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ORIGINAL ARTICLE

Retrospective Epidemiology of Dermatomycosis in Kinshasa, Democratic Republic of Congo, From 2000 to 2023

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ABSTRACT

Background: Although cutaneous mycoses are a global public health problem, very few data are available in the Democratic Republic of Congo (DRC).

Objectives: This study aimed to describe the retrospective clinical epidemiology of dermatomycosis and their associated risk factors in dermatological consultations in Kinshasa, DRC.

Methods: A retrospective study based on the medical records of patients seen in the departments of dermatology of 2 major hospitals in Kinshasa from March 2000 to August 2023 was carried out. The diagnosis of the various types of dermatomycoses was established based on the dermatologist's clinical examination. Patient demographic and clinical data were collected for study purposes.

Results: Of 27,439 patients consulted at the two sites, 1142 were diagnosed with dermatomycosis (4.16%). Young women aged 27 (17–43) were most affected. Diagnosed patients shared a history of skin mycoses (26%), use of skin-lightening products (19%) and diabetes mellitus (9.6%). Among these patients, 59.3% suffered from dermatophytosis (*tinea*), 39.1% from malassesiosis and 1.2% from candidal dermatosis. While tinea was predominantly found in children (81.88%, $p < 0.001$), pruritus and pain in the lesions were preferentially reported by the dermatophytosis patients [65.25% ($p < 0.001$) and 79.1% ($p < 0.001$), respectively]. *Tinea corporis* (45.5%), *tinea capitis* (20.4%), *tinea pedis* (19.3%) and onychomycosis (10.2%) were the main nosological entities in the dermatophytosis group, and their distribution on the body surface depended on patients' age ($p < 0.001$) and sex ($p = 0.012$).

Conclusions: Dominated by dermatophytosis, dermatomycosis are frequent in dermatological consultations in Kinshasa. While clinical diagnosis remains an important element in the description of dermatomycosis, a better epidemiological understanding would also require biological identification of the fungi involved, which was lacking in this study.

1 | Background

Dermatomycoses are infections mainly affecting the epidermis of the skin and its appendages (hair, body hair and nails), and are caused by fungal agents such as moulds (dermatophytes) and yeasts (*Malassezia* spp. and *Candida* spp.) [1]. Although these mycoses are rarely associated with disseminated forms and subsequent fatal events, the chronic and refractory infections they can induce considerably affect the body aesthetics and quality of life, social interactions, physical and mental health of those affected [2, 3]. The management of these superficial mycoses still suffers from diagnostic inaccuracies in many parts of the world, a lack of qualified personnel for these pathologies, the unavailability of effective antifungal agents in regions of great need, and the worldwide emergence of strains resistant to the usual antifungal agents [4, 5].

In 2017, the global prevalence of cutaneous mycoses was estimated at 750 million, with sub-Saharan African countries concentrating the highest burden of disease. In this African region, the number of disability-adjusted life years (DALYs) was the highest among men and women compared with all the world's super regions (89.3 and 78.42 per 100,000, respectively) [1]. In the same vein, several accounts have reported the non-negligible prevalence and burden of cutaneous mycoses among infectious dermatoses in African countries [6–8]. Similarly, in the Democratic Republic of Congo (DRC), the hospital frequency of dermatomycoses was estimated at 19.7% of all cases of infectious dermatoses diagnosed in Kinshasa hospitals. In the same study, *pityriasis versicolor*, *tinea corporis* and *tinea capitis* were the most predominant nosological entities [9]. Being the leading superficial fungal infection in children in the DRC, nearly 3,551,862 cases of *tinea capitis* are estimated in this population throughout the country, corresponding to a rate of 3726 per 100,000 inhabitants [10].

