ISOLATION AND IDENTIFICATION OF FUNGAL DERMATOLOGICAL AGENTS AMONG PATIENTS ATTENDING THIKA DISTRICT HOSPITAL THIKA, KENYA

BY

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April 2011

DECLARATION
I, Elizabeth .W. Mwaura declare that this thesis is my original work and has not been presented for a degree in any other University or any other award.

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DEDICATION
This thesis is dedicated to my friend and husband John K. Wamugi for his patience and understanding in course of this study and to my late mother Agnes Wangeci Mwaura for her encouragement to further my studies.
I am grateful to Almighty God for giving me life and the grace to undertake this study reported herein. I wish to express my sincere gratitude to all those who contributed to making this work a success in one way or another. In particular, I would wish to give my sincere appreciation to my supervisors; Dr. Joseph J. N. Ngeranwa, Dr. Christine Bii and Dr. John N. Mbithi for their guidance and support throughout this study. I wish to thank the management of Thika District Hospital for allowing me to conduct my research in the hospital and the management of Kenya Medical Research Institute, mycology laboratories for allowing me to process my samples in their laboratories. I owe much of the success of this study to co-operation of the laboratory personnel especially the technologist of mycology laboratory KEMRI, Evangeline Gatunwa and Gabriel Matheka of Thika District Hospital laboratories. To Dr. Anthony Waititu and Dr. John M. Kihoro I owe many thanks for their help in data analysis. Lastly I wish to thank Kenyatta University for giving me a chance to enroll in the Master of Sciences (Infectious Diseases Diagnosis) degree programme.

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### ACRONYMS AND ABBREVIATIONS

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<tr>
<td>AIDS</td>
<td>Acquired Immunodeficiency Syndrome</td>
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<tr>
<td>CD4</td>
<td>Immune cell that carries a marker on its surface known as cluster Differentiation of 4</td>
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<tr>
<td>HIV</td>
<td>Human immunodeficiency virus</td>
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<tr>
<td>KEMRI</td>
<td>Kenya Medical Research Institute</td>
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<td>KOH</td>
<td>Potassium Hydroxide</td>
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<td>NASCOP</td>
<td>National AIDS Control Council</td>
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<td>OR</td>
<td>Odds Ratio</td>
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<tr>
<td>SDA</td>
<td>Sabouraud Dextrose Agar</td>
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<tr>
<td>SPSS</td>
<td>Statistical Package for Social Sciences</td>
</tr>
<tr>
<td>W.H.O</td>
<td>World Health Organization</td>
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<tr>
<td>PCR</td>
<td>Polymerase Chain Reaction</td>
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ABSTRACT

Fungal dermatological conditions are caused by a group of fungi called dermatophytes. They cause infections in almost all parts of the body. The most common cause of skin infections are dermatophytes and opportunistic fungi. Dermatophytoes are not life threatening but they affect the quality of life of the patients as they can cause depression, lack of self confidence and isolation incase of deep lesions. In Kenya the prevalence and distribution of the infections as well as the common dermatological agents are not known. The predisposing factors of these infections are also not well studied in Kenya. The main objective of this study was to isolate and identify fungal dermatological agents from clinical samples from patients presenting with suspected fungal skin infection in Thika District Hospital. The study also examined the possible predisposing factors to fungal infections in patients attending Thika District hospital. Clinical samples from 126 patients were subjected to Potassium hydroxide (KOH) preparation and culture. The KOH digested specimens and fungal colonies were examined and identified macroscopically and microscopically. Patients completed questionnaires to record information on age, gender, site of infection, residence, level of education and occupation. The obtained results were analyzed by SPSS 12 software. The average age of the patients was 15.5 years and the ratio of male to female was 1.7:1. The highest isolation was from the scalp 56(44.4%) others were trunk 35(27.8%), hands 31(24.6%), neck 26 20.6%), feet 14 (11.1%) and face 9(7.1%). Out of 126 samples 107(84.9%) were KOH positive and 106(84.1%) were culture positive. Trichophyton spp. had the highest isolation of 67(62.6%), with T. verrucosum being the most common 21(16.3%) followed by T. sudanenses and T. mentagrophytes each at 12 (9.3%). The other fungal organisms isolated were yeast 26(24.3%), Epidermophyton spp. 3(2.8%), Microsporum spp. 3 (2.8%) and others that were non-dermatophyte were 8(7.5%). There was statistical association between isolation from hands, scalp and neck infection. The p-values were 0.04, 0.02 and 0.012 respectively. The association of gender, residence, age, occupation, knowledge of infection, education and infection was not statistically significant and the P-values were 1.0, 0.81, 0.64, 0.26, 0.36 and 0.11 respectively. The isolation rate of fungal infection was 84.1 % indicating that dermatophytosis in Thika District Hospital is a major cause of morbidity warranting intervention. This study recommends routine mycological investigations in both adults and children with suspected mycoses for better management of dermatological conditions in Thika District Hospital.
CHAPTER ONE
INTRODUCTION

1.1 Introduction
Fungal disorders are emerging significant infections in the world (WHO, 2005). In recent years they have become an important clinical condition that deserves public health attention (Cohen and Powdery, 2004). Mycology is a somewhat ignored field in medical research limiting the availability documented data on the overall prevalence of fungal infections in the world. However, recent literature suggests a prevalence of dermatological conditions as high as 30% depending on the type of fungal agent and the country (Williams, 1993; Souza et al., 2008; Hashemi et al., 2009). The burden is more in developing countries and also ranges from one country to another, for example the prevalence of dermatophytoses in Tunisia is 30.3%, in Brazil 38.4% and in Iran 21.1 % (Souza et al., 2008; Neji et al., 2008; Hashemi et al., 2009).

In Kenya the prevalence and distribution of fungal disorders and the causative agents are undocumented hence the situation is not known. About 1.2 million people are living with HIV and AIDS in Kenya, and there are over 700 new infection daily (NASCOP, 2004). HIV and AIDS is a major cause of immunosupression which is a significant predisposing factor to fungal infections, hence a likely increase in fungal infections in the population. Also, personal communication with health care providers suggests an upsurge of fungal infections in hospitals. Despite this, the
country lacks systematic studies to monitor the prevalence and distribution of fungal diseases hence there is lack of updated data on fungal disorders. The objective of this study was therefore to isolate and identify fungal agents of dermatological conditions among patients presenting with suspected fungal infections in Thika District Hospital.

1.2 Problem statement
The global prevalence of fungal infections has increased greatly over the last 10 years (Williams, 1993), yet the prevalence and distribution of fungal disorders and the etiological agents are largely un-documented in Kenya, consequently the situation remains unknown. The increase in HIV/AIDS cases associated with the HIV pandemic has led to the emergence of fungi associated opportunistic infections in Kenya (NASCOP, 2004). The country also lacks systematic studies to monitor the prevalence, etiology and distribution of fungal infections. There only is scanty information in various hospitals which is disorganized and undocumented. This study aimed at describing fungal dermatological conditions in terms of prevalence and distribution among patients attending Thika District Hospital. The study also described and documented the aetiological agents associated with dermatological conditions in Thika Hospital. The information obtained from this study will help in prioritizing the resources available to enhance both clinical and laboratory diagnosis and treatment of fungal diseases.
1.3 Research questions

i) Which are the most common fungal dermatological infections in patients visiting Thika District Hospital?

ii) Which is the most susceptible group to fungal infections among patients attending Thika District Hospital?

iii) What are the underlying predisposing factors for fungal infections in patients attending Thika District Hospital?

