GSC Advanced Research and Reviews

eISSN: 2582-4597 CODEN (USA): GARRC2

Cross Ref DOI: 10.30574/gscarr

Journal homepage: https://gsconlinepress.com/journals/gscarr/

(RESEARCH ARTICLE)

Epidemiology of superficial mycoses in morocco: Analysis of the impact of anti-COVID-19 preventive measures

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GSC Advanced Research and Reviews, 2023, 17(02), 144–151

Publication history: Received on 05 October 2023; revised on 13 November 2023; accepted on 16 November 2023

Article DOI: https://doi.org/10.30574/gscarr.2023.17.2.0433

Abstract

Introduction: In the face of the COVID-19 pandemic, several strategies to reduce the spread of this virus have been adopted in the community and hospital settings.

Objective: To report the epidemiological trends of all superficial mycoses (SM) diagnosed before and during the COVID-19 pandemic and to evaluate the impact of anti-COVID-19 preventive measures on the incidence and etiological profile of these SM.

Methods: This is a retrospective descriptive and comparative study conducted over four years, divided into two distinct periods: Before the COVID-19 pandemic (Period 1: January 2018 to December 2019) and during the COVID-19 pandemic (Period 2: January 2020 to December 2021), including all superficial mycoses diagnosed at the laboratory of parasitology and medical mycology of the Avicenne military hospital of Marrakech during these two periods.

Results: Out of 1598 superficial mycological specimens, 1006 were received during period 1 and 592 during period 2 (p=0.000). Onychomycosis (n=840) predominated in both periods (52.3% versus 53%, p=0.771). The incidence of ringworm and epidermomycosis decreased significantly between periods 1 and 2, with a p-value of 0.000 and 0.026, respectively. The study of the etiological profile showed a decrease in the incidence of dermatophytes (85.5% versus 79.3%, p=0.015), contrasting with a statistically significant increase in yeast MS (9% versus 11.3%, p=0.001), and this mainly concerned nonalbicans Candida (5.5% versus 35.8%, p=0.000).

Conclusion: The results of this study highlight the impact of anti-COVID-19 prevention measures on the epidemiological profile of SM. It shows that the continuation of the actions implemented to control the transmission of SARS-COV-2 will significantly contribute to reducing the incidence of superficial mycoses, especially dermatophytes.

Keywords: COVID-19; Superficial mycoses; Rate; Mycological profile

1. Introduction

In December 2019, a novel Severe Acute Respiratory Syndrome Coronavirus 2 (SARS-CoV-2), the agent of Corona virus 2019 (COVID-19) disease, emerged in the city of Wuhan, China, and rapidly spread on a large scale before being declared by the World Health Organization (WHO) on March 11, 2020, as a full-fledged global pandemic (1). Since then, preventive measures have been put in place around the Globe to contain the pandemic and limit the spread of the virus. At the individual level, these restrictive measures consisted of the mandatory wearing of masks and regular and rigorous hand washing. On a collective level, they involved closing public places, physical distancing, banning

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gatherings, closing borders, sanitary confinement, and teleworking. Telemedicine also gained importance during the pandemic (2) (3). All these significant changes in the lifestyle of individuals had an impact on the epidemiology of several disease entities, both the mental and physical health of the population.

The COVID-19 pandemic contributed to an increase in the prevalence of major depressive disorders (by 27.6%) and anxiety disorders (by 25.6%) (4). Influenza and other conventional respiratory infections became less common with the implementation of COVID-19 mitigation measures (5). An exacerbation of chronic dermatological conditions has also been reported (6). In addition, many opportunistic infections, including invasive fungal infections (aspergillus, mucorales, candida spp), have seen an unprecedented increase, especially in patients with severe forms of COVID-19 (7). Superficial mycoses (SM) are one of the most common conditions in routine medical practice (8). As these are often mild infections, few studies have evaluated the impact of COVID-19 on their epidemiological profile. To fill this data gap, the main objective of this work is to report the epidemiological trends of all documented MS before and during the COVID-19 pandemic and to evaluate the impact of anti-COVID-19 preventive measures on the incidence and etiological profile of these MS.

2. Material and methods

This is a retrospective descriptive and analytical study conducted by the Parasitology Mycology Department of the Avicenne Military Hospital in Marrakech (Morocco), including all superficial mycoses documented over a period of four years between January 1, 2018, and December 31, 2021. We analyzed the impact of anti-COVID-19 preventive measures on the prevalence of superficial mycoses (onychomycoses, epidermomycoses, ringworms, oral and genital mycoses, and malassezioses) and on their etiological profile, comparing the pre-pandemic period (period 1: January 2018 to December 2019) with the period during the pandemic (period 2: January 2020 to December 2021). Clinical and mycological data were collected from the laboratory mycology records.

