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The Profile of Navy Military Students with Superficial Fungal Foot Infections : A Descriptive Study

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ABSTRACT

Background: Superficial fungal foot infection is an infectious disease caused by dermatophyte, Candida spp., and mold. Risk factors are thought due to poor personal hygiene, frequent used of closed shoes, and high physical activity. **Purpose:** Investigate the profile and the risk factors of superficial fungal foot infections in military students. **Methods:** This is a cross-sectional study. Inclusion criteria for this study were navy military students with lesions on their feet. **Result:** This study involved 194 students as the populations with 97 students as the sample of the study. The average age were 17-25 years old, and male students being the major. Erythema and scale were found in the plantar and interdigital pedis. Students with good personal hygiene were 81 students among 97 students (83,5%). Wearing closed shoes for > 8 hours were found in 72 students among 97 students (74.2%). Most of the students exhibit a high physical activity with an average score of 26,880 MET minutes/week. Positive KOH 20% and cultures were found in 30 students (30.9%). Negative KOH 20% and positive culture were found in 27 students (27.8%). Positive KOH 20% and negative cultures were found in 9 students (9.3%). Negative KOH 20% and negative fungal culture results were found in 31 students (31,9%). Mold was the predominant fungal type. **Conclusion:** The students had good personal hygiene. The average wears closed shoes for >8 hours. Mold was the predominant fungal type in this study.

Keywords: Superficial fungal foot infections, personal hygiene, closed shoes, high physical activity, mold, humanand direase.

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BACKGROUND

Superficial fungal foot infections is an infectious diseases caused by dermatophyte species, *Candida* spp., and mold.[1] The incidence of superficial fungal foot infections in Thailand military school from a total 788 navy students, 57 students were found with superficial fungal foot infections (7,2%).[2] Dermatophyte is a fungal species that can infect the skin layered that has keratin, hair follicle, and nails. Report state that *Tricophyton rubrum* is the most common cause of dermatophyte infections, followed by *Trichophyton mentagrophytes* and *Epidermophyton floccosum.*[3] Tinea pedis represent dermatophyte infection with 5,5% cases common worldwide.[4] The prevalence of tinea pedis in Indonesia is still unclear. Those between the ages of 20 and 50 who have worked in jobs like farming, car washing, or wearing closed shoes are more likely to have tinea pedis infection. A descriptive report taken in the Center of Basic Military in Bandung has published a detailed results on tinea pedis in Indonesian soldiers. One hundred armies included the research sample. The findings indicate that 25 armys (25%) had tinea pedis, with an average age of 30 years.[5]

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Candida spp. is another type of fungal cause of superficial fungal foot infections. *Candida albicans* is the most common cause of *candida* infection in the world. The incidence report of candidiasis in Thai naval military student was reported with 3 students (8,3%) from the total of 57 students as the sample of the study. [2] It has also been noted that mold can also cause superficial fungal foot infections. Recent studies on 2016 in Dakar, Senegal reported *Fusarium* spp. was the most common cause of tinea pedis with 29 cases found (44,6%). The total cases of *Fusarium* spp. as the cause of superficial fungal foot infections in the army is still unknown.[6] It is believed that number of risk factors including personal hygiene, prolonged usage of closed shoes, and high physical activities can lead to superficial fungal foot infections. Using the same bathroom in the dorm increases the risk of getting superficial fungal foot infections. Factors such as an immunosuppressive diseases also increase the incidence of superficial fungal foot infections.[2, 5]

Military students are population suspected of having a significant risk of developing superficial fungal foot infections. These students have higher physical activity than the civilian. Prolonged usage of closed shoes followed by high physical activity and poor personal hygiene are thought to be correlated with the incidence of superficial fungal foot infections. These military students also live in the same dorm with the risk of using the same bathroom is quite high in this population.[2,5]

METHODS

This study is a cross sectional descriptive study that has a purpose to investigate the profile and the risk factors of superficial fungal foot infections in military students. The populations in this study were 194 students from centre of basic military academy in Surabaya. The sample of this study were based on inclusion and exclusion criteria. Students who had a lesion in feet were included in this study. The student who had AFSS (Athletes Foot Severity Score) equal to 0 were excluded in this study. All of the data were entered to data collection sheet and analyzed with SPSS (Statistical Package for Social Sciences). This research has been through the Ethics Committee review in RSUD Dr. Soetomo with the ethic number 0517/KEPK/XI/2022.

