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Dermatophytic Infections

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Abstract
Dermatophytic infections, also known as tinea or ringworm, are superficial fungal infections caused by a group of keratinophilic fungi known as dermatophytes. These organisms, primarily from the genera *Trichophyton*, *Microsporum*, and *Epidermophyton*, invade and multiply within keratinized tissues including the skin, hair, and nails. Dermatophytosis is highly prevalent worldwide, with increased incidence in tropical and subtropical regions due to warm and humid climates, poor hygiene, and overcrowding. Transmission occurs through direct contact with infected individuals, animals, or contaminated fomites. Clinically, infections are classified based on the site of involvement, such as tinea corporis (body), tinea capitis (scalp), tinea pedis (foot), and tinea unguium (nails). Symptoms typically include erythematous, scaly, itchy patches that may become inflamed or vesicular in nature. Diagnosis relies on clinical examination and is confirmed by laboratory techniques including potassium hydroxide (KOH) microscopy, fungal culture, and molecular methods. Treatment involves topical antifungals for mild cases and systemic therapy for extensive, recurrent, or nail/scalp involvement. Emerging resistance to common antifungal agents, particularly terbinafine, is a growing concern, necessitating continuous monitoring and research into new therapeutic approaches. Public health strategies focusing on hygiene, education, and early treatment are vital for prevention and control. Dermatophytic infections, though not life-threatening, can significantly impact quality of life, emphasizing the need for effective management and awareness.

Keywords: Dermatophytic Infections, Tinea Corporis, Tinea Capitis, Tinea Pedis, Tinea Unguium

Introduction

Mycology is the study of fungi which came into existence before bacteriology in 1677 when Hooks studied the yellow spots on the leaves of Demask rose with the help of a magnifying lens and sighted the filamentous organism [1]. Historically, medical mycology began with the discovery of fungal etiology of favus and centered on three European physicians in the mid-19th century: Robert Remark, Johannes L. Schoenlein, and David Gruby [2].

Remark in 1840 published his observations about the existence of a "vegetable" in the hair of patients with favus and in 1854; he named the etiologic agent of this dermatophytosis, *Achorion schoenleinii*, in honor of his professor Johannes Lukas Schoenlein and also in an effort to improve his academic position [3].The name was later changed to *Trichophyton schoenleinii.*

David Gruby, a Pakistan Physician was the real founder of dermatomycology (medical mycology) on the basis of his discoveries during 1841-1844 [2]. He published a paper where he described the isolation of fungus on potato slices and production of the disease onto the normal skin [1]. He was the first to establish the role of microorganism in the causation of favus, he also described the dermatophyte *Microsporum audouinii* from Tinea capitis and recognized endothrix form of *Trichophyron tonsurans*.

Raimond Sabouraud, one of the most influential and best known medical mycologists began his scientific studies of dermatophytes around 1890, Sabouraud etiologic agent of dermatophytes are classified into three anamorphic genera (asexual or imperfect); *Epidermophyton*, *Microsporum*, and *Trichophyton*. These genera are described based on the classification scheme of Emmons on the basis of conidial morphology and formation of conidia [4].

Classification of dermatophytes

Dermatophytes are classified as;

Kingdom : Eumycota
Phylum : Ascomycota
Class : Euascomy
Order : Onygenales
Family : Arthrodermataceae
Genus : *Trichophyton* 24 species
Microsporum 16 species
Epidermophyton 2 species [1]

According to the ecological niche dermatophytes are grouped into three classes; Anthropophilic, Zoophilic and Geophilic [5].

Anthropophilic dermatophytes are mainly associated with community life and restricted to humans and they produce a mild, chronic inflammation.

Zoophilic dermatophytes are found primarily in animals and cause marked inflammatory reaction in humans who have contact with infected animals such as dogs, cats, birds, horses, and other animals. This is followed by rapid resolution of the infection.

Geophilic dermatphytes are saprobes in the soil where they are associated with decomposing hair, features, hooves and keratin sources. They infect both humans and animals.

The current classification of dermatophytes was published by Emmons in 1934 [3]. Dermatophyte can be classified into three groups based upon their genera; *Trichophyton* (which causes infections on skin, hair, and nails), *Epidermophyton* (which causes infections on skin and nails), *Microsporum* (which causes infections on skin and hair) [6]. There are about 40 species of dermatophytes belonging to the three genera, viz. *Mocrosporum*, *Trichophyton* and *Epidermophyton* which have the ability to invade the skin and its appendages, hair shaft and nails of humans and similarly the hair shaft and hoof or horn of animals [7]. [Fig 1].

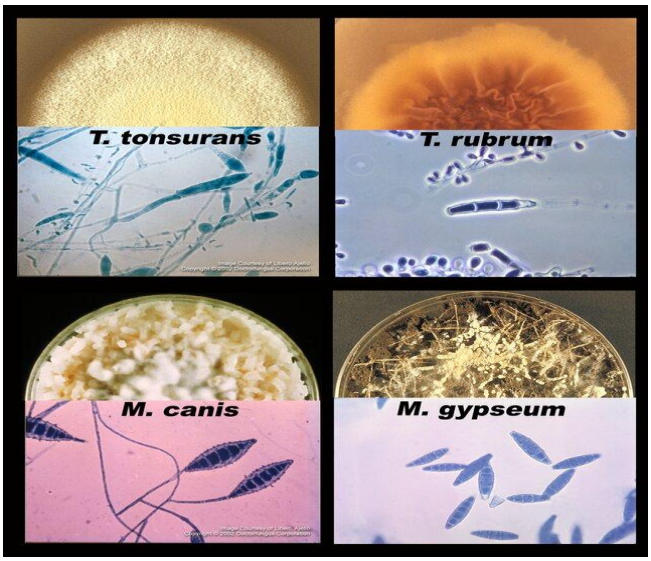

Fig 1: Major dermatophyte species-appearance in the laboratory. Each section shows one of four species of dermatophyte, including a semicircle of fungus growing on an agar plate (top) and a microscopic picture of the asexual spores (macroconidia and microconidia, bottom [7]

***Trichophyton* species**

The genus *Trichophuton* is the lagest of the three dermatophyte genera with 22 species. These are found on humans and animals, and in the soil and river sediments. The genus produces both macroconidia and microconidia. The macroconidia are phragmoseptate aleuriconidia, cigar-shaoed, 8-50µm x -8µm and smooth walled. The microconidia are spherical (2.5 to 4µm). Some species rarely produce macroonidia [8].

***Microsporum* species**

The genus *Microsporum* contains 15 species parasitic on humans and other mammals and produces both micro- and macro-conidia. The macroconidia are fusiform or spindle shaped, thick walled. The essential distinguishing feature of this genus is the echinulations on the macroconidial wall. The microconidia are clavate, 4-7µm x 2.5µm [8].

***Epidermophyton* species**

The genus contains two species which are parasitic on humans. No microconidia are produced. Macroconidia are club shaped with broadly rounded apex with fewer than five septa, 8-15µm, borne singly or in clusters on the conidiophore [8].

