

Research Article

Situation of Skin-Manifesting Neglected Tropical Diseases Through a Mobile Application: Experience from Côte d'Ivoire

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Abstract

In order to identify cutaneous NTDs in Côte d'Ivoire, we conducted a cross-sectional, prospective, descriptive study over two years, from 13 January 2022 to 17 December 2023, in the health districts of Sinfra, Bouaflé, Abidjan 1 and Abidjan 2. The study included 804 patients. Men accounted for 50.6% of cases, with a sex ratio (M/F) of 1.2. The average age of patients was 20 years. Patients with no education accounted for 37.9% of cases. In terms of occupation, farmers accounted for 30% of cases. In terms of marital status, 52% of patients were single. Among the skin diseases identified, there were 147 cases of NTDs with cutaneous manifestations (18.3%) and 657 other dermatoses (81.7%). In terms of NTDs with skin manifestations, scabies accounted for 86.4% of all cases, 74 of which were reported in the Sinfra health district. Buruli ulcer accounted for 8.8%, with 11 cases identified in the Sinfra health district. For the other dermatoses, various skin conditions were recorded, with the most common types varying from one district to another. Overall, the prevalence of skin NTDs was high (18.3%) in these four health districts. Based on these results, the implementation of teledermatology is recommended to fill this gap.

Keywords

Teledermatology, NTDs, Côte d'Ivoire

1. Introduction

Neglected Tropical Skin Diseases (NTDs) are a group of communicable diseases that are prevalent in developing

countries in the tropical and subtropical regions [1, 2]. Africa accounts for almost 40%. In Côte d'Ivoire, there are suspected

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Received: 5 April 2025; Accepted: 21 April 2025; Published: 24 May 2025



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cases in some of the local health districts. They represent one of the most serious burdens on public health, altering the physical and intellectual capacities of those affected, and are responsible for considerable disability, fostering stigmatization and discrimination. They contribute to perpetuating the cycle of poverty, which also hinders the achievement of sustainable development goals in the daily lives of these vulnerable people. NTDs are endemic in many countries and communities, especially in rural areas and hard-to-reach regions, where drinking water and sanitation facilities are scarce. In Côte d'Ivoire, a country in West Africa, progress has been made in the fight against these diseases. However, new cases continue to be detected throughout the country. It should also be noted that there is no overall statistical data in the literature on NTDs, but rather fragmented data for each disease. According to the PNLUB, the incidence of BU in 2024 was estimated at 239 cases (source PNLUB); similarly, the PNEL recorded around 525 cases of leprosy in 2024 (source PNEL).

In addition, skin observation could be very instructive, as many skin diseases could be diagnosed simply by patient history and skin observation. This method is well suited to field situations in developing countries. Photographs of skin lesions could replace direct observation and, if of sufficiently good quality, enable diagnosis on site or at a distance. We are also seeing a concentration of dermatologists in the big cities. Small towns and villages have no specialist practitioners, which is why 90% of skin diseases are treated by nurses with only minimal basic training. This shortage of specialist doctors is quite common in African countries [3]. This discrepancy

between the high prevalence of dermatoses [3] and the uneven distribution of dermatologists demands our attention. So, to combat this disparity in a context of scarce resources, and to support the individual fight against NTDs, WHO [4] in its roadmap 2021-2030 recommends an integrated approach to the fight against these diseases. To achieve this ambitious goal, we proposed detection and monitoring through tele-dermatology, an innovative mobile tool designed to bridge this gap. For this reason, the NGO "HOPE COMMISSION INTERNATIONAL" (HCI), through the "MIND-the-Skin" or "ATTENTION-à-la-peau" project, has initiated the active detection and surveillance of cutaneous cases of NTDs using a mobile application called "eSkinHealth", with the aim of significantly reducing the burden of NTDs in Côte d'Ivoire. This is the rationale behind the present study, entitled "Situation of Skin-Manifesting Neglected Tropical Diseases Through a Mobile Application: Experience from Côte d'Ivoire", with the aim of improving the early diagnosis of cutaneous NTDs.