In practice, the mycological diagnosis is conducted in 4 steps: mycological sampling, direct examination, culture, and identification. For any patient referred for clinical suspicion of a superficial mycosis, a different sample is taken according to the type and location of the lesions by experienced personnel, then subjected to direct microscopic examination and cultured on the usual Sabouraud media: simple Sabouraud, with added chloramphenicol and with added cycloheximide (actidione*). The culture is systematically performed except for pityriasis versicolor, where the diagnosis is made only on direct examination in the presence of characteristic spores on the scotch test. The identification of fungi was based on the duration of growth and the macroscopic and microscopic aspect of the colonies after staining with lactophenol blue. The identification of yeasts was based on the study of the auxanogram. The diagnosis of superficial mycosis was based on a positive direct examination and/or positive culture.

Data were collected on Microsoft Excel 2007 and analyzed on IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp., Armonk, N.Y., USA). The descriptive analysis calculated medians for quantitative variables (Age) and percentages for qualitative variables for each of the two periods 1 and 2. The $\chi 2$ test or Fisher's two-tailed exact test was used for comparing percentages, and Student's t-test was used to compare quantitative variables. For all analyses, a p-value of less than 0.05 was considered significant. Malassezia furfur was not included in the same count as the yeasts due to its specific characteristics. Its statistics will be presented separately.

3. Results

3.1. Overall results

Out of 1598 superficial mycological specimens, A total of 592 specimens were recorded during the pandemic period and 1006 during the pre-pandemic period, indicating a statistically significant decrease (63% vs. 37%, p=0.000). The mean age of patients was 38.99 ± 21.18 years (January 2018 December 2019) versus 39.41 ± 20.23 years (January 2020 December 2021) (p=0.236), with a female predominance in both periods (p=0.875). (Table 1)

Table . Epidemiological data and results of direct test of blood culture obtained from patients with suspected superficial mycosis

Variables		**Pre-COVID-19**		**While-COVID-19**		**P-value**
		Size	**Percentage (%)**	**Size**	**Percentage (%)**	
Number of patients tested (n=1598)		1006	63%	592	37%	0.000
Age (average ± Ecart-type)		38.99 ± 21.18		39.41 ± 20.23		0.236
Gender						
Male (n=746)		485	48.2%	283	47.8%	0.875
Female (n=808)		521	51.8%	309	52 .2%	
Sampling points						
Fingernails and toenails		680	67.6%	415	70.1%	0.001
Scalp and beard		151	15%	75	12.7%	
Skin sample		127	12.6%	55	9.3%	
Oropharyngeal sample		39	3.9%	27	4.6%	
genital sample		9	0.9%	20	3.4%	
Number of sampling points						
1 point		670	66.6%	412	69.6%	0.466
2 points		254	25.2%	136	25.2%	
>2 points		82	8.2%	44	7.4%	
Direct Test						
Negative		315	31.3%	209	35.3%	0.101
Positive :		691	68.7%	383	64.7%	
	Mycelia filaments	492	48.9%	281	47.5%	0 .002
	Yeasts +/- pseudofilaments	91	9%	64	10.8%	
	Yeasts in clusters + short filaments	19	1.9%	17	2.9%	
	Hair parasitism. Ecto endothrix	63	6.3%	11	1.9%	
	Hair parasitism Endothrix	24	2.4%	8	1.4%	
	Hair parasitism EE megaspore type	1	0.1%	1	0.2%	
	Hair parasitism EE microid type	1	0.1%	1	0.2%	
Culture						
Unrealised		43	4.3%	22	3.7%	0.011
Sterile		336	33.4%	242	40.9%	
Positive		627	62.3%	328	55.4%	
Isolated Fungal groups in culture						
Dermatophytes		536	85.5%	261	79.3%	0.015
Yeasts		110	17%	84	24.2%	0.005

3.2. Evolution of clinical groups of SM

Onychomycosis (n=840) predominated over both periods with a prevalence that remained stationary (52.3% versus 53%, p=0.771). The percentage of mycologically confirmed ringworms in the pre-pandemic period represented 8.8% of diagnosed MS versus 3.7% in the COVID-19 period, with a statistically significant difference (p=0.000). Similarly, the incidence of epidermomycosis decreased significantly between the two periods (30.7% versus 25.5%, p=0.026). Oral and genital mycoses and malassezioses did not show significant changes in their incidence (see Table 3 or Figure 1).