1.4 Hypothesis

Fungi are not a significant cause of dermatological infections in patients visiting Thika District Hospital.

1.5 Objectives

1.5.1 General objective

To isolate and identify fungal agents from patients presenting with dermatological conditions suspected to be fungal in Thika district hospital.

1.5.2 Specific objectives

i) To isolate fungal causative agents of dermatological conditions in patients presenting with suspected fungal dermatological infections in Thika District Hospital.

ii) To identify fungal agents isolated from patients in Thika District.

iii) To determine the prevalence of fungal infections in patients visiting
Thika district Hospital by age, gender and occupation.

iv) To determine the possible associated predisposing factors for fungal infections among patients in Thika District Hospital.

1.6 Justification and significance of the study

Fungal infections for a long time have not been given much attention due to the assumptions that they are not serious infections (WHO, 2005). Health care providers rarely request for fungal investigations on their patients, possibly delaying effective treatment. There is also lack of proper documentation of the most common aetiologies and the prevalence within the country. Currently about 1.2 million people are living with HIV and AIDS and there are about 700 new infections on daily basis (NASCOP, 2004), this means that the population at risk of fungal infections is increasing. The study aims at describing mycological etiology, prevalence and distribution of fungal pathogens among patients with dermatological conditions attending Thika District Hospital. This is essential for formulation of policies and guidelines for prevention and management of dermatological conditions in Thika Hospital and general population.
CHAPTER TWO

LITERATURE REVIEW

2.1 Fungal agents

Fungi are eukaryotic organisms with membrane bound nucleus, well differentiated apparatus and a cell wall, hence not typical eukaryotic organisms. They are much larger than bacteria, the vegetative cells being 2-10 µm in diameter (Prescott et al., 1999). Most fungi are non-motile throughout their lifecycle although spores are carried a great distance by wind. Growth of mycelium substitutes for mortality, bringing the organism into contact with new food sources and different mating strains (Sendron and Araro 1999). All fungi are heterotrophic and most of them are saprobes. Some can also be parasites on living animals or plants although very few fungi absolutely require a living host (Kathleen 2005).

Most fungi are dimorphic, meaning they exist in two forms; they have unicellular and yeast like forms in their host but when growing saprophytically in soil or lab medium, they have filamentous forms. Almost all fungi that exhibit dimorphism are pathogenic to man (Sendron and Araro1999). They replicate sexually by fusion of gametes and asexually by spore formation, and exist in macroscopic or microscopic forms (Prescott et al., 1999).
2.2 Fungal classification

Fungi are composed of organisms that are unique compared to plants and animals. They include mushrooms, rusts and smut, molds, mildew and yeast. Despite their differences in morphological features they share similar characteristic which includes; presence of chitin in the cell wall, presence of ergosterol in the cell membrane, reproduction by means of spores either sexually or asexually, lack of chlorophyll and they are heterotrophic (Forbes et al., 2002). The classification of fungi is based on the characteristic of sexual spores and fruiting bodies present during sexual stages of their lifecycles (Michael et al., 1986). They belong to the kingdom fungi which is divided into divisions Eumycota and Myxomycota (Dubey and Maheshwari 2006).

2.2.1 Division Eumycota

These are fungi consisting of filamentous structures and are further divided into five subdivisions as outlined below.

2.2.1.1 Subdivision Mastigomycotina

They are primitive fungi that may form branched chains of cells that attach to the substrate by root like structures called rhizoids (Kathleen 2005). Many are soil saprophytes where they are important decomposers. They are also found in fresh water habitats and are associated with water that is polluted by sewage. Few species are parasites of plant, insect and fish (Heritage et al.,
The subdivision also includes important plant pathogens like *Phytophthora infestans* which causes potato blight. The subdivision is divided into three classes; class Chytridiomycetes, class Hyphochytridiomycetes and class Oomycetes (Boyd and Marr 1980; Dubey and Maheshwari 2006).

### 2.2.1.2 Subdivision Zygomycotina

The mycelium is aseptate and if septate the septa are complete. Sexual reproduction is by production of zygospores and asexual by production of non motile sporangiophores (Boyd and Marr 1980; Heritage *et al.*, 1996; Forbes *et al.*, 2002). The subdivision comprises of two classes; class Zygomycetes that comprises of order Mucorales which are ubiquitous in soil and dung and order entomophthorales which includes a number of insect parasites; and class Tricomycetes whose members are mostly parasitic in guts of arthropods (Boyd and Marr 1980; Dubey and Maheshwari 2006).

Important genera in this subdivision include *Rhizopus, Mucor, Absidia* and *Cunninghamella* among others (Forbes *et al.*, 2002; Kathleen 2005).

### 2.2.1.3 Subdivision Ascomycotina

Members of this subdivision are fungi that reproduce sexually by production of ascospores and asexually by formation of conidia produced at the tip of the conidiospores (Forbes *et al.*, 2002; Kathleen 2005). The subdivision is made of six classes; Hemiascomycetes, Loculoascomycetes, Plectomycetes,
Loboulbenomycetes, Pyrnomycetes and Discomycetes (Dubey and Maheshwari 2006). Clinically important fungi that belong to this subdivision includes; *Histoplasma capsulatum*, *Microsporum spp* (when sexual form is known), *Trichophyton spp*, *Pneumocytis carinii*, (now known as jirovecii) some species of Aspergillus and *Candida spp*. (Forbes *et al.*, 2002; Kathleen 2005).

### 2.2.1.4 Subdivision Basidiomycotina

Members in this subdivision are fungi that reproduce sexually by formation basidiospores on specialized structures called basidia. Asexual reproduction is by formation of conidia that have incomplete septate hyphae and fleshy fruiting bodies are common (Forbes *et al.*, 2002; Kathleen 2005). The subdivision is divided into two classes, Teliomycetes and Hymenomycetes (Dubey and Maheshwari 2006). The fungi are generally plant pathogens or environmental organisms that rarely cause disease in humans. They include smuts, rusts, mushrooms and the human pathogen *Cryptococcus neoformans* (Forbes *et al.*, 2002; Kathleen 2005; Dubey and Maheshwari 2006).

### 2.2.1.5 Subdivision Deuteromycotina

This includes fungi that lack a sexual reproductive cycle (perfect state) or it is not yet known and are characterized by their asexual reproductive structures primarily conidia; majority are yeasts and moulds and some are dimorphic (Forbes *et al.*, 2002; Kathleen 2005; Dubey and Maheshwari
2006). Once the perfect stage is known the fungi are transferred to their proper subdivision (Prescott et al., 1999; Kathleen 2005). Most fungi in this subdivision affect human welfare and some are human pathogens which include some species of Candida, some species of Aspergillus, Blastomyces, Epidermophyton spp., Microsporum spp., Coccidiodes immitis, Geotricum, Penicillium, among others (Forbes et al., 2002; Prescott et al., 1999; Dubey et al., 2006).

2.2.2 Division Myxomycota

These are fungi with plasimodia or pseudoplasimodia. The division consists of four classes; Acrasiomyctes, Hydromyxomycetes, Myxomycetes and Plasmodiophoromycetes (Dubey and Maheshwari 2006). Members of this division rarely cause human infections (Prescott et al., 1999; Kathleen 2005).

