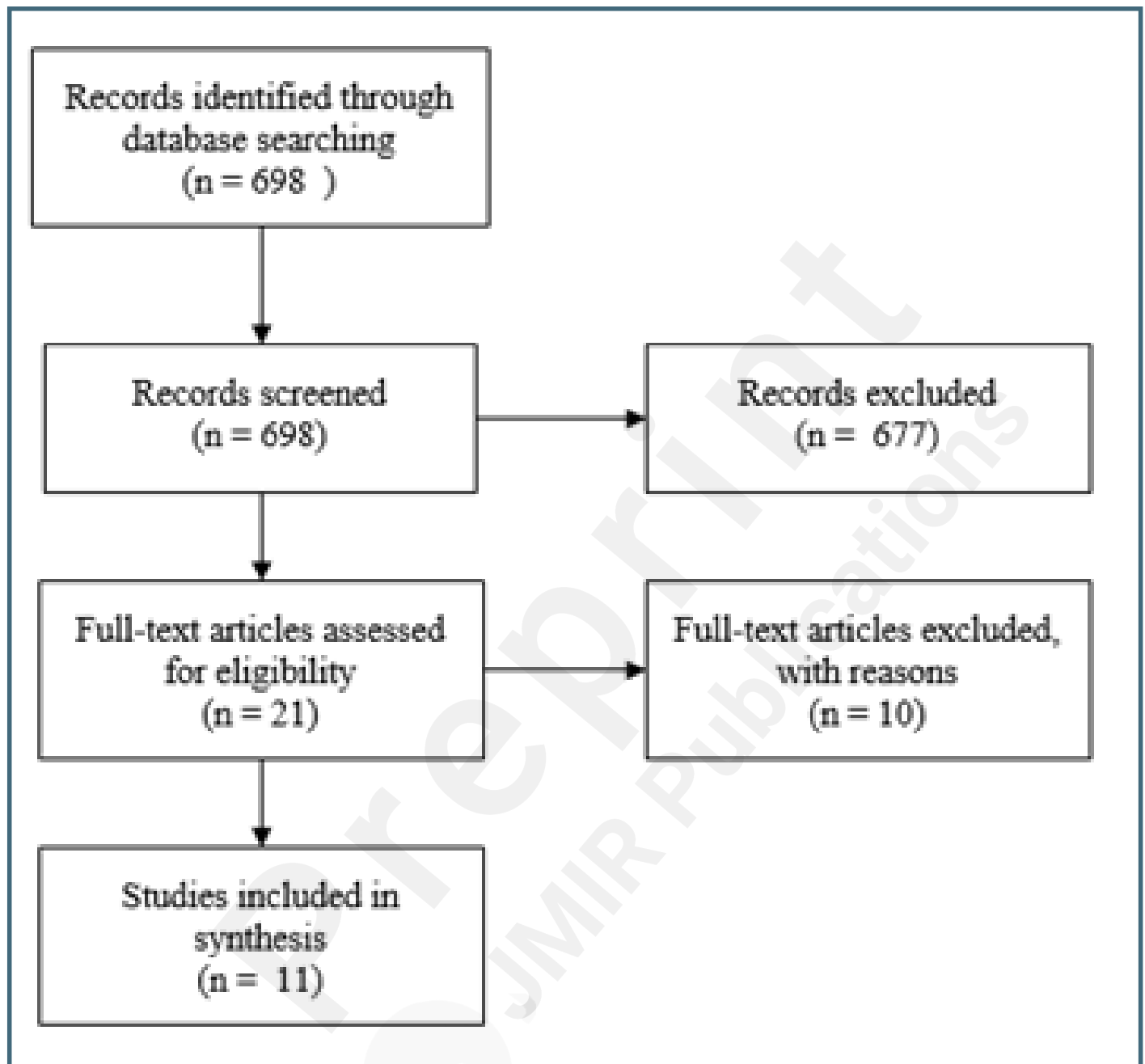
19

Study. JMIR Dermatol 2022 Jun 20;5(2):e37034. PMID:37632874

22. Hobelsberger S, Steininger J, Laske J, Berndt K, Meier F, Beissert S, Gellrich FF. Clinician's ability to identify non-melanoma skin cancer on 3D-total body photography sectors that were initially identified during in-person skin examination with dermoscopy. Dermatology 2023 Nov 6; PMID:37931611

23. Jahn AS, Navarini AA, Cerminara SE, Kostner L, Huber SM, Kunz M, Maul J-T, Dummer R, Sommer S, Neuner AD, Levesque MP, Cheng PF, Maul LV. 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 2022 Aug 7;14(15):3829. doi: 10.3390/cancers14153829

24. Marchetti MA, Nazir ZH, Nanda JK, Dusza SW, D'Alessandro BM, DeFazio J, Halpern AC, Rotemberg VM, Marghoob AA. 3D Whole-body skin imaging for automated melanoma detection. J Eur Acad Dermatol Venereol 2023 May;37(5):945–950. PMID:36708077

25. Koh U, Cust AE, Fernández-Peñas P, Mann G, Morton R, Wolfe R, Payne E, Horsham C, Kwaan G, Mahumud RA, Sashindranath M, Soyer HP, Mar V, Janda M. ACEMID cohort study: protocol of a prospective cohort study using 3D total body photography for melanoma imaging and diagnosis. BMJ Open 2023 Sep 28;13(9):e072788. PMID:37770274

