Review Article

The synergy of skin and science – A comprehensive review of artificial intelligence's impact on dermatology

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ABSTRACT

Artificial intelligence (AI) has become an omnipresent area in modern culture. Every industry in the world has been greatly impacted by the development of technology, which has improved people's quality of life. With the advent of AI, even 10 years old can now use smartphones to conquer the world by simplifying complex jobs. AI has made a substantial contribution to the health-care industry as well, sparking debates about whether robots may or may not eventually replace doctors in the medical field. Interestingly, AI additionally has made important advances in the field of dermatology. Through its discovery of applications that can predict a person's skin type and the products they should use to achieve "perfect skin," AI has greatly targeted its audience in the esthetics space, where people are most concerned with the health of their bodies and hair. AI has also developed strong relationships with these people and provided excellent advice for skin-related concerns. However, the question of whether individuals are mistreating their skin or relying too much on AI to address their skin troubles remains. Certain applications use the beauty calculator based on face symmetry, which can have a drastic impact on one's self-confidence. These commercials may also instill false hope, and they may even be an advertising strategy used by the gods of the metaverse. Applications that give predictions regarding skin health can also create a state of anxiety in people who use them. This article examines whether AI has had a discernible effect on skin health, how it may influence cosmetic dermatology in the future, how accurate AI is in diagnosing conditions and recommending treatments, and whether we should rely on AI in the future for dermatological issues.

Keywords: Artificial intelligence in dermatology, Privacy and ethical concerns of artificial intelligence in dermatology, Artificial intelligence and personalized skincare, Limitations of artificial intelligence in healthcare, Artificial intelligence versus human dermatologists

INTRODUCTION

Artificial intelligence (AI) is currently being used extensively in many different industries, greatly enhancing each one – the health-care industry most prominently among them. Clinical errors generated by physicians in medical diagnosis and treatment recommendations can be eliminated by AI, according to published literature.[1]

The AI has brought significant advancements to the detection and treatment of skin illnesses, including psoriasis, skin cancer, dermatomyositis, and onychomycosis.[2] Published literature depicts a number of the most highly reviewed smartphone applications for skin care, including MDacne – Custom Acne Treatment, Acne Intelligence, Medgic – Scan, Analyze and Detect Skin Problems, Skin Bliss: Cosmetics and Beauty, and Miiskin – Skin Cancer eHealth, which are completely AI programmed.[3] Skin conditions such as melanoma have the potential to grow rapidly into cancer. Fortunately, with the help of smartphone apps like SkinVision® – which

have been downloaded over 900,000 times on Android – laypeople are now able to identify melanoma and further classify its risk, halting the disease's progression.[4] The clinical laboratory improvement amendments govern the DermTech Melanoma Test™, a physician-ordered laboratory-designed test. DermTech is developing LuminateSM to detect ultraviolet damage at the genetic level, using a proprietary adhesive, which can amplify the RNA molecule.[5] The specialty of dermatology faces challenges with significant disparities in health-care accessibility, which are amplified by the current urbanization trends and further complicated by the COVID-19 pandemic. Dermatologists tend to specialize in metropolitan areas, leaving rural and overlooked regions with a shortage of these specialists. Meanwhile, the pandemic has accelerated the transition to virtual healthcare delivery, calling into question established care models and requiring creative solutions to guarantee dermatological services to all.