2.3 Fungal infections

They are broadly divided into 5 types described below.

2.3.1 Superficial mycosis

These are asymptomatic infections which include the following conditions;

- Tinea nigra caused by Hortoea werneckii. It affects the Stratum corneum of the palms and feet. It is found in the tropics and sub tropics in children and adults. Clinical features are brown or black scaling macules on the palms or soles and spread to other areas is rare (Mandell et al., 2000).
• White piedra caused by yeast like fungi of genus *Trichosporon*. It occurs in the tropics and template regions. It is an infection of the hair shaft of the scalp, body or pubic hairs. It is asymptomatic and presents with small yellow concretions on the hair shaft and the lesions appear as small nodules (Mandell *et al.*, 2000; Murray *et al.*, 2005).

• Tinea (pityriasis) versicolor caused by *Malassezia furfur*. The infection is more common in the tropics and may appear after sun exposure which is therefore a trigger factor. It is seen on the trunk although more extensive infection involving the face and waist are seen in the tropics. Lesions may be hypopigmented or hyperpigmented macules that amalgamate to cover the affected area with scaling plagues which do not itch (Mandell *et al.*, 2000; Murray *et al.*, 2005).

2.3.2 Cutaneous mycoses

These are infections caused by dermatophytic fungi (dermatophytosis) and non dermatophytic fungi (dermatomycoses). Dermatophytosis infections are caused by dermatophytes which colonize the hair, nails, and outer layer (stratum corneum) of the epidermis (Prescott *et al.*, 1999; Mandell *et al.*, 2000). There are three genera of pathogenic dermatophytes; Epidermophyton, Microsporum and Trichophyton and about 39 dermatophyte species most of which are parasitic and cause disease in
humans and animals. They are referred to as either zoophilic, anthropophilic or geophilic depending on whether their primary origin is animals, human or soil respectively. Transmission and distribution of the infections is largely dependent on the source of the infection (Prescott et al., 1999; Mandell et al., 2000; Murray et al., 2005).

The infections include the following: *Tinea pedis* caused by either *T. rubrum* or *T. mentagrophytes* and less common *E. floccosum*. The infection starts in lateral interdigital spaces of the foot or on the under surface of the lateral aspect of the toes. The symptoms are itching, skin cracking which may become severely macerated, scaling between the toes is often referred to as athlete’s foot. The infection is commonly seen in young adults or teenage children and is common where common bathing facilities are used (Mandell et al., 2000; Murray et al., 2005).

*Tinea cruris* caused by *T. rubrum* and *E. floccosum*: This is a fungal groin infection which mainly affects young adult males though it also affects women particularly in the tropics. Infection usually starts with scaling and irritation in the groin (Mandell et al., 2000; Murray et al., 2005). *Tinea corporis* caused by *M. canis, T. verrucosum* and *T. gypseum*: It is common in the tropics and can occur in any age although in temperate countries it is often seen in children. Clinical presentations are lesions with prominent
edges that may contain pupules with inflamed center and scaling (Mandell et al., 2000; Murray et al., 2005).

*Tinea imbricata* is caused by *T. concentricum* and can infect patients at any age although infants and children are frequently affected. Patients have a characteristic rash that forms concentric rings on the body that amalgamates to form waves of scaling (Mandell et al., 2000; Murray et al., 2005). *Tinea manum* caused by *T. rubrum* affects hands and feet. Tinea faciei caused by *T. rubrum, M. canis, T. verrucossum* and *T. gypseum* (Mandell et al., 2000; Murray et al., 2005). Tinea barbae caused by zoophilic organism such as *T. verrucosum* infects the neck and beard areas. Tinea capitis (scalp ring worm) is caused by a variety of dermatophytes such as *T. tonsurans*. It is a disease of childhood and common in Africa, Asia and widespread in some urban areas in the United states, central and south America.

Infections where arthrospores are formed on the outside of the shaft are known as ectothrix infections and those where spores are formed within the hair itself are called endothrix. Clinical features include scaling of the scalp with variable degree of erythema and inflammation and alopecia (Prescott et al., 1999; Mandell et al., 2000; Murray et al., 2005). Non-dermatophyte fungi can also cause onychomycosis which is fungal infection of the nails.
2.3.3 Subcutaneous mycoses

These are fungal infections that involve the dermis, subcutaneous tissues, muscles and facia (Cohen and Powdery 2004). They are chronic and are introduced traumatically through the skin (Mandell et al., 2000; Murray et al., 2005). They include; Chromoblastomycosis (Chromomycosis) which is encountered in every continent and in all climates however, it is more common in tropical and subtropical regions among bare footed agricultural workers (Mandell et al., 2000). Aetiological agents are Phialophora verrucosa or Fonsecaea pedrosoi (Mandell et al., 2000; Cohen and Powdery 2004). Eumycotic mycetoma is caused by true fungi (Eumycetes) which include M. mycetomatis and M. grisea (Mandell et al., 2000). It is more frequent in Africa and Asia subcontinent (Mandell et al., 2000; Cohen and Powdery 2004). Sub-cutaneous Zygomycoses (entomophthoromycoses) common aetiologies are Conidiobolus coronatus and Basidiobolus ranarum in Africa and India (Murray et al., 2005). Sporotrichosis caused by Sporothrix schenckii. It is sporadic and common in warmer climates; areas of current incidence include Japan, North and South America (Mandell et al., 2000; Murray et al., 2005).

2.3.4 Systemic mycoses

These are infections that originate primarily in the lungs and spread to many organ systems including lymph nodes, bones, subcutaneous tissue and the skin (Cohen and powdery 2004). They include Cryptococcosis caused by the
yeast like fungus *Cryptococcus neoformans* which has a world wide distribution. Naturally acquired cryptococcosis occurs in animals as well as in humans, but animal to person transmission has not been documented (Mandell *et al.*, 2000). Blastomycosis is caused by a dimorphic fungus *Blastomyces dermatitidis*. Initial infection is through the lungs and is often sub-clinical (Mandell *et al.*, 2000). Coccidioidomycosis caused by the fungus *Coccidioides immitis*. It is endemic in certain areas of North America, Central and South America (Mandell *et al.*, 2000). Histoplasmosis caused by *Histoplasma capsulatum* which is endemic in United States and Mexico and *Histoplasma duboisii* which is confined in the tropical areas of Africa including Gabon, Uganda and Kenya (Mandell *et al.*, 2000; Murray *et al.*, 2005).

**2.3.5 Opportunistic mycoses**

These are infections of patients with immune deficiencies who would otherwise not be infected. They include; Candidiasis which is caused by *Candida* species and the most common is *C. albicans* (Murray *et al.*, 2005). *Candida* species are normal flora in human beings are and found in nature worldwide. Primary site of colonization is the gastrointestinal tract, mouth and rectum. Given the right conditions *Candida* can cause clinically significant apparent infections of virtually any organ system. Infections range from superficial mucosal and cutaneous candidiasis to widespread hematogenous disseminations involving organs such as the liver, spleen,
kidney, heart and brain. Mucosal infections are generally seen in persons with local or generalized immunosuppression (Mandell et al., 2000; Murray et al., 2005). Pneumocytosis caused by *Pneumocystis jiroveci* (formerly *Pneumocystis carinii*) is seen almost exclusively in debilitated and immunosuppressed individuals especially those with HIV infections with low CD4 counts (Murray et al., 2005). Aspergillosis is a broad spectrum disease caused by members of the Genius *Aspergillus*. The species are common throughout the world (Murray et al., 2005). Cryptococcosis caused by *Cryptococcus neoformans*, the organism has a worldwide distribution and is found as a ubiquitous saprophyte of soil especially that enriched with pigeon droppings. Cryptococcosis is most seen in immunocompromised patients with impaired cell-mediated immunity, common risk factor includes AIDS, corticosteroids therapy and lymphoma. It is a common cause of fungal meningitis which occurs in patients with defective cellular immunity (Forbes et al., 2002; Murray et al., 2005).