RESULT

The results of the study found 194 students as a population. After the inclusion and exclusion criteria were determined, there were 97 students (50%) who were excluded from this study. This led to the selection of 97 students (50%) as the sample. The results of male students were higher than female students with the total of 88 male students (90,7%) and 9 female students (9,3%). Students in this study ranged in age from 17-25 years old (late adolescence) and 26-35 years old (early adulthood). There are 94 students (96.9%) in the age group of 17-25 years (late teens), while the age group of 26-35 years has 3 students (3.1%). The score of personal hygiene, the used of shoes, and physical activity scores were determined by the questionnaires. Students with a poor personal hygiene were 16 students (16,5%), meanwhile 81 students (83,5%) have a good personal hygiene. Based on this study, the use of a close contact shoes > 8 hours was found in 72 students (74,2%). The students who have a low frequency use of close contact shoes were 25 students (25,8%) (table 1).

The IPAQ (International Physical Activity Questionaires) score was used to tally the amount of physical activity. Calculating the Prior to turning all activity time into METS minutes, the IPAQ score was calculated in minutes. 1 METS score is earned at resting, therefore a 2 METS score is twice as much as earned at rest. Since a 1 METS score is obtained when at rest, a 2 METS score is twice as much as that obtained at rest. The METS value for walking exercise is 3.3 METS, for moderate physical activity it is worth 4 METS, and for vigorous activity it is worth 8 METS. This allows us to evaluate the range in scores from the IPAQ. The assigned grades are multiplied by the daily activity duration in minutes and the number of days the activity was completed in order to determine the IPAQ score. For example, if someone reported walking for 30 minutes 5 days a week, the total METS minutes for that activity would be 3.3 x 30 x 5 = 495 METS minutes per week. The overall METS score for 1 week is obtained by adding up the METS scores in each category (walking, moderate activity, and high activity).

Table 1. General distribution of navy military students

Variable	Total	Percentage
Gender		
Male	88	90,7%
Female	9	9,3%
Age group		
17-25 years old	94	96,9%
26-35 years old	3	3,1%
Personal hygiene		
Poor	16	16,5%
Good	81	83,5%
The use of closed shoes		
High (>8 hours)	72	74,2%
Low (<8 hours)	25	25,8%
Lesion		
Scale	97	100%
Erythema	33	34%
Lesion distribution		
Plantar pedis and *interdigital pedis*	77	79,3%
Plantar pedis	10	10,3%
Plantar pedis, dorsum pedis, and *interdigital pedis*	10	10,3%

The conclusion of IPAQ score were concluded based on established criteria that: 1. High category: which is classified as a category of high physical activity if it includes at least one of the criteria: a) Perform high-intensity physical activity for at least three days who achieved the minimum value of MET-minutes/week of total physical activity by 1500 MET-minutes/week, or b) Doing physical activity in combination with walking, moderate intensity or strenuous intensity for seven days or more that achieves a minimum value of MET-minutes/week of total physical activity of 3000 MET/week. 2. Moderate category: which is classified as a category of moderate physical activity if it includes the following criteria: a) Engage in moderate-intensity physical activity or long walks five days or more, for a minimum of 30 minutes per day, or b) Doing a combination of walking, moderate-intensity or vigorous-intensity physical activity for five or more days that achieves a score 62 minimum MET-minutes/week of total physical activity of 600 MET- minutes/week. 3. Light category: which is classified as a category of physical activity mild is if the individual's physical activity does not meet the criteria of the high and moderate categories or the MET minutes/week value is > 600 MET-minutes/week.

The average IPAQ score in military students for one week are 26.880 minutes/week, therefore we can conclude all of the military students have high physical activities every week (table 2).

Table 2. General distribution of IPAQ score in navy military students

IPAQ score	Total
Minimum	3.360 MET minutes/week
Maximum	67.200 MET minutes/week
Mean	35.470 MET minutes/week
Median	26.880 MET minutes/week
Std deviation	16.309 MET minutes/week

IPAQ : International Physical Activity Questionaires
MET :Metabolic Equivalent of Tasks

Clinical examination was determined by the inclusion criteria. According to the criteria 97 students were all had scaly lesions, while erytema lesions were seen in 33 students (34%). This study indicated that the plantar area, dorsum pedis, and interdigital areas all had scaly and erythematous lesions. Lesions were found in the interdigital and plantar pedis areas in 77 students (79.3%) of the total. Students reported complaints only in the plantar pedis area were 10 students (10.3%). Other students had complaints in the plantar pedis, dorsum pedis, and interdigital pedis areas as many as 10 students (10.3%).