The ecological groups of dermatophytes [2]:

Anthropophilic species	Zoophilic species(typical host)	Geophilic species
Epidermophyton floccosum	*Trichophyton sarkisorii(Bactrian camel)*	*Epidermophyton stockdaleae*
Trichophyton rubrum	*T. bullosum(bull)*	*Trichophyton ajelloi*
T. schoenleinii	*T. equinum(horse)*	*T. gloriae*
T. mentagrophytes var interdigitale, T. mentagrophytes var nodular	*T. mentagrophytes var mentagrophytes, T. mentagrophytes var quinkckenum, T. mentagrophytes var erinacei (rodents, rabbit, hedgehog)*	*T. vanbreuseghemii*
T. violeceum	*T. simii(monkey, fowl)*	*Microsporum gypseum*
T. concentricum	*T. verrucosum(cattle, sheep, dromedary)*	*M. racemosum*
T. soudanense	*Microsporum canis(cat, dog)*	*M. flavescens*
Microsporum audounii	*M. equinum(horse)*	*M. nanum*
M. ferrugineum	*M. gallinae(fowl)*	*M. ripariae*

Epidemiology of cutaneous mycoses

A lot of works have been done about cutaneous fungal infections in various parts of the world. The distribution of dermatophytic infections depends on geographic and climatic conditions and it's influenced beyond individual factors such as age and host defenses, by individual and social behaviors [9]. Fungal diseases kill over 1.5millon and affect over one billion people [10]. Oladele and Denning, estimated 17,983,517 cases of serious fungal diseases in Nigeria in 2014, 15,581,400 (86.6%) of which were attributed to tinea capitis [11].

Basak *et al.,* carried out a research on the prevalence of dermatophytic infections in a tertiary day care hospital in India. During the research, it was discovered that males (60.5%) were more commonly affected than females (39.5%) with male to female ratio 1.5:1. Most of the age groups affected were 21-30 years (25.4%) followed by 31-40 years (20.3%). *Trichophyton mentagrophytes* (57.5%) was the most common isolate followed by *Trichophyton rubrum* (30.1%). Tinea corporis (57.5%) was the most common clinical presentation followed by tinea unguium (14.1%) and tinea cruris (12%) [12]. This has the same findings as Santhosh *et al.*, where the most common clinical presentation was tinea corporis (40.9%), followed by tinea cruris (31.81%) and tinea pedis (15.90%) [13]. In present study, there is low incidence of the disease in both extremes of life (in young children 1-10 years and persons above 60years, 6% and 7.1% respectively).

From January 2006 to December 2009, Simonnet *et al.,* carried out a retrospective analysis on patients with a presumptive diagnosis of fungal infections in French Guiana [9]. During the study period, 726 patients were tested whose mean age was 34 years (range< 1-87years) and 54% (392/726) were women. The clinical diagnoses were classified into four categories; Onychomycosis 28.2% (205/726), superficial involvement of the feet 22.0% (160/726), suspected tinea capitis 27.8% (202/726), and superficial mycosis of the body 21.9% (159/726).

In Denmark, anthropophilic dermatophytes *Trichophyton violaceum* and *Trichophyton tonsuras* caused approximately 45% of the dermatophytes infections at the beginning of the 20th century, this prevalence declined in 1930s when *Microsporum canis* became the most identified pathogen of Tinea capitis [14]. In Tanzania, Macha *et al.,* reported the prevalence of tinea capitis amongst 10 primary school children in Morogoro 16.6%, this prevalence is slightly lower than in previous reports; 48.86% in the Tanzania [15, 16]. Ahmed *et al.,* reported the prevalence of tinea capitis to be more amongst children between the ages 4 and 8 years [17]. This is similar to the findings by other studies, which reported that most of the infected children were below the age of ten years. These results support the suggestion that dermatophytosis especially tinea capitis is predominantly a pre-pubertal disease. some of the explanations being given to this are; fatty acids in the sebum produced at puberty may have some fungistatic properties which prevents the infection in older children; likelihood to poor hygiene in pre-pubertal stages, compared to older children who usually are more conscious of their hygiene. Studies done in the United States and Europe revealed that tinea capitis affects mainly African American children and migrant African children. The prevalence of tinea capitis varies widely in Nigeria between 9.4% and 51.8% in the eastern part of Nigeria. In Ivory Coast, the prevalence was 11.34% and in Ethiopia a high prevalence similar to that of Ebonyi state in Nigeria was noted. Etiological agents of tinea capitis varies geographically and changes over time. The finding of *Trichophyton mentogrophytes* (51.7%) followed by *Microsporum audouinii* (20.7%) as the most prevalent causative organisms of tinea capitis corroborates findings from studies in the South western and south eastern Nigeria, while studies from the north revealed different organisms (*Microsporum ferrugineum* and *Trichophyton schoenleinii*) [18].

Tinea capitis is the most common form of ringworm in children caused by the genera *Trichophyton* and *Microsporum species* [19]. In Mali, Tinea capitis is the most common dermatophyte infection of childhood [20]. The main causative agent for tinea capitis worldwide is *Microsporum canis* [21]. In a research work carried out by Claudia and her team in children aged 12 and under showed that out of 590 cases of dernatophytosis, 210 cases were positive and with respect to distribution, 72.9% cases were tinea capitis, 22.9% were tinea coporis 2.9% were tinea cruris and 1.4% were tinea pedis. Children are generally more susceptible to tinea capitis than adults [22]. Tinea capitis remains a common infection amongst school children.

Fungi infections of man

Fungal infections are not uncommon in humans, right from dandruff to deep invasive infections are caused by fungi present in our environment [23]. Fungi infections are classified according to superficial, cutaneous, subcutaneous, systemic and opportunistic mycoses. Opportunistic infections and deep mycoses usually occur in immunocompromised hosts. Invasive fungal infections are life threatening and usually affect people with compromised immune systems and fungi causein these infections live on humans (e.g. *Candida* spp.) or in the environment (e.g. *Aspergillus* spp., *Cryptococcus* spp., *Pneumocystis* spp.).

Dermatophytes and dermatophytosis

Dermatophytes are filamentous keratinophillic fungi from the genera *Trichophyton, Microsporum, Epidermophyton*, and *Nannizzia*, which affects nails, hair and skin [24]. Superficial skin infections are less commonly caused by non-dermatophytic fungi, examples includes; *Malassezia furfur* in tinea versicolor [25]. Dermatophytes also degrade claws, feathers, hooves, horns, and wools in animals. The diseases caused by dermatophytes are known as dermatophytoses which constitutes an important public health problem, not only in underdeveloped countries but also in elderly and immunocompromised patients worldwide [26]. Dermatophytes can affect various parts of the body and they tend to grow in an outward pattern on the skin, thereby producing a ring-like lesion, hence the term 'ring worm [22].

Dermatophytosis is a general term for acute to mild chronic lesions of the outer layers of keratinized tissue of the body caused by dermatophytes [8]. Dermatophytoses includes; Tinea barbae, Tinea corporis, Tinea capitis, Tinea manuum, Tinea unguium, Tinea cruris, Tinea pedis, Tinea faciei, Tinea incognitio, and Tinea favosa. Dermatophytosis is a clinical childhood disease and the fungal species involved varies according to age, and clinical presentation. The most dermatophytoses in children is dermatophytoses of the scalp and hair. Dermatophyte infection can be disfiguring and recurrent and generally need long term treatment with antifungal agents [27]. Superficial mycoses of dermatophytes are named after anatomical localization of the lesions. A characteristic feature of dermatophyte infection is an inflammatory pattern at the edge of the skin lesion noted by erythema and scaling or, occasionally blister formation [25]. Patients with typical dermatophytic lesion, physical examination reveals pattern of inflammation termed an "active border" [25].