2. Materials and Methods

From November 2023 to October 2024, we conducted a cross-sectional study of skin diseases. The study was carried out in four health districts in Côte d'Ivoire. Those various centers were selected on the basis of the DHIS report on the management NTDs in previous years.

Table 1. Study site.

Health region	Health district	Village
Marahoué	Sinfra	Bazre, Kononfla, Manoufla-N, Djenedoufla, Huafla, Binoufla, Kouétinfla, Gbrizokro
	Bouafle	Bozi, Yoho, Garango, Gobazra, Siétinfla, Konefla, Pakouabo, Aka n'guessankro
Abidjan 1	Yopougon East	FSU-COM Andokoi, FSU-COM Santé
	Yopougon West Songon	FSU-COM Azito, FSU-COM Micao, FSU-COM Gesco, CSU Songon
Abidjan 2	Cocody Bingerville	FSU-COM Colombie, FSU-COM Génie 2000, FSU-COM Akouédo attié, FSU-COM, SSSU Bingerville, CSU de Gbagba, CSU de M'badon, CSU de Abata

Patients of all ages and genders with dermatoses who were willing to participate were included in the study. Patients were identified and registered through the "eSkinHealth"

application, either by a health care provider (HCP) and referred to his or her IDE or directly examined and registered by a registered nurse (RN) (Figure 1).

