Efficacy, perception, and utilization of pediatric teledermatology: A systematic review

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Background: The use of teledermatology abruptly expanded with the arrival of COVID-19. Here, we review recent studies regarding the efficacy, perception, and utilization of telemedicine in the pediatric population.

Objective: To evaluate the current state of pediatric teledermatology.

Methods: A literature search was performed using the terms "pediatric," "teledermatology," "dermatology," "telemedicine" and "telehealth" in PubMed, Scopus, Embase, and Google Scholar. 44 articles published between 2008 and 2022 were included.

Results: Diagnostic concordance between pediatric teledermatologist and in-person dermatologist ranged from 70.1% to 89%. Conditions treated with pediatric teledermatology were similar to those treated in-person. The rate of in-person follow-up after an initial telemedicine appointment pre and postpandemic was 12% to 51.9% and 13.5% to 28.1%, respectively. Patient satisfaction with teledermatology was between 70% to 98% and provider satisfaction was approximately 95%. The integration of teledermatology can reduce missed appointments and wait times among pediatric patients. However, considerable technological challenges exist, particularly in underserved communities. Globally, teledermatology may expand access to care though limited literature exists regarding its use in pediatric populations.

Conclusion: Telemedicine is effective for the diagnosis and treatment of many dermatological conditions in children, with high patient and provider satisfaction. Implementation of teledermatology can potentially increase access to care both locally and globally, but obstacles to engagement remain. (JAAD Int 2023;12:3-11.)

Key words: access; concordance; global; health equity; pediatric; teledermatology; telemedicine; underserved.

INTRODUCTION

Access to pediatric dermatologists is limited. According to the Society for Pediatric Dermatology, there were less than 400 board-certified pediatric dermatologists in the United States in 2020[1] and wait times for appointments can be up to 4-6 months.[2,3] Since the arrival of COVID-19, teledermatology has been proposed as a means to augment dermatological services for pediatric patients. However, the current state of virtual medicine remains in flux.

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Here we discuss recent literature on pediatric teledermatology regarding diagnostic and management concordance with in-person evaluation, conditions treated, rates of in-person follow-up, parent and physician satisfaction, utilization in underserved communities, and international approaches to virtual care.

METHODS

A systematic review of literature on pediatric teledermatology was performed. The terms "pediatric," "teledermatology," "dermatology," "telemedicine," and "telehealth" were used to search PubMed, Scopus, Embase, and Google Scholar. Original and review articles published before November 2022 were evaluated for relevance to pediatric teledermatology (Fig 1). Risk level of selection, attrition, and reporting bias were evaluated (Fig 1).

CAPSULE SUMMARY

- Telemedicine is effective for diagnosing and managing many dermatological conditions in children, and patients and providers have expressed satisfaction with the modality.
- Despite some encouraging data, it is unknown if sufficient interest, utilization and infrastructure exist to meaningfully increase access to care.

RESULTS

Study characteristics

Of 44 publications included, there were 25 retrospective analyses, 6 prospective studies, 6 survey studies, and 3 literature reviews (Table I). There was 1 of each: clinical trial, systematic review, case series, and commentary. Studies were published between 2008 and 2022 encompassing a sample size of 34,995 patients.

Diagnostic and management concordance

Teledermatology relies on the clinician's ability to accurately diagnose and manage cutaneous disease in a virtual setting. Diagnostic concordance of pediatric teledermatology with in-person evaluation for common dermatologic conditions was between 70.1% and 89% (Table II).[4-9] Lasierra et al[5] demonstrated diagnostic concordance of 76% for inflammatory dermatoses, 75% for infections and infestations, and 79% for tumors in pediatric patients. In a randomized clinical trial by O'Connor et al[7] diagnostic concordance was 100% for hemangiomas, 92% for rashes, and 64% for alopecia-related diagnoses.

