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Analysis of skin health management through telemedicine and mobile health in dermatology in the post-COVID era

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ABSTRACT

Mobile health has made significant strides in the field of tele-dermatology (TD) following the developments post the COVID-19 pandemic. The application of telemedicine and mobile health to dermatology holds the potential to enhance the quality of healthcare for citizens and streamline workflows in the healthcare domain, hence this subject is of great importance. This research encompasses the last three years. A comprehensive overview examining the opportunities, perspectives, and encountered challenges regarding the integration of TD with mHealth has been provided. The narrative review methodology is based on (I) conducting research via PubMed and Scopus, and (II) conducting compliance assessment using the proposed parameters. The outcome of the research indicates rapid progress in the integration of TD with mobile health during the COVID-19 pandemic. This integration has facilitated the monitoring of dermatological issues and allowed for remote specialist visits, thereby reducing face-to-face interactions. Artificial intelligence and mobile applications have empowered citizens to take a more active role in their own healthcare, which is distinct from other imaging areas where information exchange is limited only to professionals. Opportunities that TD can offer in the field of mobile health include enhancing service quality, increasing the efficiency of healthcare processes, reducing costs, and providing more accessible care. This is applicable not only to conditions like acne, vitiligo, psoriasis, and skin cancers but also to other conditions. Integration with artificial intelligence and augmented reality (AR), along with the use of wearable sensors, are expected as future developments. However, the integration of TD with mobile health brings along issues and challenges related to regulation, ethics, cybersecurity, data privacy, and device management. These issues, along with the involvement of citizens in the process, should be addressed by scientists and policymakers.

Keywords: Telemedicine, mobile health, dermatology, tele-dermatology

Telemedicine's application in dermatology, commonly termed tele-dermatology (TD), encompasses two distinct approaches: synchronous (real-time, RT) TD and asynchronous (store-and-forward, SaF) TD. The SaF model allows for asynchronous consultations between patients and dermatologists, effectively reducing wait times for appointments. Conversely, RT TD employs video conferencing for immediate patient-doctor interaction and remains a popular method in dermatology practice [1, 2].

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TD has witnessed significant growth since 1995, with an abundance of related literature. A specific search strategy conducted on PubMed revealed 1287 related articles, with 590 (45.8%) published post-January 2020, aligning with the COVID-19 pandemic. TD enhances the quality of healthcare services, positively impacting the healthcare system including patients, general practitioners, and specialists. This enhancement is evident in improved monitoring, treatment, and overall healthcare processes, contributing to increased satisfaction among all involved parties [3, 4].

The integration of mobile health (mHealth) with TD introduces a synergistic advancement in dermatology. TD, leveraging digital health solutions, can significantly reduce or eliminate the necessity of physical travel, delivering treatments directly to the patient's location. mHealth, through specific applications on smartphones or tablets, democratizes dermatological care, enabling users to manage their conditions via virtual consultations and self-care applications. This integration marks a departure from traditional digital imaging fields such as digital radiology and pathology [5, 6].

In addition to the opportunities and challenges seen in other digital imaging disciplines, this paper also explores unique prospects and challenges in the integration of mHealth with TD. This integration plays a pivotal role in reshaping dermatological practices and enhancing patient engagement, highlighting its significance in the field [7, 8].

The scholarly focus on this topic, especially against the backdrop of the mobile technology boom, is relatively recent, with literature available on PubMed dating back to 2012. The growing interest in this area aligns with the advancements in mobile technology.

The search strategy used in this study involved targeting both teledermatology and digital dermatology and their intersections with mobile health applications. The findings indicate that, as of the date of this research, 87 studies were identified, with 40 (45%) published since January 1, 2020, during the COVID-19 pandemic. This period has notably spurred innovation in biomedical technologies, including TD. This narrative review aims to provide an overview of the developments in TD and mHealth integration over the past three years, identifying opportunities, challenges, and offering guidance for clinicians, researchers, and policymakers. The specific objectives include assessing the evolution of studies in this field; evaluating the current state of TD and mHealth, highlighting their strengths and limitations; identifying potential benefits of integration such as improved diagnostic accuracy and patient outcomes; exploring challenges like data privacy and regulatory issues; and providing best practice recommendations for implementation in dermatology. The studies discussed offer insights into both research directions and indirectly highlight gaps and bottlenecks [9].