Conversely, teledermatology offers a viable solution to address the discrepancy in accessibility to dermatological care by providing virtual consultations and diagnostic assessments. This approach improves marginalized communities' access to healthcare while also overcoming geographical limitations. Teledermatology is enhanced by AI analytics and monitoring, which optimizes patient self-care, personalized therapy recommendations, and diagnostic accuracy.[6] Dermatology relies on recognizing morphological traits, mostly patterns in visual data which are used for diagnosis. Although newer skin imaging methods such as dermoscopy, Reflectance confocal microscopy (RCM), and Very high frequency (VHF) ultrasonography show promise, reliable diagnosis still depends on in-person patient examinations. According to published studies, human intelligence as a whole performs better in identifying skin conditions than conventional neural networks. Other factors that have been identified as challenges since the use of AI was introduced in medicine, consist of bias in the data and algorithm of the technology, a lack of transparency about how these technologies operate, and the anxiety that follows, user privacy concerns, and issues like health-care professionals relying too much on AI. The findings might represent the consequence of many different variables.[7] In this review of the scientific literature, we will delve extensively into the wide-ranging subject of AI and look at its actual contributions to the field of dermatology.

MATERIAL AND METHODS

Thirty-one published articles from 2019 to 2024 were analyzed for this literature review using keywords such as "skincare and AI," "healthcare innovations," "online applications for skincare," "precision of AI in skincare" from Google Scholar, PubMed, and various online articles sharing more information about AI and dermatology. This literature review describes a vast array of uses of AI in dermatology

that go beyond skin cancer diagnosis. Numerous published case studies, clinical trial studies, and literature reviews were examined for the purpose of this study. The study also covers AI's natural language processing (NLP), neural networks, and machine learning, along with hazards and limitations of AI as well as how it is impacting dermatological decisions and how much it advances dermatological procedures.

RESULTS

In the discipline of dermatology, AI has proven to be extremely helpful, particularly in the early detection of skin malignancies and in resolving scheduling conflicts during patient visits. AI has also been crucial in the development of teledermatology. Furthermore, several applications use the smartphone camera to analyze and predict the future of skin. These applications also provide amazing visual demonstrations of how various skincare and haircare products may affect our skin, as well as AI has assisted dermatologists make more accurate decisions regarding their treatment strategies. However, some of the drawback's AI has promoted in dermatology include privacy concerns associated with employing face recognition systems in these applications, incomplete knowledge of how AI's internal processes work, an overreliance on technology by dermatologists and laypeople for diagnosis, or self-diagnosis by users of these applications, which occasionally may not be accurate. The AI-based applications have also led many individuals to believe misconceptions about how to take care of their skin and hair and to focus only on maintaining a "perfect appearance." As a result, from the review of published literature, it is suggested that AI should only be used as a tool to assist dermatologists and regular people, never as a substitute for a professional dermatological consultation. In addition, we may be able to depend more on the scientific advances that these technologies bring about in the field of dermatology if the gaps in the literature and the limitations of AI are addressed and presented appropriately.

How does AI in dermatology work?

The combined use of AI with machine learning is one of the most captivating ideas about its relevance to dermatology. Dermatologists insert photos of different skin disorders into machine learning algorithms, such as neural networks and support vector machines, to train algorithms. These technologies use "feature extraction" to analyze a person's face, locate lesions, measure their features, and uncover patterns that may help diagnose skin cancers earlier on.[8] With the aid of automated learning and tagged databases, the machine learning algorithm is also capable of classifying various lesions. Because the machines have good storage capacity, they can process more data more quickly, which results in more accurate diagnoses. Using its NLP models, AI can also

be used to analyze various electronic medical records, patient notes, and research articles to provide epidemiological data about a rare dermatological disease.[9] In addition, they are capable to identify and categorize skin lesions while concurrently keeping a tab on public health to determine the prevalence and incidence of the condition in the present. In addition, AI algorithms are designed to forecast a disease's prognosis based on clinical, environmental, and demographic factors.[10] Some applications are also well-known for their pre-processing configurations, which improve the sharpness of the uploaded image and adjust its size to detect the correct skin condition. A deep learning study generally employs three different types of datasets: training, validation, and testing.[11] Models for deep learning are created using a training dataset, and the algorithms are then "fitted" to carry out certain tasks. The model's design is then adjusted while its performance is assessed using a validation dataset. The test dataset offers the model's final assessment. A receiver operating characteristic curve can be utilized to demonstrate how a classifier based on machine learning behaves when the threshold is changed.[12] The classifier's accuracy increases with the increased area under the curve. A case study was cited in the published literature to clarify the notion. In the instance of melanoma, a low threshold will lead to a higher detection rate of melanomas (high sensitivity); nevertheless, benign nevi may inadvertently be misclassified as malignant (poor specificity). Raising the threshold results in a drop in sensitivity and a rise in specificity, or the number of benign naevi classified as melanoma.[12] AI algorithms improve cosmetic dermatology by assisting detect relevant data through automated energy-assisted devices and robotic treatments. AI developments have a lot to offer dermatology, including teledermatology, digital dermoscopy, and 3D imaging.