When comparing diagnostic concordance between televisits conducted by dermatologists and referring providers, there was a wide range of concordance, from 39% to 82.4%.[8,10,11,17,18] One study found that referring providers had the lowest concordance with tinea versicolor, seborrheic dermatitis, pityriasis rosea, xerosis, and lichen striatus.[10] In another study, pediatricians had high-concordance with infantile hemangiomas and low-concordance with tumors.[17] While some conditions were accurately diagnosed by nondermatologists, many others required specialized dermatological knowledge, which may account for the wide range of concordance in these studies.

A study conducted post-COVID-19 found diagnostic concordance of 70.1% between virtual assessment and in-person evaluation,[6] a rate on the lower end compared to studies conducted prior to the pandemic. Although this study did not specify the cause of decreased diagnostic concordance, its limitations suggested that the pandemic resulted in fewer in-person appointments, which may have decreased the number of ultimate diagnoses at follow-up visits.[6] Furthermore, teledermatologists rated their confidence as high and medium in 51.3% and 39.4% of the cases, respectively, indicating that a learning curve may be a factor in correctly diagnosing teledermatology cases.[6] This retrospective analysis found management concordance of 74.4% between physicians treating patients in-person and teledermatologists.[6] Overall, literature suggests that diagnostic and management concordance is relatively high, validating the effectiveness of pediatric teledermatology for many dermatologic diseases.[4-6]

Diseases commonly treated via pediatric teledermatology

The most common conditions evaluated utilizing pediatric teledermatology were atopic dermatitis, inflammatory dermatoses, benign melanocytic nevi, infantile hemangioma (IH), molluscum contagiosum, verruca vulgaris, and acne.[8,12-15,17,18] There was little divergence from conditions commonly treated by pediatric dermatologists during in-person encounters.[16] A cross-sectional retrospective study by Giavina Bianchi et al[13] found that the use of store-and-forward photography enabled 63% of pediatric skin lesions identified in the primary care setting to be managed without an in-person visit. In the same study, the most common diseases treated via teledermatology varied by age: 0-2 years: atopic dermatitis and benign melanocytic nevi; 3-12 years: atopic dermatitis, verruca, and molluscum; and

Abbreviation used:

IH: infantile hemangioma

13-19 years: acne, atopic dermatitis, benign melanocytic nevi, and verruca.[13] Duan et al[15] found that among patients age 0-2 years, IH was more likely to be treated via telemedicine than in-person, whereas the opposite was true for management of atopic dermatitis. Among patients aged 13-17 years, acne was more commonly managed through telemedicine while higher rates of in-person evaluation were noted for viral warts and scars.[15] Occurrence rates of common cutaneous conditions treated via teledermatology include IH (19% to 22%),[17,18] infections (15% to 20%),[8,17,18] benign melanocytic nevi (23% to 45%),[8,14] and viral warts (15%).[14]

During the pandemic, 1 study found that the majority of pediatric teledermatology encounters consisted of "inflammatory dermatoses" (75%), primarily atopic dermatitis.[12] A minority of diagnoses were described as "lesions" (25%), the most prevalent of which was IH.[12] Duan et al[15] also found that patients and families more often chose teledermatology for diagnosis and management of acne, IH, and contact dermatitis rather than atopic dermatitis, verruca vulgaris, and alopecia areata. Despite numerous studies demonstrating treatment of skin conditions via telemedicine,[8,12-15,17,18] consensus on the optimal modality for management of individual dermatologic diseases in the pediatric population remains unclear.

In-person follow-up after telemedicine encounters

Prior to the COVID-19 pandemic, the rate of an in-person follow-up visit after a pediatric teledermatology appointment ranged from 12% to 51.9%.[8,17-21] Since the arrival of COVID-19 this rate ranged from 13.5% to 28.1%.[6,22] The lower rate during the pandemic could potentially be due to restrictions on in-person visits and/or a growing acceptance of teledermatology. Notably, in-person visits following e-consult referrals, had a significantly lower no-show rate compared with appointments generated through a traditional referral system (39% vs 71%) in pediatric patients.[20]

The modality used during the telemedicine encounter may also affect the need for in-person follow-up. One study using live video conferencing found that 13.5% of cases required in-person follow-up.[22] Most other studies used store-and-forward teledermatology reporting a wide range of rates of in-person follow-up postencounter (12% to 51.9%).[6,8,17-21] Additional studies are warranted to understand the differential impact of various communication methods on overall efficacy and the need for in-person follow-up after a telemedicine encounter.