EMERGİNG TRENDS İN TELE-DERMATOLOGY AND MOBİLE HEALTH INTEGRATİON

Responding to the COVID-19 Pandemic

The burgeoning interest in tele-dermatology (TD) prior to the COVID-19 pandemic is well-documented through significant studies [10-19]. These studies reflect the maturity of this technology, transcending its nascent stage. Clark *et al*. [19], in a systematic review conducted at the end of 2018, underscored the global access to mobile phones (4–6 billion users) and posited TD as a viable tool for diagnosis and management in dermatology. They offered a thorough assessment of mobile phone technology's integration in dermatology, probing the accuracy and concordance of mobile TD compared to traditional face-to-face consultations for skin condition diagnoses. Done *et al*. [18] explored an interoperable informatics client-server system (VA Telederm) comprising a web server and client-accessing apps. VA Telederm, designed for integration into the US Veterans Health Administration's existing TD workflow, showcased the feasibility of using mobile technology for consultative store-and-forward dermatology in large healthcare organizations. Koh *et al*. [17] examined the potential of mobile TD in facilitating skin self-examinations (SSEs) and enhancing melanoma monitoring and detection. Their study evaluated consumer acceptability and expectations of a mobile health app designed for SSE instruction and consumer-performed mobile teledermoscopy. Silveira *et al*. [16] conducted a study in Brazil on a mobile application developed for aiding skin cancer diagnosis, demonstrating its potential and reliability. The study indicated its viability as an auxiliary option in regions with limited access to dermatology clinics. Akdeniz *et al*. [15] focused on encouraging primary healthcare professionals to engage actively in early skin cancer diagnosis among nursing home residents. They emphasized the significance of integrating mHealth with TD, suggesting dermoscopy courses and web or smartphone-based applications to support healthcare professionals in early skin cancer detection. Shambi *et al*. [14] investigated acne apps, assessing their features and overall quality in facilitating clinical management. Their findings indicated the effectiveness of mobile acne apps in self-management and collaborative management of acne, despite variability in app quality and the absence of certain crucial features for effective clinical management. Marwaha *et al*. [13] evaluated the efficacy and value of TD compared to face-to-face workflows in diagnosing lesions. Their study, examining risks associated with biopsy and cancer diagnosis across different workflows, underscored the importance of mHealth implementation for TD effectiveness. Damsin *et al*. [12] provided a synthesis of the TeleSPOT project objectives, focused on early melanoma detection through TD in general practice. TeleSPOT utilized smartphone-based pigmented lesion diagnosis and an online taskforce to aid dermatologists in distinguishing suspect pigmented skin lesions. Tongde *et al*. [11] highlighted the growing integration of mobile apps in the medical field, with dermatology being no exception. They reviewed various types of dermatology apps, including those for TD, self-surveillance, disease guides, reference, dermoscopy, and others, analyzing their popularity in the Apple App Store.

THE UNPRECEDENTED IMPACT OF THE COVID-19 PANDEMİC

The Idea of the Overview

The last three years have witnessed a significant surge in interest in TD and its integration with mobile health (mHealth), largely due to the COVID-19 pandemic [10]. The pandemic has been a catalyst for TD's amalgamation with mHealth and artificial intelligence, influencing remote diagnoses of general skin pathologies and specific pathological conditions indicative of COVID-19.

The transfer of image detection tools into the hands of citizens, a necessity for protecting vulnerable groups and maintaining social distancing, has not completed the transition process. This shift has inevitably exposed critical issues, leading to a paradigm change in citizen–patient and doctor–specialist relationships, a contrast to the practices in teleradiology or telepathology. This new paradigm involves citizens as operators/technologists, raising significant implications including digital divide, privacy, data security, technology, standardization, ethics, and specific training of use. The integration of AI with patient-held apps has further broadened the scope of this field, prompting reflections by scholars, developers, and decision-makers. [20].

RESULTS

All studies passed the qualification step of Algorithm. The search yielded 40 relevant studies [21-60] since the onset of the COVID-19 pandemic.

The analysis categorized the contributions into various emerging fields of interest, including opportunities in TD and mHealth, development and testing methodologies, integration models, and challenges and bottlenecks. Some studies overlapped these categories, addressing multiple issues.

The categorization revealed specific fields of interest: opportunities in TD and mHealth, development and implementation methodologies, integration models, and identification of problems and bottlenecks.

Opportunities of TD and mHealth

Studies in this sector unanimously agreed on the promising prospects of tele-dermatology (TD) in mobile health (mHealth), emphasizing its role in enhancing overall service quality [21, 26, 27, 31, 33-35, 40-45, 48, 50-60]. Evidence suggests that TD and mHealth can improve care quality, healthcare processes, cost efficiency, and patient satisfaction, while reducing the stress on healthcare facilities. Specific studies have delved into various aspects, including potential bottlenecks, care models, and development requirements.

For instance, Gandhi *et al*. [21] highlighted a TD application's accuracy in diagnosing vitiligo. Handa *et al*. [42] assessed acceptance and opinions of TD during the COVID-19 pandemic, noting its effectiveness as an alternative to in-person visits. Hampton *et al*. [44] evaluated an app's usability for guiding skin care, finding it user-friendly. Yotsu *et al*. [45] explored an app (eSkinHealth) for disease management in sub-Saharan Africa. Tognetti *et al*. [51] reviewed an AI-based TD service for melanoma screening, noting its potential for widespread use. Peracca *et al*. [52] examined the feasibility and usage frequency of mobile mHealth tools in TD. The TELESPOT project [57] in Belgium developed a smartphone-based dermoscopy app with success in user-friendliness and effectiveness. Sondermann *et al*. [59] showed that TD and mHealth successfully reduced spatial and temporal barriers in dermatology care.

