# Better Understanding Digital and AI-enabled Technologies for Improving the Care of Patients with Acne Vulgaris

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## Abstract

**Background:** Acne vulgaris is a common dermatologic condition, especially among young pubescent. This often leads to long-term physical and psychological conditions. While traditional treatments are effective, significant barriers to optimal outcomes remain.

**Objective:** This review examined how emerging digital tools (eg, artificial intelligence, mobile applications, SMS reminders, chatbots, and teledermatology) are improving acne vulgaris treatment monitoring, patient adherence, and self-management.

**Methods:** A review of 136 recent literature was conducted on PubMed. This includes randomized controlled trials, qualitative studies, and technology evaluations of AI and digital tools (eg, digital education tools and patient-facing apps). Studies varied by different technological approaches and populations, focusing on adolescents and young adults.

**Results:** Out of the 21 studies reviewed, multiple showed that patients' self-regulation, quality of life, satisfaction, and clinical outcomes significantly improved via digital education platforms such as SMS reminders, mobile health apps, and AI-based image analysis tools. However, limitations included variable user engagement and privacy concerns. In terms of AI-based interventions, they were highly accurate in acne severity grading and lesion detection, but would benefit from more sufficient diversity in training datasets for AI systems.

**Conclusions:** AI and technological applications have great potential for improving acne treatment and patient engagement. While much evidence supports their value in improving adherence and monitoring, further research is needed to ensure accuracy and justify long-term clinical benefits.

## Introduction

Acne vulgaris is one of the most common dermatologic conditions worldwide, affecting around 85% of young pubescents between the ages of 12 and 24. While it is not typically life-threatening, it has substantial physical, psychological, and social impacts. Many treatments are widely available, but many patients still end up with poor outcomes due to inadequate treatment adherence, delayed care, or lack of follow-up.

In recent years, inroads have been made for digital health technologies and AI in dermatology for improving acne management. Tools such as smartphone apps, SMS reminders, web-based behavioral platforms, and AI-driven image analysis have been developed to enhance patients' treatment experience. These technologies are especially important where the need for consistent follow-up is challenging.

Many studies have investigated the potential of these technology-based tools to improve clinical outcomes, which ranged from automated SMS reminders to AI-based analysis from selfies. Furthermore,

virtual follow-up appointments and online education programs have shown promise in improving satisfaction while minimizing barriers to care. While most studies support the use of AI and digital tools, limitations still exist. Some examples include limited access to technology, trust in technology, and limited education.

This review synthesizes the current literature on the application of AI and digital tools in the management of acne vulgaris. It focuses on three parts: treatment adherence, treatment monitoring, and the effects of digital tools on clinical outcomes.
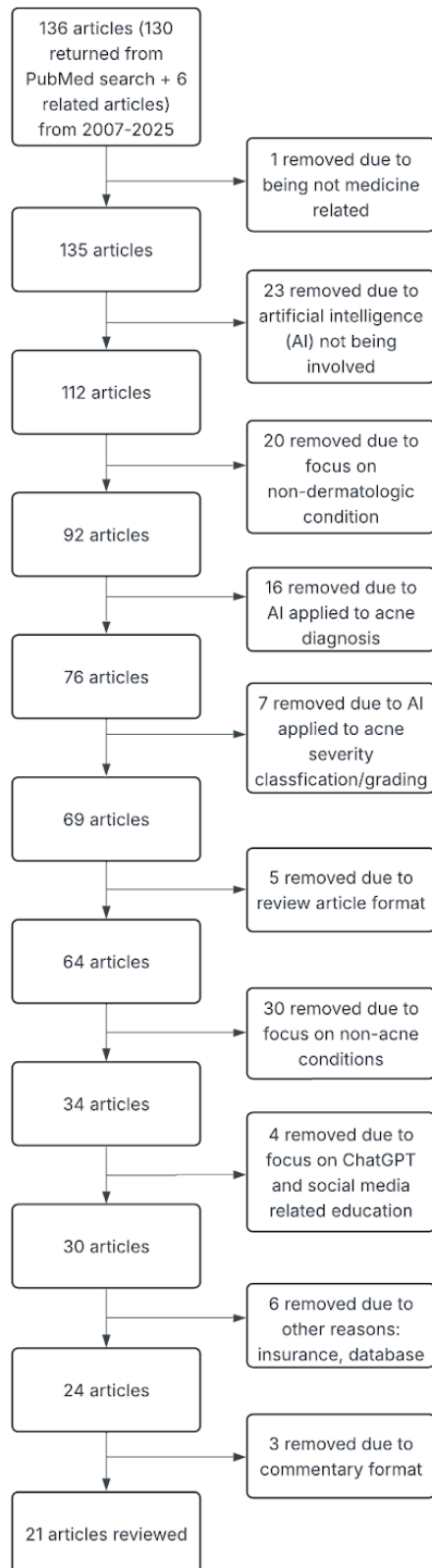
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# Methods