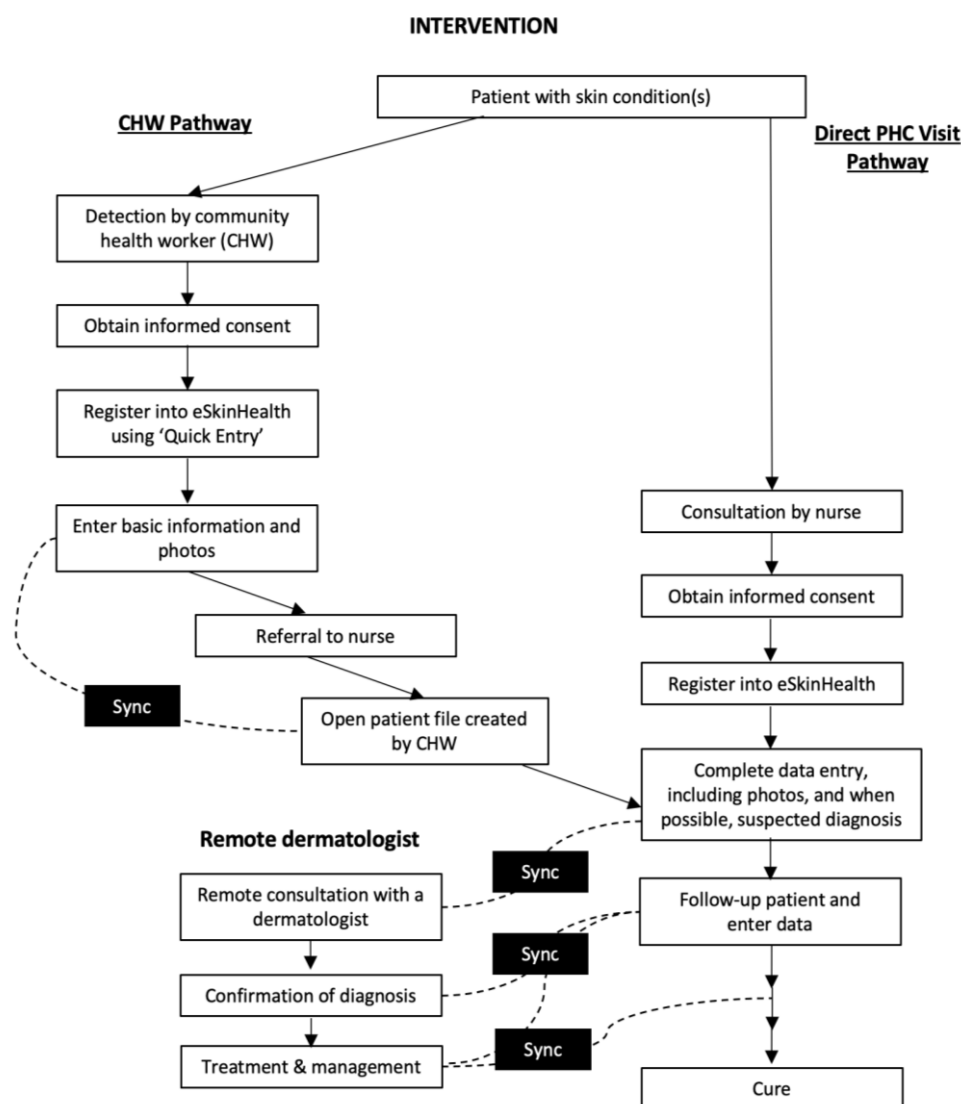


Figure 1. Patient flow.

2.1. Survey Process

Community Health Workers were instructed to register patients when they detected a suspected case of cutaneous NTDs or any apparently significant skin condition, and to refer them to their designated primary health care center. Patients suspected of having the targeted cutaneous NTDs (Buruli ulcer, leprosy, lymphatic filariasis, scabies and yaws) and other skin conditions, who provided informed consent at the time of consultation in the rural or urban health centers, were registered by nurses and doctors on the eSkinHealth application platform. Nurses and doctors were instructed to enter clinical data at the initial visit and at each follow-up until recovery into the eSkinHealth application, including photos of skin lesions. Data were downloaded when connected to the Internet and integrated into a database server. When they needed a consultation, a request was sent to remote dermatologists affiliated to the project in Bouaké (towns), and ad-

vice or clinical confirmation was provided. The dermatologists were instructed to review registered cases periodically and provide their assessment and recommendations, when possible.

2.2. Data Collection

Data were obtained by the research team. For data storage, we used Amazon Web Service's Simple Storage Service (S3), which offers a safe, secure and highly durable storage infrastructure with continuous backups, regulated by the US Health Insurance Portability and Accountability Act. Only the study team and those registered in the eSkinHealth application system (registered nurses and community health workers) had access to the data. Access to data in eSkinHealth is regulated by user levels, meaning that, for example, nurses and community health workers can only view patient data designated for their data collection area. All physical documents, including signed consent forms,

were kept in a secure cabinet, and only research team members approved by the Institutional Review Board had access. Dermatological diagnosis was based on clinical examination, supplemented where necessary by biological tests and skin histopathology.

Data were collected and analyzed using Sphinx-PLUS.V5.tuiTe software. Data included demographic variables (age, gender, education, origin), clinical variables (reason for consultation, clinical diagnosis) and biological variables (blood tests, skin histopathology, bacteriological and mycological examinations, etc.).

2.3. Ethics

Our methods were reviewed and approved by the IRB of the Ministry of Health of Côte d'Ivoire (No. IRB000111917) and by Tulane University (IRB 2020-2054-SPHTM). This study is registered on ClinicalTrials.gov (2020-2054).

3. Results

We enrolled 804 patients with skin disease (Table 2) in the four health districts. The Sinfra health district accounted for 48% of patients (Table 3).

Table 2. Number of cases per month over one year.

Month /Year	Number of cases	Percentage
11/2023	23	2.9
12/2023	19	2.4
01/2024	36	4.5
02/2024	45	5.6
03/2024	85	10.6
04/2024	104	12.9
05/2024	101	12.6
06/2024	78	9.7
07/2024	91	11.3
08/2024	113	14.1
09/2024	97	12.1
10/2024	12	1.5
Total	804	10.0

Table 3. Cases per district.