Environmental conditions, the precarious living conditions of populations in tropical zones, lifestyles and the various states of immunodepression prevalent in these areas are all factors that favour and sustain the emergence of these fungal dermatoses [11, 12]. In addition, the overpopulation of Kinshasa (capital of the DRC) due to the rural exodus of nationals from other provinces and the business immigration of internationals, notably from countries known to have impressive proportions of dermatophyte strains resistant to the usual antifungal agents, raises the need for a national dermatomycosis epidemiological surveillance program [13, 14]. The epidemiology of dermatomycoses in the DRC is poorly described, which hinders the commitment of decision-makers and healthcare staff, and impedes the improvement of care for affected patients based on local data.

With a view to building a solid base on which to conduct case and strain surveillance surveys, the present study aimed to provide an epidemiological and clinical retrospective overview of cutaneous mycoses and their associated risk factors in dermatological consultations in Kinshasa, DRC.

2 | Methods

2.1 | Study Design, Clinics and Patients

This is a retrospective documentary study of dermatomycosis cases carried out in the dermatology department of two of Kinshasa's major specialised hospitals, the University Hospital of Kinshasa and HJ Hospital, from March 2000 to August 2023, that is, 23 years and 6 months. These hospitals are tertiary and secondary level, respectively. At the University Hospital of Kinshasa, the main data collection site, the dermatology department offers a wide range of outpatient and sometimes inpatient services. University Hospital of Kinshasa's outpatient capacity is around 90 patients per month, with 2–3 hospital admissions per month for delicate cases. The dermatology department at the HJ Hospital sees just over 100 patients a month.

A total of 27,439 patients were seen in dermatological consultations during the study period at both sites. We included all patients diagnosed with dermatomycosis in its various clinical presentations. Patients whose medical records did not contain the essential information were excluded from the study. In the DRC context with multiple limitations and for this study purposes, the diagnosis of dermatomycosis was made essentially on the basis of clinical presumption by dermatologists.

2.2 | Study Parameters

In addition to the type of dermatomycosis diagnosed on first and second clinical presumption, the following parameters were collected from patients' medical records: epidemiological data (age, sex, commune of patient residence, month, season and year of diagnosis), and clinical data (relevant clinical history and lesion site). The age of the participants was grouped according to the Sturges rule into 11 different classes; and according to the general development of living beings for statistical purposes, into 4 categories [baby (0–2 years), child (3–11 years), teenager (12–17 years), adult (18–70 years) and elderly (over 70 years)]. In categorising annual climatic seasons, we considered the 2 main seasons recognised for the city of Kinshasa: the dry season (March, June, July and August) and the rainy season (January, February, April, May, September, October, November and December).

2.3 | Data Collection Techniques and Instruments

Data were collected from patient registers and medical records on the basis of the previously established collection form and then encoded in an Excel 2016 spreadsheet (Microsoft Office, USA) before being exported to the analysis software.

2.4 | Statistical Analysis

Analyses were performed using SPSS software (IBM-Chicago, USA) for Windows version 26.0. Quantitative variables were

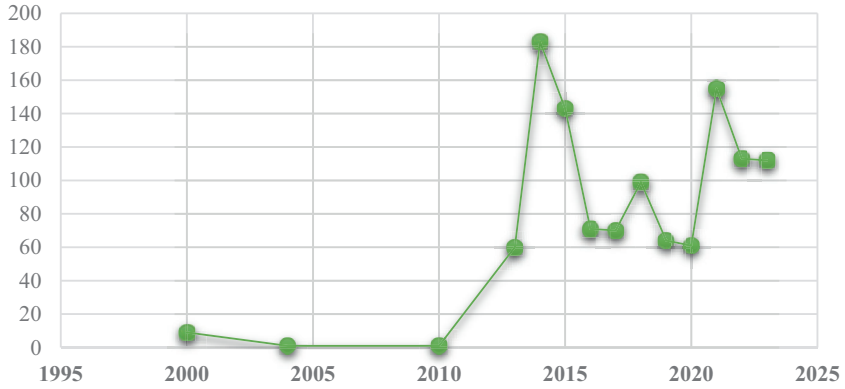

FIGURE 1 | Number of cases over the years.

summarised as mean ± standard deviation or median and interquartile range, as appropriate. Comparative analysis of categorical data was performed by Pearson's Chi-squared test or Fischer's exact test (if expected values were ≤ 5). Bivariate logistic regression analysis was performed to investigate the determinants of dermatomycoses and dermatophytoses in the study population. All tests were two-tailed and a $p < 0.05$ was considered statistically significant.

