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

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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.

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Narrative review

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promising results, expert overview is still recommended, and AI should be used as a support tool.

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 121.000 of the cancer fatalities worldwide [1]. Belgium is no exception for these elevated and still increasing rates. In the 2021 report of the Belgian Cancer Foundation (Stichting Tegen Kanker), SC accounted 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].

Currently, 1 in 5 Belgians is diagnosed with SC before the age of 75. 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 (SSDI) 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 a number of parameters, including the longest diameter, contrast, border and colour variation, hue and naevus confidence. At this time this software is available as a research only tool. On SDDI images an AI generated risk score, the DEXI score, can be

used to assist in de 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 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 years filter was used. An additional electronic search was conducted to obtain data on Belgian epidemiology and healthcare costs concerning SC screening and management.
Two authors (D.E. and B.F.) 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.

Results

Study description

Given that 3D TBP is a recent innovation, only a limited number of studies are available. An overview of the characteristics of the different studies can be found in Table 1.
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 every six months over a period of three years to monitor changes in naevi [19]. These articles included a report on the final outcomes [17], performance of the lesion visualiser [14,15,20] and study participant experiences [21].

All other 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].
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 current software [14–16]. 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).

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 on different types of lesions [17], while 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 and thus 3D TBP imaging including SDDI of lesions that were suspicious or >5mm for assessment and diagnosis of lesions. Fifty-six percent of participants (108/193) received a referral for biopsy or excision, cryotherapy, topical treatment or further clinical examination. 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 a high number of NMSC (BCC n=36 and SCC n=3 vs melanoma n=6) and their precursors (n=25) in the general populations. 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, including dermoscopy, from one clinician and were then seen by a second clinician for one-time 3D TBP imaging without SDDI. The clinicians, both in clinic and on screen, gave a specific diagnosis for 182 suspicious lesions and 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); it had lower specificity 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].
As a part of a broader study (cf. infra) also based on the MyM protocol, on screen naevus vs non naevus identification were compared to in-clinic identification by the same clinician in 10 test participants. 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

An American study conducted by Marchetti et al. in 2023 found that the lesion characteristics, such as diameter, asymmetry and colour 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 (total of 43 histopathologically confirmed melanoma, 29 in situ and 14 invasive) and had available 3D TBP imaging captured within 90 days prior to their histopathological diagnosis. The prediction model and its multiple individual variables, namely longest diameter, contrast between the lesion and surrounding skin, asymmetry and irregularity of contour, asymmetry and variance of colours and hue, were examined to determine their predictive power. This was based on their AUC (area under the curve). The lesion visualiser detected 49 melanoma lesions and 22,489 nonmelanoma lesions, all >2mm. Within each patient, the prediction model-based probability for each lesion was ranked from lowest to highest. Of the melanoma lesions, 14% had the highest predicted score among all lesions for an individual patient and 78% were above the 90th percentile. Of the lesions that scored below that percentiles, 85% were incorrectly segmented. Five melanomas were recognized as two or more distinct lesions by the software. One melanoma was not detected. The prediction model achieved an AUC of 0.94, indicating that the 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

Three studies revealed how a CNN (a form artificial intelligence used primarily for image recognition and processing due to its ability to recognize patterns) can improve the diagnostic accuracy of the existing system to aid clinicians in the assessment of skin lesions. 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 on the general population. One study trained and tested a CNN on the 3D TBP images of 20 participants to detect, localise and count cherry angiomas and thus distinguish them from other skin lesions. The 3D TBP CNN achieved a sensitivity of 87% and a sensitivity of 99% and was able to perform the requested task [15]. In the second study, they trained (82 participants – 57,742 lesions >2mm; 5,106 naevi vs 52,636 non-naevi lesions) and tested (10 participants – 4,868 lesions >2mm; 520 naevi vs 4,348 non-naevi lesions) a CNN to detect and count naevi (both >2mm and >5mm) and compared these 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 of the diameter (91% for >2mm and >5mm). The Cohen's kappa indicated moderate agreement (0.56) for naevi ≥2 mm, and substantial agreement (0.72) for naevi ≥5 mm between machine and clinician. The agreement was lower when participants had numerous seborrheic keratoses due to an