Tinea pedis (athlete's foot)

Tinea pedis is universal infection observes in one in five adults and the occurrence boost up with age from adolescence [28]. Infections are derived as the itching and shedding of skin scales holding viable infections agents like arthroconidia [28]. Tinea pedis is a term that denotes dermatophyte infection of the soles of the feet and the interdigital spaces. Tinea pedis is mostly caused by *Trichophyton rubrum* (60%), *Trichophyton mentagrophytes* (20%), and *Epidermophyton floccosum* (10%) and rarely *by Microsporum canis* and *Trichophyton tonsurans* [2].

Tinea pedis tends usually presents in one of the four ways;

1. Interdigitale Tinea pedis: Usually arise in the interspaces between the 4th and 5th toes and spreads occasionally to the underside of the foot.
2. Hyperkeratotic/ moccasin toe: Scale covering the sole and sides of the feet and it's usually caused by *T. rubrum*.
3. Ulcerative Tinea pedis: this is an acute uncreative process usually affecting the soles and associated with maceration, denudation of the skin and oozing.
4. Vestibulobullous type: This is the least common form of this infection and patient's presents with small vesicles and blisters on erythematous base, usually near the instep and adjacent plantar surface of the feet. Sometimes pustules are also found in this type [29].

The incidence is higher in warm and humid climate which are known to promote the infection but has found to occur less frequently in areas of the world where shoes are not commonly worn.

Tinea corporis

Tinea corporis is most often caused by *Trichophyton rubrum, T. tonsurams*, and *Microsporum canis*. Tinea corporis occurs most frequently in post-pubertal children and young adults and rare cases has been reported in new born babies [30]. There is no sex predominance, and humans become infected through close contact with an infected individual, infected animal, or contaminated soil. Infection may be as a result of spread of dermatophytic infection from other sites (example, tinea capitis, tinea pedis, onychomycosis). Tinea corporis typically presents as a well-demarcated, sharply circumscribed, oval or circular, mildly erythematous, scaly patch or plaque with a raising leading edge [31]. The lesion starts as a flat spot that spreads centrifugally and clears centrally to form a characteristic annular lesion giving rise to the term 'ringworm' with the central area becomes hypo pigmented or brown and less scaly as the active border progress outward [32]. Tinea corporis in adults occurs most commonly on the exposed parts of the skin while in children and adolescents, the site of predilection is the trunk.

Tinea gladiotorum presents with a well demarcated, erythematous, annular, scaling plaques on areas of skin-to-skin contact, such as head, neck and arms. This condition is common amongst wrestlers and those who engage in judo. Tinea galdiatorum is most often caused by *Trichophyton tonsurans* [33].

Tinea incognito refers to a cutaneous fungal infection that has lost its classical morphological features because of the use of calcineurin inhibitors or corticosteroids [34].

Tinea unguium (onychomycosis)

Tinea unguium is a fungal infection of the toenails or fingernails and it may involve any component of the nail unit, including the matrix, bed, or plate. Onychomycosis has been reported as a gender related disease being more prevalent in males [35]. Toe nails are much more likely to be affected than fingernails. The infection is uncommon in children and it frequency increases with age and spreads from tinea pedis and tinea manuum. Two major pathogens are responsible for approximately 90% of all onychomycosis. *Trichophyton rubrum* accounts for 70% and *Trichophyton mentagrophytes var interdigitale* accounts for 20% of all cases. Onychomycosis caused by non-dermatphytes molds (*Fusarium* spp., *Scopulariopsis brevicularis, Aspergillus* spp.) is becoming more common worldwide accounting for up to 10% of cases [36]. Yeast, like *Candida parapsilosis* represent the third cause of nail infection, and they occur only when predisposing factors are present, diabetes and immunosuppression. Onychomycosis has 5 main clinical presentations;

1. Distal and Lateral Subungunal Onychomycosis (DLSO): DSLO usually affects one or both of the big toenails and is usually in association with tinea pedis [37]. There is white to yellow discoloration on the nail plate and the nail is detached due to oncholysis with distal subungunal hyperkeratosis. DSLO may also be associated with black pigmentation of the nail (fungal melanonychia) when the pathogen is Melanoides variation of *Trichophyton rubrum* or other fungi that produce melanin [38].

2. White Superficial Onychomycosis (WSO): The dorsal nail plate is invaded are invaded by fungi and they appear as white opaque formations and are easily scrapped away. Classical form of WSO is due *to Trichophyton interdigitale*, the dermatophytes invade the most superficial layers of the nail plate without penetrating it but *Fusarium* spp. and other molds may cause a white superficial onychomycosis with a deeper nail infection [35].
3. Proximal Subungunal Onychomycosis (PSO): the fungal elements are usually located on the ventral nail plate producing a proximal leuconychia. PSO due to dermatophytes are rare as it is a common presentation due to non-dermatophyte mold infection especially *Aspergillus* spp. and *Fusarium* spp [35]. Usually presents as white area under the nail plate in the lunula area.
4. Endonyx Onychomycosis: This is characterized by massive nail plate invasion in the absence of nail bed involvement. The affected nail presents with lamella splitting and a milky white discoloration.There is no nail bed hyperkeratosis or onycholysis and the nail plate is firmly attached to the nail bed [35].
5. Total Dystrophic Onychomycosis (TDO): This is the most severe stage of onychomycosis and it usually result from a long standing DSLO or PSO. The nail plate is diffusely thickened, friable and yellowish.

Tinea barbae

Tinea barbae is a superficial fungal infection of the bearded areas of the face and neck. It occurs almost exclusively in older adolescent and adult males. Tinea barbae is caused by zoophilic and anthropophilic fungi. Zoophilic dermatophytes include; *Trichophyton mentagrophytes var granulosum* and *Trichophyton verrucosum* while the anthropophilic dermatophyte is *Trichophuton rubrum* [39]. Predisposing factors which favors the development of the disease are severe concomitant diseases such as diabetes mellitus, congenital or acquired immunodeficiency, previous corticosteroid therapy and contact with animal or people suffering from the disease. Clinical presentation of Tinea barbae depends on the causative organism. Infection usually starts from the neck or chin.

Zoophilic dermatophyte causes severe and more inflammatory reaction. Chin, cheeks and neck are mostly involved. An inflamed noodle(s) is formed with multiple pustules and draining sinuses on its surface. The hairs are broken; exudate, pus and crust are seen all over the affected area (kerion Celsi). Non-inflammatory type is caused by anthropophilic species and begins as flat, red patches with a raised border. Scaly patches may be studded with papules, pustules or crusts [40].

Tinea cruris (jocky itch)

This is a superficial fungal infection of the groin and adjacent skin. The most common etiological agent for tinea cruris is *Trichophyton rubrum, Epidermophyton floccosum* and less ommonly *Trichophyton mentagrophytes*, and *Trichophyton verrucosum* are also involved. *Epidermphyton floccosum* is mostly associated with outbreaks while *Trichophyton rubrum* remains the most common cause worldwide [41]. Tinea cruris is 3 times more common in men than women [42]. This infection is very contagious and spread by fomites or by autoinoculation from another fungal infection of the hands, or feet (tinea manum or tinea pedis).