Development, Implementation, Testing, and Shared Methodologies

Five studies focused on design specifics and procedures in this field. Ritvi *et al*. [27] detailed a smartphone app in Norway for referring skin lesion cases to dermatologists, reducing unnecessary specialist consultations. Abbott *et al*. [43] proposed a guideline for capturing high-quality clinical images. Po Harvey Chin [50] developed a mHealth tool for remote self-assessment of digital ulcers. Huang *et al*. [55, 56] investigated the Nuru-goTM Derma device, a cost-effective tool for preliminary triage and remote diagnosis through teledermoscopy.

TD, mHealth, and the Integration Models

Six studies concentrated on the models of TD and mHealth and their implications. Trinh *et al*. [53] assessed organizational readiness for implementing a patient-facing mobile TD app. Veronese *et al*. [54] piloted a care model for elderly patients in senior living communities. Kho *et al*. [41] explored different business models in TD and mHealth. Yadav *et al*. [35] assessed patient satisfaction with a hybrid TD model during the pandemic. Johnson *et al*. [26] identified barriers and facilitators in monitoring low-risk skin lesions. Kling *et al*. [34] found that TD and mHealth increased follow-up care capacity but did not significantly improve care transition timeliness.

Problems and Bottlenecks

Six studies tackled the challenges in TD and mHealth. Lull *et al*. [31] evaluated German apps for psoriasis, emphasizing the importance of involving patients in app development. Han *et al*. [48] focused on privacy and security in healthcare, proposing a zero-watermarking scheme. Vestergard *et al*. [58] discussed the accuracy of TD in skin cancer recognition. Cronin *et al*. [60] reported how camera distance and angle can affect color accuracy in medical photography. Sun *et al*. [33, 40] highlighted issues in application standards and consent procedures in digital skin imaging.

Data Synthesis from the Observational Studies

Three observational studies [39, 46, 47] revealed various insights. Mostafa and Hegazy [39] showed high satisfaction and efficiency in using TD and mHealth in Cairo, Egypt. Dusendang *et al*. [46] compared different TD workflows and their impact on dermatology service utilization. Gimeno-Vicente *et al*. [47] assessed the emotional impact of WhatsApp consultations on dermatologists, noting negative effects and a preference for moderated use.

In summary, these sections synthesize a wealth of findings in TD and mHealth, covering opportunities, developmental methodologies, integration models, and identified challenges, thereby providing a comprehensive view of the current state and future potential in this evolving field.

Data Synthesis from Randomized Clinical Trials

The overview returned two randomized clinical trials (RCTs) [37, 49]. Domogalla *et al*. [37] highlighted the use of a disease management smartphone app to improve the mental health of patients with psoriasis. The study found that the app was able to induce a significant reduction in HADS-Depression scores, although further research is needed to assess the app's use frequency and its relationship with the patient outcomes. Zhang *et al*. [49] focused on the development of an image-AI-based system called Skin-Teller App to assess the severity of psoriasis. The study found that the model outperformed the average performance of 43 experienced dermatologists, with a 33.2% performance gain in the overall PASI score. The app has been used in multiple hospitals and has been confirmed to be an excellent alternative for accurate assessment by dermatologists and chronic disease self-management in patients with psoriasis.

Considered together, these two studies showed that the TD integration with mHealth:

•Improved access to healthcare: TD and mHealth can improve access to healthcare services for patients who may face geographic, financial, or other barriers to in-person appointments.

•Increased efficiency: TD and mHealth can help to reduce wait times and streamline the triage and treatment processes.

•Better patient outcomes: TD and mHealth can lead to better patient outcomes, such as more accurate diagnoses and improved management of chronic skin conditions.

•Enhanced patient engagement: TD and mHealth can empower patients to take a more active role in their healthcare by providing them with tools and resources to better manage their skin health.

•Improved mental health: The use of disease management smartphone apps may improve the mental health of people with psoriasis.