Preceding the COVID-19 pandemic, common conditions requiring in-person follow-up included IH,[17] acute rash/flare, chronic rash, suspicious lesion,[21] "nonspecific skin eruption"[20] and "tumors and vascular anomalies".[18] Specifically, for IH patients, children under 2 months of age had the highest rate of in-person visit referrals.[17] Since the start of the pandemic, the most to least common conditions for in-person follow-up were verruca, psoriasis, alopecia, vascular lesions (eg, IH, pyogenic granuloma), pigmented lesions, café-au-lait macules, pigmentary alteration, molluscum, nail disorders, atopic dermatitis, infections, scalp lesions, and acne.[6,22] Variability in study design may contribute to the discrepancy in reported conditions before and after the pandemic. There is a wide range of reported rates for in-person follow-up encounters.[6,8,17-22] Further research is needed to determine which conditions are more likely to require in-person follow-up after a virtual visit.

Parent, patient, and provider satisfaction

Several publications have reported high satisfaction rates with use of telemedicine among pediatric patients, parents, and dermatologists.[19,23-26] An increasing acceptance of technology for use in clinical care may be contributory.[27] In one survey, 98.4% of patients were either somewhat satisfied or very satisfied with their telemedicine encounters,[23] while other studies showed parent satisfaction of 77%[19] and 70%.[26] Conversely, Lowe et al[12] found that 52% of patients and parents were unsatisfied with telephone consultations. While 65% of respondents preferred face-to-face encounters in the future, 98% had no outstanding concerns after their televisit. Reasons for dissatisfaction included the lack of opportunity for a complete examination (eg, photographs that do not capture full extent of rash), inadequate patient/parent−clinician communication by telephone (eg, lack of visual cues or body language), variable digital literacy, and the absence of a personal element.[12] Notably, visits in this study were conducted via telephone calls supported by images, and many respondents indicated that video conferencing may better address these concerns.[12]

Overall, pediatric dermatologists relayed positive feedback regarding the use of telemedicine. In one study, 95.2% were somewhat satisfied or very satisfied with telemedicine.[23] Kourosh et al[24] reported that 90% of providers predicted telemedicine would increase access, 77% thought it could save

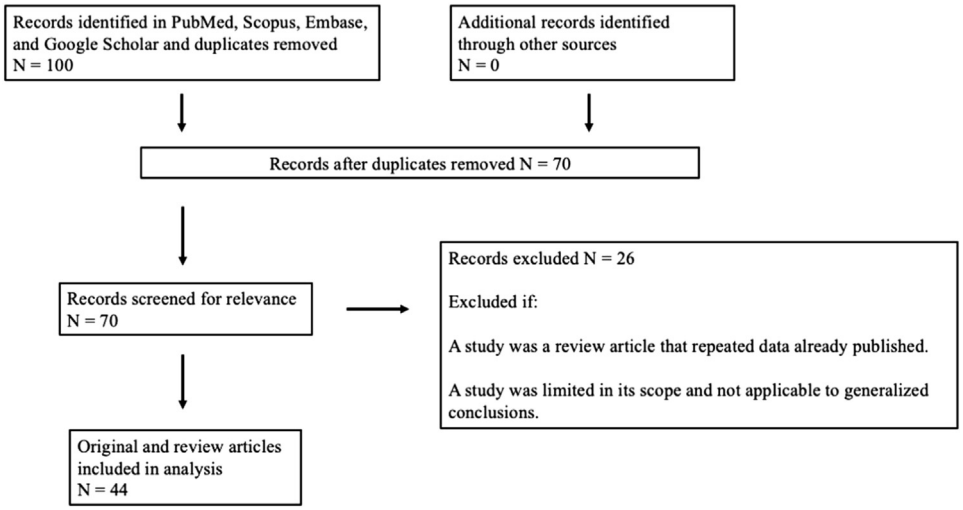

Fig 1. Systematic review of pediatric teledermatology. Studies were deemed eligible if they included patients in the pediatric demographic, were published in English and examined any of the following: (1) diagnostic and management concordance, (2) conditions treated, (3) rates of in-person follow-up after telemedicine encounters, (4) patient, parent, and physician satisfaction, (5) utilization in underserved communities, or (6) international approaches to virtual care. Studies not written in the English language, review articles repeating previously published material and studies limited in scope or not generalizable were excluded. Articles were screened independently by 2 authors and data were collected from each article selected.

time, and 69% believed it could be used to adequately manage disease.