overestimation of the number of naevi by the CNN [14]. Based on these findings, 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].
In a third study from a Swiss research group led by Cerminara et al., CNN's used on SDDI images were compared, 1,690 pigmented lesions in 143 participants at a high-risk of melanoma were used. Patients first underwent TBP with both a 3D (VECTRA WB360) and 2D (2D-FotoFinder-ATBM) imaging system. After this all melanocytic lesions ≥3mm 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. Their objective was to examine the capabilities of AI in a real-world setting. They concluded that 3D TBP CNN was superior to 2D TBP CNN (in both sensitivity and specificity). However, they found that when histopathological outcomes were used as a ground truth (75 lesions), dermatologists (without the aid of a CNN) achieved higher specificity than dermatologists aided by a CNN (so called augmented intelligence) or a CNN without human interference (respectively 92.3%, 86.2%, 64.6% for 3D CNN and 40% for 2D CNN). However, the sensitivity of dermatologist and the 3D CNN was identical (both 90%). In a sub-analysis, 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].

Advantages of 3D TBP

The main 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 ugly duckling sign (having a mole that appears significantly different than others), the evolution and appearance of new moles and lesions are important for the early detection of (de novo) SC [8,12–15,21]. 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 as 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].
Two studies explored the consumer experience and concluded that 94% of participants find 3D TBP a comfortable examination, 98% would recommend it, the majority has a high acceptability and confidence in the new technology and that there is also a reduction in melanoma-related anxiety [21,23].

Other potential benefits of the system include: a decrease in the benign/malign ratio and the NNE, 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].

Limitations of 3D TBP

Despite being a great innovation, 3D TBP holds a few 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].
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 centered around 3D TBP without published results were found on the online databases.
A new prospective population based cohort study protocol by the Australian research team of MyM, wants to investigate whether 3D TBP can be used for melanoma imaging and diagnosis on 15.000 participants from the general population. They are also including the implementation of a CNN, a cost-analysis, consumer experience [25]. The first two arm randomised controlled trial (RCT) protocol in a high-risk melanoma cohort was released in 2019 by the same Australian research group under Primiero et al. However, no results are found up to March 2024 [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 standard clinical examination to 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, number of excisions and consumer experience [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 commonly 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

narrative 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 visualiser is already highly performant and achieves great diagnostic accuracy scores, making it a great tool for independent lesion detection and counts, and possibly assessment in a near future. The 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.

Although the results are promising, 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. 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.

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 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 visualisation software are presented. 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. 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.

Conflicts of interest

None declared

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

Table 1. Characteristics of articles including 3D TBP with the VECTRA WB360 (Canfield Science).

Study	Country	Study design	Data collection	Number of participants	Median age and interval	Number of lesions	Lesion type	Clinical exam.	Use of 3D TBP FP type	SDDI of lesions type / size	Histo-pathology Number	Lesion visualiser	CNN	Conclusion
Hobelsberger et al. 2023 [22]	DE	Prospective cohort study (Susp. lesions)	2021/04 – 2022/06	129 M: 60% F: 40%	77y [42-91] >50y:	182	NMSC	Yes	One time No FU FP: 1-3	No	Yes 158 lesions	No	No	Diagnostic accuracy for 3D TBP is slighty lower than for dermoscopy in NMSC diagnosis.
Soyer et al. 2023 [17] MyM	AU	Prospective population- based cohort study (General popul.)	2016/12 – 2020/02	164 (193) M: 58% F: 42%	Not reported [18-70]	250 Susp.	MSC NMSC	Yes	3y FU 6m intervals FP: 1-4	Yes Susp. OR >5mm	Yes 234 lesions	No	No	3D TBP results in diagnosis of a high number of keratinocyte cancers (KCs) and their precursors in the general population.
Jayasinghe et al. 2023 [20] MyM	AU	Prospective population-based cohort study (General popul.)	2016/12 – 2020/02	156 M: 63% F: 37%	55y [23-70]	Not reported Autom.C	Naevus	Yes	3y FU 6m intervals FP: 1-4	No	No	Yes >2mm AND <100 naevi	No	3D TBP is an objective tool for automated naevus count.
Marchetti et al. 2023 [24]	US	Single centre retrospective observational study (High risk popul.)	2015/07 – 2021/10	35 M: 66% F: 34%	64y [26-89]	23,538 Autom.C 49 MSC 22,489 others	MSC NMSC	No	One time No FU “white”	No	Yes 43 MSC	Yes >2mm	No	3D TBP software for automated analysis has a high accuracy to differ MSC from other skin lesions
Grochulska et al. 2021 [12]	AU	Case series	2017/01 – 2020/10	3	67y [48-71]	3	Naevus	Yes	5-12 months	Yes Susp.	Yes 2 lesions	No	No	3D TBP is a valuable tool alongside dermoscopy to assist clinicians