Data Synthesis from the Reviews

The reviews covered various aspects of the integration of TD and mHealth, sometimes in the context of the COVID-19 [22-25, 28-30, 32]. Glines *et al*. [22] studied the impact of technology, particularly imaging technologies, on the field of dermatology. The article discussed the use of TD and mHealth to improve diagnostic accuracy and provide access to dermatologic evaluations for underserved communities and those in rural settings. It was suggested that incorporating digital dermatology into clinical practice required legal frameworks to be addressed and reimbursement policies to be updated in order to benefit patient care. Petracca *et al*. [23] evaluated the implementation of a mobile TD app at three Department of Veterans Affairs sites using a properly designed approach. The study evaluated the organizational readiness for change (ORC) and identified enablers, obstacles, and factors affecting its implementation. The results showed a high readiness for change, with an ORC score of 4.2 out of 5. The study by Marasca *et al*. [24] was a review of the scientific literature on the applications of TD and mHealth for inflammatory skin diseases. The study found that TD and mHealth have been demonstrated to increase access to resources in the health domain, improving the access to specific dermatological care for people living in remote areas. Kevderiane *et al*. [25] reviewed and discussed the use of TD and mHealth in the care of allergic diseases of the skin. This was studied both in everyday life and in the context of COVID-19. The review discussed the TD and mHealth applications and their practical benefits for clinical trials. The study highlighted a high level of patient satisfaction. However, the review also discussed some of the limitations and challenges of these technologies. Havelin *et al*. [28] specifically reviewed the use of TD and mHealth, including AI, in managing psoriasis. The authors conducted literature searches and reviewed research publications linked to apps containing the keyword "psoriasis" to answer key questions relating to this field. In addition, they searched for apps dedicated to "psoriasis" on the analytic website www.appannie.com and reviewed research publications linked to these apps. Lee *et al*. [29] discussed how the COVID-19 pandemic affected dermatology and how TD became a popular alternative to in-person visits. Mobile TD, which allows patients to monitor and forward images of suspicious skin lesions to dermatologists for remote medical evaluation, was shown to represent a useful communication tool between medical practitioners and patients. AI technology was also used to assess clinical images for skin cancer. The authors concluded that there is a future for TD and mHealth in skin cancer detection, based on the incorporation of direct-to-consumer mobile dermoscopy with mole-scanning artificial intelligence. Perrone *et al*. [30] discussed the various areas of telemedicine that have evolved during the COVID-19 pandemic, including teleradiology, telecardiology, and TD and mHealth. The latter has enabled the early identification of diseases through diagnoses of cutaneous signs. AI has also enabled the early diagnosis and monitoring of infections. Greis *et al*. [36] highlighted the advantages of mHealth and AI in dermatology, particularly in African countries with limited medical care and long distances between patients and physicians. However, the challenge of ethnic variation needed to be addressed to improve the accuracy of automated algorithms. To achieve this, the authors concluded that there must be an increase in the quantity of available clinical data, which would require the active participation of local healthcare providers and the dermatological community. Blum *et al*. [38] discussed the advantages and potential risks of using artificial intelligence in dermato-oncology, particularly for skin cancer diagnosis and treatment. The advantages included increased efficiency and the ability for medical professionals to focus on patients, while the potential risks included a lack of trust and misclassification of benign lesions. The work also mentioned that smartphone apps could be useful for disease-specific information, but they required clear guidelines and proper implementation. Mbunge *et al*. [32] proposed a systematic review on the use of TD and mHealth in South Africa during the COVID-19 pandemic. The researchers found that South Africa adopted various digital solutions based on mobile technology during the pandemic, including SMS services, messengers (for example, WhatsApp), mHealth apps, eHealth and telemedicine, AI, chatbots, and robotics. However, these technologies faced many obstacles, including managerial and financial barriers, legal and policy barriers, infrastructure and technology barriers, and cultural barriers. The authors recommended that energy be invested in community networks, especially in rural/remote areas, to modify mHealth policies, to develop sustainable strategies for the mobilization of resources, and to link accessible worldwide initiatives supporting this mobile technology.

The reviews considered herein identified the following opportunities and problems, in which AI was also considered an element:

OPPORTUNITIES

•TD and mHealth can provide access to specialized care and improve patient outcomes.

•TD and mHealth can increase access to healthcare resources, improving access to specialized centers for people living in remote areas.

•TD and mHealth can enable the early identification of patients through diagnoses of cutaneous signs.

•mHealth and AI can be useful in dermatology, particularly in African countries with limited medical care and long distances between patients and physicians.

•TD and mHealth can be useful for disease-specific information, screening, disease surveillance, medication compliance, and communication during pandemics.

•Incorporating digital dermatology into clinical practice can improve diagnostic accuracy and provide access to dermatological evaluations for underserved communities and those in rural settings.

PROBLEMS

•The adoption and implementation of TD and mHealth technologies, including those integrated with AI, face technical issues, legal frameworks, and regulatory barriers.

•Incorporating digital dermatology into clinical practice requires legal frameworks to be addressed and reimbursement policies to be updated to benefit patient care.

•Technical issues can negatively affect the adoption of TD and mHealth technologies.

•The challenge of ethnic variation needs to be addressed in order to improve the accuracy of automated algorithms.

•TD and mHealth technologies face infrastructural and technological barriers, organization and financial barriers, policy and regulatory barriers, as well as cultural barriers.

CONCLUSION

The topic explored in this overview, concerning the integration of Digital Dermatology and Telemedicine (TD) with mobile health (mHealth), is notably intricate. Both technologies have historically faced significant challenges when integrating into the healthcare domain.

Telemedicine inherits regulatory issues similar to telemedicine and e-Health, which were only partially addressed during the COVID-19 pandemic. The integration of mHealth, a relatively new technology in its connection with digital health imaging, primarily relies on smartphone applications. While it offers opportunities to reach a wider population, it also presents its own set of challenges.

The integration of mHealth with digital dermatology and TD has accelerated during the COVID-19 pandemic, providing new possibilities for citizens and healthcare stakeholders. This review aims to contribute by assessing the current state of integration in this field. Our study adopts a narrative review approach, particularly useful in emerging scientific fields with limited medical knowledge. Narrative reviews, alongside systematic reviews, play an essential role in building knowledge in these young sectors. In this narrative review, we formulated research questions, followed a standardized checklist, and employed a well-defined review process to connect the various specific issues addressed in this field.