2.5 | Ethical Considerations

Confidentiality rules concerning patient privacy and anonymity were respected in accordance with the Helsinki principles. Data collected were completely depersonalised and used solely for study purposes.

3 | Results

3.1 | Epidemiological Data

Out of the 27,439 patients admitted for consultation at the two collection sites during the study period, 1142 patients presented suspected cutaneous mycoses and therefore constituted the subjects of the present study. The hospital prevalence of dermatomycoses was thus evaluated at 4.16%. The affected patients were mainly from Kinshasa (99.21%), especially from urban–rural areas (81.17%) and predominantly from the commune of Lemba (26.36%), Mont Ngafula (16.9%), Ngaliema (7.35%) and Selembao (5.4%); although all communes in the Kinshasa city were represented. While the greatest number of annual cases were recorded in 2014 (183 cases, i.e., 16.11% of all included cases) (Figure 1), the rainy season was more favourable to dermatomycosis than the dry season (687/1142 cases; 60.16%).

Although the age group between 17 and 24 years old was the most represented (219/1142; 19.18%), the median age of the study population was 26.5 (17–43) years old, with age extremes ranging from 2 days to 90 years old. Female subjects were slightly more affected than males [614 (53.77%) vs. 528 (46.23%)], with a F/M sex ratio of 1.2.

3.2 | Clinical Data

Among dermatomycosis patients, approximately 26% (298/1142) of patients had at least one history of cutaneous mycosis, 9.6% (110/1142) were followed up for diabetes mellitus, and 19% (218/1142) used (at least in the past) skin-lightening products. Although a small number of patients complained of pain at the lesion site (134/1142; 11.3%), a more consistent number reported pruritus at the lesion site (636/1142; 29.4%). Regarding the clinical presentation of dermatomycosis in the included patients, the majority had a single lesion on the head (391/1142; 34.2%), followed by the trunk (295/1142; 25.8%), disseminated involvement of more than three lesion sites (260/1142; 22.8%) and pelvic limbs (241/1142; 21.1%).

While for some patients, the skin lesions enabled dermatologists to retain only one diagnostic hypothesis (94.2% of cases), for others, by contrast, two hypotheses were evoked. As first-line diagnosis, dermatophytosis (*tinea*) was the most frequent dermatological mycosis in the present series (677/1142; 59.3%), followed by *Malassezia* spp. infections (447/1142; 39.1%) and candidal dermatosis (14/1142; 1.2%). Overall, the *tinea capitis* lesions were classic: erythematosquamous lesions in most cases, rarely inflammatory and variable in size. In places, they were either large, sparse alopecic patches on the scalp with short broken hairs, or numerous alopecic patches scattered over the scalp with long broken hairs. The demographic, clinical and diagnostic characteristics of included patients are detailed in Table 1.

Concerning dermatophytosis, the following proportions were found for different localisations, defining the main nosological entities: *tinea corporis* (308/677; 45.5%), *tinea capitis* (138/677; 20.4%), *tinea pedis* (131/677; 19.3%), onychomycosis (69/677; 10.2%), Hebra's marginal eczema (23/677; 3.4%), herpes circinis (5/677; 0.7%), *tinea facei* (3/677; 0.4%). *Malassezia* spp. infections included *pityriasis versicolor* (285/447; 63.8%), seborrheic dermatitis (160/447; 35.8%) and *pityriasis capitis* (2/447; 0.4%). Of all included patients, only 5.8% (66/1142) had a second diagnostic hypothesis based on clinical presumption. These were mainly dermatophytosis (43/66; 65.2%), *Malassezia* spp. infections (22/66; 33.3%) and cutaneous-ungual candidiasis (1/66; 1.5%). Table 2 provides data on the body location of dermatomycosis and the presumed clinical entity.