Tinea cruris usually presents as a collection of several erythematous papulovesicles with distinct raised borders. This is unilateral and begins as the crural fold but may advance onto the thigh and scaling is sharply demarcated at the periphery [41]. Acute infection presents as exudative lesion whereas chronic infections presents with dry, popular, annular, or arch shaped, with mild border scaling and can evolve into Majocchi granuloma [42]. *Epidermophyton floccosum* often limits to the upper thigh and also crural fold between the groin and leg and also shows central clearing while *Trichophyton rubrum* infections extend to the pubic, perianal, buttock, and lower abdominal regions with coalescence [31].

Tinea versicolor (pityriasis versicolor)

Tinea versicolor is a superficial fungal infection characterized by changes in skin pigmentation due to colonization of the stratum corneum by a dimorphic lipophilc fungus of the normal flora of the skin known as *Malassezia furfur*. Tinea versicolor is also known as tinea flava, and dermatomycosis furfuracea. This infection is distributed globally but majorly in the tropic. Pityriasis versicolor presents as multiple bald patches of variable appearance (hypopigmented, hyperpigmented, dark brown or erythematous) surrounded by normal skin. These lesions are non-inflammatory and characterized by brown or fawn coloured lesions. These lesions vary in colour due to the production of dicarboxylic acids such as azelaic acid. Areas of the body affected include; back, chest, abdomen, neck, and upper limbs, however the back carries more lesions.

Dermatophytes Studies in Nigeria

Cutaneous mycoses of the skin and its appendages have been studied in different parts of Nigeria. In a study of the prevalence of tinea capitis carried out by Dogo *et al.,* it was revealed that out of 100 School children in Nok community of Kaduna State reported eight (8) species of dermatophytes were isolated. The most prevalent being the *Trichophyton rubrum* (28.8%); others are *Microsporum canis* (22.2%), *Microsporum audouinii* (10.6%), *Mirosporum gypseum* (12.1%), *Trichophyton mentagrophytes* (6.1%), *Trichophyton verrucosum* (4.5%), *Trichophyton tonsurans* (4.5%), *Trichophyton schoenleinii* (10.6%).

In Nkanu West LGA of Enugu state, Ogu *et al.,* did a clinical dermatophytoses in seven (7) primary schools. A total of 1544 pupils were examined for Tinea infections and 186 pupils showed obvious signs of infection and 176(96.4%) were diagnosed clinically. A total of eight (8) dermatophytes constituting (97.7%) of the samples and two (2) non-dermatophytes constituting (2.3%) were isolated. Concerning the dermatophytes, two (2) genera; *Trichophyton* and *Microsporum* were isolated. *Trichophyton mentagrophtes* being the leading organism isolated 105 (56.1%), followed by *Trichophyton rubrum* 26 (14%), while the least dermatophyte isolated was *Trichophyton soudanense* 1 (0.5%. The non-dermatophytes isolated include; *Candida albicans* 3 (1.6%), and *Aspergillus flavus* 1 (0.5%). Based on distribution of dermatophytes according to site, it was found that Tinea capitis was the commonest accounting for (72.5%) of the prevalence. Tinea corporis, Tinea unguium, Tinea manuum had a prevalence of (16.18%), (3.8%), and (2.2%) respectively [50].

A survey of six (6) hair dressing and beauty salons was carried out in Anyigba, a University community in Kogi

State Nigeria by Enemuor *et al.,* Swabs were made of the main equipment (combs, brushes, rollers, hairpins, and dryers) used in the salons and transported to the laboratory for culture. Out of the forty two (42) samples obtained from the different salons, only 5 bacterial and 6 fungal species were isolated. The fungi species isolated were; *Trichophyton* spp., *Aspergillus* spp., *Rhizopus, Penicillium* spp., *Cephalosporum* spp., and *Mucor* spp. The bacterial isolates include; *Staphylococcus aureus, Streptococcus* spp., *Enterococcus* spp., *Staphylococcus epidermidis*, and *Enterobacteriaceae* spp [51].

Stanley *et al.,* carried out a research on microbial contamination of combs and brushes used in beauty salons within the University of Port Harcourt, Rivers state. A total of twelve (12) composite samples were collected from the combs and brushes within the three (3) campuses using sterile swab sticks and cultures were made in the laboratory. Bacteria and fungi were isolated from the combs and brushes. The study revealed *Aspergillus flavus* (36.6%) as the most prevalent fungal isolate, other fungal isolates include; *Penicillium* spp. (27.3%), *Trichophyton* spp. (18.2%), and *Microsporum* spp. (18.2%) [52]. In the study carried out by Mbaj iuka *et al., Aspergillus* spp. *Mucor* spp. and *Rhizopus* spp. were also isolated combs and brushes used in hair dressing salons in Michael Okpara University of Agriculture, Umudike in Abia state. The isolation of these bacterial and fungal species in these samples also indicates that infection like ringworm or dermatophytosis can also be spread via these salons.

A study of dermatophytosis among primary school children aged 5-16 years in Oke-oyi community of Kwara state by Adefemi *et al.,* revealed that in a total of 602 pupils (398 males and 204 females), 180 respondents (123 males and 57 females) were diagnosed to have dermatophytic lesion clinically. Of the 180 clinically suspected fungal infection cases, only 94 (52.2.5%) was mycologically proven. Single fungal infections were observed in 87/180 (48.3%) cases, of which dermatophytes account for 23/180 (12.8%). Multiple infections of two species were observed in 15/180 (8.3%) of the cases, of which dermatophytes account for another 7 7/180 (3.9%). The prevalence of dermatophytes in the series was 30/602 (5.0%). Other non-dermatophytes accounts for the rest 93/602 (15.4%). *Trichophyton mentagrophytes* was the predominant specie, followed by *Microsporum audouinii* and *Trichophyton verrucosum*. The non-dermatophytes species include; *Candida albicans* being the most prevalent, followed by *Mucor, Rhizopus*, and *Alternaria* spp.

A research was carried out by Omoruyi and Idemudia, on comparative analysis of antiseptic properties of some disinfectants on bacteria and fungi of public health importance isolated from barbing clippers. The study revealed *Malassezia* and *Trichophyton* spp. as consistent fungi species while *Staphylococcus, Streptococcus*, and *Bacillus* spp. were common bacteria consistently isolated from barbing clippers before and after the use of disinfectant (Jik, Dettol, Kerosene, and Fuel). *Malassezia* and *Trichophyton* occurred respectively in (70.8%) and (58.3%) of samples while *Staphylococcus, Streptococcus,* and *Bacillus* spp. occurred in (91.67%), (75%), and (83.3%) of samples respectively. Of all the used disinfectants, Hydrogen Peroxide shows more antiseptic properties on all isolates with a zone of inhibition for all the isolates. The result therefore showed that Hydrogen Peroxide is suitable for barbing operations and could be an alternative to high disinfection.

Tinea capitis

Tinea capitis is an infection of the scalp hair follicles and the surrounding skin, caused by dermatophytic fungi, usually in the genera *Microsporum* and *Trichophyto*n. Tinea capitis infection is often asymptomatic and undiagnosed, with consequent spread to close contacts especially siblings. Tinea capitis continues to be a disease of pre-pubertal children between the age of 3-7 years, living in poverty stricken areas and common in inner city cosmopolitan communities with no sign of reduction in incidence. This is due to the relatively low production of sebum and immature immune system in children. Tinea capitis infection is more prevalent in boys than girls, although the occurrence in post-menopausal women has been described. Also two anthropophiic dermatophyte species, *Trichophyton soudanense* and *Microsporum audouinii*, were the main etiological agents isolated from Tinea capitis cases in West African countries.