The overview reveals several opportunities in this area, accelerated by the urgency created during the COVID-19 pandemic. Moreover, evidence suggests that this technology was maturing even before the pandemic. By the end of 2018, with a significant portion of the global population having access to mobile phones, TD had the potential to be a valuable tool for diagnosis and management when integrated with mHealth. The integration of mHealth-based solutions into TD presents a novel paradigm in image diagnostics, enabling citizens to actively participate in their healthcare. Self-diagnosis apps have emerged across various categories in dermatology, including TD, self-surveillance, disease guidance, reference, dermoscopy, conferences, education, photograph storage, sharing, and journal apps. The ability for self-diagnosis in dermatology represents a significant technological advancement, with applications ranging from monitoring acne, vitiligo, psoriasis, and skin cancers. These opportunities extend to diverse populations, including young people, frail individuals, the elderly, and those in disadvantaged areas. The availability of robust client and server architectures for storing images also facilitates professional training in dermatology. Similarly to digital pathology, which allows remote access to electronic slides via smartphones, digital dermatology provides smartphone access to a repository of digital images, simplifying training and freeing up laboratories for more critical tasks.

The overview also highlights various challenges and barriers in this sector. While mobile devices have proliferated worldwide, the issue of the digital divide persists, particularly concerning infrastructure and devices in disadvantaged regions. Digital literacy, particularly among the elderly population, also poses a challenge. The central role of citizens in connecting to healthcare services transforms them into de facto operators/technologists. This places a substantial responsibility on app- and hardware-based smartphone tools, necessitating attention to aspects like cybersecurity, standardization, technological innovation, and ethics. In addition to mobile technology, artificial intelligence (AI) is emerging as a game-changer in healthcare. Integrating AI with TD and mHealth introduces new complexities, including issues of trust, time required for assessing benign lesions, insufficient medical knowledge for interpreting AI decisions, rapid follow-up in case of incorrect AI classifications, medico-legal concerns, reimbursement challenges, and limitations in providing adequate assistance based on AI-generated images. Moreover, various domains of intervention are emerging in this area, encompassing technologies and ethical considerations. By shifting the focus to decision-makers and diagnosticians, the overview underscores that challenges on the patient's side, such as image capturing issues, translate into difficulties for diagnosticians. The lack of guidelines, specific legislation, clear reimbursement procedures, and well-defined workflows further complicate the diagnostic process. Ultimately, the satisfaction of all actors in the mHealth process, including citizens, depends on the quality of images, ease of data upload, efficient data exchange, medical reimbursement, and medico-legal aspects.

As observed in the overview, artificial intelligence has made a significant contribution to TD and its integration with mHealth. This integration signifies a promising trajectory for future development. Challenges in this path, including regulatory and ethical aspects, mirror those in other imaging disciplines such as digital pathology and radiology. However, the active involvement of citizen-patients-operators necessitates unique attention in this integration process. Training AI algorithms to eliminate population bias, collecting more clinical data, and involving local healthcare providers and dermatological communities are crucial steps for enhancing AI's efficacy and usability in dermatology. Augmented reality presents another promising development area, with applications in patient-centric settings, medical education, training, and cosmetology. AR holds potential for improving education outcomes, enhancing dermatological condition measurement, and expanding clinical interventions. Wearable devices offer additional integration possibilities. These devices are increasingly empowering citizens to engage in virtual healthcare through interconnected tools.

In conclusion, the integration of mHealth, AI, AR, and wearable devices in TD and digital dermatology presents an attractive development scenario. Citizens, as active participants in monitoring and treatment processes, can connect with virtual healthcare through these integrated tools. However, addressing the complexities of integration requires collaborative efforts from scholars, healthcare professionals, and policymakers across various intervention domains. This collaborative approach is essential to ensure the responsible and effective integration of TD and mHealth into the healthcare ecosystem.

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Study Conception: ŞG; Study Design: ŞG; Supervision: ŞG; Funding: N/A; Materials: N/A; Data Collection and/or Processing: ŞG; Statistical Analysis and/or Data Interpretation: ŞG; Literature Review: ŞG; Manuscript Preparation: ŞG and Critical Review: ŞG.