Different ways AI can assist personalized skincare

Personalization is the main strategy utilized by manufacturers and distributors of cosmetics to demonstrate, through AI, how a certain product and its constituents can enhance a person's skin. Applications such as Skin+Me employ user-uploaded images to suggest appropriate products.[13] ArcSoft Portrait is an application that automatically recognizes wrinkles, moles, acne, and cicatrices. It then intelligently softens, moisturizes, and smoothes the skin while preserving the maximum amount of skin texture and detail.[14] Utilizing these applications is subject to several restrictions, the most significant of which are physical ones related to the light exposure and pixel quality of the smartphone camera we use. The additional ethical issues with these AI-dependent apps could be privacy concerns and inaccurate diagnostic and treatment recommendations. AI has influenced dermatology and aesthetics not solely regarding skin health but also in terms of virtual try-ons. Virtual try-on tools essentially show us how a particular product, for example, a hairstyle,

or glasses can look on a particular person. The launch of Haut's SkinGPT is one such advancement in virtual try-ons. AI is used by SkinGPT to apply skin conditions to input image data and produce synthetic images. With the use of AI, users of SkinGPT may upload images and see how their skin changes over time after using different skincare products.[15] By generating simulated representations of the impacts of aging, products, and environmental harm, this application makes research, development, and testing easier. It makes data augmentation possible and closes data gaps related to phenotype and age. Incorporating this revolutionary technology may help cosmetic firms create appealing experiences for their clients while simultaneously gathering insightful information about their preferences. The personalization of skincare products can also substantially cut down unwanted expenses after purchasing a skincare product that won't be effective for one's skin. These personalized services are considered to be a boon to dermatologists because they can help them precisely choose a treatment plan for their patients without much of a time lag. Although personalization is probably one of the big goals in dermatology, and corporations are experimenting with it, we have not reached the maximum potential. As a result, smartphone applications using AI technology should never be a replacement for dermatologists, who have been visualizing, learning, and practicing in their field of expertise for years. In the ideal scenario, patients would analyze their skin at home and bring the recommended products from the app to their consultation. Dermatologists can then guide them through their options and ensure they do not use substances that they have previously reacted poorly to, as they have a better understanding of the patient's skin history.

Does AI possess some risks in dermatology?

Regardless of the matter whether AI is used in dermatology, safety, and privacy concerns pose the biggest risk. Based on data analytics published in the literature regarding AI security, the results indicate that 56% of the identified AI-driven cyberattack techniques were demonstrated in the access and penetration phase, 12% in the exploitation and command and control phase, 11% in the reconnaissance phase, and 9% in the delivery phase of the cybersecurity kill chain. These figures also demonstrate that more AI assaults can be expected in the future and that the current approach will not be sufficient to offer cyber security.[16]