TABLE 1 | Demographic, clinical and diagnostic characteristics of included patients.

Characteristic	Overall data *n* (%)
Demographic characteristics	
Female sex ($n=1142$)	614 (53.77)
Median age (P25–P75) (year) ($n=1142$)	26.5 (17–43)
Age range (year) ($n=1142$)	
0–8	161 (14.09)
9–16	124 (10.86)
17–24	219 (19.18)
25–32	191 (16.73)
33–40	132 (11.56)
41–48	97 (8.49)
49–56	89 (7.79)
57–64	70 (6.13)
65–72	39 (3.42)
73–80	18 (1.58)
≥81	2 (0.18)
Human development age (year) ($n=1142$)	
Baby	46 (4.03)
Child	149 (13.05)
Teenager	112 (9.80)
Adult	805 (70.49)
Elderly	30 (2.63)
Residence in Kinshasa ($n=1142$)	1133 (99.21)
Area of residence ($n=1142$)	
Rural	215 (18.83)
Urban–rural	927 (81.17)
Consultation season ($n=1142$)	
Rainy season	687 (60.16)
Dry season	455 (39.84)
Clinical characteristics	
Relevant history ($n=1142$)	
Diabetes mellitus	110 (9.63)
Use of lightening products	218 (19.09)
Superficial mycosis	298 (29.09
Lesion site ($n=1142$)	
Head	391 (34.24)
Trunk	295 (25.83)
Upper limbs only	120 (10.51)
Lower limbs only	241 (21.10)
Upper and lower limbs	59 (5.17)
External genitalia	36 (3.15)
Generalised lesions (≥3 sites)	260 (22.77)
Functional signs ($n=1142$)	
Pain	134 (11.73)
Pruritus	636 (55.69)
Diagnosis 1 ($n=1142$)	
Tinea	677 (59.28)
Malassezia spp. infections	447 (39.14)
Candida infections	14 (1.22)
Intertrigo	4 (0.35)
Diagnosis 2 ($n=66$)	
Tinea	43 (65.15)
Malassezia spp. infections	22 (33.33)
Candida infections	1 (1.51)

TABLE 2 | Body location and presumed clinical entity of diagnosis 1.

Diagnosis 1	Overall data (%)
Tinea ($n=677$)	
Tinea corporis	308 (45.49)
Tinea capitis	138 (20.38)
Tinea pedis	131 (19.35
Onychomycosis	69 (10.19)
Hebra marginal eczema	23 (3.39)
Circinate herpes	5 (0.74)
Tinea facei	3 (0.44)
Malassezia ssp. infections ($n=447$)	
Pityriasis versicolor	285 (63.76)
Seborrheic dermatitis	160 (35.79)
Pityriasis capitis	2 (0.45)

Comparing the type of dermatomycosis diagnosed according to the demographic and clinical characteristics of included patients, only age, pain and pruritus at the lesion site were significantly associated with a specific type of dermatological mycosis ($p<0.001$). More precisely, dermatophytosis were the main dermatomycosis in children (81.88%), pruritus and pain on the lesions were remarkably associated with *tinea*, 65.25% and 79.1%, respectively. Concerning dermatophytosis, patient age and sex influenced the type of diagnosed dermatophytosis ($p<0.001$ and $p=0.012$, respectively). Detailed information on the measurement of the association between demographic and clinical parameters on the one hand, and types of dermatomycoses and

TABLE 3 | Distribution of dermatomycoses according to demographic and clinical characteristics.