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REFERENCES

1. Kaliyadan F, Ramsey ML. Teledermatology. In: StatPearls [Internet]. Treasure Island (FL): StatPearls Publishing; 2022 Jan.
2. Daungsupawong H, Wiwanitkit V. Revolutionizing Teledermatology: Exploring the Integration of AI, Including GPT Chatbots for AI-Driven Anamnesis, Diagnosis, and Treatment Plans: Correspondence. Clin Dermatol. 2024 Jul 13:S0738-081X(24)00131-7. doi: 10.1016/j.clindermatol.2024.07.006.
3. Santiago S, Lu J. Patient Satisfaction in Teledermatology: an Updated Review. Curr Dermatol Rep. 2023;12(1):23-26. doi: 10.1007/s13671-023-00382-z.
4. Kriwy P, Nötzold A, Seitz AT, Berger R. [Acceptance of Teledermatology: Results of a Survey of General Practitioners and Dermatologists in Saxony]. Gesundheitswesen. 2023;85(12):1149-1156. German. doi: 10.1055/a-1999-7523. [Article in German]
5. Giansanti D, Di Basilio F. The Artificial Intelligence in Digital Radiology: Part 1: The Challenges, Acceptance and Consensus. Healthcare (Basel). 2022 Mar 10;10(3):509. doi: 10.3390/healthcare10030509.
6. Giovagnoli MR, Giansanti D. Artificial Intelligence in Digital Pathology: What Is the Future? Part 1: From the Digital Slide Onwards. Healthcare (Basel). 2021 Jul 7;9(7):858. doi: 10.3390/healthcare9070858.
7. Chao E, Meenan CK, Ferris LK. Smartphone-Based Applications for Skin Monitoring and Melanoma Detection. Dermatol Clin. 2017;35(4):551-557. doi: 10.1016/j.det.2017.06.014.
8. Damanpour S, Srivastava D, Nijhawan RI. Self-acquired patient images: the promises and the pitfalls. Semin Cutan Med Surg. 2016 Mar;35(1):13-7. doi: 10.12788/j.sder.2016.013.
9. Huang K, Wu X, Li Y, et al. Artificial Intelligence-Based Psoriasis Severity Assessment: Real-world Study and Application. J Med Internet Res. 2023;25:e44932. doi: 10.2196/44932.
10. Liopyris K, Gregoriou S, Dias J, Stratigos AJ. Artificial Intelligence in Dermatology: Challenges and Perspectives. Dermatol Ther (Heidelb). 2022;12(12):2637-2651. doi: 10.1007/s13555-022-00833-8.
11. Tongdee E, Markowitz O. Mobile app rankings in dermatology. Cutis. 2018 Oct;102(4):252-256.
12. Damsin T, Jacquemin P, Canivet G, Giet D, Gillet P, Nikkels AF. [TeleSPOT Project : early detection of melanoma by teledermoscopy in general practice]. Rev Med Liege. 2019;74(12):650-654. [Article in French]
13. Marwaha SS, Fevrier H, Alexeeff S, et al. Comparative effectiveness study of face-to-face and teledermatology workflows for diagnosing skin cancer. J Am Acad Dermatol. 2019;81(5):1099-1106. doi: 10.1016/j.jaad.2019.01.067.
14. Sambhi RD, Kalaichandran R, Tan J. Critical analysis of features and quality of applications for clinical management of acne. Dermatol Online J. 2019;25(10):13030/qt1668h2kt.
15. Akdeniz M, Hahnel E, Ulrich C, Blume-Peytavi U, Kottner J. Prevalence and associated factors of skin cancer in aged nursing home residents: A multicenter prevalence study. PLoS One. 2019;14(4):e0215379. doi: 10.1371/journal.pone.0215379.
16. Silveira CEG, Carcano C, Mauad EC, Faleiros H, Longatto-Filho A. Cell phone usefulness to improve the skin cancer screening: preliminary results and critical analysis of mobile app development. Rural Remote Health. 2019;19(1):4895. doi: 10.22605/RRH4895.
17. Koh U, Horsham C, Soyer HP, et al. Consumer Acceptance and Expectations of a Mobile Health Application to Photograph Skin Lesions for Early Detection of Melanoma. Dermatology. 2019;235(1):4-10. doi: 10.1159/000493728.
18. Done N, Oh DH, Weinstock MA, et al. VA Telederm study: protocol for a stepped-wedge cluster randomised trial to compare access to care for a mobile app versus a workstation-based store-and-forward teledermatology process. BMJ Open. 2018;8(12):e022218. doi: 10.1136/bmjopen-2018-022218.
19. Clark AK, Bosanac S, Ho B, Sivamani RK. Systematic review of mobile phone-based teledermatology. Arch Dermatol Res. 2018;310(9):675-689. doi: 10.1007/s00403-018-1862-4.
20. Morone G, Pirrera A, Iannone A, Giansanti D. Development and Use of Assistive Technologies in Spinal Cord Injury: A Narrative Review of Reviews on the Evolution, Opportunities, and Bottlenecks of Their Integration in the Health Domain. Healthcare (Basel). 2023;11(11):1646. doi: 10.3390/healthcare11111646.
21. Gandhi K, Ezzedine K, Anastassopoulos KP, et al. Prevalence of Vitiligo Among Adults in the United States. JAMA Dermatol. 2022;158(1):43-50. doi: 10.1001/jamadermatol.2021.4724.
22. Glines KR, Haidari W, Ramani L, Akkurt ZM, Feldman SR. Digital future of dermatology. Dermatol Online J. 2020;26(10):13030/qt75p7q57j.
23. Peracca SB, Fonseca A, Hines A, et al. Implementation of Mobile Teledermatology: Challenges and Opportunities. Telemed J E Health. 2021;27(12):1416-1422. doi: 10.1089/tmj.2020.0500.
24. Marasca C, Annunziata MC, Camela E, et al. Teledermatology and Inflammatory Skin Conditions during COVID-19 Era:

New Perspectives and Applications. J Clin Med. 2022;11(6):1511. doi: 10.3390/jcm11061511.
25. Kvedarienė V, Burzdikaitė P, Česnavičiūtė I. mHealth and telemedicine utility in the monitoring of allergic diseases. Front Allergy. 2022;3:919746. doi: 10.3389/falgy.2022.919746.
26. Johnson A, Shukla N, Halley M, et al. Barriers and facilitators to mobile health and active surveillance use among older adults with skin disease. Health Expect. 2021;24(5):1582-1592. doi: 10.1111/hex.13229.
27. Rizvi SMH, Schopf T, Sangha A, Ulvin K, Gjersvik P. Teledermatology in Norway using a mobile phone app. PLoS One. 2020;15(4):e0232131. doi: 10.1371/journal.pone.0232131.
28. Havelin A, Hampton P. Telemedicine and e-Health in the Management of Psoriasis: Improving Patient Outcomes - A Narrative Review. Psoriasis (Auckl). 2022;12:15-24. doi: 10.2147/PTT.S323471.
29. Lee C, Witkowski A, Żychowska M, Ludzik J. The role of mobile teledermoscopy in skin cancer triage and management during the COVID-19 pandemic. Indian J Dermatol Venereol Leprol. 2023;89(3):347-352. doi: 10.25259/IJDVL_118_2022.
30. Perrone G, Bilotta C, Tullio V, Pirrone R, Argo A, Zerbo S. Telehealth modulation and new proposals during the Covid-19 pandemic: a literature review. Clin Ter. 2022;173(5):489-495. doi: 10.7417/CT.2022.2467.
31. Lull C, von Ahnen JA, Gross G, et al. German Mobile Apps for Patients With Psoriasis: Systematic Search and Evaluation. JMIR Mhealth Uhealth. 2022;10(5):e34017. doi: 10.2196/34017.
32. Mbunge E, Batani J, Gaobotse G, Muchemwa B. Virtual healthcare services and digital health technologies deployed during coronavirus disease 2019 (COVID-19) pandemic in South Africa: a systematic review. Glob Health J. 2022;6(2):102-113. doi: 10.1016/j.glohj.2022.03.001.
33. Sun MD, Kentley J, Wilson BW, et al; ISIC Technique Working Group. Digital skin imaging applications, part I: Assessment of image acquisition technique features. Skin Res Technol. 2022;28(4):623-632. doi: 10.1111/srt.13163.
34. Kling SMR, Saliba-Gustafsson EA, Winget M, et al. Teledermatology to Facilitate Patient Care Transitions From Inpatient to Outpatient Dermatology: Mixed Methods Evaluation. J Med Internet Res. 2022;24(8):e38792. doi: 10.2196/38792.
35. Yadav D, Bhatia S, Ramam M, et al. Patient perception and satisfaction with a smartphone-based teledermatology service initiated during the COVID-19 pandemic at a tertiary care hospital in North India. Indian J Dermatol Venereol Leprol. 2022;88(5):623-632. doi: 10.25259/IJDVL_608_2021.
36. Greis C, Maul LV, Hsu C, Djamei V, Schmid-Grendelmeier P, Navarini AA. [Artificial intelligence to support telemedicine in Africa]. Hautarzt. 2020;71(9):686-690. doi: 10.1007/s00105-020-04664-6. [Article in German]
37. Domogalla L, Beck A, Schulze-Hagen T, Herr R, Benecke J, Schmieder A. Impact of an eHealth Smartphone App on the Mental Health of Patients With Psoriasis: Prospective Randomized Controlled Intervention Study. JMIR Mhealth Uhealth. 2021;9(10):e28149. doi: 10.2196/28149.
38. Blum A, Bosch S, Haenssle HA, et al. [Artificial intelligence and smartphone program applications (Apps) : Relevance for dermatological practice]. Hautarzt. 2020;71(9):691-698. doi: 10.1007/s00105-020-04658-4. [Article in German]
39. Mostafa PIN, Hegazy AA. Dermatological consultations in the COVID-19 era: is teledermatology the key to social distancing? An Egyptian experience. J Dermatolog Treat. 2022;33(2):910-915. doi: 10.1080/09546634.2020.1789046.
40. Sun MD, Kentley J, Wilson BW, et al; ISIC Technique Working Group. Digital skin imaging applications, part II: a comprehensive survey of post-acquisition image utilization features and technology standards. Skin Res Technol. 2022;28(6):771-779. doi: 10.1111/srt.13195.
41. Kho J, Gillespie N, Horsham C, et al. Skin Doctor Consultations Using Mobile Teledermoscopy: Exploring Virtual Care Business Models. Telemed J E Health. 2020;26(11):1406-1413. doi: 10.1089/tmj.2019.0228.
42. Handa S, Mehta H, Bishnoi A, et al. Teledermatology during the COVID-19 pandemic: Experience at a tertiary care centre in North India. Dermatol Ther. 2021;34(4):e15022. doi: 10.1111/dth.15022.
43. Abbott LM, Soyer HP. A CLOSE-UP guide to capturing clinical images. Australas J Dermatol. 2020;61(4):353-354. doi: 10.1111/ajd.13330.
44. Hampton P, Richardson D, Brown S, Goodhead C, Montague K, Olivier P. Usability testing of MySkinSelfie: a mobile phone application for skin self-monitoring. Clin Exp Dermatol. 2020;45(1):73-78. doi: 10.1111/ced.13995.
45. Yotsu RR, Itoh S, Yao KA, et al. The Early Detection and Case Management of Skin Diseases With an mHealth App (eSkinHealth): Protocol for a Mixed Methods Pilot Study in Côte d'Ivoire. JMIR Res Protoc. 2022;11(9):e39867. doi: 10.2196/39867.
46. Dusendang JR, Marwaha S, Alexeeff SE, et al. Association of teledermatology workflows with standardising co-management of rashes by primary care physicians and dermatologists. J Telemed Telecare. 2022;28(3):182-187. doi: 10.1177/1357633X20930453.
47. Gimeno-Vicente M, Alfaro-Rubio A, Gimeno-Carpio E. Teledermatology by WhatsApp in Valencia: Characteristics of Remote Consultation and Its Emotional Impact on the Dermatologist. Actas Dermosifiliogr (Engl Ed). 2020;111(5):364-380. doi: 10.1016/j.ad.2019.10.003.
48. Han B, Jhaveri RH, Wang H, Qiao D, Du J. Application of Robust Zero-Watermarking Scheme Based on Federated Learning for Securing the Healthcare Data. IEEE J Biomed Health Inform. 2023;27(2):804-813. doi: 10.1109/JBHI.2021.3123936.
49. Zhang J, Mihai C, Tüshaus L, Scebba G, Distler O, Karlen W. Wound Image Quality From a Mobile Health Tool for Home-Based Chronic Wound Management With Real-Time Quality Feedback: Randomized Feasibility Study. JMIR Mhealth Uhealth. 2021;9(7):e26149. doi: 10.2196/26149.
50. Po Harvey Chin Y, Hsin Huang I, Yu Hou Z, et al. User satisfaction with a smartphone-compatible, artificial intelligence-based cutaneous pigmented lesion evaluator. Comput Methods Programs Biomed. 2020;195:105649. doi: 10.1016/j.cmpb.2020.105649.
51. Tognetti L, Cartocci A, Balistreri A, et al. The Comparative Use of Multiple Electronic Devices in the Teledermoscopic Diagnosis of Early Melanoma. Telemed J E Health. 2021;27(5):495-502. doi: 10.1089/tmj.2020.0057.
52. Peracca SB, Fonseca AS, Lachica O, et al. Organizational