2.4 Epidemiology of fungal infections

Superficial mycoses are extremely rare in United States and most them occur in the tropics (Prescott et al., 1999). White piedra is found world wide but is now not common because of modern hygienic practices. It is native to South East Asia, the Pacific and South America. Tinea nigra is common in the tropics and subtropical regions (Cohen and Powdery 2004). Dermatophytosis is among the most common of all communicable diseases but because many
cases are not brought to medical attention reliable incidences do not exist. The infections are found throughout the world although some are endemic and they tend to spread rapidly throughout non endemic regions (Mandel et al., 2000; Cohen and Powdery 2004; Murray et al., 2005). Cutaneous candidiasis is common in infants and at least 10% of those who have skin colonization have Candida. Chromoblastomycosis occurs throughout the world with peak incidences in American subtropics and tropics. Men working on farms are more vulnerable (Cohen and Powdery 2004; Kathleen 2005). Sporotrichosis has a world wide distribution but occurs most frequently in temperate humid climatic regions. It is endemic in North America, South Africa and South East Asia (Mandell et al., 2000; Cohen and Powdery 2004; Murray et al., 2005). Mycetoma is common in arid tropical and subtropical regions of Africa and Central America especially those bordering great deserts (Mandell et al., 2000; Kathleen 2005).

2.5 Prevalence and distribution of dermatophytosis

Fungal infections of the skin and scalp represent a relatively common problem especially in the tropical and subtropical regions of the world where warm and humid climates provide a favorable environment for fungi (Cohen and Powdery 2004). Dermatological problems manifesting as primary and secondary cutaneous complaints constitute at least 30% of all out patients visits the hospitals (Thappa 2002). Skin infections due to dermatophytes have become a significant health problem affecting children adolescents and adults (Kannan et al., 2006). The real prevalence of dermatophytosis is not know.
because patients do not seek medical advice unless their quality of life is affected as these are not life threatening diseases (Joseph et al., 2000). A recent multicenter epidemiological survey carried out in North America reported a prevalence of 12.8% (Woodstock 2005); while in Peru the prevalence of dermatophytosis among teenagers is around 12.61% (Flores et al., 2009). In the developing countries the prevalence of dermatophytosis ranges from 10.1% -51 %, in Tunisia it is 30.3%, in Brazil 38.4% and in Iran 21.1% (Souza et al., 2008; Neji et al., 2008; Hashemi et al., 2009). In Nigeria the prevalence of dermatophytosis among school going children is 51% (Uneke et al., 2006), while in Zimbabwe the prevalence of ideologically proven fungus is 39% (Wright and Robertson 2001).

In Kenya dermatophytosis accounts for almost 19 % of the skin diseases affecting school going children (Thappa 2002). According to recent data obtained from primary school going children in Kibera slums, Kenya, the prevalence rates was at 11.25% with Tinea capitis being the most common type of infection (Chepchirchir et al., 2009). In 1997 the prevalence was 10.1% according to data obtained from school going children in Kisumu (Schmeller et al., 1997). However, there is no hospital data on the prevalence of dermatological conditions in the country.
2.6 Transmission and pathogenesis of dermatophytes

Dermaphytosis is transmitted from person to person directly by means of contact or indirectly via formites contaminated with infected skin, scales or hairs. It can also be acquired by humans from infected animals and by direct exposure to infected soils (Greenwood et al., 2005). Transfer of infecting organisms from soil, animals or humans is accomplished by means of arthrospores which are vegetative cells with thickened cell walls formed by dermatophytes hyphae in vitro or in vivo. The fungal cells adhere to keratocytes in vitro (a process that takes 2-3 hours) and germination follows which leads to invasions and development of the infection (Mandell et al., 2000). After invasion dermatophytes secrete proteinases such as zinc containing metallo-proteases which aids in penetration. The inflammatory response to dermatophytosis is after 9-16 days and after this there is resolution of the infection. The main efferent limb of immunological resistance is the T-lymphocyte. The mechanism by which T-lymphocytes affect recovery is less understood (Mandell et al., 2000; Hay, 2005).

2.7 Social economic impact of dermatophytosis

Skin infections can affect one’s self esteem especially in children where it may interfere with individual performance despite adequate potential to excel. In some type of employment such as health care, bar and resultant, infected staff may require sick leave to access medical attention and mycological cure would take months resulting to loss of revenue. This aspect
of the diseases has not been considered to date nor has any consideration been made of the cost (Chepchirchir, 2009).

2.8 Management of fungal infections

Fungi present a special problem in chemotherapy because their cells are eukaryotic meaning that the drugs toxic to their cells are also capable of harming human tissues. Most of the anti-bacterial drugs are ineffective in treating fungal infections. However, several antifungal drugs have been developed (Prescott et al., 1999). Superficial mycoses are treated by removing skin scales and infected hairs with a cleansing agent. Good personal hygiene prevents these infections. Dermatophytoses are treated with topical ointment like miconazole, clotrimazole, itraconazole and terbinafine (Greenwood et al., 2005).

In subcutaneous mycoses, oral 5- fluorocytosine, iodides, amphotericin B, and surgical excision are common modes of treatment (Prescott et al., 1999). There is no satisfactory treatment for Candidiasis but cutaneous lesions are treated with topical agents such as nystatin, miconazole, and trichomazole while in systemic candidiasis Ketoconazole, amphotericin B, fluconazole, itraconazole and flucytosine are the drugs of choice (Prescott et al., 1999). Amphotericin B is the drug of choice for systemic infections but also several azoles are used e.g. ketoconazole. Immunization is not usually effective
against fungal infections; however, work is proceeding on vaccines for coccidiodomycoses and histoplasmosis (Kathreen 2005).

2.9 Diagnostic methods used to identify dermatophytes

Microscopic morphology of the micro and or macro conidia is the most reliable identifications character but one need good slide preparation. Clinical information such as the site, appearance of the lesion, geographic location, travel history, animal contact and race is also important. Microscopic morphology of dermatophytes includes the following. *E. floccosum* has smooth thin walled macro conidia and there are no microconidia. Colonies have green to brown to khaki colour. *Microsporum* spp. have rough walled macroconidia microconidia may or may not be present. *Trichophyton* spp. have smoothed walled microconidia while the macroconidia may or may not be present. For non sporulating ones the macronidia may not be present (Greenwood et al., 2005). Presently use of PCR in fungal research is been adopted which is more accurate however it is not used in this research due to limitation of resources.
CHAPTER THREE
MATERIALS AND METHODS

3.1 Study area

The study was carried out at Thika Districts hospital which is located in Thika Town in the Central province of Kenya (figure 3.1& 3.2). The hospital provides medical services to the town population and the surrounding peri-urban and rural areas. It also serves as a referral hospital for the various surrounding sub-district hospitals like Kirwara, Kandara and Ruiru. After collecting specimens from patients the main laboratory work was done at Mycology Laboratory of the Kenya Medical Research Institute (KEMRI) Nairobi.