### Search strategy
A comprehensive literature search was conducted using PubMed. All studies were in English. The search terms included a variety of keywords such as "acne", "artificial intelligence", and "machine learning". We only included studies from 2007 to 2025 (for the full search query, see Appendix 1).

## Figure 1: The Exclusion Process

136 articles (130 returned from PubMed search + 6 related articles) from 2007-2025

→ 1 removed due to being not medicine related

135 articles

→ 23 removed due to artificial intelligence (AI) not being involved

112 articles

→ 20 removed due to focus on non-dermatologic condition

92 articles

→ 16 removed due to AI applied to acne diagnosis

76 articles

→ 7 removed due to AI applied to acne severity classfication/grading

69 articles

→ 5 removed due to review article format

64 articles

→ 30 removed due to focus on non-acne conditions

34 articles

→ 4 removed due to focus on ChatGPT and social media related education

30 articles

→ 6 removed due to other reasons: insurance, database

24 articles

→ 3 removed due to commentary format

21 articles reviewed

### Inclusion and Exclusion Criteria

Articles were included if they focused on acne vulgaris, examined the use of AI and other digital tools, involved young adult populations (generally ages 12-30), reported on treatment monitoring, patient adherence, and satisfaction, and clinical outcomes.

Articles were excluded if they didn't have artificial intelligence (AI) involved, didn't include a dermatologic condition, focused on AI in acne diagnosis, focused on AI in acne classification and grading, were review articles, focused on another dermatologic condition, focused on ChatGPT and social media-related education, or focused on others: insurance and database, were commentary (see also figure 1).

### Article Selection Process

The initial search returned 130 articles, and we also added 6 similar articles. Titles and abstracts were reviewed to determine their relevance. Then full texts were reviewed to confirm inclusion.

# Results

### Digital Tools Improve Treatment Adherence and Outcomes for Acne Vulgaris Patients

Several randomized trials showed that pairing digital educational materials with reminders improved adherence more than reminders alone. For example, one study combining SMS reminders with visual leaflets for patients using topical adapalene/benzoyl peroxide (A-BPO) achieved the greatest improvement in Investigator's Global Assessment (IGA) scores and quality-of-life measures compared to leaflet-only and standard-care groups (1). Similarly, supplementary digital educational materials increased adherence rates to 63.1% compared to 48.2% in a group receiving additional clinic visits without materials (2). In contrast, twice-daily SMS reminders without educational support failed to significantly improve adherence (33.9% vs 36.5%, $p = .75$) (3), underscoring the importance of multimodal strategies. Pilot studies suggested that message frequency tapering may sustain engagement, with patients rating such programs highly for usability and helpfulness (4). Responsiveness was highest during the initial phase with daily reminders, but gradually declined over time, and patients reported that shifting to less frequent, weekly messages helped maintain motivation while reducing message fatigue (4).