District	Number of cases	Percentage
Sinfra	386	48
Bouaflé	117	14.5
Abidjan 2	145	17.4
Abidjan 1	156	19.4
TOTAL	804	100

Males accounted for 50.6% of cases, with a sex ratio (M/F) of 1.2. The average age of patients was 20 years. Patients not attending school accounted for 37.9% of cases. Concerning occupation, farmers represented 30% of cases (Table 4). In terms of marital status, 52% of our patients were single.

Table 4. Socio-economic aspects of our patients.

		Number of patients	Percentages
Age range (year)	[00-05[151	18.7
	[06-15[211	26.3
	[16-85[442	54.9
Occupations	Farmers	242	30
	Students	211	26.2
	Unemployed	202	25.1
	Craftsmen	98	12.1
	Managers	51	6.3
Education Level	No education	305	37.9
	Primary school	179	22.2
	Secondary school	198	24.6
	literate	19	2.3
	University	103	12.8

Out of the skin diseases identified, 147 cases of NTDs (18.3%) and 657 other dermatoses (81.7%) were found. Scabies accounted for 86.4% of all NTDs, including 74 cases in the Sinfra health district. Buruli ulcer accounted for 8.8%, including 11 cases recruited in the Sinfra health district (Table 5).

Table 5. *Diagnosis of cutaneous NTDs, by district.*

	Sinfra	Bouaflé	Abidjan 2	Abidjan 1	Number	Percentage
UB	11	1	0	0	13	8.8
Leprosy	5	0	0	0	5	3.4
Lymphatic filariasis	0	2	0	0	2	1.4
Scabies	74	12	15	26	127	86.4
Pian	1	0	0	0	1	0.7
Total	91	15	15	26	147	100

For the other dermatoses, we identified various skin conditions. The top dermatoses vary by district (Table 6).

Table 6. *Top 5 other skin conditions by district.*

	Sinfra		Bouaflé		Abidjan 1		Abidjan 2	
1	STI	54	STI	12	Ringworm	26	Contact Eczema	15
2	Tinea Corporis	13	Erysipelas	7	Contact Eczema	7	Ringworm	11
3	Erysipelas	12	Prurigo	2	Tinea Corporis	6	Pityriasis versicolor	7
4	Necrotizing Fasciitis	11	Tinea Corporis	2	Atopic Dermatitis	5	Acne	5
5	Impetigo	9	Warts	2	Acne	4	Lichen planus	3
Total		360		115		152		139

4. Discussion

This study highlighted the incidence of skin diseases and cutaneous NTDs in the health districts using a mobile application. The Sinfra health district recorded the highest number of cases (48%). April and August are characterized by rainy periods and vacations, periods when the risk factors for skin disorders are very high. According to the Ivorian DIIS report, the Sinfra health district is renowned for its endemicity of NTDs, notably leprosy and Buruli ulcer. Men were more frequent visitors to the health centers, with a sex ratio (M/F) of 1.2. However, this male predominance was not observed by Diabaté [3]. Diabaté [3] in his study obtained a predominance of the female sex (79.2%), a study carried out in a single health district and in contrast this study was carried out in several health districts. In addition, the general census of the Ivory Coast (2022) showed more men than women. The average age of patients was 20 years, with a predominance of subjects over 15 years of age. This age group is predominant, probably due to the rejuvenation of the Ivorian population [5, 6] and is therefore more frequent in peripheral health centers.

The health district in Côte d'Ivoire comprises rural and urban

health centers, community-based health facilities and general hospitals. Most of our patients were young people who did not attend school, accounting for 37.9% of cases. In terms of occupation, farmers were the most frequent subjects. Our study was carried out in rural and urban areas. In urban areas, we found more public and private sector workers, who generally have health insurance and are therefore frequent visitors to private clinics and university hospitals. In rural areas, we find more agricultural workers who have no alternative health center, as there is generally only one health center in these areas. In terms of marital status, 52% of our patients were single. In terms of level of education, in urban areas we find people with higher education, and in rural areas patients who generally have no schooling or who have only attended elementary school. In our study, skin diseases were diverse and varied, including NTD's (18.3%). This proportion varies from country to country.