Variable	Dermatomycosis				
	Candida infections	*Malassezia* spp. infections	Intertrigo	*Tinea*	*p*
Age groups					**<0.001**
Baby ($n=46$)	0 (0.0)	21 (45.64)	0 (0.0)	25 (54.35)	
Child ($n=149$)	1 (0.67)	26 (17.45)	0 (0.0)	122 (81.88)	
Teenager ($n=112$)	2 (1.79)	57 (50.89)	1 (0.89)	52 (46.43)	
Adult ($n=805$)	11 (1.37)	336 (41.74)	3 (0.37)	455 (56.52)	
Elderly ($n=30$)	0 (0.0)	7 (23.33)	0 (0.0)	23 (76.67)	
Sex					0.475
Female ($n=614$)	8 (1.30)	232 (37.79)	1 (0.16)	373 (60.75)	
Male ($n=528$)	6 (1.14)	215 (40.2)	3 (0.57)	304 (57.58)	
Place of residence					0.472
Rural ($n=215$)	3 (1.40)	75 (34.88)	1 (0.46)	136 (63.26)	
Urban–rural ($n=927$)	11 (1.19)	372 (40.13)	3 (0.32)	541 (58.36)	
Diabetes mellitus ($n=110$)	2 (1.82)	47 (42.72)	0 (0.0)	61 (55.45)	0.328
Use of lightening products ($n=218$)	3 (1.38)	95 (43.58)	0 (0.0)	120 (55.05)	0.454
Superficial mycosis ($n=298$)	2 (0.67)	129 (43.29)	0 (0.0)	167 (56.04)	0.189
Pain ($n=134$)	1 (0.75)	26 (19.40)	1 (0.75)	106 (79.10)	**<0.001**
Pruritus ($n=636$)	9 (1.42)	209 (32.86)	3 (0.47)	415 (65.25)	**<0.001**
Season of consultation					0.150
Rainy season ($n=687$)	6 (0.87)	270 (39.30)	2 (0.29)	409 (59.53)	
Dry season ($n=455$)	8 (1.76)	177 (38.90)	2 (0.44)	268 (58.90)	

Note: Bold *p* values indicate a statistically significant test (Pearson's Chi-2 test or Fischer's exact test), indicating an association between the variables evaluated. The strength of the association is then verified in a multivariate test presented in Table 5.

dermatophytoses on the other, are given in Tables 3 and 4, respectively. In bivariate logistic regression, no determinant was associated with the types of dermatophytosis described above in the patients. The results of these analyses are provided in Table 5.

4 | Discussion

Cutaneous mycoses are among the most widespread skin infections in the world, particularly in tropical and subtropical regions such as the DRC, where high heat and humidity create favourable conditions for the growth and emergence of fungal agents [8, 10, 15]. The present study focused on the retrospective and clinical epidemiology of dermatomycosis in Kinshasa hospitals over a period of 23 and a half years, in a diagnostic context based essentially on clinical presumption of skin lesions by a dermatologist. In this study, 4.16% of patients admitted for consultation in the two dermatology departments were diagnosed with cutaneous mycoses. This hospital prevalence is higher than that reported 6 years ago in Kinshasa University Hospital by Seudjip et al. (181 dematomycosis cases out of 9396 dermatological consultations, or 1.9%) [9]. Unlike the previous study, ours covered a wide consultation period in two hospitals in Kinshasa, including the one where the previous study was carried out, thus partially explaining the difference in results observed. Although the target population and the methodological approach applied are sometimes distinct, the hospital prevalence reported in the present study is lower than those described in other African countries [8, 16, 17] and elsewhere in the world [15, 18, 19]. While in some studies, the diagnosis of cutaneous mycosis was based primarily on clinical lesions, in others, clinical hypotheses were confirmed by laboratory evidence, which may justify the disparity in prevalence reported in different studies.

In this study, dermatophytoses were the most represented dermatological mycoses, followed by *Malassezia* spp. infections and cutaneous candidiasis, corroborating the results of other studies [16, 18]. Although these clinical presumptions were not associated with biological confirmation of the diagnosis, studies that adopted both approaches to establish the definitive diagnosis reported acceptable diagnostic consistency [15, 17–19]. Among dermatophytosis cases reported in the present study, *tinea*

TABLE 4 | Distribution of dermatophytoses according to demographic characteristics.