Given that the deeper workings of AI are beyond the comprehension of the average person, if these technologies fall out of human hands and are taken over by non-human technologies, humans will be incapable of managing the situation. This could be disastrous for the medical field, which depended on AI to reduce workloads.[17] Moreover, facial recognition, data collection, and storage of patient

complaints, along with family history and genetic factors, are the main uses of AI in dermatology. These features could be exploited by third parties who gain access to the data through system hacking, potentially resulting in threats to individuals, impersonation, and a breach of patient and doctor confidentiality.[17,18] The AI has more expanding knowledge in the discipline of dermatology than human dermatologists have. As a result, there is a possibility that AI will eventually replace human dermatologists, making the year's-worth of education that they have invested to be practically pointless. Applications such as the Beauty Scale, which examines facial characteristics to establish standards for beauty, could infringe on an individual's independence and confidentiality over their physical appearance. These applications have the potential to compromise people's privacy and self-esteem by reinforcing unattainable beauty standards, fostering problems with body image, and adding to social pressure to meet these standards.[19] These applications have also encouraged some to pursue extreme measures such as plastic surgery and other procedures that they feel would make them more idealistic in the eyes of society. However, some have also undertaken unsuccessful attempts that did not turn out the way they had anticipated. The prevalence of applications that make unrealistic promises about skincare and haircare is also not less nowadays. These applications just thrive on false advertisements, asking for payments to upgrade the therapeutic strategy, and come out to be a scam in skincare facilities. Furthermore, these AI applications can create deepfake images of people and use them for unethical purposes.

DISCUSSION

By generating greater accuracy in treatment plans and diagnostic models, AI has improved both people's lives and those of dermatologists. However, applying AI in dermatology comes with several downsides. One of them is the complexity of data collections stored in these applications. Larger and more intricate models have become the foundation for recent advancements in AI systems, particularly in deep neural networks and generative AI (like ChatGPT). As networks become more complex, they become more challenging to comprehend and audit, and humans are less able to provide the necessary resilience to step in when a system breaks.[10] Health-care practitioners are required to adhere to stringent standards, which include refraining from sharing patient data with other companies, as a result of healthcare patient confidentiality legislation, such as the Health Insurance Portability and Accountability Act of 1996 (HIPPA).[20] This has shown to be a barrier to accessing a large amount of health-care data for AI developers. In addition, this restriction might have an impact on the variety of datasets and images that these AI systems process, which could have a detrimental effect on health-care disparities

and increase their prevalence. The challenge of algorithmic explainability comes from having discovered that machine learning models' internal operations tend to be difficult to comprehend and opaque. This usually does not occur during an appointment with the patient, where the dermatologist can more clearly and simply explain to the patient when, why, and how to take the treatment prescribed.[21] This aspect of AI can result in a loss of control over decision-making and a decline in patient and medical staff's trust in these technologies. Even though AI might be more advantageous than more conventional approaches, like using a logistic regression model, it is not used often in medical curriculum reviews. These benefits include, for instance, Artificial neural network (ANNs') capacity to resolve multidimensional issues, offer improved classification accuracy, and create robust correlations between variables.[22] The lack of ability of deep learning algorithms to articulate their method of decision-making renders it challenging to assess AI's efficacy in medical education curriculum. A vital aspect of the medical curriculum is clinical reasoning, which includes evaluating and managing patients' medical conditions by taking a thorough medical history and developing differential diagnoses. The intricacy of deep learning restricts its usefulness in supporting clinical reasoning. Research contrasting AI with conventional teaching approaches is hard to come by and necessitates sizable sample numbers as well as distinct surrogate indicators for impartial evaluation. Time restrictions and a lack of expertise can also make it difficult to integrate AI into medical school curriculum.[23] In medical education, collaboration secures clinical relevance and accuracy. Furthermore, individuals these days are increasingly inclined to turn to the internet and AI for answers about their skin and hair, which might give rise to conflicting opinions on the treatment plans recommended by dermatologists and those generated by AI.[24] Countless datasets have been fed into AI technology in an attempt to diagnose skin disorders, but it has been observed that this technology is not as effective when it comes to skin of color (SOC). SOC photos are currently noticeably underrepresented in AI training datasets since these datasets were initially trained on resources with lighter skin tones.[24,25] To avoid biased algorithms, it is crucial to teach AI computers to recognize skin lesions across skin tones, as dermatological illnesses may present differently in patients with diverse skin tones. Furthermore, AI in some instances cannot understand the real texture, quality as well as form of the skin if the device used to capture the image does not have enough pixel or lighting adjustments; thus, it could form a biased treatment, which might further do bad more than a good output. Furthermore, an individual might not be fully informed where their data is being collected and processed, thus promoting a higher chance for these data to be mishandled.[26] The legal issues, ethical issues, and data privacy issues regarding AI are not yet fully resolved. As we have mentioned before, AI is incredibly user-friendly, but those who lack digital and health literacy frequently find it challenging to