In Togo it is 7.5% according to Saka [2]; in Ethiopia 17.2% [7] and 657 other dermatoses 81.7%. Scabies (86.4%) accounted for the majority of all NTDs, including 74 cases in the Sinfra health district. Scabies is a ubiquitous disease, but very common in Africa, particularly in Côte d'Ivoire. In the literature, scabies predominates among all NTDs [2, 6-10]. Buruli ulcer (8.8%) is also very common, with 11 cases recruited in the Sinfra health district. According to the Ivorian National Buruli

Ulcer Control Program, the Sinfra health district is a bastion of Buruli ulcer [11, 12]. Sinfra, like the other study sites, is a locality where several swamps are used to grow rice, which favors the spread of Buruli ulcer. Aboa [10], on the other hand, found a predominance of buruli ulcer in the Zouan Hounien and Oum é districts. Another NTDC was detected in Sinfra, leprosy (3.4%). According to the Programme National d'Élimination de la Lèpre [13], the bastion of leprosy is the health district of Zouan Hounien, which has received special attention and whose incidence has fallen sharply. This is recounted in Aboa's study [10] where, in addition to Zouan hounien, he also mentions the district of Divo.

On the other hand, teledermatology has enabled more cases to be identified in the Sinfra health district. This can be explained either by health practitioners' lack of awareness of the signs of leprosy, or by patients' carelessness due to the painless onset of leprosy [14, 15]. In his study of primary school children in Adzopé, Rie identified 2 types of NTDs: 1 case of MB leprosy in a 12-year-old child and 36 cases of scabies [16]. NTDs such as lymphatic filariasis (1.4%) were identified in the Bouaflé health district and Pian in Sinfra. The latter two NTDs are much rarer in Côte d'Ivoire due to a lack of mapping. These programs are struggling to get data in the field. In Togo [2], 105 NTDs were observed (7.5%), and the main NTDs diagnosed were scabies (n = 86; 6.1%) and suspected yaws (n = 16, 1.1%). Similarly, in Benin [17], 1.4% cases of BU and three cases of leprosy were reported.

5. Conclusion

To summarize, we noted that there was a high prevalence of NTDs (18.3%) in these 4 health districts, including 86.4% cases of scabies, followed by Buruli ulcer. In view of these findings, it would be interesting to introduce teledermatology in all health districts of Côte d'Ivoire, to detect NTDs early, thereby reducing handicaps and stigmatization.

Abbreviations

NTDs	Skin-Manifesting Neglected Tropical Diseases
FSU- COM	Community-based Urban Health Training
SSSU	School and University Health Service
DHIS	District Health Information Software
CHW	Community Health Worker
CSP	Primary Health Centre (Rural and Urban)
RN	Registered Nurse
PNLUB	National Buruli Ulcer Control Programme
PNEL	National Leprosy Elimination Programme

Acknowledgments

We would like to express our deep gratitude to the de-

partmental health directors of Abidjan 1 and 2, Sinfra, Bouaflé to the chiefs of the villages visited and to the health staff of each village visited.

Author Contributions

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Rie Rosalie Yotsu: Conceptualization, Supervision

Sule Akanbi Mutiyu: Formal Analysis, Writing – original draft

Bamba Vagamon: Supervision, Writing – review & editing

Aubin Yao: Conceptualization, Supervision, Validation, Writing – review & editing

Ronald Blanton: Supervision

Conflicts of Interest

The authors declare no conflicts of interest.