Figure 3.1: Map showing the location of Thika District Dospital.
Figure 3.2: Map of Thika District showing Thika District Hospital and its catchment areas
3.2 Study population
The study patients were both adults and children in patients and out patients from Thika District Hospital whose chief complaints were dermatological conditions consistent with fungal infections.

3.3 Inclusion and exclusion criteria
Consenting patients were eligible for enrollment if they had the following symptoms; Discolored or brittle nails, scaly skin lesions, scaling and hair loss on the scalp, inflammatory lesions with weeping vesicles, pustules or ulcerations. Non-consenting patients and those without the symptoms stated above or had been treating the infections were not eligible for the study.

3.4 Sampling and sample collection methods
Purposive sampling was done by enrolling patients presenting with clinical symptoms of fungal infection. Samples were obtained by scraping the infected skin and nails with a sterile scalpel blade while infected hairs were removed by plucking with forceps. The samples were placed in sterile Petri dishes and immediately taken to the laboratory for analysis. Adequate sample material of about 1 cm$^3$ was collected which ensured it was available for all the investigations required.

3.4.1 Sample size
The prevalence of fungal infection in Kenya is not known; therefore a prevalence of 10% was used in reference to Chepchirchir et al. (2009). The sample size was determined using the formula as used by Fisher (1999).
\[ N = \frac{pqz^2}{d^2} \]

n= minimum sample size required

p = proportion of the target population estimated to have particular problem

q = 1 – p

z = level of precision (1.96) which corresponds to 95% confidence level

d = degree of accuracy desired set at 0.05

\[ n = 0.1 \times (0.9) \times (1.96^2) \times \frac{0.05}{0.05^2} \]

= 119.2

Hence the minimum sample size to be processed was 119 respondents.

### 3.5 Ethical consideration

Permission to carry out this research was obtained from Kenyatta University while the KEMRI laboratory provided diagnostic services for fungal infections to many hospitals Thika district hospital included. Also informed consent was obtained from the individual patients before collecting the specimen from them. All patient data obtained was handled with confidentiality. Laboratory coding was used to identify patients from whom samples were collected.
3.6 Laboratory investigations

3.6.1 Microscopy
The specimens were examined for the presence of characteristics of dermatophyte infection such as hyphae or spores by adding 20% potassium hydroxide (KOH) and leaving it over night for the digestion of keratin to occur. Diagnosis of dermatophytes in the skin scales and crusts was predicted on visualization through direct microscopy of branching septate hyphae with angular or spherical anthroconidia (arthropores) usually in chains. On hair pieces, it was predicted on visualizing of anthroconidia arranged along the length of the hair in chains or in masses around the hair (Ectothrix infections) or inside the hair shaft (endothrix infection) (Forbes et al., 2002; Greenwood et al., 2005; Ochei and Kollatkar 1996).

3.6.2 Culture
Specimens were inoculated in Sarborauds Dextrose Agar (SDA) that contained Chloramphenical to inhibit the growth of bacterial contaminants. Cultures were read weekly to capture pathogens as well as their rate of growth. A culture plate was kept for a maximum of six weeks before being ruled out as negative growth. Identification of dermatophytes from positive cultures was based on colonial characteristics in pure culture and microscopic morphology of fungi using lactophenol blue, which includes the presence of conidia (macro and micro) and microscopic appearance of the conidia. Suspected yeast on SDA agar was stroked on CROMEagar candida (CROMEagar Paris France) and identified by observing the type of growth
and coloration. CHROMEagar candida is a special chromogenic media for presumptive identification of yeast where they exhibit different colors on growth. *C. albicans* has green coloration, *C. tropicalis* blue, *C. grablata* pulple, and *C. parapsilosis* pink.

Indian ink was used to screen *Cryptococcus neoformans*. Normal saline with the growth was placed on a slide and Indian ink added in equal proportions. The polysaccharide capsule displaced the ink to produce clear halo around the cells surrounding the yeast of *Cryptococcus* indicating presence of the organism.

### 3.7 Data analysis

Data was processed using SPSS version 12. Categorical measurements were analyzed using chi-square test. It was used to test the significance of development of infection in relation to age, residence, occupation, knowledge and site of infection. Odds ratio was used to test the level of risk of developing an infection. The data was presented in tables, graphs and pie charts and Microsoft Excel and word 2003 were used for tables.
CHAPTER FOUR
RESULTS

4.1 Demographic distribution of patients

According to the questionnaires filled by the patients, the age of the patients ranged from 1 year to 70 years. The median age of this patient was 15.5 years. There were 56/126 (44.4%) patients who were below ten years, 15/126 (11.9%) between eleven to twenty years, 21/126 (16.7%) between twenty one and thirty years, 23/126 (18.5%) between thirty one and forty years and 11/126 (8.7%) were above forty years (Appendices Table 1). Out of the 126 patients 79 (62.7%) were males and 47 (37.3%) were females with male to female ratio of 1.7: 1.

Figure 4.1: Age and sex distribution of the study patients
4.2 Clinical presentation of the patients

The most common clinical manifestations in the study patients were lesions on almost all parts of the body including the scalp, neck, hands, back, chest, thighs, vagina, face and feet. The clinical conditions were recorded in the questionnaire administered to the patients. Most of the lesions were from patients with lesions on the scalp 56 (44.4%), others were 26 (20.6%) from neck, 35 (27.8 %) from the trunk, 31 (24.6 %) from the hands, 14 (11.1 %) from the feet and 9 (7.1%) from the face (Appendices Table 2).

![Distribution of mycotic lesions on patient's body](image)

**Figure 4.2; Distribution of mycotic lesions on patients body**
4.3 Microscopic examination of specimens (KOH)

From a total of 126 specimens collected 107 (84.9 %) were KOH positive indicating that the lesions were caused by fungi hence confirming the presence of fungal infection. However, 19 (15.1%) specimens were KOH negative. The KOH positivity is a presumptive diagnosis of fungal infection.

4.3.1 Distribution of infection by gender

The presence of infection according to gender was as follows; 67 (62.6%) of the patients were males and 40 (37.4%) were females (Appendices Table 3). More males were infected than females by proportion but the difference was not statistically significant, (P – Value = 1.0, OR = 1.02). This implies that males are 1.02 times more likely to get a fungal infection than females.

![Distribution of infection by gender](image)

Figure 4.3; Distribution of infection by gender
4.3.2 Distribution of infection by residence

The presence of infection according to residence was as follows; the patients from rural areas were 53 (49.5%) and those from urban areas were 54 (50.5%) (Appendices Table 4). The association of residence and infection was not statistically significant, (P- Value = 0.81 OR = 0.36). This implies that people in rural areas are 0.36 more likely to get fungal infection than those in urban areas. In rural areas the percentage positivity of the infection was 91.3 % and in urban areas it was 79.4%, indicating that although the difference between infection in rural and urban areas is not statistically significant the rate of infection is higher in rural areas than in urban areas.
Figure 4.4: The distribution of infection by residence

4.3.3 Distribution of infection by age

The presence of infection according to age was as follows; patients who were less than ten years 42 (39.3), between eleven and twenty years 13 (12.1%), between twenty one and thirty years 19 (17.8%), between thirty one and forty years 22 (20.6%) and above forty years 11 (10.3%) (Appendices Table 5).