3.3. Evolution of fungal groups in SM

The study of the etiological profile showed a decrease in the incidence of dermatophytes (85.5% versus 79.3%, p = 0.015), contrasting with a statistically significant increase in SM of yeast origin (9% versus 11.3%, p = 0.001). For anthropophilic dermatophytes, Trichophyton (T.) rubrum was the most frequently isolated species in periods 1 and 2, with a statistically significant increase in its prevalence (77.2% versus 85.5%, p = 0.01). Among the zoophilic species, the prevalence of M. canis significantly decreased from 12.1% to 5.8% (p = 0.005) between the two periods. The distribution over the four years of M. canis and ringworms showed a similar downward trend (Figure 2). For yeast MS, we observed a significant increase in their frequency (9% vs. 11.3%, p = 0.001) with a preponderance of Candida (C.) species (98 .9% before COVID-19 and 97% during COVID-19). This increase was observed in favor of non-albicans Candida (5.5% vs. 35.8%, p = 0.000), including mainly C. glabrata (p = 0.000) and C. famata (p = 0.042), while C. albicans showed an apparent decrease (93.4% vs. 61.7%, p = 0.000). For Malassezia spp, no statistically significant difference was found (1.9% versus 2.9%, p = 0.191) (Table 2).

Table 2. Comparison of superficial mycoses confirmed upon causative virus

	Pre-COVID-19		**While-COVID-19**		**P-value**
	Size	**Percentage**	**Size**	**Percentage**	
SM due to dermatophytes (n=784)	536	85.5%	261	79.3%	0.015
Antropophilic dermatophytes					
T. rubrum	414	77.2%	222	85.1%	0 .010
T. mentagrophytes var. interdigitalis	21	3.9%	13	5%	0.479
Trichophyton violaceum	25	4.7%	2	0.8%	0.004
Microsprorum auduinii	1	0.2%	3	1.2%	0.070
Zoophilic dermatophytes					
Microsprorum canis	65	12.1%	15	5.8%	0.005
T. mentagrophytes var. mentagrophytes	9	1.7%	5	1.9%	0.806
Trichophyton verrucosum	0	0%	1	0.2%	0.486
Telluric dermatophytes					
Microsprorum gypseum	0	0%	1	0.4%	0.151
SM due to yeasts (Malassezia spp excluded)	**91**	**9%**	**67**	**11.3%**	**0.001**
Candida albicans	85	93.4%	41	61.2%	0.000
Candida Non albicans	5	5.5%	24	35.8%	0.000
C. glabrata	1	1.1%	11	16.4%	0.000
C. famata	0	0%	3	4.5%	0.042
C.dubliniensis	1	1.1%	3	4.5%	0.182
C. parapsilosis	1	1.1%	2	3%	0.391
C. tropicalis	1	1.1%	3	4.5%	0.182
C.magnoliae	0	0%	2	3%	0.097
C. guilliermondii	1	1.1%	1	1.5%	0.827

Trichosporon spp	1	1.1%	0	0%	0.389
Cryptococcus spp	0	0%	1	0.2%	0.166
Malassezioses	19	1.9%	16	2.9%	0.191

Table 3 Comparison of clinical groups of superficial mycoses diagnosed prior to and during COVID-19

Types of superficial mycoses	**Pre-COVID-19**		**While-COVID-19**		**p-value**
	Size	**Percentage(%)**	**Size**	**Percentage(%)**	
Onychomycosis[1] (n=840)	526	52.3%	314	53%	0.771
Epidermomycosis[2] (n=460)	309	30.7%	151	25.5%	0.026
Tinea corporis (n=38)	28	9%	10	6.6%	0.403
Tinea pedis (n=414)	274	88.7%	140	92.7%	0.315
Tinea manuum (n=8)	7	2.3%	1	0.7%	0.708
Association « Onychomycosis + Epidermomycosis » (n=400)	265	34.5%	135	31.4%	0.274
Moths[3] (n=111)	89	8.8%	22	3.7%	0.000
Tinea capitis (n=110)	89	100%	21	95.46%	0.000
Tinea barbae (n=1)	0	0%	1	4.54%	0.439
Malassezioses[4] (n=36)	19	1.9%	17	2.9%	0.201
Pytiriasis versicolor (n=29)	19	100%	10	58.8%	0.076
Pytiriasis capitis (n=7)	0	0%	7	41.2%	0.005
Oral mycoses (n=35)	17	1.7%	18	3%	0.075
Genital mycoses (n=7)	2	0.2%	5	0.8%	0.059
Negative mycological research (n=511)	310	30.8%	201	34%	0.194