Variable	Dermatophytosis							
	Hebra marginal eczema	**Circinate herpes**	**Onychono-mycosis**	***T. capitis***	***T. corporis***	***T. facei***	***T. pedis***	***p***
Age groups								**< 0.001**
Baby ($n = 25$)	1 (4.0)	0 (0.0)	3 (12.0)	5 (20.0)	14 (56.0)	0 (0.0)	2 (8.0)	
Child ($n = 122$)	4 (3.28)	0 (0.0)	9 (7.38)	49 (40.16)	47 (38.52)	0 (0.0)	13 (10.66)	
Teenager ($n = 52$)	2 (3.85)	1 (1.92)	2 (3.85))	14 (26.92)	27 (51.92)	0 (0.0)	6 (11.54)	
Adult ($n = 455$)	15 (3.30)	4 (0.88)	54 (11.87)	69 (15.16)	212 (46.59)	3 (0.66)	98 (21.54)	
Elderly ($n = 23$)	1 (4.35)	0 (0.0)	1 (4.35)	1 (4.35)	8 (34.78)	0 (0.0)	12 (52.17)	
Sex								**0.012**
Female ($n = 373$)	14 (3.75)	4 (1.07)	43 (11.53)	55 (14.75)	181 (48.53)	2 (0.54)	74 (19.84)	
Male ($n = 304$)	9 (2.96)	1 (0.33)	26 (8.55)	83 (27.30)	127 (41.78)	1 (0.33)	57 (18.75)	

Note: Bold *p* values indicate a statistically significant test (Pearson's Chi-2 test or Fischer's exact test), indicating an association between the variables evaluated. The strength of the association is then verified in a multivariate test presented in Table 5.

TABLE 5 | Determinants of dermatophytoses.

Variables	Bivariate analysis	
	p	**Crude OR (95% CI)**
Season of consultation	0.860	0.977 (0.758–1.260)
Development age	0.008	0.277 (0.107–0.714)
Sex	0.099	1.237 (0.961–1.592)
Place of residence	0.166	1.254 (0.910–1.728)
Diabetes mellitus	0.441	1.178 (0.776–1.788)
Superficial mycoses	0.471	1.111 (0.834–1.481)
Use of lightening products	0.528	1.108 (0.806–1.525)
Pain	< 0.001	0.332 (0.213–0.519)
Pruritus	< 0.001	0.568 (0.443–0.728)

corporis, *tinea capitis*, *tinea pedis* and onychomycosis were the most frequent nosological entities. This trend is also observed in literature data [1, 18]. The fungal agents that induce dermatophytosis seem to affect certain parts of the human body more than others. This is the case for certain species of *Microsporum audouinii*, *Trichophyton tonsurans* and *T. soudanense*, which are more often incriminated in *tinea corporis* and rarely implicated in dermatophytosis of other parts of the human body. By contrast, other species are mainly involved in onychomycosis, notably *T. rubrum* and *T. interdigitale*. *Epidermophyton floccosum*, on the other hand, has an exclusive affinity for the skin [20]. The lack of identification of the fungi responsible for dermatomycoses in the present study considerably hinders the establishment of a holistic epidemiology of these mycoses in Kinshasa. In addition to the fact that the epidemiology of fungal species can define the predominance of clinical forms in a given region, in close relation to the latter, poor housing conditions, high population densities, limited water supply, poor sanitary conditions, population movements from one region to another both nationally and internationally, also influence the evolution of this clinical epidemiology [7, 21]. The present study showed that children were significantly more affected by *tinea* than other skin mycoses, notably *tinea capitis* and *tinea corporis*, in line with observations from other studies [10, 21].