Readiness for Patient-Facing Mobile Teledermatology to Care for Established Veteran Patients in the United States. Telemed J E Health. 2023;29(1):72-80. doi: 10.1089/tmj.2022.0009.
53. Trinh P, Yekrang K, Phung M, et al. Partnering with a senior living community to optimise teledermatology via full body skin screening during the COVID-19 pandemic: A pilot programme. Skin Health Dis. 2022;2(3):e141. doi: 10.1002/ski2.141.
54. Veronese F, Tarantino V, Zavattaro E, et al. Teledermoscopy in the Diagnosis of Melanocytic and Non-Melanocytic Skin Lesions: NurugoTM Derma Smartphone Microscope as a Possible New Tool in Daily Clinical Practice. Diagnostics (Basel). 2022;12(6):1371. doi: 10.3390/diagnostics12061371.
55. Huang K, Wu X, Li Y, et al. Artificial Intelligence-Based Psoriasis Severity Assessment: Real-world Study and Application. J Med Internet Res. 2023;25:e44932. doi: 10.2196/44932.
56. Veronese F, Branciforti F, Zavattaro E, et al. The Role in Teledermoscopy of an Inexpensive and Easy-to-Use Smartphone Device for the Classification of Three Types of Skin Lesions Using Convolutional Neural Networks. Diagnostics (Basel). 2021;11(3):451. doi: 10.3390/diagnostics11030451.
57. Damsin T, Canivet G, Jacquemin P, et al. Value of Teledermoscopy in Primary Healthcare Centers: Preliminary Results of the TELESPOT Project in Belgium. Dermatol Ther (Heidelb). 2020;10(6):1405-1413. doi: 10.1007/s13555-020-00445-0.
58. Vestergaard T, Prasad SC, Schuster A, Laurinaviciene R, Andersen MK, Bygum A. Diagnostic accuracy and interobserver concordance: teledermoscopy of 600 suspicious skin lesions in Southern Denmark. J Eur Acad Dermatol Venereol. 2020;34(7):1601-1608. doi: 10.1111/jdv.16275.
59. Sondermann W, von Kalle C, Utikal JS, et al. [External scientific evaluation of the first teledermatology app without direct patient contact in Germany (Online Dermatologist-AppDoc)]. Hautarzt. 2020;71(11):887-897. doi: 10.1007/s00105-020-04660-w. [Article in German]
60. Cronin A, Tkaczyk ER, Hussain I, Bowden A, Saknite I. Effect of camera distance and angle on color of diverse skin tone-based standards in smartphone photos. J Biophotonics. 2023;16(6):e202200381. doi: 10.1002/jbio.202200381.