### Teledermatology Offers Comparable Clinical Outcomes

Multiple trials demonstrated that remote follow-up care is clinically equivalent to in-person visits. Asynchronous e-visits matched office visits in inflammatory lesion reduction (–6.67 vs –9.39; $p = .49$) and patient satisfaction levels (5), while mobile teledermatology for isotretinoin monitoring achieved similar Global Evaluation Acne (GEA) score improvements ($\Delta = 2.25$ vs 2.0) and high patient acceptance, with some requesting occasional live check-ins (6). Smartphone-based post-procedure monitoring following acne scar resurfacing was viewed as convenient and reassuring by 100% of surveyed users (n =

14). However, a significant minority voiced concerns about data privacy and the reliability of remote image review, with nearly half questioning whether photographs alone could fully replace in-person assessment (7). Taken together, these findings suggest that while teledermatology offers a safe, efficient, and well-accepted alternative to office visits, its long-term success will depend on balancing convenience with safeguards for accuracy, confidentiality, and patient trust.

**AI-Based Systems for Diagnosis and Monitoring**

AI-based applications have shown promising results in acne diagnosis and monitoring in technical validation studies. Deep learning models for acne grading achieved accuracies ranging from 67% to 97.9% (8)(9), with IoT-integrated convolutional neural network (CNN) systems delivering up to 97.93% detection accuracy while reducing computational latency (9). Smart LED therapy devices combined lesion detection (via architecture ResNet50 + YOLOv2) with IoT-enabled treatment delivery, demonstrating reliable automation potential (10). An AI-based patient-visit forecasting model predicted dermatology outpatient demand with $R^2 = 0.9885$ (11), enabling proactive scheduling. Despite technical promise, most AI studies were limited by dataset bias, lack of diversity reporting, and insufficient clinical validation (8)(12).

AI-based systems for acne diagnosis and monitoring showed impressive accuracy, but several drawbacks limit their clinical applicability. Most studies carried a high risk of bias, with few conducted in real-world settings. Dataset diversity was also limited, as fewer than one in five studies reported participant ethnicity or skin type, raising concerns about generalizability across different populations. In addition, only a minority of models underwent independent validation, meaning reported accuracy rates may overestimate real-world performance. Finally, privacy risks, lack of model transparency, and inconsistent regulatory standards remain major barriers to routine clinical use.

**Self-management and Behavioral Interventions**

Digital self-management programs significantly improved self-regulation, reduced acne-related disability, and enhanced quality of life (13). A web-based youth intervention ("Spotless") (14) and the MiDerm app (15) showed high engagement, with participants valuing autonomy and tailored support. Internet-based weekly follow-ups (16) and chatbot-assisted self-regulation programs (13) both led to notable clinical improvements and better patient-reported outcomes. However, some users experienced notification fatigue (15,3), highlighting the need for personalization in reminder frequency. Overall, these findings highlight that digital self-management tools are most effective when they combine clinical support with flexibility, ensuring patients remain engaged without feeling overwhelmed.

**Psychological and Sociocultural Factors in Acne Care**

The psychological aspects of acne care affect both treatment outcomes and the effectiveness of digital tools. Surveys revealed that acne scars impose greater psychological and social burdens than acne alone, often linked to delayed professional treatment and reliance on non-dermatologic care (17). Patients with scarring frequently reported reduced self-confidence, social withdrawal, and emotional distress, with many expressing dissatisfaction over the limited effectiveness or high costs of cosmetic treatments (17). These burdens not only shaped treatment-seeking behavior but also influenced patients' willingness to engage with digital interventions, as those struggling with greater psychological distress often desired more comprehensive, supportive features beyond simple reminders.

In addition to psychological concerns, sociocultural factors played a key role in shaping treatment patterns. Racial and ethnic differences influenced the types of treatments used, with over-the-counter reliance and adherence rates varying across groups despite similar expectations for quick results (18). Cosmetic use was also widespread, functioning as both a coping mechanism to improve self-confidence and a potential exacerbating factor that patients believed could worsen acne (19). Together, these findings highlight that acne management extends beyond pharmacologic care, requiring sensitivity to both the emotional and cultural dimensions of patient experience.

**Educational Innovations**

Digital education strategies not only improve patient knowledge and engagement, but also strengthen the training of future healthcare providers." A short clinician-created educational video improved patient acne knowledge scores from 81 to 99 ($p < .001$) (20)  and was preferred over pamphlets for clarity and engagement. Among pharmacy students, an active-learning "Personal Pharmacy" assignment strengthened confidence in recommending nonprescription acne treatments (21). These findings suggest that interactive, professionally guided digital education benefits both patients and future providers.