Betz-Stablein, Koh et al. 2022 [15] MyM	AU	Retrospective population-based cohort study? (General popul.)	2016/12 – 2020/02	**163 total** M: 61% F: 59% **20 CNN** labelling 12 training 8 testing	57y [25-72]	**Training** 882 cherry angioma 7,167 other skin lesions **Testing** 334 cherry angioma 2,199 other skin lesions Autom.C	Cherry angioma	CE 20	One time No FU FP: 1-4	No	No	Yes >1mm >2mm	No	Angioma detection and counts are possible with 3D TBP
Betz-Stablein, D'Alessandro et al. 2022 [14] MyM	AU	Retrospective population-based cohort study? (General popul.)	2016/12 – 2020/02	92 total 82 training M: 62% F: 48% 10 testing M: 50% F: 50%	Training 55y [23-69] Test 57y [37-67]	62,610 Autom.C 57.742 >2mm training 4.868 testing >2mm	Naevus	Yes 10 tests	One time No FU FP: 1-4	No	No	No	Yes >2mm AND >5mm	Objective naevus detection and counts are possible with 3D TBP CNN
Rayner et al. 2018 [11]	AU	Case report (High risk case)	2016/05 – 2017/02	1 F: 100%	50y	1	MSC	No?	9m FU	Yes Susp.	Yes	No	No	3D TBP and SDDI can potentially increase the diagnostic accuracy in melanoma screening
Cerminara et al. 2023 [16]	CH	Prospective single centre observational cohort study?	2021/01 – 2021/08	143 M: 52% F: 48%	56y [22-85]	1,690 Autom.C	Naevus	Yes	One time No FU FP: 1-4	Yes Susp. OR >3mm	Yes 75 lesions	Yes	Yes 2D CNN	Dermatologist are more accurate than dermatoscopic CNN included in 3D TBP and 2D TBP.

		(High risk popul.)											3D CNN	The novel DEXI score on 3D-CNN device outperformed the 2D-CNN and achieved comparable sensitivity with dermatologists
Jahn et al. 2022 [23]	CH	Prospective single centre comparative observational cohort study (High risk popul.)	2021/01 – 2021/06	114 M: 49% F: 51%	59y [22-85]	1,204	MSC	Yes	One time No FU FP: 1-4	Yes Susp. OR >3mm	Yes 61 lesions	Yes	Yes Susp. OR >3mm	Patients rate 3D TBP as trustworthy
Horsham et al. 2022 [21] MyM	AU	Prospective population-based cohort study (General popul.)	2016/12 – 2020/02	149	55y [23-70]	/	MSC NMSC	Yes	3y FU 6m intervals FP: 1-4	Yes Susp. OR >5mm	Yes	No?	No	Majority is content, +/- 50% sees barrier

Abbreviations:	
Autom.C = automated count CNN = convolutional neural network FU = follow up M = male / F = female FP = Fitzpatrick scale MyM = based on the Mind your Moles protocol by Koh et. Al Susp.= Suspicous Popul.= Population	AU = Australia DE = Germany CH = Switzerland US = United States of America MSC = melanoma skin cancer NMSC = non melanoma skin cancer SC = seborrheic keratosis Autom.C.= Automatic count

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