Carrying of objects on the scalp and sharing of hair clippers, scissors, combs, towels and formites are the most predisposing factors to tinea capitis. Overcrowding and poor hygiene also predispose to tinea capitis infection.

Classification of tinea capitis

Tinea capitis is classified on the basis of the type of hair invasion and site of formation of arthronidia as endothrix, ectothrix, and favus [34]

Endothrix infection

In endothrix infection, the fungus grows completely within the hair shaft; the hyphae are converted to arthroconidia (spores) within the hair shaft while the cuticle surface of the hair remains intact. This infection is characterized by arthroconidia destroying the cuticle, often appearing like “a bag of marbles”. Hairs often break at the scalp level leaving swollen hair stubs within the follicles giving rise to the “black dot” appearance. Endothrix infections results from anthropophillic fungi, notably *Trichophyton tonsurans, Trichophyton soundanense*, and *Trichophyton violeceum* [34]. The affected hairs do not fluoresce with a Wood lamp ultraviolet light.

Ectothrix infection

The hair invasion develops in a manner similar to endothrix except that the hyphae are destroyed within the cuticle and grow around the exterior of the hair shaft. The hair shaft is invaded at the level of the mid-follicle. The cuticle is destroyed by the hair shaft. Infected hairs usually fluoresce with a Wood lamp ultraviolet light. The causative agents include *Microsporum canis, Trichophyton verrucosum, Microsporum audouinii, Microsporum gypseum, Microsporum distortum, Microsporum ferrugineum, and Microsporum nanum* [34].

Favus

The favic type of infection is caused by the anthropophillic dermatophyte *Trichophyton schoenleinii.* The affected hairs are less damaged than in other types, and may continue to grow to considerable lengths. Air spaces in the hair shafts are characteristic and fungal hyphae form large clusters at

the base of hairs where they enter the follicle at the level epidermis.

Types of lesions and clinical appearance of Tinea capitis

The clinical appearance is highly variable, depending on the causative organism, the degree of hair invasion, degree of host inflammatory response.

1. Non-inflammatory or epidemic type

This is also known as grey patch ringworm. It is mostly caused by *Microsporum audouinii* and *Microporum ferruginuem*. It is characterized by fine scaling with patchy circular alopecia, dull grey in colour due to arthrospores coating the affected hairs. It occurs more at the occipital and nuchal areas of the scalp. It is transmitted from person to person and also by way of fomites. They produce relatively non-inflammatory patches of alopecia with fine scale, classically studded with broken off, swollen hair stubs, resulting in a black 'dot appearance'. Diffuse scale alopecia is minimal or absent and infection presents as generalized, diffuse scaling of the scalp resembling dandruff.

2. Inflammatory type:

This type is caused by a zoophilic dermatophyte *(Microsporum canis*); a similar presentation is also seen with *Microsporum gypsum*. Presents with a localized scaliness of the scalp which is rarely recognized occurs first. Shortly a slightly pruritic, itchy, erythematous, papulovesicular area of hair protruding from the centre of the vesicle is seen. The involved hair is usually broken off 1-2mm from the scalp but in some lesions there may be complete hair loss.

3. Kerion

This type is very inflammatory. Presents with folliculitis and pustules (serious boils), also a boggy eczematous lesions with highly inflamed areas which may be described as indolent abscesses. It may be accompanied by fever and lymphadenopathy and other toxic manifestations. Popular vesicular eruptions may appear on the trunk or extremities (legs and hands). When kerion heals, it leaves a scar. Kerion is commonly seen with zoophilic, large-spore ectothrix species (*Trichophyton mentagrophtes, Trichophyton verrucosum*) [44].

4. Favus

This is also called 'honey comb' ringworm. This is a chronic hair infection caused by *Trichophyton schoenleinii*. Can also be caused by *Trichophyton violeseum*. The infection is limited only to the scalp where the organism produces honey coloured cup shaped crust called 'scutula' (or scutum for one). This secretion has a distinctive mousy odour and it comes with the hair matted together.

5. Alopecia

Usually caused *by Trichophyton tonsurans* and *Trichophyton violeseum*. It is characterized by multiple bald areas in the scalp; they emerge to give complete and general hair loss (Onyemelukwe Unpublished).

Laboratory diagnosis of tinea capitis

Laboratory diagnosis of tinea capitis is based the clinical appearance and demonstration of the hyphal elements and arthrospores on keratinized tissue microscopically by the use of KOH mount procedure for scales of the skin and hair (10% for skin and hair scrapings and 20-40% for nail clippings). A wood lamps test may be performed to confirm the presence of a fungal scalp infection. Culture is needed to identify the species of the ringworm fungus. The specie of the dermatophyte is identified from the colonial appearance of the culture and by examining the mycelial growth microscopically for specialized hyphae such as spiral, pectinate or antler hyphae, presence or absence and morphology of macroconidia, and chlamydospores [28]. The addition of actidione to culture media inhibits environmental fungi. It is important to collect samples with little or no contamination. The surface of the skin should be disinfected with 70% ethanol and cotton wool before sample collection. The samples are collected from the active border (towards the periphery). For skin lesions, scales are collected by scraping the surface of the margin of the lesion using a sterile scalpel blade. For nail pieces, it is collected by taking snipping of the infected part of the nail using a sterile scissors, where the nail is thickened scrapings from beneath the nail is also collected. Hairs are collected by removing dull broken hairs from the margin of the lesion using sterile tweezers or scraping with a blunt scalpel. When available, Wood's light is used to examine the hair *(Microsporum* infected hairs fluoresce).

In the laboratory, KOH mount is done with 10%, 20-40% depending on the nature of the sample. The KOH digest the keratin surrounding the fungi so that the hyphae and conidia (spores) can be seen. The addition of dimethylsulphoxide (DMSO) to KOH enables specimens to be examined immediately or after only a few minutes. For the culture, the samples are inoculated into Sabouraud Dextrose Agar (SDA) with actidione (S+A) at 26-28◦C for 3 weeks (21days). Identification is based on growth, texture, pigmentation, and colony topography. The growths are examined microscopically by LPCB (Lactophenol cotton blue) mount. Size, shape, arrangement of microconidia and macroconidia, type of hyphae, and special structures like favic chandelier helps to identify the dermatophyte.

Treatment of tinea capitis

The causative organism of tinea capitis is considered when choosing the appropriate therapy. The treatment of tinea capitis requires systematic antifungal therapy because topical antifungal agents cannot penetrate the hair shaft sufficiently to eradicate infection [45]. Topical therapy is only used as an adjuvant therapy to systemic antifungals. Since 1950s Greseofulvin has been the gold standard for the treatment of systemic therapy for tinea capitis and it is active against dermatophytes and has a long-term safety profile. The main disadvantage for greseofulvin is its long duration of treatment required (6-12 weeks or longer) which may lead to educed compliance. Most clinical types of dermatophytoses respond well to topical antifungal therapy while tinea capitis and tinea unguium do not and require systemic therapy.

Initiation of antifungal therapy is essential for proper treatment and prevention of the disease and this has led to introduction of antifungal susceptibility testing by agar based disc diffusion method [12]. The newer oral antifungal agents including terbinafine, itraconazole, ketoconazole, and fluconazole. Itraconazole is more sensitive followed by Clotrimaole, and Fluconazole. Treatment decision between greseofulvin and newer antifungal agents for children with tinea capitis caused by Trichophyton species depends on the balance between duration of treatment and compliance and economic considerations. In children with tinea capitis caused by *Trichophyton tonsurans*, terbinafin is preferred for the treatment; however it is not enough for the treatment

of *Microsporum canis* tinea capitis. Fluconazole is more effective for *Microsporum canis* tinea capitis.