By proportion the rate of infection was highest in patient below ten years followed by the patients of age thirty one to forty years, while the lowest rate of infection was observed in patients who were above forty years; however, the association of age and infection was not statistically significant (X² = 8.87, P – value = 0.64).
4.3.4 Distribution of infection by occupation

The presence of infection according to occupation was as follows; patients in social jobs (jobs that involved a lot of contact with people) 67 (62.6%), farmers 16 (15%), children 10 (9.3%), house help/wife 9 (8.4%), and those in closed jobs (jobs that have minimal contact with people) 5 (4.7%) (Appendices Table 6). The rate of infection was highest in patients involved in social jobs by proportion, followed by farmers and the lowest was in patients involved in closed jobs. Being in a social job was a risk factor for fungal infection; however there was no statistical
significance between the infection and occupation ($X^2 = 5.2$, P-value = 0.26).

![Distribution of the infection by occupation](image)

**Figure 4.6: The distribution of infection by occupation**

**4.3.5 Patients knowledge of infection**

The patient’s knowledge of the presence of the infection was as follows; 25 (23.4%) of the patient’s had information on fungal infection while 82 (76.6%) of the patients had no information on fungal infection (appendices Table 7). More patients who had no information on fungal infection were infected by proportion, compared to those who had information on fungal infection.
However, the association of information of fungal infection and infection was not statistically significant (P-value = 0.36 and OR = 2.6). This implies that patients who have no information on fungal infection are 2.6 times more likely to contact a fungal infection than those who have information on fungal infection.


Figure 4.7: The distribution of infection by patient’s knowledge of infection.
4.3.6 Distribution of infection by site of lesions

The presence of infection according to site of lesions was as follows. Thirty (20.1%) patients had lesions on their hands and the association of hand lesions and infection was statistically significant (P–value = 0.041 and OR = 7.0). This implies that people with hand lesions are 7 times more likely to test positive of fungal infection than those with lesions elsewhere. Forty one (37.5%) had lesions on the scalp and the association of scalp lesions and infection was statistically significant (P–Value = 0.02 and OR = 0.17). This implies that people with scalp lesions are less likely to test positive for fungal infection (OR ratio < 1). Twenty six patients (17.5%) had lesions on the neck and the association of neck lesions and infection was statistically significant (P – Value = 0.01 and OR = 0.81). Patients with neck lesions were less likely to test positive for fungal infection (OR < 1).

Seven patients (4.7%) had lesions on the face and the association of face lesions and infection was not statistically significant (P – Value = 0.62 and OR = 0.1). People with face lesions are less likely to test positive for fungal infection (OR < 1). Twelve patients (7.1%) had lesion on the feet and the association of feet lesion and infection was not statistically significant, (P – Value = 1.0 and OR = 1.1) People with feet lesions were 1.1 times more likely to test positive for fungal infection than those with infection elsewhere. Thirty three patients (22.1%) had lesions on the trunk. However, the association of trunk lesions and infection was not statistically significant, (P–Value = 0.095 and OR = 3.79). People with trunk lesions were 3.79 more
likely to test positive for fungal infections than those with lesions else where.

(Appendices Table 8)

Figure 4.8: The distribution of infection by site of lesions

4.3.7 Relationship of fungal infection with education

The relationship between the presence of fungal infection with level of education was as follows; those with no education were 17 (15.9%), lower primary 25 (23.4%), upper primary 39 (36.4%), secondary 21 (36.4%), college 4 (3.7%) and university 1 (0.93%) (Appendices Table 9). More patients with upper primary education were infected by proportion, followed by those with lower primary education and lowest infection was in patients with university education. The association of education
and infection was not statistically significant ($x^2 = 8.92$ and $P$-Value $= 0.11$).

**Figure 4.9: The distribution of infection by education levels**

### 4.4 Confirmation of infection by culture

The entire 126 specimen were cultured and out of the 107 specimens that was KOH positive, 106 (84.1%) were culture positive. The specific fungal agents causing the infections were identified. In some specimens two different types of fungal agents were isolated. Only twenty (15.8%) specimens were culture negative but had growth characteristic of bacteria. A total of 107 fungal agents were isolated. *Trichophyton species* had the
highest occurrence of 67/107 (62.6%) with *T. verrucosum* being the most common with 21/107 (16.3%) followed by *T. saudanense* and *T. mentagrophyte* each with 12/107 (9.3%). Other agents were yeast 26/107 (24.3%), *Epidermophyton spp.* 3/107 (2.8%), *Microsporum spp.* 3/107 (2.8%) and others that were not dermatophyte or yeast were 8/107 (7.5%) (Appendices Table 10).

Figure 4.10: The distribution of the fungal aetiologies
Plate 4.11: Sabourauds dextrose agar culture plate of *T. saudanense*

arrow showing a deep yellow color on the colony which is important in identification
Plate 4.12: SDA culture plate of *T. violaceum*. Arrow showing a deep violet coloration on the colony which is important in identification of *T. violaceum*. 
Plate 4.13: A colony of *Rhizopus* spp on SDA plate

The arrow shows wooly appearance with grey to brown colour which is a major characteristic of the *Rhizopus* colony
Plate 4.14: Sabourauds dextrose agar culture plate of *T. verrucosum*

showing white to brown colony with rugal folds
Plate 4.15: Sabourauds dextrose agar culture plate (reverse) of *T. verrucosum*
Plate 4.16: Sabourauds dextrose agar culture plate of *T. concentricum*

showing a heaped colony which is highly folded (the white colour (a) intercepted with yellow to brown colour(b))
Plate 4.17: Lactophenol cotton blue stain of *Alternaria alternata* isolated from one of the patients
Plate: 4.18: Lactophenol cotton blue stain of *Absidia corymbfera*. Arrows showing sporangium (a) on long sporangiophore (b)
Plate 4.19:  Lactophenol cotton blue stain of *T. verrucosum*. Arrow showing hyphal strands which are characteristic to *T. verrucosum*.
Plate 4.20: Lactophenol cotton blue stain of T. tonsurans
Plate 4.21:  Lactophenol cotton blue stain of *T. mentagrophyt*, arrows showing spiral hyphae and club shaped conidia.
CHAPTER FIVE

DISCUSSION, CONCLUSIONS AND RECOMMENDATIONS

5.1 Discussion

In many clinical and epidemiological studies, fungal infections of the skin and scalp represent a relatively common problem especially in the tropical and subtropical regions of the world where warm and humid climate provides a favorable environment for fungi. They have become a significant health problem affecting children, adolescents and adults (Thappa 2002: Kannan et al., 2006; Chepchirchir et al., 2009). The infections are caused by pathogenic fungi, dermatophytes, which invade the stratum cornea (Cohen and Powdery 2004). They are transmitted from person to person directly by means of contact or via fomites contaminated with infected skin scales or hairs. They can also be acquired by humans from infected animals and by direct exposure to infected soils (Raza and Howard1997; Cohen and Powdery 2004).