Nonetheless, physicians remain concerned about the quality of care provided via telemedicine.[25] In one survey, 65% of pediatric dermatologists felt that teledermatology was not as effective as in-person care with 46% believing that mistakes were more likely to be made, and only 8% reporting that treatment outcomes were equivalent to in-person care.[25] The experience of physician assistants and nurse practitioners with teledermatology in the pediatric populations has yet to be explored; future studies would be useful to characterize their involvement.

The type of teledermatology utilized may also have an effect on satisfaction rates.[19,23,26] Jew et al[23] found that 77% of parents had their concerns addressed with store-and-forward consultations.[19] Kohn et al[26] determined that patient and provider satisfaction for synchronous video conferencing was 98.4% and 95.2%, respectively. Parent satisfaction for avatar-based telemedicine was 70%. Additional research is needed to determine the relationship between patient satisfaction and the modality of teledermatology utilized during the visit.

Accessibility and performance of teledermatology in underserved communities

The adoption and utilization of pediatric teledermatology in underserved populations is less well-characterized. Additional factors limit access to medical care in these populations, including financial constraints, parental health, parents' inability to take time off from work, lack of support with childcare, inadequate transportation, long wait times, cultural beliefs, communication and education.[28] Teledermatology imposes its own barriers on low-income communities, specifically, the need for a reliable and strong internet connection, computers or smart devices, digital literacy, the need for translator services, and the availability of a private location for the visit.[29,30] Blundell et al[31] found that during the COVID-19 pandemic, Spanish-speaking patients were less likely to have an email address listed in the electronic medical record or activate an online patient portal account.

Nonetheless, there is compelling evidence that teledermatology in the pediatric population can expand access to care for underserved communities. In a multicenter study, Cline et al demonstrated a 9% to 21% decrease in missed pediatric dermatology appointments when telemedicine was implemented in urban safety-net clinics.[32,33] These sites largely provide care to Medicaid recipients, minority and uninsured populations, immigrants, and patients below the poverty line.[32,33] This is significant since these groups have an especially high rate of missed appointments ("no-shows") in pediatric dermatology.[32,34] Albeit in adults, it was found that the use of teledermatology improved attendance among non-English speakers and

Table I. Summary of reviewed publications

Ref	First author	Publication year	Type of study	Sample size	Concordance rate	Type of teledermatology
Diagnostic concordance						
4	Heffner	2009	Prospective	135	82%	Store-and-forward
5	Lasierra	2012	Prospective	120	76%	Store-and-forward
6	Pahalyants	2021	Retrospective analysis	302	70.1%	Store-and-forward
7	O'Connor	2017	Clinical Trial	40	83%	Store-and-forward
8	Batalla	2016	Retrospective analysis	183	89%	Store-and-forward
9	Philp	2013	Retrospective analysis	395	-	Store-and-forward
10	Chen	2020	Retrospective analysis	429	-	Store-and-forward
11	Paradela-De-La-Morena	2015	Retrospective analysis	383	-	Store-and-forward

Diseases commonly treated via pediatric teledermatology						
12	Lowe	2022	Prospective	116	-	Telephone
13	Giavina Bianchi	2019	Retrospective analysis	6879	-	Store-and-forward
14	Whitaker	2017	Retrospective analysis	412	-	Store-and-forward
15	Duan	2022	Retrospective analysis	1488	-	Live video
16	Ho	2021	Retrospective analysis	-	-	-

