TEHRAN UNIVERSITY OF MEDICAL SCIENCES

IRANIAN OCCUPATIONAL HEALTH ASSOCIATION IOHA

ORIGINAL ARTICLE

Investigating the Prevalence of Fungal Infections among Operating Personnel at a Petroleum Refinery Complex on Warm and Humid Conditions

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This paper is available on-line at *http://ijoh.tums.ac.ir*

ABSTRACT

Infectious diseases are one of the most important health and economic problems in the world, especially in developing countries. Hence, the present study was aimed to investigate the epidemiological prevalence and predict the fungal infections' effective factors among operating personnel at a petroleum refinery complex located in the south of Iran on warm and humid conditions. A group of 200 individuals was selected to collect fungal infections samples from five parts of their body including the auricle, ear canal, foot toes, foot palm, and foot nail. After sampling, the collected samples were transported into a laboratory and cultured in a culture medium for three weeks in thermal conditions of 25 centigrade on an incubator. In the next step, the grown fungi were detected using the colony examination and fungal characteristics of staining with lactophenol cotton blue, and the slide culture method. As well as, air temperature and relative humidity were measured using a WBGT. Data were analyzed finally using SPPSS software version 22. The mean and standard deviation of the air temperature and relative humidity in the operating units were 39.2 ± 7.34 Celsius degrees and 75.8 ± 15.31 percent, respectively. Of 200 samples cultured in the laboratory, 188 showed negative culture results and 12 samples had positive culture results. The fungal infections were founded in measured body parts of some people including the auricle of four subjects, ear canal of nine subjects, foot toes of five subjects, foot palm of six subjects, and foot nail of twelve subjects. Of 1000 isolated samples, 15 cases had been infected with trichophyton, eight cases with onychomycosis, six cases with aspergillus, four subjects with Candiais, and three cases with microsporum harborum. Based on the results, trichophyton were the most common fungal infections. As well as, foot nail and ear canal areas were founded as the most prevalence of places with the infections.

KEY WORDS: *Epidemiological Prevalence, Fungal Infection, Operating Personnel, Operating Personnel*

INTRODUCTION

Infectious diseases are one of the most important health and economic problems worldwide,

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especially in developing countries [1-2]. Biological agents can directly or indirectly affect the workers' health and cause infectious diseases. Annually, more than 300,000 workers die from illnesses due to biological agents. Therefore, controlling and

combating the harmful biological agents is always one of the major parts of development programs [3-4]. In addition, some harmful biological agents in a workplace have the carcinogenic potential. Based on the results of various studies, it has been reported that nearly 15 percent of the new carcinogens around the world were related to biological agents such as viruses or bacteria [5-6]. On the other hand, the infectious diseases are recently considered as the most common occupational diseases [3-7].

The parasitic and fungal diseases have particular importance to infectious disease analysis. Given that accurate reports are not available for the prevalence of parasitic and fungal infections, it is not possible to estimate their real statistics. The world health organization, based on the limited reports and biological evidence, published the results every few years [8]. The superficial and cutaneous diseases have consisted of a great part of various fungal diseases. The superficial and cutaneous fungal diseases can also involve the nails in addition to skin and hair. These diseases are often caused by dermatophytes, malocclusions, trigocosporin, and opportunistic fungi such as aspergillus [9-2].

Three main types of dermatophytes including trichophyton, epidermophyton flucosum, and microsperm in the human body cause disease. The prevalence of the superficial and cutaneous fungal diseases is different at various seasons. These diseases are more likely to occur during the warm seasons due to the high air temperatures, humidity, and sweating rate and during the cold seasons due to the thickness clothes wearing [13]. However, sometimes, the mild clinical symptoms such as discoloration and tinea do not attract the attention of the patient and therefore, due to lack of timely treatment, the infections are directly and indirectly transmitted to other individuals. The prevalence of 20 to 25 percent of the fungal and cutaneous infections in the world's population will characterize the importance of this type of infectious disease [14].

Fungal and cutaneous infectious are some of the most common diseases. Wilson et al. found paramount importance for investigating these types of diseases although these two forms of illnesses are often limited and treatable [15]. Many studies have been conducted to evaluate the prevalence of fungal

infections around the world. Koksal et al. concluded that onychomycosis was the most common infection among Turkish suspected to disease people [16]. Moreover, Afshari et al. analyzed the prevalence of fungal infections among 3,000 military personnel and found that 7.1% of them were infected [17]. Similarly, Tan et al. reported that the prevalence of fungal infection among Singaporean people was 3.27 percent [18]. In these studies, the main risk factors of fungal infections among individuals have been identified including lack of health principles implementation on the working environment particularly in warm and humid environments which cause to increase the cases of infections [19-20]. The poor hygienic workstations, warm, and humid conditions may aggregate fungal infections among oil industry workers in the south of Iran.