use these apps. There could be several causes for this, such as a language barrier, where the individual utilizing AI technology is unable to comprehend the slang, dialect, or language utilized by the application.[27] This could result in miscommunication, a delay in receiving treatment, or an inaccurate self-diagnosis. The trained dataset contains a reduced representation of several languages, which leads to these language disparities. Even though the majority of people are experienced smartphone users, those without smartphones or those using outdated models for whom these apps are not compatible may find these apps to be of no use. These groups primarily consist of the elderly, those 65 years of age and older, people with limited resources, and those without formal education.[28] These groups might not find the independent and user-friendly aspects of these programs beneficial, or they might be heavily dependent on their family members to use them for personal use. In either case, they might only find the in-person interactions with dermatologists to be helpful. The other drawback of AI is that human dermatologists may have a propensity to rely solely on AI rather than expanding their knowledge and becoming up to date on new methods and developments in the field.[29] Careful consideration of the equity issue in AI diagnosis is necessary to prevent unintentionally aggravating healthcare inequities.[30] If technology does not support the recommended treatment by a human dermatologist, it might lead to prejudice and erode patient-physician trust.[31]

CONCLUSION

The use of AI in dermatology has generated discussion since the advent of this technology. Concerns about personal privacy have been raised by the use of facial recognition technology in dermatology. However, AI has also played a crucial role in the early detection of skin cancer, the exclusion of conditions like malignant melanoma, the assessment of skin ulcers, the recommendation of appropriate treatment, and the assistance of dermatologists in making more precise diagnoses. Nevertheless, AI technologies might occasionally display outcomes that vary for the same input, indicating a lack of logic in these systems. As such, we cannot fully rely on them in the same way as we could on a skilled dermatologist. AI does not consist of the lengthy, peer-reviewed research and historical participation that form the basis of medicine. The human element that is essential for patient-doctor relationships is lacking in these technologies. Legal systems find it difficult to handle culpability when AI harms patients. Liability clarification and overcoming resistance are critical to using AI in healthcare. Furthermore, errors made by the AI should never be liable on the physician. It is more of a combined approach, rather than trusting the technology blindly and taking the decisions.[31] Furthermore, there are many situations in which a dermatologist must connect all the physical findings with the histology findings and the patient's history to draw a judgment rather than merely depending on their theoretical knowledge. An AI that receives input such as this is unlikely to deliver a correct diagnosis since these machines are limited in their ability to comprehend, integrate, and produce a logical explanation for all the data they encounter. In certain instances, AI has also given laypeople unrealistic expectations, which has led to doubts about dermatologist's treatment recommendations and anxiety about one's skin condition. As a result, it is accurate to end this literature study by saying that AI should only be used as a tool to assist dermatologists and regular people, never as a substitute for a professional dermatological consultation. In addition, we may be able to depend more on the scientific advances that these technologies bring about in the field of dermatology if the gaps in the literature and the limitations of AI are addressed and presented appropriately.

Ethical approval

The Institutional Review Board approval is not required.

Declaration of patient consent

Patient's consent was not required as there are no patients in this study.

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Conflicts of interest

There are no conflicts of interest.

Use of artificial intelligence (AI)-assisted technology for manuscript preparation

The authors confirm that there was no use of artificial intelligence (AI)-assisted technology for assisting in the writing or editing of the manuscript and no images were manipulated using AI.

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