In-person follow-up after telemedicine encounters					**Required in-person follow-up**	
17	Betlloch-Mas	2020	Retrospective analysis	432	51.9%	Store-and-forward
18	Cabanes	2021	Retrospective analysis	702	48.9%	Unspecified
19	Jew	2020	Prospective	43	23%	Store-and-forward
20	Calafiore	2021	Retrospective analysis	876	12%	Store-and-forward
21	Seiger	2020	Retrospective analysis	188	31.9%	Store-and-forward
22	Damani	2021	Retrospective analysis	182	13.5%	Live video

Parent, child, and provider satisfaction					**Satisfaction with telemedicine**	
23	Kohn	2022	Prospective	519	'Patients: 98.4% Providers: 95.2%	Live video
24	Kourosh	2020	Survey	188	-	Unspecified
25	Fogel	2015	Survey	100	-	-
26	Pollock	2021	Survey	130	Parents: 70%	Avatar-based
27	Fiks	2018	Prospective	198	-	Store-and-forward

Efficacy and accessibility of teledermatology in underserved communities						
2	Havele	2021	Retrospective analysis	1110	-	Hybrid
28	Toy	2021	Literature review	-	-	-
29	Hadeler	2021	Commentary	-	-	-
30	Barry	2022	Literature review	-	-	-
31	Blundell	2020	Retrospective analysis	1078	-	Unspecified
32	Cline	2022	Retrospective analysis	5206	-	Unspecified
33	Cline	2021	Retrospective analysis	2253	-	Unspecified
34	Chaudhry	2019	Retrospective analysis	2407	-	-
35	Franciosi	2021	Retrospective analysis	6883	-	Unspecified

Continued

Table I. Cont'd

Efficacy and accessibility of teledermatology in underserved communities							
[36]		Payvandi	2022	Survey	137	-	Live video
[37]		Fieleke	2008	Survey	76	-	-
[38]		Desrosiers	2019	Retrospective analysis	199	-	-
[39]		Kittler	2022	Retrospective analysis	281	-	Hybrid
Global perspectives on pediatric teledermatology							
[3]	Fogel	2015	Survey	108	-	-	
[40]	Seth	2017	Literature review	-	-	-	
[41]	Nathanson	2018	Retrospective analysis	47	-	Store-and-forward	
[42]	Byrom	2016	Retrospective analysis	406	-	Store-and-forward	
[43]	Weinberg	2009	Retrospective analysis	345	-	Store-and-forward	
[44]	Bianciardi	2016	Case series	19	-	Store-and-forward	

people of color which may have similar implications for pediatric attendance in those populations.[35] For non-English speaking families, interpreter services have been effectively used for televisits via audio and videoconferencing with reportedly high patient satisfaction. Use of interpreter services can help overcome communication barriers for patients whose preferred language is not English; making teledermatology a feasible option for patients who may otherwise struggle to access care.[31,36] Teledermatology may also provide a means to alleviate geographic barriers to care by reducing the need for travel to appointments.[37] Evidence suggests that families who travel farther to clinic (>20 miles) are more likely to be noncompliant or lost to follow-up for treatment of IH.[38] Encouragingly, Kittler et al[39] demonstrated that dermatologists had 95% median confidence in the treatment of IH via teledermatology. Additionally, the integration of virtual visits was correlated with a significant reduction in wait times for appointments for this condition (17 days vs 28 days).

Studies have also explored other approaches for teledermatology to expedite care for pediatric patients. Provider-to-provider e-consults had an average time of 6 hours in 1 study[2] and 12 hours in another[19] from inputting the consult request to acceptance by a dermatologist. Families then received recommendations from their primary care provider after a median of 3 days from the initial e-consult.[19] Seiger et al[21] found that e-consults abrogated the need for in-person visits in 54% of patients. E-consults also reduced wait times by 31% for patients who needed in-person visits.[21] These data suggest that e-consults are a promising modality for populations with limited options for specialty care.[2]

Barriers to care for underserved populations remain pervasive and formidable, but can be ameliorated through community outreach initiatives, patient education about teledermatology, increased use of translator services, and less complicated patient registration and email requirements.[33] Strategies to encourage uptake and optimization of teledermatology in underserved communities derived from the literature on adults can be modified and adapted for the pediatric population (Table II).[33] Further research is needed to determine uptake, utilization, and performance of pediatric teledermatology in underserved communities.