Having considered these issue, the present study was aimed to investigate the prevalence and predict the effective factors on the fungal infections among the operating personnel at a petroleum refinery complex located in the south of Iran on warm and humid conditions.

METHOD

In this cross-sectional study, a group of 200 workers was selected at an oil refinery located in the south of Iran in 2019. The study was carried out at two steps including individuals sampling and laboratory analysis.

Individual sampling:

All workers were participated from eight sections of the refinery including zone one, zone two, zone three, tanks unit, water and power unit, workshops, restaurant, and firefighting and their information such as age, gender, and education degree was collected using a questionnaire. The exclusion criteria included skin lesions suspected to the fungal infection, skin diseases such as eczema and psoriasis, had a shower two days before sampling, and took the anti-fungal infection drugs and ointments.

Experimental analysis:

A group of 200 individuals was selected to collect fungal infections samples from five parts of their body including the auricle, ear canal, foot toes, foot palm, and foot nail. 1000 samples were collected

totally. The collected fungal infections included trichophyton, onychomycosis, aspergills, candiais, and Microsporum harborum. The fresh and active injuries were identified and the place was disinfected by alcohol to collect skin fungal lesions samples. A sample of skin lesions was collected using a sterile scalpel-sharp edge after drying the sampling region. The nail was also disinfected by alcohol. The nails were cut using a special nail clipper and a scalpel was used to scrape off the nail. The first scraped part was discarded and sample was collected from other parts. The auricle was also sampled to investigate probable ear infection.

After sampling, the collected samples were transported into a laboratory and cultured in a Sabouraud Dextrose medium at the presence of 0.05 gram per liter of chloramphenicol and 0.5 gram per liter of cycloheximide for three weeks under thermal conditions of 25 centigrade in an incubator. In the next step, the grown fungi were detected using colony examination and fungal characteristics of staining with a lactophenol cotton blue and slide culture method [21-22]. Air temperature and relative humidity of the operating units were measured using a WBGT meter (Casella model) with an accuracy of 0.01 Celsius degrees. The collected data ultimately were analyzed using SPPSS software version 22.

RESULTS

The mean and standard deviation of air temperature and relative humidity on operating units were 39.2 ± 7.34 Celsius degrees and 75.8 ± 15.31 percent, respectively. The demographical information of studied subjects has been presented in Table 1. The mean and standard deviation of the workers' age were 38.5 and 8.2, respectively. All the participants were male. Of 200 sampled subjects, 188 showed negative culture results and 12 samples had positive culture results.

The distribution frequency of the identified fungal infections in various units and different parts of the workers' body was investigated and the related results have been illustrated in Tables 2 and 3, respectively. Additionally, the frequency of infected areas based on types of fungal infections has been showed in Figure 1. Based on the results, the fungal infections were founded in sampled body parts of some people including the auricle of four subjects, ear

canal of nine subjects, foot toes of five subjects, foot palm of six subjects, and foot nail of twelve subjects. The results determined that the foot nail has the highest rate of pathogenic opportunistic fungi. The subjects' fungal infections types and frequency have been presented in Figure 2.

The finding showed that out of 1000 isolated samples, 15 cases infected with trichophyton, eight cases with onychomycosis, six cases with aspergillus, four subjects with candiais, and three cases with microsporum harborum. The results also indicated that trichophyton fungus was the most common infection type among the refinery operational staff.

Besides, the frequency of measured samples in various operating units and the numbers of negative and positive samples has been presented in Figure 3. Of 1000 samples isolated in the different units of this refinery, the most measured samples were related to the water and power unit with 270 samples and seven positive cases. The most positive cases of opportunistic pathogens belonged to the units of water, power, and workshops with seven registered positive cases.