References

- [1] Mitjà O, Marks M, Bertran L, Kollie K, Argaw D, Fahal AH, et al. Integrated control and management of neglected tropical skin diseases. *PLoS Negl Trop Dis* 2017; 11(1): e0005136.
- [2] Bayaki Saka, Pabawé Kassang, Piham Gnossike, Michael Head, Abia Séfako Akakpo, Julienne Noude Teclessou et al. Prevalence of skin Neglected Tropical Diseases and superficial fungal infections in two peri-urban schools and one rural community setting in Togo. 2022. Disponible sur www.medrxiv.org Consulté le 16 septembre 2022.
- [3] Diabaté A, Rie RY, Sule AM, Bamba V, Aubin Y, Ronald B, Dermatoses in Ivorian Rural Areas: A Case Study of the Health District of Zouan Hounien international Journal of Clinical Dermatology 2025, Vol. 8, No. 1, pp. 1-5 <https://doi.org/10.11648/j.ijcd.20250801.11>
- [4] WHO. Combating Neglected Tropical Diseases to Meet the Sustainable Development Goals: Roadmap for Neglected Tropical Diseases 2021-2030. 2021. Available at <https://apps.who.int/iris/handle/10665/346560> Accessed 02 November 2022.
- [5] General Census of Population and Housing 2021 INS/2022/RGPH 2021/01.
- [6] HS Kourouma, Kaloga M, Kouassi YI et al. Epidemiological and clinical aspects of patients seen in dermatology consultation at Treichville University Hospital [In French]. *j.annder*. 2017; 143(4) (Supp 1): S36.
- [7] Kouotou EA, Nansseu JRN, Kouawa MK, Bissek A-CZ-K. Prevalence and drivers of human scabies among children and adolescents living and studying in Cameroonian boarding schools. *Parasites & vectors*. 2016; 9(1): 400.

- [8] Collinson S, Timothy J, Zayzay SK, Kollie KK, Lebas E, Candy N et al. The prevalence of scabies in Monrovia, Liberia: A population-based survey. *PLoS Negl Trop Dis*. 2020; 14(12): e0008943.
- [9] Motswaledi HM. Clinical diagnosis and treatment of scabies, a neglected tropical disease. *S Afr Fam Pract* (2004). 2021 July 9; 63(1): e1-e6.
- [10] Koffi AP, Yao TAK, Barogui YT, Diez G, Djakeaux S, Zahiri MH, et al. Integrated approach in the control and management of skin neglected tropical diseases in three health districts of Côte d'Ivoire. *BMC Public Health* 2020; 20(1): 517 [FREE Full text] <https://doi.org/10.1186/s12889-020-08632-6> [Medline: 32303204].
- [11] Programme National de lutte Contre l'Ulcère de Buruli. Rapport d'activités. Abidjan: Programme National de lutte contre l'Ulcère de Buruli; 2019.
- [12] Aboagye S, Ampah K, Ross A, Asare P, Otchere I, Fyfe J, et al. Seasonal pattern of *Mycobacterium ulcerans*, the causative agent of Buruli ulcer, in the environment in Ghana. *Microb Ecol*. 2017; 74: 350–61.
- [13] Programme National d'Élimination de la Lèpre. Rapport d'activités. Abidjan: Programme National d'Élimination de la Lèpre; 2019.
- [14] Niang SO, Diallo M, Ndiaye M, Diop A, Diatta BA, Wadih M, et al. Epidemiologic and clinicopathologic aspects of leprosy in Dakar; evaluation of 73 new cases. *Dermatol reports*. 2011 Oct 25; 3(2): e18.
- [15] Dioussé P, Dione H, Bammo M, Gueye N, Diallo TAA, Seck F, et al. La lèpre de l'enfant à Thiès/ Sénégal: signal d'une recrudescence. *Pan Afr Med J*. 2017 Jul 5; 27: 174.
- [16] Yotsu RR, Kouadio K, Vagamon B, N'Guessan K, Akpa AJ, Yao A, et al. Skin disease prevalence study on schoolchildren in rural Cote d'Ivoire: implications for integration of neglected skin diseases (skin NTDs). *PLoS Negl Trop Dis*. 2018; 12: e0006489.
- [17] Barogui YT, Diez G, Anagonou E, Johnson RC, Gomido IC, Amoukpo H et al. Integrated approach in the control and management of skin neglected tropical diseases in Lalo, Bénin. *PLoS Negl Trop Dis*. 2018; 12(6): e0006584.