Globally, dermatological mycoses are predominantly described in young adult males [1, 19, 21], a trend not fully observed in the present study, which reports a greater number of young adult females than males. The fact that skin-lightening products are mainly used by African and Asian women [22], whose association with the occurrence of dermatomycoses is also highlighted in the present study, could justify this observation in our population. Despite this, the study's findings still raise questions about the hypothesis that hormonally active women are protected against mycoses, as has been widely described for cryptococcal infection [23, 24]. The hot, dry and humid periods of the year, summer in the western countries and the rainy season in the DRC, have always been very favourable for dermatomycosis

compared to the cold seasons [15, 25], an observation also noted in our study. During the hot rainy season, not only do the growth and spread of known pathogenic fungi find a favourable environment, there is also an emergence of fungal agents hitherto known to be non-pathogenic or weakly pathogenic [26, 27].

In the present series, a history of cutaneous mycosis, diabetes mellitus and the use of skin-lightening products were significantly found in patients with cutaneous mycosis. The risk of developing superficial mycoses remains a concern in other black communities, notably in Benin [16] and in the French regions [28]. As described by Gits-Muselli et al., skin-lightening products, depending on their compositional balance between corticosteroids and hydroquinone, can induce local and/or systemic complications, including mycoses. Their use is therefore subject to strict legislation in some countries, such as France, to prevent complications [28]. Pruritus and pain at the site of lesions in dermatomycoses are often associated with an inflammatory process, and therefore well known in these superficial mycoses [29]. Acute pruritus can have a chronic course, evolving into pain if scratching persists, and leading to macerations that can be the source of secondary infections. In the present study, a significant number of patients had developed these symptoms. Through primary pathogenic phenomena (vascular disease, neuropathy, poor wound healing, metabolic factors and leukocyte dysfunction) and secondary ones (long periods of hospitalisation, antibiotic administration, use of intravascular lines, use of a Foley catheter/chronic renal failure/dialysis and obesity), diabetes mellitus can potentially create conditions conducive to infections of all kinds, including mycoses [30].

5 | Conclusions

Dermatomycoses are relatively common in Kinshasa clinics, mainly among young adults of both sexes. While the majority of cutaneous mycoses developed in diabetic patients and those who had used skin-lightening products, dermatophytosis patients were clinically marked by pruritus and pain at the lesion sites compared to other dermatomycosis. Dermatophytoses were therefore the skin mycoses most frequently found in this study, and manifesting mainly in the clinical form of *tinea corporis*, *tinea capitis*, *tinea pedis* and onychomycosis. These clinical data highlight the great need to determine the epidemiology of the fungal species responsible for these dermatological mycoses, both to gain a better understanding of the epidemiology and to establish a solid basis for routine surveillance in the country.

5.1 | Study Limitations

As with any retrospective study in non-computerised institutions, the present study experienced a loss of some data due to the poor conservation system of patient records and notebooks. Since samples from patients suspected of dermatomycosis were not collected and stored during consultations, no identification of the responsible fungi was possible, which constitutes a significant weakness of this study. In addition, as the treatment regimen and patient outcomes were missing from most medical records, they were not included in this manuscript.

Author Contributions

Nono Lydie Joëlle Seudjip: conceptualization, methodology, writing – review and editing, writing – original draft, formal analysis, validation. **Simplice Konga Libeko:** writing – review and editing, investigation, resources, validation. **Luc Kalala Ntshila:** investigation, resources, validation, writing – review and editing. **Paulo Muntu Bunga:** writing – review and editing, project administration, validation. **Georges Lelo Mvumbi:** writing – review and editing, project administration, validation. **Tshimy Yona Tshimanga:** formal analysis, writing – review and editing, validation. **Marie José Bajani Kabedi:** writing – review and editing, validation. **Tshimy Tshimanga Yona:** validation, writing – review and editing. **Doudou Malekita Yobi:** validation, writing – review and editing. **Marie-Pierre Hayette:** writing – review and editing, validation. **Bive Bive Zono:** conceptualization, methodology, formal analysis, validation, writing – review and editing, writing – original draft.

Conflicts of Interest

The authors declare no conflicts of interest.

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