Opinion

BIOMEDICAL Journal of Scientific & Technical Research

ISSN: 2574 -1241

DOI: 10.26717/BJSTR.2022.44.006995

One Health and Dermatophytes, what is the Link Between Them?

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ARTICLE INFO

Received: May 12, 2022

Published: May 23, 2022

Citation: Dario Corrêa-Junior, Rodrigo Almeida Paes, Susana Frases. One Health and Dermatophytes, what is the Link Between Them?. Biomed J Sci & Tech Res 44(1)-2022. BJSTR. MS.ID.006995.

Keywords: Dermatophytosis; Infection; Virulence; Mycoses; One Health; Zoophilic

ABSTRACT

Dermatophytes infect keratin-rich tissues such as skin, hair, and nails. Dermatophytosis affects approximately 25% of the world population and its distribution is influenced by geographic and climatic factors as well as population habits. Infection occurs by contact with the fungal propagules existing in the environment, or by direct contact with humans, animals, and contaminated soil, which names the three dermatophyte ecological groups: anthropophilic, zoophilic and geophilic. These fungi accompany the increasing domestication of dogs and cats and are part of our urban niche. The World Health Organization (WHO) currently recommends that diseases should be studied following the concept of one health, where there is a joint look at human, animal, and environmental health, therefore, dermatophytes fit this concept and need to be studied under this point of view.

Abbreviations: WHO: World Health Organization; FAO: Food and Agriculture Organization; OIE: Organization for Animal Health

Opinion

Fungi are agents of infectious processes called mycoses. According to the place of installation of these pathogens, fungal diseases can be clinically classified as superficial, cutaneous, subcutaneous, and systemic. Of more than 2.2 to 3.8 million estimated fungal species, about 300 cause disease in humans [1]. In general, fungal disease surveillance is not reportable, which suggests that most estimates are unreliable. Cutaneous mycoses are the more common type of fungal infections, which are limited to the outermost layers of the skin. When caused by dermatophyte fungi, they are called dermatophytosis, affecting tissues rich in keratin, such as the skin, hair, and nails. It is believed that skin infections caused by dermatophyte fungi affect approximately 25% of the world population [2]. Although they rarely cause serious or invasive disease, cutaneous mycoses have an important impact on public health, as their spread can be difficult to control and have high rates of recurrence [2]. About 50 dermatophyte species are of medical interest worldwide. Currently, nine monophyletic groups are accepted as genera: *Guarromyces, Ctenomyces, Paraphyton, Arthroderma, Epidermophyton, Lophophyton, Microsporum, Nannizzia* and *Trichophyton* [3]. Regarding physiology and morphology, dermatophytes are filamentous fungi with diverse colonial morphology, keratinophilic, and can affect humans and

other animals. Dermatophytosis are also classified according to the site of infection, using the word tinea followed by the Latin term for the body location, *barbae, capitilis, corporis, crurus, faciei, manuum, pedis* and *inguium* [4].

Their distribution is influenced by geographic and climatic factors, population habits, among others, varying significantly from country to country. Its distribution depends directly on population density and social activities in rural and urban areas, in addition to ecological and socioeconomic changes [4]. Infection occurs through contact with the spores or propagules of the fungus existing in the environment, or through direct contact with humans, animals and contaminated soil, a fact that names three dermatophyte ecological groups: anthropophilic, zoophilic and geophilic [2]. The World Organization for Animal Health (OIE) introduced the concept of One Health in the early 2000s in an initiative signed with the World Health Organization (WHO) and the Food and Agriculture Organization of the United Nations (FAO) to emphasize that human health and animal health are interdependent and linked to the ecosystems in which they coexist. About 60% of pathogens capable of infecting humans cause zoonoses that come from domestic or wild animals [5]. The study of the environmental, animal, and human health triangulation allows the understanding of pathogenic and non-pathogenic microbial transfer between humans, animals, and ecosystems [6]. This microbe transposition could occur between people, animals and the environment and is related to factors such as, urbanization and environmental stress, which leads these microorganisms to make changes and develop intrinsic virulence factors that can lead to disastrous consequences for human health.

Although affected by environmental exposures, human pathogens can also modulate the response to environmental factors through metabolic and immune functions. The study of these interactions is necessary to improve interventions to prevent and manage a variety of diseases, including those that have the potential for zoonotic transmission such as dermatophytosis. Although the number of cases of these mycoses is increasing, knowledge about the diseases and especially about the eco-epidemiology of their agents is still scarce. These fungi accompany the increasing domestication of dogs and cats and are part of our urban niche. Therefore, studies that evaluate the mechanisms by which the fungus causes disease on these hosts are of paramount importance. Virulence aspects must be studied continuously because the immunity commitment in possible hosts and adaptations to environmental stresses make fungi to acquire abilities that can increase virulence, representing threats to the human health. Although there are virulence studies that try to explain these adaptations, many species that are not yet studied under the One Health concept can cause new fungal epidemics. The damage caused by them not only affects animals, but it can also compromise the quality of the soil and plants, causing great losses in agricultural activities linked to the emergence of new infective strains. The main virulence factors of fungi are grouped in their metabolic and structural plasticity, leading to clinical changes in these mycoses.

Thermotolerance is intrinsically related to global warming, as with the increase of heat in the world, strains of fungi can adapt, facilitating the interaction of environmental fungi with human populations, leading to the emergence of new fungal pathogens [7]. *Microsporum canis* has a low thermotolerance, but that can change if the climate change scenario is not changed, causing them to invade deeper tissues and consequently causing more serious infections [8]. Production of hydrolytic enzymes and factors related to characteristics of fungal structures that favor adhesion and initiation of infection are the main virulence factors found in these pathogens. Pathogenicity is closely related to virulence factors, as they allow the establishment and development of the fungus in the host tissue. Moreover, the environmental use of fungicides in soil can promote the emergence of antifungal resistant geophilic dermatophytes, as occurred already with *Aspergillus fumigatus* [9]. In Brazil, the main representative of sapronotic and mainly zoonotic mycosis with cases throughout the country is sporotrichosis, which in the last two decades has become hyperendemic in Rio de Janeiro [10]. Considering that *S. brasiliensis* can be transmitted from animals to humans such as dermatophytes, surveillance must include the environment, in addition to people and animals, as recommended by the One Health approach, especially in urban areas with high population density, aiming at the prevention and control of this disease, important zoonosis in our country.

The importance of studies with a One Health approach is clear and necessary. Today, cutaneous mycoses are emerging diseases in the world, driven by epidemiological changes that have occurred in recent decades and with great morbidity. Therefore, it is necessary to study the metabolic and structural plasticity of these agents to clarify questions related to their biology and their participation in the infectious process. Finally, investigations into the fungus-host-environment interactions are crucial for the development of strategies for therapeutic intervention and control of dermatophytosis.

Acknowledgement

This work was supported by the Brazilian agencies Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) and Fundação Carlos Chagas Filho de Amparo à Pesquisa do Estado do Rio de Janeiro (FAPERJ).

Conflict of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to infuence the work reported in this paper.

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ISSN: 2574-1241

DOI: 10.26717/BJSTR.2022.44.006995

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