AFSS based on the scores were separated into four categories: minimum, mild, moderate, and severe. There were 2 students had minimal AFSS score (2.1%), while 30 students (30.9%) had a mild AFSS score. Around 43 students (44.3%) had a moderate AFSS score, and severe AFSS scores were obtained by 22 students (22.7%). KOH 20% and mycological culture examination were performed to diagnose superficial fungal foot infections. The sample was taken in scaly and erythema lesions, particularly in the interdigital spaces, dorsum pedis area, and plantar pedis area. The samples were subsequently evaluated in the laboratory of the dermatology and venereology outpatient unit after being kept in an airtight petridish. Examination of 20% KOH was carried out according to mycology laboratory standards. The culture test was carried out using SDA (Saborrhaud Dextrose Agar) and then kept at the room temperature. Result of KOH 20% and positive cultures were found in 30 students among 97 students (30.9%). Negative KOH 20% and positive culture found in 27/97 students (27.8%). Positive KOH 20% and negative cultures were found in 9 students among 97 students (9.3%). Negative KOH 20% and negative fungal culture results were found in 31 students among 97 students (31,9%) indicating as non-superficial fungal foot infections (Table 3, Table 4, Table 5).

Table 3. Distribution of KOH result in navy military students

KOH result	Total	Percentage
Positive	39	40,2%
Negative	58	59,8%
Total	97	100%

Table 4. Distribution of fungal culture results in navy military students

Fungal culture result	Total	Percentage
Positive	57	58,8%
Negative	40	41,2%
Total	97	100%

Table 5. The result of KOH and fungal culture in navy military students

Negative KOH and negative fungal culture	Negative KOH and positive culture	Positive KOH and negative culture	Positive KOH and culture	Total
31 Students (31,9%)	27 Students (27,8%)	9 Students (9,3%)	30 Students (30,9%)	97 Students (100%)

Table 6. Distribution of the cause of superficial fungal foot infections in navy military students

Fungal type	Total	Percentage
Candida spp.	17	29,8%
Mold	39	68,4%
Tricophyton rubrum	1	1,7%

Among 57 students who had positive culture findings, 39 students had mold infection, which was the most common kind of fungal infections in this study (68.4%). Surprisingly, out of the 57 students whose cultures were counted as positive, we found that dermatophyte is the least common cause of superficial fungal foot infections in this study, affecting only 1 student (1,7%). *Tricophyton rubrum* was the cause of dermatophyte infection in this study. *Candida* spp. was the other cause affecting 17 out of the 57 students who had positive culture results (29.8%). (Table 6).

In the mold group 16 students from the total of 39 students (41,1%) had affected by *Aspergillus* spp. which is the most prevalent type for superficial fungal foot infections. The next most common type were *Penicillium* spp. (11 students, 28,6%), *Neocystalidum* spp. (3 students, 7,7%), *Fusarium* spp. (2 students, 5,1%), and *Chaetomium* spp. (2 students, 5,1%). *Curvularia* spp., *Drechslera* spp., *Syncephalastrum* spp., *Gliocladium* spp., and *Bipolaris* spp. each infected 1 students (2,5%) (Table 7).

Table 7. Distribution of the mold type as the cause of superficial fungal foot infections in navy military students

Mold type	Total	Percentage
Aspergillus spp.	16	41,1%
Penicillium spp.	11	28,6%
Neocystalidum spp.	3	7,7%
Fusarium spp.	2	5,1%
Chaetomium spp.	2	5,1%
Curvularia spp.	1	2,5%
Drechslera spp.	1	2,5%
Syncephalastrum spp.	1	2,5%
Gliocladium spp.	1	2,5%
Bipolaris spp.	1	2,5%
Total	39	100%