Topical therapies such as Selenium sulphide, zinc pyrithione, povidoneiodide or ketoconazole shampoos and fungicidal creams or lotions decrease the carriage of viable spores responsible for re-infection and disease contagion. Terbinafin solution kills completely arthroconidia of five (5) *Trichophyton* species in an exposure of 15-30minutes [46].

Immunity

Dermatophyte invasion is mostly restricted to keratinized tissues such as skin, hair, and nails and they have the potential to cause extensive chronic superficial infections or invasive systemic disease in immunocompromised patients. The dryness of the skins outer layer prevents microorganisms from thriving and the constant shedding of the epidermal layer keeps many microbes from establishing residence. Adults rarely have tinea capitis due to the secretion of fatty acid in the sebum, which has antifungal properties and the fully mature immune system after puberty [47] although they develop Tinea coporis of the head or neck through spread from a Childs scalp [48].

Predisposing factors of tinea capitis

Factor like poverty, poor hygiene, immune status and occupation play an important role in the development of dermatophytoses [12]. HIV/AIDS pandemic, tuberculosis, chronic obstructive pulmonary disease (COPD), asthma, and the increasing incidence of cancers are the major drivers of fungal infections in both developed and developing countries [10]. Unfavorable sterilization and disinfection procedures as well as poor knowledge can help in the widespread of tinea capitis in salons [49] and also the use of contaminated salon tools such as towels, combs and brushes. Large family size and sharing of beds increases the risk of anthropophylic dermatophytes whereas animals such as dogs, cats, pigs, chickens, cattle rodents and horses are sources of zoophilic dermatophyte infections. Poor personal hygiene, use of local barbers, ignorance, increased frequent contacts with playmates and siblings, and short hair promotes the transmission of dermatophyte from one scalp to another amongst children of primary school age [50].

Salon and Salon hygiene practices

Hair dressing salon is a business that focuses on braiding, cutting, colouring and styling a customers hair. The concept of salon is linked to beauty, an establishment dealing with cosmetics products and tools to improve the appearance of one's hair, face, and body. Salons provide a wide range of services including hairdressing, nail care (manicures and pedicures), hair removal by waxing and threading, mud baths and many other services. However, all these are considered a major health concern and the risk associated with salon vary according to the tools used in the salon and the nature of the business. Salons can contribute to and help spread viral, bacterial and fungal infections [51]. Unfortunately, there are no established regulations, guidelines and best practices for many of these salons in our environment. Salon hygiene can broadly be divided into three areas; the products and equipments used, the service given, and the salon professionals themselves.

Physical and chemical methods are often used by salons to sterilize tools and equipment, such as chemical reagents, boiling water, autoclaving, and untraviolet (UV) light. The method of using hot after hot water sterilization involves placing the tools in boiling water for a period of no less than 3-5 minutes. This method is fast and has been shown to be insufficient in killing of microorganisms. Bacteria can survive detergent so the use of hot water and a product with activated oxygen bleach to clean towels thoroughly. Autoclaving is the most reliable way of killing microbes but it involves a relatively long time. Chemical disinfectants are effective in killing microbes or at least slowing their growth; however most of these chemicals are hazardous and need to be used with caution. After cleaning of tools, they should be stored in a cool and dry place to reduce the risk of any growth of bacteria and fungi on them as wet and damp towels provides a perfect environment for the growth of microorganisms.

Personal hygiene for hairdressers and stylists include washing of hands before and after attending to a customer; covering of cuts or wounds with sealed water proof bandage.

For the laundry, all used towels must be washed after each client use; all used towels and other clothes items must be placed into a container separate from the clean linen; all used towels must be washed in a washing machine with a water temperature of a minimum of 65◦C for not less then 10minutes using a laundry detergent or washed in a cooler wash with a laundry detergent and a laundry disinfectant added to the water or washed by a commercial laundey; washed items must be hung out to dry and all claen items stored in a designated clean area.

Dermatophytes spores are susceptible to benzalkonium chloride, dilute chloride bleach (1% sodium hypochlorite), eniconazole (0.2%), formaldehyde and some strong detergents. Dermatophytes are susceptible to high heat. Moist heat of 121◦C, applied for at least 20 minutes, or dry heat of 165-170◦C for 2 hours have been reported to be effective.

Salon towels

A towel is a piece of absorbent fabric or paper used for drying or wiping a body or a surface. It draws moisture through direct contact. There are many types of towels each made of different materials; microfiber, cotton, and chamois. Each of these three types has its advantages and disadvantages that suits it for different businesses and uses. For salon use, cotton towels offer the best option for it softness, and comfort and microfiber towels harbor greater number of bacteria compared with the cotton towels. The most importance function of towels is absorbance of moisture, the towels used in salons are used to absorb moisture from wet hairs and in the process gets contaminated. If used on another person without proper washing and disinfection, it can lead to the spread of diseases (such as dermatophytoses, lice).

Fig 2: Hairdressing salon towels.

Dermatophytes isolated from salon equipments

Several literature reports document the existence of variety of microorganisms isolated from tools from beauty salons. There are reports of people who have been infected with head lice from direct hair-to-hair contact with someone who has head lice. The common use of hairdressing tools, mostly combs, razors, brushes and towels is a potential way of transmission of dermatophytes.

Hairdressing and beauty salons are classified as personal service establishments and such services may pose potential health concerns to their clients including the risk of infection and sometimes injury [51]. In a survey carried out in beauty salons in University of Port Harcourt, dermatophytes isolated include *Trichophyton* spp. and *Microsporum* spp [52]. Results obtained by Enemuor *et al.,* revealed conatnmination of salon equipment by *Trichophyton* spp., this indicates that ringworm or dermatophytosis can also be spread via salons and it is clear that hygienic practice is far below expected standard [51]. Similar result was obtained by Edward *et al.,* which showed 3% contamination of hair-brushes by *Trichophyton* spp. The study carried out by Alharbi and Mohammed, revealed *Trichophyton* spp. as the indicator fungus of contamination of salon equipment by more risky microorganisms. Since spores of Trichophyton species are quite resistant to environmental influences, inadequate hygiene can lead to transmission of the dermatophyte even after months. Another study carried out by Coulibaly *et al.,* in hairdressing salons in West African suburban community revealed the contamination of equipment by two (2) anthropophylic dermatophytes; *Microsporum audouinii* and *Trichophyton soudanense* with a prevalence of (53.3%) and (46.7%) respectively [20].

A study was conducted in Calabar, in which one hundred and fifty (150) salon tools were sampled from thirty (30) salons, 52 (34.7%) fungi was recovered from those tools out of which dermatophytes were 40 (26.6%) *Trichophyton interdigitale* 12(30%) was the most common dermatophyte recovered followed by *Trichophyton rubrum* 9(22.5%) and *Trichophyton tonsurans* 6(15%), *Trichophyton soundanense* 3(7.5%) was the least isolated.