**Table 1.** Demographic data of studied subjects (n = 200)

Variables		Frequency	Relative frequency
Marital status	Single	172	86
	Married	28	14
		20	10
Work experience	5-10 years		
	11-20 years	163	81.5
	21-25 years	5	2.5
	26-30 years	12	6
Age	25-30 years	24	12
	31-40 years	89	44.5
	41-50 years	64	32
	51-60 years	23	11.5
Education status	Under diploma	19	9.5
	Diploma	56	28
	Undergraduate	45	22.5
	Bachelor	67	33.5
	Master	13	6.5
Shift work status	Daytime	164	82
	Rotating	36	18
Unit	Zone one	32	14
	Zone two	22	11
	Zone three	19	12
	Tanks unit	15	14
	Water and power	54	17.5
	Workshops	26	13
	Restaurant	16	8
	Fire fighting	16	10.5

***Table 2.*** Distribution frequency of identified fungal infections in studied various units

Operating units / Types of infections	Zone one	Zone two	Zone three	Tanks unit	Water and power unit	Workshops	Restaurant	Fire Fighting	Total
	N	N	N	N	N	N	N	N	N
Trichophyton	4	0	2	1	2	4	1	1	15
Onychomycosis	1	1	1	1	1	1	1	1	8
Aspergills	1	2	1	0	1	0	1	1	7
Candiais	0	1	1	1	0	1	0	0	4
Microsporum harborum	0	0	1	0	1	0	0	0	2
Total	6	4	6	3	5	6	3	3	36

Table 3. Distribution frequency of identified fungal infections in different parts of body