Global perspectives on pediatric teledermatology

Global adoption of telemedicine can potentially increase access to dermatologic care amid shortages of trained pediatric dermatologists and/or significant geographic barriers.[40,41] There is limited English language literature on use of teledermatology for pediatric patients internationally. A cross-sectional study from Brazil by Giavina Bianchi et al[13] established that teledermatology is an efficient tool for triage and treatment of less complex dermatoses and also decreases appointment wait times. In an Australian study, Byrom et al[42] found that a third of rural patients seen via an Australian national teledermatology service were pediatric patients. Teledermatology networks in African and Latin American countries have connected patients with dermatologists, reduced travel and wait times, and

Table II. Suggestions for optimizing telemedicine for pediatric patients in underserved populations

1. Triage new patients based on chief complaint
   - Certain conditions are more amenable to telemedicine (eg, acne, eczema, psoriasis)
   - Straightforward diagnoses and medication management can be scheduled as telemedicine
   - More complicated disease management and difficult diagnoses should be preferentially scheduled in-person
   - Requesting patients to send photographs prior to visit can assist with triage
   - Conditions in need of procedures should be scheduled in-person
   - Triage e-consults for in person or telemedicine based on the referring diagnosis
2. Assess patient desire for virtual care
   - Determine patient comfort with technology and if they own an appropriate device
   - Patients may have a preference for telemedicine versus in-person visit
   - Patients may have difficulty physically traveling to clinic and prefer a remote visit
3. Assess for barriers to telemedicine
   - Cultural beliefs may influence a preference for one visit type over another
   - Underserved, minority, and immigrant communities have lower rates of email use and patient portal activation. Applications and services with simple registration requirements helps to ameliorate this issue.
   - Determine the need for translator services
   - Implement a reminder system via calls or text messages to prepare patients for appointments
4. Schedule follow-up visits as in-person or telemedicine based on condition, treatment needs, and patient preference
   - Ensure choices are provided to patients and encourage selection of the option that most benefits them

provided support for local staff.[40,43] In Africa, teledermatology has been used to treat atopic dermatitis, infection, psoriasis, adverse drug reactions, and HIV/AIDS-related cutaneous diseases.[43] A case series out of Italy demonstrated the productive use of teledermatology for pediatric wound care.[44] Global access to pediatric dermatologic care, especially in remote locations, may significantly benefit by expansion of telemedicine.

Communication modalities utilized during teledermatology encounters

Communication modalities utilized during teledermatology encounters included synchronous (eg, live video, telephone), asynchronous (eg, store-and-forward), and hybrid methods.[1] Thirty-three studies included primary data on pediatric teledermatology, utilizing: store-and-forward (19), live video (4), hybrid (2), telephone (1), avatar-based (1), and unspecified (6) (Table I).

Limitations

Limitations of this study include the inability to incorporate literature that was not present in the databases queried. Although articles were screened by 2 authors to ensure accuracy and completeness; it is possible that relevant articles were missed. To limit selection bias, a systematic review was completed using multiple large databases. Given that this review describes previously published data and since studies utilize varying sample sizes and methodologies, the possibility of reporting and publication bias is also a limitation.

CONCLUSION

Teledermatology has high rates of diagnostic concordance with in-person evaluation in the pediatric population. A variety of common cutaneous conditions in children can be effectively managed via virtual dermatology. Parent, child, and provider satisfaction with the modality has been noted, though pediatric dermatologists continue to express concern and harbor uncertainty regarding quality of care. Literature on necessity for in-person follow-up after a virtual encounter has a wide range of reported rates. Although studies have demonstrated successful use of pediatric teledermatology in underserved communities, the broader uptake and utilization of this method of care in vulnerable populations is unclear. Technological barriers and lack of clarity on reimbursement structure remain significant barriers to implementation and acceptance. Global expansion of pediatric teledermatology could likewise augment access but similar challenges remain.

Conflicts of interest

None disclosed.

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