Overall, the literature supports the integration of AI-driven tools, teledermatology, and multimodal educational strategies to improve acne management. Yet, engagement sustainability, equitable access, privacy safeguards, and rigorous validation remain critical for widespread adoption.

# Discussion

This review highlights the increasing role of digital health tools in managing acne vulgaris. Overall, interventions such as teledermatology, mobile apps, SMS reminders, and AI-based monitoring have demonstrated clear benefits in improving treatment adherence, clinical outcomes, and patient satisfaction. While many of these tools are still in early stages of development, the evidence suggests they can provide outcomes that are at least equivalent to, and often more convenient than, traditional in-person care.

A consistent theme across studies was that technology works best when paired with education and personalization. Simple reminders, such as SMS reminders alone, rarely sustained long-term adherence,

whereas combining reminders with visual instruction or behavioral support led to meaningful improvements. This suggests that successful digital interventions must do more than prompt patients—they must empower them to understand and manage their condition.

Teledermatology and remote monitoring emerged as especially promising, offering comparable clinical outcomes to office visits while saving time and increasing accessibility. At the same time, patient feedback indicated that occasional live check-ins remain valuable, pointing toward hybrid models of care as the most realistic path forward.

AI showed remarkable technical performance in acne detection and severity grading, but challenges remain. Most AI models were trained on narrow datasets, raising concerns about bias and generalizability across different skin types. Until these systems are validated in larger, more diverse clinical settings, they should be used cautiously and always in conjunction with dermatologist oversight. Relying solely on AI risks overlooking important nuances such as variations in skin tone, comorbid conditions, and patient history—factors that not all automated systems are equipped to fully interpret. As such, AI should currently serve as a supportive tool that augments, rather than replaces, the clinical judgment of trained dermatologists.

The psychosocial dimension of acne also came through strongly in this review. Digital tools that incorporated self-management, autonomy, and psychological support improved quality of life as much as, or more than, they improved disease severity. This reinforces the need for acne care to extend beyond the skin to address the social and emotional burdens that patients face.

Despite these promising findings, there are clear limitations. Many of the reviewed studies were small, short-term, and conducted in populations with good access to technology. Barriers such as digital literacy, data privacy, and trust in AI were often underexplored, yet they are critical for real-world adoption.

Looking forward, future work should focus on long-term trials that include diverse populations and integrate digital interventions into standard care pathways. Hybrid models that blend in-person and digital follow-up, combine personalized education with behavioral reinforcement, and ensure equity of access are likely to be the most effective. If these challenges are addressed, digital health tools have the potential not only to improve adherence and monitoring but also to transform the overall experience of living with acne.

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# Appendix

Full search query: ("acne"[Title/Abstract] OR "acne vulgaris"[MeSH Terms]) AND ("artificial intelligence"[MeSH Terms] OR "AI"[Title/Abstract] OR "machine learning"[Title/Abstract] OR "deep learning"[Title/Abstract] OR "neural network"[Title/Abstract] OR "neural networks"[Title/Abstract] OR "chatbot"[Title/Abstract] OR "chatbots"[Title/Abstract] OR "virtual reality"[Title/Abstract] OR "VR"[Title/Abstract] OR "mobile"[Title/Abstract] OR "smartphone"[Title/Abstract] OR "mobile application"[Title/Abstract] OR "mHealth"[Title/Abstract] OR "computer-guided"[Title/Abstract] OR "web-based"[Title/Abstract]) AND ("treatment"[Title/Abstract] OR "therapy"[Title/Abstract] OR "management"[Title/Abstract] OR "compliance"[Title/Abstract] OR "adherence"[Title/Abstract] OR "monitor"[Title/Abstract] OR "monitoring"[Title/Abstract] OR "prediction"[Title/Abstract] OR "remission"[Title/Abstract] OR "prognosis"[Title/Abstract])