Parts of body / Types of infections	Auricle	Ear canal	Foot toes	Foot palm	Foot nail	Total
	N	N	N	N	N	N
Trichophyton	2	6	4	3	2	15
Onychomycosis	-	-	-	-	8	8
Aspergills	2	2	-	-	2	6
Candidasis	-	-	1	2	1	4
Microsporum harborum	-	1	-	1	1	3
Total	4	9	5	6	12	36
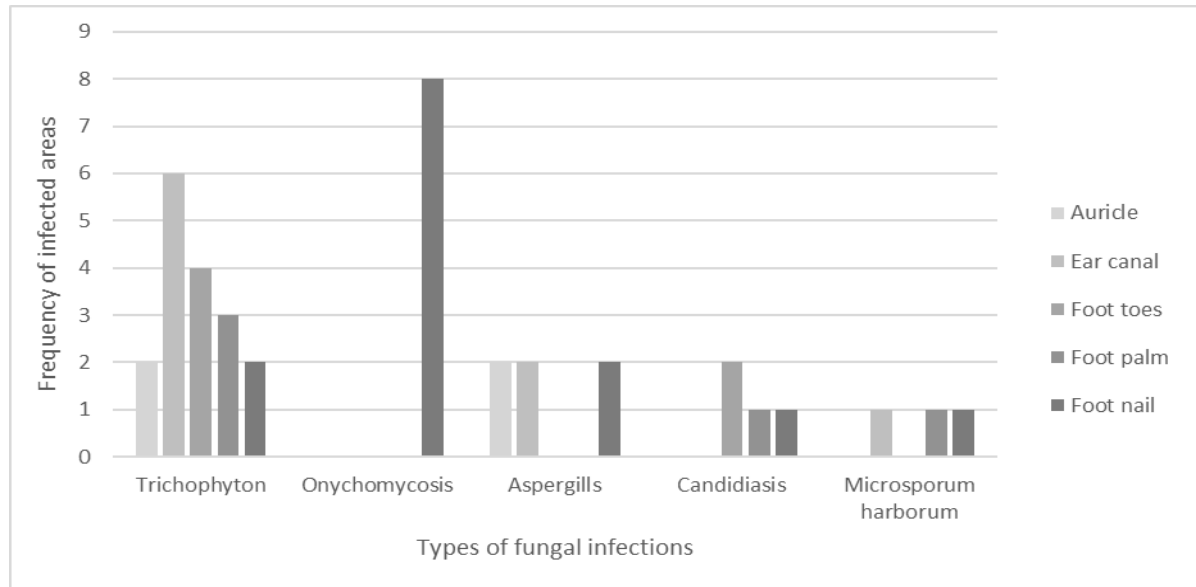
Fig 1. *Frequency of infected areas based on fungal infections types*
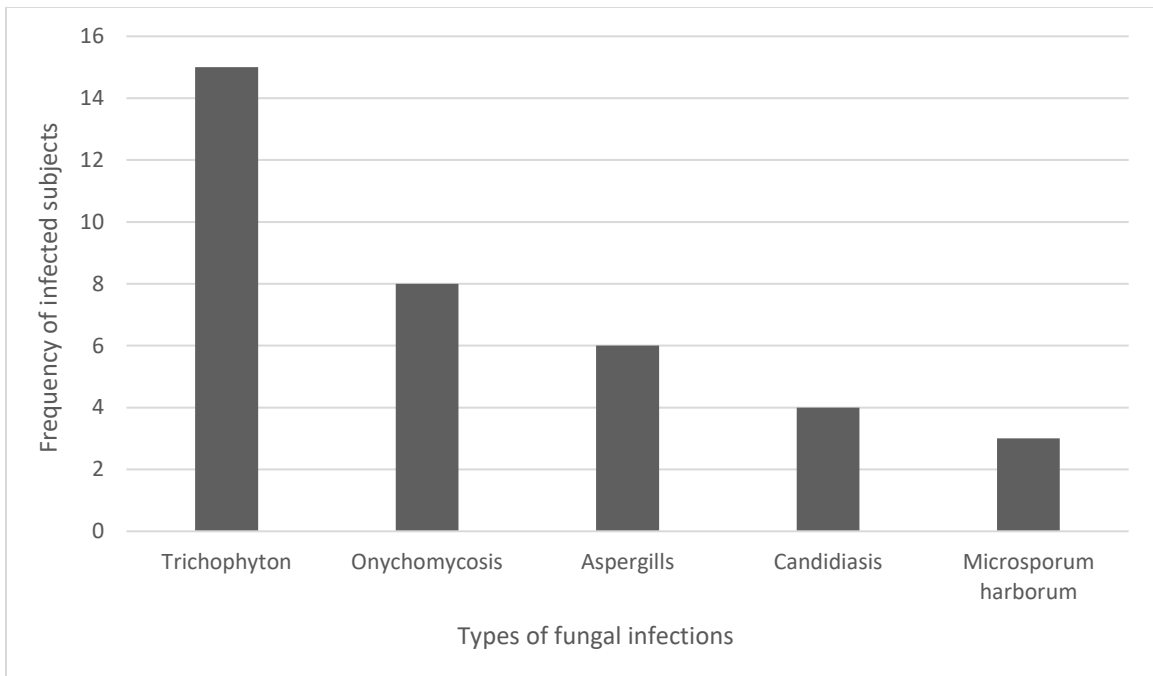
Fig 2. *Fungal infections types and their frequency in the studied subjects*
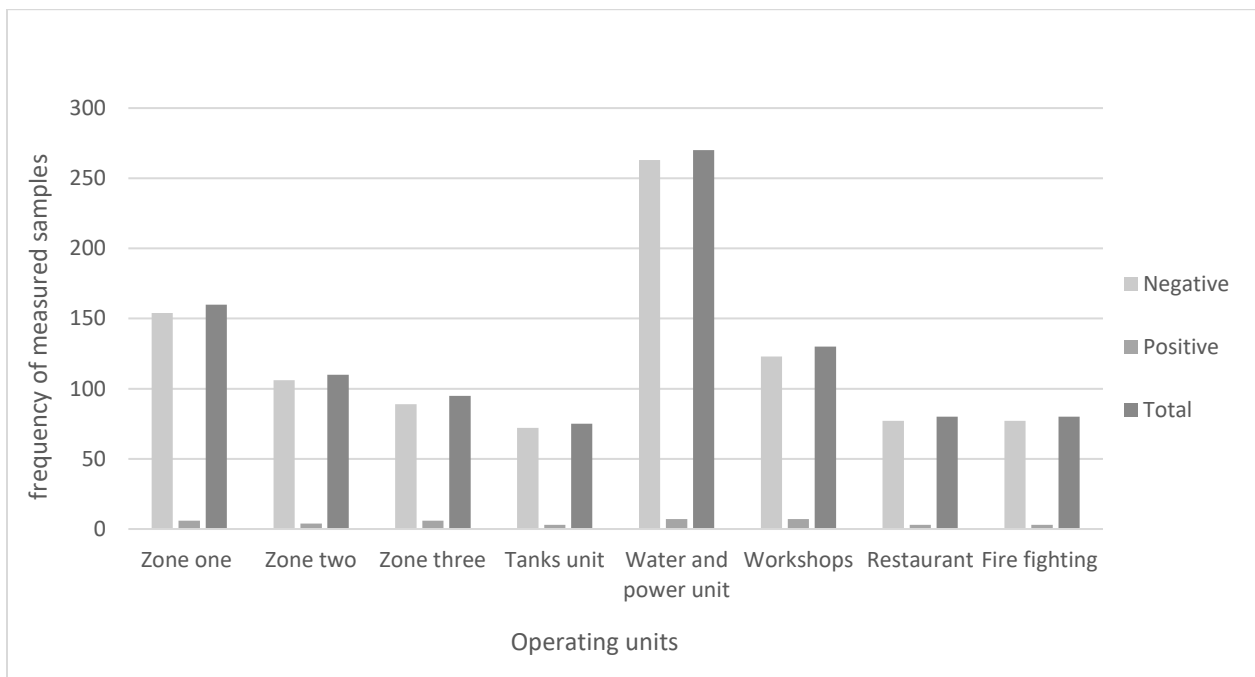
Fig 3. Samples measured frequency in various operating units and numbers of negative and positive samples