Non-dermatophyte associated with salon equipments

Several literature reports document the existence of a variety of microorganisms isolated from beauty tools used in salons such as hair stretchers, rollers, hair pins, nail care tools an sponges but not much work has been done on salon towels. However a research done on kitchen towels by Londiwe revealed the following microbes, *Staphylococcus, Escherichia*, and *Pseudomonas*. A research done in salons in Taraba state by *Ebuara et al.,* revealed the contamination of combs and brushes by the genera *Mucor, Malassezia*, and *Aspergillus.* Stanley MC *et al.,* also isolated *Aspergillus* spp., *Mucor* spp., and *Rhizopus* spp., from tools used in Hair dressing salons in Michael Okpara University of Agriculture, Umudike, these fungi isolates shows that ringworm or dermatophytosis can also be spread via salons [53]. Stanley *et al.,* isolated *Aspergillus flavus* and *Penicillium* spp [52]. from combs and brushes used in beauty salons within the University of Port Harcourt. *Aspergillus, Cladosporon, Mucor, Candida*, and *Penicillium* were isolated by Farzaneh *et al.,* from tools used in barbershop in Kamyaran city Iran [54]. The study carried out by Ogba *et al.*, the non-dermatophytes recovery rates was 12(8.0%), the most common dermatophyte recovered was *Malassezia* spp. 5(41.6%), followed by *Aspergillus flavus* 3(25%) [55]. Study carried out by Danyar and Chro in Iraq revealed contamination of salon equipment by bacteria (79%) and fungi species (21%) of which *Candida albicans* was the most prevalent (19%). *Candida albicans* can cause diseases in different locations of the body such as skin and eyes and seen mostly among women who share salon tools [56].

Non-dermatophytes are filamentous fungi that are commonly found in nature as saprophytes and plant pathogens. They are regarded as uncommon or secondary pathogens of already deceased nails. Studies carried out by Edward *et al.,* in detection of fungi in hair-brushes in beauty salon at Jat inangor revealed 93% positive cultures of which 90% were non dermatophytes [57]. Infections caused by non-dermatophytes include: candidiasis, aspergillosis, geotrichosis, scopulariopsis, penicilliosis, rhodotorulosis, trichosporonosis [58].

Conclusion

The epidemiology revealed that there is significant variation in the prevalence and causative organisms of dermatophytic infections. Trychophyton mentagrophytes and Trichophyton rubrum are the most predominant isolates in dermatophyte infections with tinea corporis being the most common clinical presentation. Nigeria shows prevalence rates of tinea capitis 9.4% and 51.8% in the eastern regions and tinea capitis also have high prevalence rates among children in African. Demographic patterns are reveald with males being the most affected than females in some parts of the world. Certain age groups (21-40 years) showed higher susceptibility.

References

1. Vishwa Priya K. Clinicomycological Profile of the Dermatophytes and Its Antifungal Susceptibility Pattern in Patients Attending Dermatology Out Patient Department in a Tertiary Care Hospital (Doctoral dissertation, Chengalpattu Medical College, Chengalpattu).

2. Weitzman I, Summerbell RC. The dermatophytes. Clinical Microbiology Reviews, Apr 1995; 8(2):240-259.
3. Negroni R. Historical aspects of dermatomycoses. Clinics in Dermatology, Mar 1 2010; 28(2):125-132.
4. Emmons CW. Dermatophytes: Natural grouping based on the form of the spores and accessory organs. Archives of Dermatology and Syphilology, Sep 1, 1934; 30(3):337-362.
5. Al Laham N, Abdelateef N, Naieem M. Dermatophytosis Among Outpatients in Gaza, Particularly Tinea Capitis.
6. Datt S, Datt T. Pathogenesis and Clinical Significance of Dermatophytes. Int. J. Curr. Microbiol. App. Sci. 2019; 8(11):1877-1886.
7. Achterman RR, White TC. A foot in the door for dermatophyte research. PLoS Pathogens. 2012; 8(3):e1002564.
8. Aneja KR, Joshi R, Sharma C, Surain P, Aneja A. Biodiversity of dermatophytes: An overview. Annu Rev Plant Pathol, Jul 1, 2013; 5:299-314.
9. Simonnet C, Berger F, Gantier JC. Epidemiology of superficial fungal diseases in French Guiana: A three-year retrospective analysis. Medical Mycology, Aug 1, 2011; 49(6):608-611.
10. Bongomin F, Gago S, Oladele RO, Denning DW. Global and multi-national prevalence of fungal diseases-estimate precision. Journal of Fungi, Oct 18, 2017; 3(4):57.
11. Oladele RO, Denning DW. Burden of serious fungal infection in Nigeria. West Afr J Med. 2014; 33(2):107-114.
12. Basak P, Mallick B, Pattanaik S. Prevalence of dermatophytic infections including antifungal susceptibility pattern of dermatophytes in a tertiary care hospital. Int J Res Med Sci. 2019; 7(3):699-705.
13. Gadadavar S, Shilpa HS, Patil CS, Vinay PS, Shettar N. Clinico-mycological study of dermatophytosis at a tertiary care hospital in Belagavi, Karnataka, India. Int J Curr Microbiol Appl Sci. 2018; 7:1872-1880.
14. Kromann CB, Graversgaard C, Riis PT, Jemec GB, Serup J, Saunte DM. Dermatophyte prevalence in tools of 43 hairdressing salons in Copenhagen. Acta Dermato-Venereologica. 2016; 96(6):846-847.
15. Macha ME, Makange MR, Misinzo G. Prevalence and identification of fungi associated with Tinea capitis in school children of Morogoro municipality, Tanzania. African Journal of Medical and Health Sciences. 2020; 19(7):103-109.
16. Chikoi R, Nyawale HA, Mghanga FP, Nyawale H. Magnitude and associated risk factors of superficial skin fungal infection among primary school children in Southern Tanzania. Cureus. 2018; 10(7).
17. Ahmed AS, Ahmed MA, Abdelrahma NA, Adam NK, Abdel-Aziz DS, Ahmed NB. Prevalence of tinea capitis among school age children in eastern Sudan. J. Bacteriol. Mycol Open Access. 2021; 9(2):94-97.
18. Ayanlowo O, Akinkugbe A, Oladele R, Balogun M. Prevalence of Tinea capitis infection among primary school children in a rural setting in south-west Nigeria. Journal of Public Health in Africa. 2014; 5(1):349.
19. Cortez AC, De Souza JV, Sadahiro A, De Oliveira JA. Frequency and aetiology of dermatophytosis in children age 12 and under in the state of Amazonas, Brazil. Revista Iberoamericana de Micologia. 2012; 29(4):223-226.
20. Coulibaly O, Thera MA, Piarroux R, Doumbo OK, Ranque S. High dermatophyte contamination levels in hairdressing salons of a West African suburban community. Mycoses, Feb 2015; 58(2):65-68.
21. Gürtler TG, Diniz LM, Nicchio L. Tinea capitis micro-epidemic by Microsporum canis in a day care center of Vitória-Espírito Santo (Brazil). Anais Brasileiros de Dermatologia. 2005; 80:267-272.
22. Coulibaly O, L'Ollivier C, Piarroux R, Ranque S. Epidemiology of human dermatophytoses in Africa. Medical mycology, Feb 1, 2018; 56(2):145-161.
23. Prakash B, Khedkar GD, Akshay SP. Newer Aspects of Diagnosis and Treatment of Human Fungal Infection. Int. J. Curr. Microbiol. App. Sci. 2019; 8(6):1873-1876.
24. Colosi IA, Cognet O, Colosi HA, Sabou M, Costache C. Dermatophytes and dermatophytosis in Cluj-Napoca, Romania-A 4-year cross-sectional study. Journal of Fungi, Aug 28, 2020; 6(3):154.
25. Hainer BL. Dermatophyte infections. American Family Physician, Jan 1, 2003; 67(1):101-109.
26. Abd Elmegeed AS, Ouf SA, Moussa TA, Eltahlawi SM. Dermatophytes and other associated fungi in patients attending to some hospitals in Egypt. Brazilian Journal of Microbiology. 2015; 46(3):799-805.
27. Nweze EI, Eke IE. Dermatophytes and dermatophytosis in the eastern and southern parts of Africa. Medical Mycology, Jan 1, 2018; 56(1):13-28.
28. Sharma V, Kumawat TK, Sharma A, Seth R, Chandra S. Distribution and prevalence of dermatophytes in semi-arid region of India. Advances in Microbiology, Feb 10, 2015; 5(2):93-106.
29. Tilak R, Prakash P, Nigam C, Gupta R. Tinea pedis: An update. Asian Journal of Medical Sciences, Sep 17, 2011; 2(2):134-138.
30. Alter SJ, McDonald MB, Schloemer J, Simon R, Trevino J. Common child and adolescent cutaneous infestations and fungal infections. Current Problems in Pediatric and Adolescent Health Care, Jan 1 2018; 48(1):3-25.
31. Gupta AK, Chaudhry M, Elewski B. Tinea corporis, tinea cruris, tinea nigra, and piedra. Dermatologic Clinics, Jul 1, 2003; 21(3):395-400.
32. Kaushik N, Pujalte GG, Reese ST. Superficial fungal infections. Primary care: Clinics in office practice, Dec 1, 2015; 42(4):501-516.
33. Kermani F, Moosazadeh M, Hedayati MT, Abastabar M, Haghani I, Aghili SR, *et al*. Molecular epidemiology of Tinea gladiatorum in contact sports in northern Iran. Mycoses, May 2020; 63(5):509-516.
34. Leung AK, Hon KL, Leong KF, Barankin B, Lam JM. Tinea capitis: An updated review. Recent Patents on Inflammation & Allergy Drug Discovery, May 1, 2020; 14(1):58-68.
35. Piraccini BM, Alessandrini A. Onychomycosis: A review. Journal of Fungi, Mar 27, 2015; 1(1):30-43.
36. Nouripour-Sisakht S, Mirhendi H, Shidfar MR, Ahmadi B, Rezaei-Matehkolaei A, Geramishoar M, *et al*. Aspergillus species as emerging causative agents of onychomycosis. Journal de Mycologie Medicale, Jun 1, 2015; 25(2):101-107.
37. Pichardo-Geisinger R, Mora DC, Newman JC, Arcury TA, Feldman SR, Quandt SA. Comorbidity of tinea