[1] Fingernails and toenails. [2] Hairless skin samples, largest and smallest folds, scaling of soles and dorsum of feet, scaling of lalms and backs of hands (malassezioses excluded). [3] Scalp and beard; [4] Research on *Malassezia sp* on skin or hair

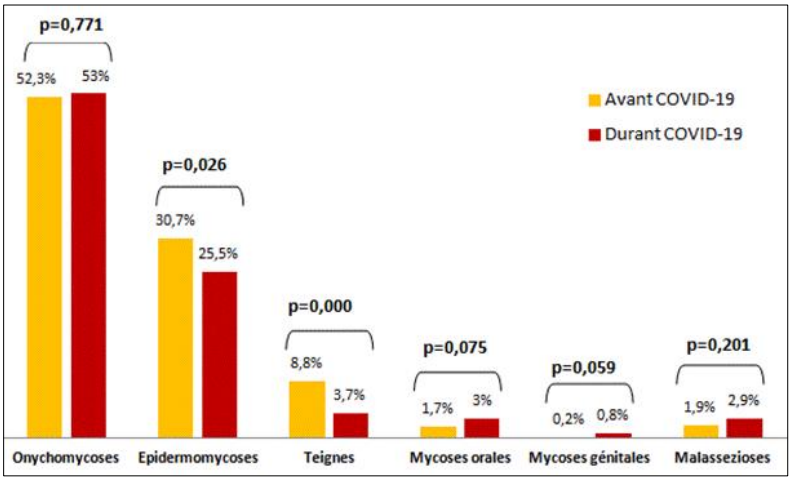

Figure 1 Comparison of the incidence of different clinical groups of superficial mycoses diagnosed prior to and during COVID-19

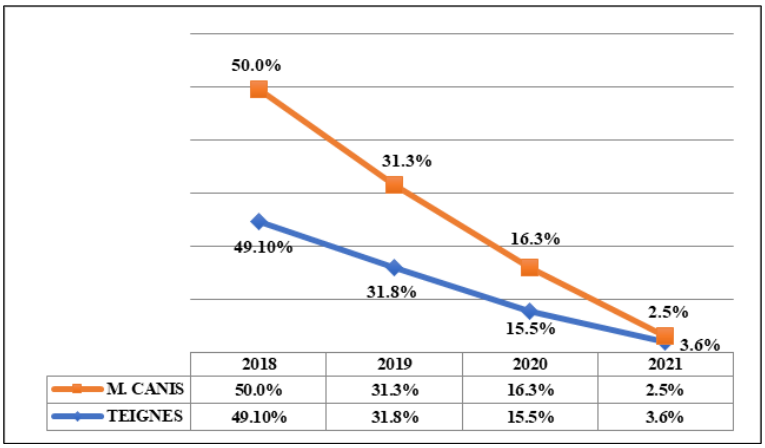

Figure 2 Evolution of incidence of moths and of Microsporum (M.) canis between 2018 and 2021

4. Discussion

From the first months of the pandemic, Morocco has shown great anticipation by implementing early preventive measures to counter the pandemic (9). These measures were initially materialized by developing the "National Plan for Surveillance and Response to Coronavirus Infection 2019-nCoV". In response to the declaration of the first case of SARS-Cov2 infection in Morocco on March 2, 2020, a set of restrictive measures aimed at containing the spread of SARS-CoV-2 were put in place. These include a ban on cultural and sporting events and gatherings in closed areas. At the same time, an information and awareness campaign was launched to inform the population about hygiene rules and "barrier" actions to be taken (10). Following the increase in the number of cases of COVID-19, control strategies have been reinforced. International flights and intercity travel were suspended (since March 13). Then, a state of health emergency with total containment of the population was declared in the country (since March 20). The measures accompanying the lockdown included the suspension of face-to-face teaching in schools and universities, the deployment of distance learning, and the indefinite closure of public spaces such as shops, cafes and restaurants, Moorish baths, sports halls, swimming pools, and mosques (10).

We thus evaluated the impact of these anti-COVID-19 preventive measures on the epidemiological situation of superficial mycoses in our context. Superficial mycoses are frequent infectious pathologies of the skin, phanera, and mucous membranes caused by microscopic fungi: yeasts, dermatophytes, and molds (8). They represent a real public health problem, affecting approximately 25% of the world's population (11). The epidemiology of these SM varies over time and according to many factors.