26. Yan MK, Cust AE, Soyer HP, Janda M, Loewe K, Byars G, Fishburn P, White P, Mahumud RA, Saw RPM, Herschtal A, Fernandez-Penas P, Guitera P, Morton RL, Kelly J, Wolfe R, Mar VJ. Study protocol for a randomised controlled trial to evaluate the use of melanoma surveillance photography to the Improve early detection of MelanomA in ultra-hiGh and high-risk patiEnts (the IMAGE trial). Trials 2023 Mar 29;24(1):236. PMID:36991460
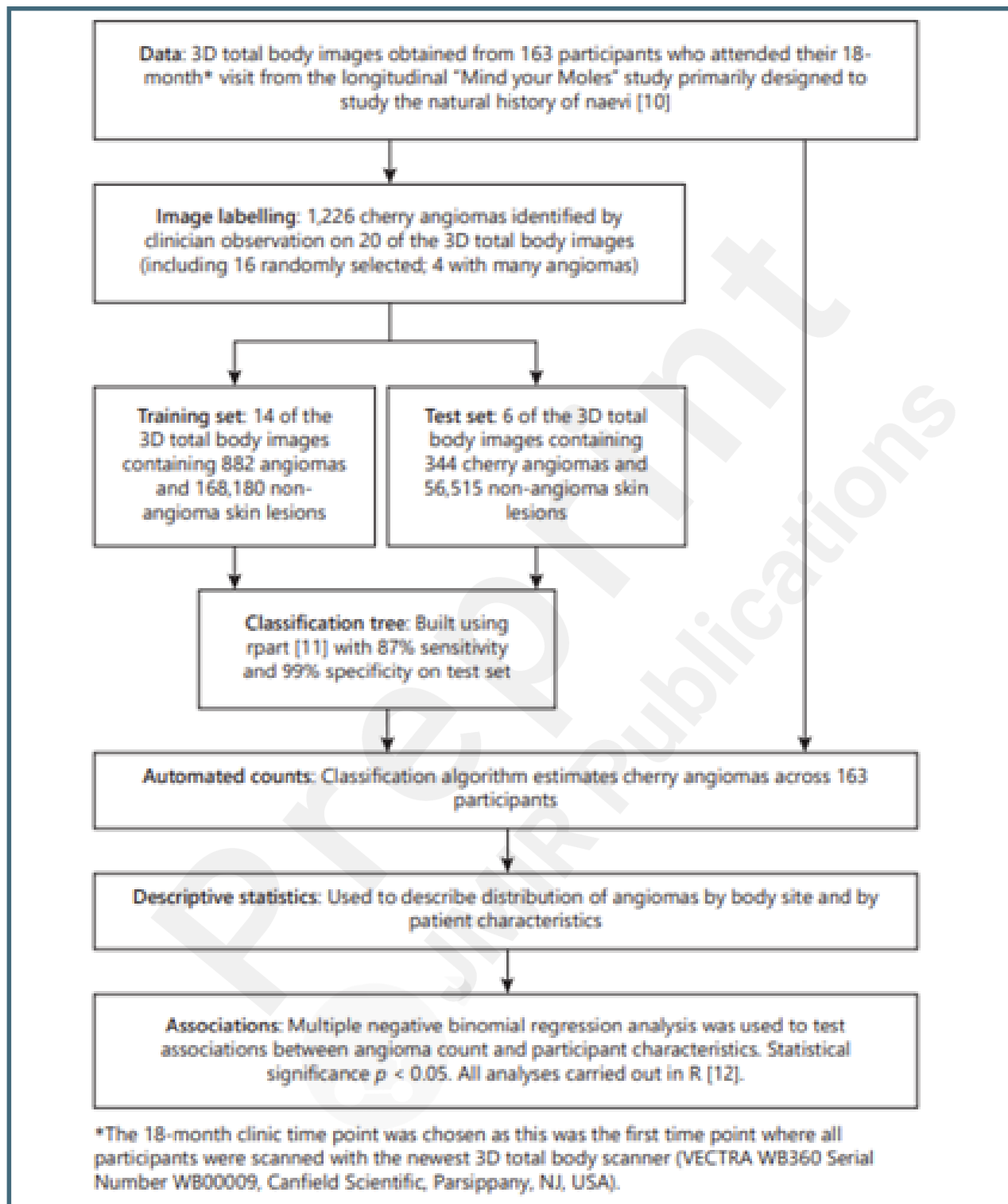
20

Supplementary Files

Figures

PRISMA Flow Diagram.

Study population and methodology. Adapted from [15].

Data: 3D total body images obtained from 163 participants who attended their 18-month* visit from the longitudinal "Mind your Moles" study primarily designed to study the natural history of naevi [10]

Image labelling: 1,226 cherry angiomas identified by clinician observation on 20 of the 3D total body images (including 16 randomly selected; 4 with many angiomas)

Training set: 14 of the 3D total body images containing 882 angiomas and 168,180 non-angioma skin lesions

Test set: 6 of the 3D total body images containing 344 cherry angiomas and 56,515 non-angioma skin lesions

Classification tree: Built using rpart [11] with 87% sensitivity and 99% specificity on test set

Automated counts: Classification algorithm estimates cherry angiomas across 163 participants

Descriptive statistics: Used to describe distribution of angiomas by body site and by patient characteristics

Associations: Multiple negative binomial regression analysis was used to test associations between angioma count and participant characteristics. Statistical significance $p < 0.05$. All analyses carried out in R [12].

*The 18-month clinic time point was chosen as this was the first time point where all participants were scanned with the newest 3D total body scanner (VECTRA WB360 Serial Number WB00009, Canfield Scientific, Parsippany, NJ, USA).

Methodology. Adapted from [14].