pedis and onychomycosis and evaluation of risk factors in Latino immigrant poultry processing and other manual laborers. Southern Medical Journal, Jun 1, 2014; 107(6):374-379.
38. Finch J, Arenas R, Baran R. Fungal melanonychia. Journal of the American Academy of Dermatology, May 1, 2012; 66(5):830-841.
39. Vazheva G, Zisova L. Tinea barbae profunda caused by Trichophyton rubrum-an autoinoculation from a primary Tinea pedis. Folia Medica, Apr 30, 2021; 63(2):292-296.
40. Baran W, Szepietowski JC, Schwartz RA. Tinea barbae. Acta Dermatovenerologica Alpina, Pannonica et Adriatica, Sep 2004; 13(3):91-94.
41. Seebacher C, Bouchara JP, Mignon B. Updates on the epidemiology of dermatophyte infections. Mycopathologia, Nov 2008; 166(5):335-352.
42. Devi VN, Balachandrudu DP. Prevalence and patterns of genital dermatoses in children. Methodology. 2011, Jul 2013.
43. Ilkit M, Durdu M, Karakaş M. Majocchi's granuloma: A symptom complex caused by fungal pathogens. Sabouraudia, Jul 1, 2012; 50(5):449-457.
44. Fuller LC, Barton RC, Mohd Mustapa MF, Proudfoot LE, Punjabi SP, Higgins EM, *et al*. British Association of Dermatologists' guidelines for the management of tinea capitis 2014. British Journal of Dermatology, Sep 1, 2014; 171(3):454-463.
45. Alkeswani A, Cantrell W, Elewski B. Treatment of tinea capitis. Skin Appendage Disorders, Jan 17, 2019; 5(4):201-210.
46. Bennassar A, Grimalt R. Management of tinea capitis in childhood. Clinical, Cosmetic and Investigational Dermatology, Jul 2010; 14:89-98.
47. Park TH, Kim WI, Cho MK, Whang KU, Kim S. Tinea Capitis and Tinea Corporis caused by Microsporum canis in an 82-year-old Woman: Efficacy of Sequence Analysis. Journal of Mycology and Infection, Mar 2020; 25(1):17-21.
48. Moriarty B, Hay R, Morris-Jones R. The diagnosis and management of tinea. Bmj, Jul 10, 2012; 345.
49. Hassan SM, Hamad AK, Shallal AF, Abdullah SM. Isolation of pathogenic microbes from beauty salons in Ranya, Iraq. Gazi Medical Journal, Mar 15, 2018; 29(2).
50. Ahmed AS, Ahmed MA, Abdelrahma NA, Adam NK, Abdel-Aziz DS, Ahmed NB. Prevalence of tinea capitis among school age children in eastern Sudan. J. Bacteriol. Mycol Open Access. 2021; 9(2):94-97.
51. Enemuor SC, Ojih MI, Isah S, Oguntibeju OO. Evaluation of bacterial and fungal contamination in hairdressing and beauty salons. African Journal of Microbiology Research, 2013.
52. Stanley HO, Oba TT, Ugboma CJ. Evaluation of microbial contamination of combs and brushes in beauty salons within the University of Port Harcourt, Rivers State, Nigeria. Arch Curr Res Int, Mar 6, 2019; 16(2):1-7.
53. Stanley MC, Ifeanyi OE, Kingsley O, Onyekachi IS. Evaluation of microbial contamination of tools used in hair dressing salons in Michael Okpara University of Agriculture, Umudike, Abia State. Curr Allergy Asthma Rep. 2015; 15(1).
54. Janmohammadi F, Fathi G, Roshani D, Farahmandi K. Evaluation of bacterial and fungal contaminations in barbershops in Kamyaran city, Iran-Summer 2015. Int J Med Res Health Sci. 2016; 5(9):368-371.
55. Ogba OM, Bassey DE, Olorode OA, Mbah M. Barbing Equipments: Tools for Transmission of Tinea Capitis. Microbiol. Res. J. Int. 2017; 19(1):1-7.
56. Amin DH, Qadir CN. Prevalence of infective agents on equipment used in female cosmetic centers in Sulaymaniyah Governorate-Iraq. EurAsian J. Biosci, Aug 1, 2020; 14(2):5939-59341.
57. Edward SM, Megantara I, Dwiyana RF. Detection of fungi in hair-brushes in beauty salons at Jatinangor. Althea Medical Journal, Dec 31; 2015; 2(4):516-520.
58. Welsh O, Gonzalez GM. Dermatophytosis (Tinea) and other superficial fungal infections. In Diagnosis and treatment of fungal infections. Cham: Springer International Publishing, May 13, 2015, 245-260.