From Thika District Hospital fungal agents were isolated from 106(84.1%) specimens out of the total 126 that were cultured. Out of these 62.6% were isolates of *Trichophyton spp.*, 24.3% yeast, 2.8% Epidermophyton *spp.*, 2.8% *Microsporum spp.* and 7.5% for others (those that were not yeast or dermatophytes). The results showed that *Trichophyton spp.* was a leading fungal agent of dermatophytosis while *Epidermophyton spp.* was the least. These results are similar to those obtained from school going children in Kibera slums, Kenya, where *Trichophyton spp.* appeared at 94% while *Epidermophyton spp.* was at 2.1% (Chepchirchir et al., 2009). In other parts
of the world the genus *Trichophyton* has been the highest isolate but species vary from one region to another. This could be due to the fact that *Trichophyton* is a keratinophilic filamentous fungus with a high ability to invade keratinized tissue due to possession of several enzymes such as acid proteinases, elatinases, keratinases and other proteinases while Epidermophyton species lack the ability to perforate the hair hence they are low in occurrence (Weitzman and Summerbell 1995).

Of the *Trichophyton* spp., *T. verrucosum* was the highest isolated 16.3% this was in agreement with hospital findings reported in Sina hospital Iran and primary school children in India (Nejad *et al.*, 2007; Maruthi *et al.* 2008) but different from results obtained in Kenya, Kibera slums, and India where *T. violacium* was the main isolate (Kannan *et al.*, 2006; Chepchirchir *et al.*, 2009). In other parts of the world different *Trichophyton* species have been reported as most abundant. For example in University of Nigeria hospital *T. soudanense* was the most prevalent (Ozumba and Nlemadium 2008) while in North America and Turkey *T. rubrum* was reported as the most prevalent (Babel and Rogers 2009; Rogers and Babel 2004).

*Trichophyton verrucosum* was the most commonly isolated agent of dermatophytoses in this study. It is good to note that *T. verrucosum* causes a variety of lesions in cattle and proximity of cattle to human habitation could be the reason. This may be due to the fact that Thika town is surrounded by farming communities who could be coming in contact with animals.
especially cattle. Rural urban migration could also be the reason, where people migrate when they are already infected. None dermatophyte fungi that were isolated include _Aspergillus niger, Fusarium semitectum, Cryptococcus spp_ and _Rhizopus spp_. One suspected _Penicillium marneffei_ was isolated. This is similar to findings of Maruthi _et al._, (2008) where _Aspergillus flavus, Fusarium oxysporum_ and _Penicillium spp_ were isolated. Presence of other non-dermatophytes particularly _Aspergillus_ and _penicillium_ species may be due to the ubiquitous nature of their spores in our environment carried transiently on health skin (Maruthi _et al._, 2008)

The distribution of infection between males and female was 62.6% and 37.4% respectively. It showed a male predominance among infected persons although it was not statistically significant. Fungal infections can begin during early childhood and persist until old age. This pattern is similar to that of Popoola _et al._ (2006) in Nigeria where infection was higher in male than females. Other studies done in India and Iran also follow a similar pattern (Rajesh _et al._, 2005: Sapahvand _et al._, 2009), however it differs with studies done in Saudi Arabia where more females than males were infected (Alsheikh _et al._, 2009). The occurrence of more infected male than females may be due to the nature of occupational activities that makes males more at risk. Males may be exposed to fungal agents right from childhood where they are more exposed to soil or when taking care of animals.
In this study the distribution of infection by residence was 59.5% rural and 50.5% urban. Although there was no significant association between infection and residence, more people in rural areas seemed to be infected than those in urban areas. Odds ratio (O.R) was 0.36, meaning that people in rural areas are 0.36 more likely to get infected with fungal infection than those in urban areas. People in rural areas are more exposed to soil and have frequent encounters with animals while poor hygiene practices may prevail. This may explain the slightly higher proportion of those infected having come from rural areas. Indeed fungal infections are often associated with animals (Cohen and Powdery 2004).

In this study the highest number of isolates were from patients below 10 years of age (39.3%) and the lowest from those above 40 years of age (10.1%). This pattern is similar to that reported by Popoola et al. (2006) and Mbatia and Nwajagu (2001) in Nigeria where infection was highest in pupils below 11 years and reduced as age increased. It also was similar to that reported by Al-sheikh (2009) in Saudi Arabia, Maruthi et al. (2008) in India and Sapahvand et al. (2009) in Iran where infection was highest in patients below 10 years. This may be due to low levels of fungistatic fatty acids at the early stages of development (Al-sheikh 2009).

The prevalence of dermatological infection was highest in people on social jobs 62.6% (jobs that involved frequent contact with people) and lowest in people on closed jobs (jobs that involved little or no contact with people).
This may be due to dermatological infections being contagious and contact with infected individuals could lead to a health person being infected.

From this current study the highest isolates were from the scalp 37.5% followed by trunk 22.1% and the least was from feet 7.1%. This is similar to studies done in Nigeria where the scalp was most frequently infected (Popoola et al. 2006). A similar pattern was also observed by Kannan et al. (2006) in India, Petrini and Woldeamanuel (2005) in Ethiopia, Adeleke et al. (2008) in Nigeria and Babel and Rogers (2009) in North America. This may suggest that the scalp is the most prone site to dermatophytosis and should not be overlooked during clinical examination. According to Cohen and Powdery (2004) and Kathleen (2005) fungi thrive on warm and moist skin and also survive directly on the hair shaft or in their interiors. This may be why the scalp is a major site of infection because it provides a conducive environment for fungus survival.

5.2 Conclusion

- In conclusion the findings of this study suggest that dermatophytosis is a significant cause of morbidity in Thika District Hospital affecting all ages. The isolation rate of 84.1% compared well with those observed in other developed and developing countries. *Trichophyton* spp. is the major cause of fungal dermatological conditions in Thika Hospital. This is in agreement with other findings in work done in other countries. There was no significant association in isolation between different ages, gender, residence and occupation, however
the rate of isolation suggest that fungal skin infections are a major infection and need to be given more attention. The results indicate increase in fungal dermatological infection in the wake of HIV/AIDS meaning that they can no longer be assumed as minor infections and there should be allocation of resources to control them. I do reject the null hypothesis and accept the alternate hypothesis that fungi are a significant cause of fungal dermatological infections in patients visiting Thika District Hospital.

5.3 Recommendations

- This study recommends routine mycological investigations in both adults and children presenting with skin infections suspected to be of fungal nature for better management of infections.

- Although Dermatophytosis is not life threatening it should be a public health concern so as to improve the quality of life of those infected.

- A policy should be formulated on the prevention and treatment of fungal dermatological infections in the country.

5.4 Recommendation for further work

- There is need for further hospital survey involving a large number of patients to ascertain any association between age, gender, residence and infection.
• More studies are recommended to establish the significance of the other non-dermatophyte infections especially in the context of HIV/AIDS opportunistic infections.

• There is need for a study in a school in Thika District to capture those sub-clinical cases that are not presented in hospital which may be a significant reservoir for dissemination.