DISCUSSION

The aim of this study was to investigate the prevalence of fungal infections among the operational staff of an oil refinery located in southern Iran which has hot and humid weather. The results of 200 employees' samples collected from the operational units of petroleum refinery with an average age of 38.5 years revealed that the highest percentage of fungal infections were related to the foot nail. The trichophyton was the most common type of fungal infection. All fungal infections types were observed in the collected samples of the present study. The workers in workshops, water, and power units had the highest number of infected individuals. An ineffective indoor air conditioning may cause high prevalence of fungal infections among workers and excessive sweating during the hot seasons. Furthermore, personal protective equipment (PPE) use for a long time provides an appropriate environment for fungal infection growth.

To the best of our knowledge, the prevalence of fungal infections among refinery staff has not been investigated; therefore it was impossible to compare the findings of the present study with the other studies. However, Mousavi et al. studied the biological agents among the blood transfusion administration staff and stated that 39.6 percent of the employees had a mucosal skin contact during their work periods and the exposure level was higher among people who had not been participated in the occupational protection courses [23].

The results of a five-year survey on 1281 cases suspected to the superficial and cutaneous fungal infections in Neyshabour indicated that fifteen percent of people had these infectious diseases. Dermatophytosis had the highest prevalence by 74.5 percent and cutaneous candidiasis by one percent had the lowest prevalence. These results were consistent with the results of the present study. The higher percentages of the performed study in Neyshabour compared to the present study may be due to proximity to rural areas, infection transmission from soil and animals, low level of health, and differences in studied sample numbers [21].

In a study performed by Khazaei et al. on 148 suspected individuals, the results showed that 62.8

percent of the samples had fungal infections and dermatophytosis was the most common infection by 81.11 percent. In the study of Khazaei et al. similar to the results of the present study, the most common fungal disease was dermatophytosis [24-25]. The findings of another study on 1054 patients with suspected cutaneous lesions in the central laboratory of Yazd determined that dermatophytosis by 84.70 percent was the most common cutaneous fungal infection [26]. Similarly, in the study of Nasrollahi et al. dermatophytosis was the most common fungal infection by 57.31 percent [27].

The results of these studies were consistent with the current study. However, Panasiti et al. also carried out a study on 3160 subjects with suspected fungal infections in Rome. The results showed that 19.7 percent of people were diagnosed as subjects with dermatophytosis [28]. The difference of these results with the results of the present study can be due to the availability of suitable health facilities, high levels of health culture, and climatic conditions. The results of the present study showed that the mean and standard deviation values of the air temperature and relative humidity in the operating units were equal to 39.2 ± 7.34 Celsius degrees and 75.8 ± 15.31 percent, respectively. These conditions seem to be one of the effective factors to provide an appropriate environment for fungus growth. Molabagheri et al. reported the high prevalence of the fungal infections under relative humidity conditions of 78 to 83 percent in Scotland. Rippon also concluded that the humidity rate was as one of the fungal infections causes in various areas of the United States [29-30]. In addition, in studies conducted by Moosavian in Loretan and Taheri in Tonekabon, the annual rainfall and humidity rate were two direct important factors impact on the growth rate of fungal infections [31].

The results of the present study were compatible with the stated results of other studies [32]. Various factors play a role in the development of fungal infections, as mentioned above. Therefore, in order to prevent skin complications, different strategies can be adopted in different industries. It was recommended that managers apply multi-criteria decision-making techniques to measure control strategies and improve the working environment as well as employees' health [33]. Jahangiri et al. proved

that employees' health education could be the first way to prevent skin problems among workers [34]. There are some available standard models for health education to employees such as Basnef and health belief models which can be applied as an educating platform. In various studies, the effectiveness of these models to use personal protective equipment and promote self-care behavior among employees has been reported which indicated that these actions can also be used to reduce the prevalence of the fungal infection [35-36].

CONCLUSION

Based on the results, trichophyton was the most common fungal infections. Moreover, foot nail and ear canal were founded as the most prevalent parts of the human body for infections. Having considered these results, more hygienic instruction should be noticed to control and minimize infections effect such as breathable shoes and cotton socks use to decrease sweating and moisture of the foots especially in warm seasons, and disinfecting the personal protective equipment.

ETHICAL CONSIDERATIONS

The participants in this study voluntary informed consent to participate in this research.

CONFLICT OF INTERESTS

The authors declare that have no conflict of interest.

ACKNOWLEDGMENT

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