An apparent decrease in the number of mycological samples taken over the two periods was observed in this study (63% versus 37%, p=0.000). Indeed, the pandemic situation has led to a postponement of non-urgent consultations, and telemedicine has been increasingly solicited by patients and health professionals, particularly in the field of dermatology, given its advantages, allowing patients to bypass hospitals, avoid contamination and implement social distancing (12)(3). Morocco has been a pioneer in introducing telemedicine and digital health in Africa. Among the applications implemented by the Moroccan Ministry of Health are both the digital platform for free medical "tele-counseling" (www.tbib24.com) in which doctors of all specialties participated during the lockdown for the benefit of citizens and the Système Informatique de Laboratoire (LIS) for the public and private sectors (12).

The stay-at-home strategy impacted the number of patients seeking outpatient dermatology consultation in secondary and tertiary care hospitals in Turkey and the incidence of several dermatological conditions, in this case, dermatophytosis, the percentage of which decreased after the pandemic (13). In our cohort, the incidence of dermatophytes also decreased during COVID-19 (85.5% versus 79.3%, p=0.015). These epidemiological data differ from one series to another. According to F. Pelin Cengiz et al., the study of the profile of dermatological pathologies encountered in consultation during the pandemic showed that the vast majority of patients presented with acne vulgaris (24.1%), various types of dermatitis (14.1%) and superficial mycoses (7.4%) (14) In the Republic of Kazakhstan, analysis of the dynamics of dermatomycosis incidence between 2019 and 2020 revealed that the incidence rate in 2020 decreased by a factor of 1.2 compared with 2019 (15). For Italy, the percentage of mycologically confirmed epidermomycosis (tinea coporis) cases during March 2020-2021 decreased significantly compared with the percentage of positive patients during March 2019-2020 (77.6% versus 59.8%, $p < 0.01$) (3).

The main factors favoring the transmission of anthropophilic dermatophytes are direct contact or contamination, mainly indirect, by parasitized keratin fragments on toiletries or wet floors in public baths, swimming pools, ablution areas in mosques, sports halls, Etc. Exposure to geophilic and zoophilic species is mainly professional (farmers, breeders, veterinarians) or family (cohabitation of domestic animals: cats, dogs) (8) (16). In the era of COVID-19, social distancing measures and the closure of public places could partly explain the decrease in the incidence of dermatophytes, especially anthropophilic, in our population. In a survey conducted in Saudi Arabia to assess precautionary behaviors among pre- and post-pandemic gym-goers, a dramatic change in perception and commitment to personal hygiene and disinfection measures was observed. Adopting such behaviors contributes to controlling factors that promote the transmission of dermatophytes (17). M. canis, known for its high contagiousness, is the zoophilic species that dominates the epidemiology of ringworm in Morocco (18). The remarkable decrease in the incidence of ringworm ($p = 0.000$), especially with M. canis, is thought to be related to the anti-COVID-19 measures adopted by the Moroccan population during the pandemic, including social distancing, improved hygiene conditions, and lifestyle changes. Several cases of domestic animals, mainly cats, infected with Sars-CoV-2 after contact with COVID-19-positive individuals have been reported in New York, Hong Kong, Belgium, Germany, Spain, France, and Russia. Although there is no evidence to date that these infected animals have transmitted Sars-CoV-2 to humans (19), many families have hunted their pets and domestic animals as a preventive measure (20), which may explain the decreased incidence of these zoonotic dermatophytes.

COVID-19-associated candidiasis can be superficial or invasive, with infection rates ranging from 0.7 to 23.5%. Most mycologic investigations have focused on invasive forms because of their severity. Nonalbicans C. constituted the majority of isolates in the series of P. Macauley et al. when considering all COVID and non-COVID candidemic patients, and even when these two groups are considered separately with a predominance of 71.8% and 69.2%, respectively. Other contemporary studies state that in patients with severe COVID-19, invasive C. albicans candidiasis ranks first, followed by C. auris, C. glabrata, C. parapsilosis, C. tropicalis, and others (21). Data on the evolution of the epidemiology of superficial oral, genital, cutaneous, or nail candidiasis during the pandemic in subjects infected or not with COVID-19 are mainly lacking. In our study, a comparison of the percentage of superficial candidiasis diagnosed during the two periods showed a decreasing trend of C. albicans species in favor of an increase of C. nonalbicans species. The same trend was reported by Jayant et al. in their prospective study during the pandemic (65.9% nonalbicans Candida versus 34.07% C. albicans) (22).

5. Conclusion

The COVID-19 pandemic has caused significant changes in the frequency of various diseases, including dermatological diseases. The present study describes the changing epidemiological profile of different types of SM in this pandemic context. The results highlight the impact of anti-COVID-19 prevention measures on SM. They show that continued action to control SARS-COV-2 transmission will significantly contribute to reducing the incidence of MS, including anthropophilic and zoophilic dermatophytes.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest

Statement of informed consent

Informed consent was obtained from all individual participants included in the study.

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