• More study on the social economic effect of fungal dermatological conditions on the patients.
REFERENCES


APPENDICES

Table 1: Age and Sex distribution of the patients

<table>
<thead>
<tr>
<th>Age in year’s</th>
<th>Males</th>
<th>Females</th>
<th>No of patients</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt;10</td>
<td>40</td>
<td>16</td>
<td>56</td>
<td>44.4</td>
</tr>
<tr>
<td>11-20</td>
<td>7</td>
<td>8</td>
<td>15</td>
<td>11.9</td>
</tr>
<tr>
<td>21-30</td>
<td>12</td>
<td>9</td>
<td>21</td>
<td>16.7</td>
</tr>
<tr>
<td>31- 40</td>
<td>13</td>
<td>10</td>
<td>23</td>
<td>18.2</td>
</tr>
<tr>
<td>Above 40</td>
<td>7</td>
<td>4</td>
<td>11</td>
<td>8.7</td>
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</table>
Table 2: Distribution of mycotic lesions on patient’s body

<table>
<thead>
<tr>
<th>Clinical conditions</th>
<th>Frequency</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Scalp lesions</td>
<td>56</td>
<td>44.4</td>
</tr>
<tr>
<td>Trunk lesions (back, chest Thighs)</td>
<td>35</td>
<td>27.8</td>
</tr>
<tr>
<td>Hands lesions</td>
<td>31</td>
<td>24.6</td>
</tr>
<tr>
<td>Neck lesions</td>
<td>26</td>
<td>20.6</td>
</tr>
<tr>
<td>Feet lesions</td>
<td>14</td>
<td>11.1</td>
</tr>
<tr>
<td>Face lesions</td>
<td>9</td>
<td>7.1</td>
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<tr>
<td>Total</td>
<td>126</td>
<td>100</td>
</tr>
</tbody>
</table>

Table 3: Distribution of infection by sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Number examined</th>
<th>Number positive</th>
<th>%Positive</th>
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</thead>
<tbody>
<tr>
<td>Males</td>
<td>79</td>
<td>67</td>
<td>84.8</td>
</tr>
<tr>
<td>Females</td>
<td>47</td>
<td>40</td>
<td>85.1</td>
</tr>
<tr>
<td>Total</td>
<td>126</td>
<td>107</td>
<td>84.9</td>
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</table>
Table 4: Distribution of infection by residence

<table>
<thead>
<tr>
<th>Residence</th>
<th>Number examined</th>
<th>Number positive</th>
<th>% Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rural</td>
<td>58</td>
<td>53</td>
<td>91.4</td>
</tr>
<tr>
<td>Urban</td>
<td>68</td>
<td>54</td>
<td>79.4</td>
</tr>
<tr>
<td>Total</td>
<td>126</td>
<td>107</td>
<td>84.9</td>
</tr>
</tbody>
</table>

Table 5: Distribution of infection by age

<table>
<thead>
<tr>
<th>Age</th>
<th>Number examined</th>
<th>Number positive</th>
<th>% Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 - 10</td>
<td>56</td>
<td>42</td>
<td>75</td>
</tr>
<tr>
<td>11 – 20</td>
<td>15</td>
<td>13</td>
<td>86.7</td>
</tr>
<tr>
<td>21 – 30</td>
<td>21</td>
<td>19</td>
<td>90.5</td>
</tr>
<tr>
<td>30 - 40</td>
<td>23</td>
<td>22</td>
<td>95.7</td>
</tr>
<tr>
<td>Above 40</td>
<td>11</td>
<td>11</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>126</td>
<td>107</td>
<td>84.9</td>
</tr>
</tbody>
</table>
Table 6: Distribution of infection by occupation

<table>
<thead>
<tr>
<th>Occupation</th>
<th>Number examined</th>
<th>Number positive</th>
<th>%Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Social</td>
<td>82</td>
<td>67</td>
<td>81.7</td>
</tr>
<tr>
<td>Farmers</td>
<td>16</td>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>Children</td>
<td>13</td>
<td>10</td>
<td>76.9</td>
</tr>
<tr>
<td>House w/h</td>
<td>10</td>
<td>9</td>
<td>90</td>
</tr>
<tr>
<td>Closed</td>
<td>5</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
<td>126</td>
<td>107</td>
<td>84.9</td>
</tr>
</tbody>
</table>

Table 7: Distribution of infection by knowledge of fungal Infections

<table>
<thead>
<tr>
<th>Knowledge</th>
<th>Number examined</th>
<th>Number positive</th>
<th>%Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>27</td>
<td>25</td>
<td>92.6</td>
</tr>
<tr>
<td>No</td>
<td>99</td>
<td>82</td>
<td>82.6</td>
</tr>
</tbody>
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Table 8: Distribution of infection by site of lesions

<table>
<thead>
<tr>
<th>Site of lesion</th>
<th>Number examined</th>
<th>Number positive</th>
<th>%Positive</th>
<th>P – value</th>
<th>OR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hands</td>
<td>31</td>
<td>30</td>
<td>96.8</td>
<td>0.041</td>
<td>0.7</td>
</tr>
<tr>
<td>Scalp</td>
<td>56</td>
<td>41</td>
<td>72.2</td>
<td>0.02</td>
<td>0.17</td>
</tr>
<tr>
<td>Face</td>
<td>9</td>
<td>7</td>
<td>77.2</td>
<td>0.62</td>
<td>0.6</td>
</tr>
<tr>
<td>Neck</td>
<td>26</td>
<td>26</td>
<td>100</td>
<td>0.01</td>
<td>0.81</td>
</tr>
<tr>
<td>Feet</td>
<td>14</td>
<td>12</td>
<td>85.7</td>
<td>1.0</td>
<td>1.07</td>
</tr>
<tr>
<td>Trunk</td>
<td>35</td>
<td>33</td>
<td>94.3</td>
<td>0.1</td>
<td>3.79</td>
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### Table: 9  Distribution of infection by education

<table>
<thead>
<tr>
<th>Education</th>
<th>Number examined</th>
<th>Number positive</th>
<th>% Positive</th>
</tr>
</thead>
<tbody>
<tr>
<td>No education</td>
<td>21</td>
<td>17</td>
<td>81.0</td>
</tr>
<tr>
<td>Lower primary</td>
<td>35</td>
<td>25</td>
<td>71.4</td>
</tr>
<tr>
<td>Upper primary</td>
<td>42</td>
<td>39</td>
<td>92.9</td>
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<tr>
<td>Secondary</td>
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<td>21</td>
<td>91.3</td>
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<td>College</td>
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<td>4</td>
<td>100</td>
</tr>
<tr>
<td>University</td>
<td>1</td>
<td>1</td>
<td>100</td>
</tr>
<tr>
<td>Total</td>
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<td>84.9</td>
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</tbody>
</table>
Table 10: Fungal aetiologies

<table>
<thead>
<tr>
<th>Aetiology</th>
<th>frequency</th>
<th>percentages</th>
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<tbody>
<tr>
<td><em>Trichophyton spp.</em></td>
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<td>62.6</td>
</tr>
<tr>
<td>Yeast</td>
<td>26</td>
<td>24.3</td>
</tr>
<tr>
<td><em>Epidermophyton spp.</em></td>
<td>3</td>
<td>2.8</td>
</tr>
<tr>
<td><em>Microsporum spp.</em></td>
<td>3</td>
<td>2.8</td>
</tr>
<tr>
<td>Others</td>
<td>8</td>
<td>7.5</td>
</tr>
<tr>
<td>Total</td>
<td>107</td>
<td>100</td>
</tr>
</tbody>
</table>
Informed consent

I ELIZABETH W. MWAURA am a student in Kenyatta University and am doing a research on fungal conditions in patients attending Thika District Hospital. I wish to request you to allow your specimen to be used in the research. The samples will not be used for any other study or exported to another country. All the information obtained will be held confidentially.

I Mr/ Mrs/ Ms ......................................................on this ..........day of .........., year 2009 hereby agree my samples to be used in this study having been given relevant information pertaining requirements, procedures and need for the samples to be taken for purpose of this study.

Signed .............................................. Date ......................................

Witnessed........................................... Date ......................................