DISCUSSIONS

The sample of this study were 97 students with the number of male students were higher than female students. Through this study, there were 88 male students (90.7%) while the female students were 9 students (9.3%). Male soldiers were more likely to have superficial fungal foot infections than female soldiers, according to earlier studies in Italia. The study reported that the number of male soldiers was 975 military students (95.21%) while the number of female students was 49 students (4.79%).[3,8] It is explains why men make up the majority of military students. Students in this study ranged in age from 17 to 25 (late adolescence) and 26 to 35 (early adulthood). There are 94 students (96.9%) in the late teenage group (17–25 years old). and 26-35 years old (early adulthood). The number of students with the age group of 17-25 years (late teens) is 94 students (96.9%), while the 26-35 years age group has 3 students (3.1%) with a maximum age of 28 years. An earlier study on military students in Thailand found that the average age of the group was between 18 and 20 years old. The age range of students enrolled in military training in Pakistan is smaller than that of students impacted by study performed in Thailand and at the Center of Basic Military Academy in Surabaya, which involved students ages 16 to 23.[2,7]

The goal of good personal hygiene is to shield people against physical and mental disease. Culture, geography, and environment are the key factors that affect personal hygiene. Other factors influencing include energy, age growth, health, and personal preferences.[9] According to this survey, 81 students (83,5%) of military students had good personal hygiene, while 16 students (16.5%) had poor personal hygiene. Through this study, students who had a poor personal hygiene were low. Studies in Thailand, reported personal hygiene as a risk factor for superficial fugal foot infections. Though these report were highly controversial because the general perceptions about good personal hygiene and regular bathing can prevent infection. In most countries in South East Asia, bathing twice a day is a routine hygiene practice that has been carried out for a long time. Thus reason is a basic principle of good personal hygiene that are widely known by the public.[2]

Prolonged used of wearing closed shoes was also reported in this study. Of the military students, 72 (74.2%) wore closed shoes on a high frequency, while 25 (25.6%) wore closed shoes on a low frequency. It is required of military students to wear closed shoes. More than eight hours were spent wearing closed shoes on average. A study conducted in Pakistan examined

the distribution of closed shoes, finding that 336 military students (96%) out of 350 military students in total wore them for more than eight hours each time.[7]

Military closed shoes are tight and have poor ventilation creating a hot, humid environment that support mold to growth. Wearing closed shoes for more than 8 hours makes the fungus easier to grow.[10] The incidence of superficial fungal foot infections in soldiers in a subtropical country is said to be higher during summer. This is in line with research conducted on army troops in Georgia during the summer. This condition can be caused by a change condition in the area around the shoe. In winter, the shoe area tends to be colder and drier, which reduces the incidence of superficial fungal foot infections.[11]

Most of the military students had a high frequency physical activity. The students carried out outdoor activities in the forest area of Purboyo, Southern Malang for 3 weeks before the day of collecting the sample. The activities for 3 weeks including morning assembly, morning run, rapelling, long march, map reading, combat training, and drills rescue at the sea. All activities not only require students to walk but also run. The average IPAQ score for 1 week is 26.880 MET minutes/ week. In this case, we can conclude that all military students have a high physical activity every week. High physical activity is one of the factors in superficial fungal foot infections case in the army. Study was conducted in Israel with a total of 223 military students filled out the questionaires. The results reported the average of millitary students have a high physical training including basic training, armor commander training, advanced infantry training, armor office training had a clinical prevalence of superficial fungal foot infections of 60.1%.[3, 12]

This study showed 97 students were all had scaly lesions, while erythema lesions were seen in 33 students (34%). Both scaly and erythematous lesions found in the plantar area, dorsum pedis, and interdigital areas. A total of 77 students (79.3%) had lesions in the plantar pedis area and the interdigital area. Students who had complaints in the plantar pedis area alone were 10 students (10.3%). Other students had complaints in the plantar pedis, dorsum pedis, and interdigital pedis areas as many as 10 students (10.3%). Other study in Pakistan reported beyond 350 military students there were 34 students (9,71%) suspected with superficial fungal foot infections. The most general clinical signs were found erythema and scale. The most affected area in pedis was interdigital.[7, 12]

The result of KOH 20% and positive cultures were found in 30 students (30.9%). Negative KOH 20% and positive culture found in 27 students (27.8%). Positive KOH 20% and negative cultures were found in 9 students (9.3%). Negative KOH 20% and negative fungal culture results were found in 31 students (31,9%) and concluded as non-superficial fungal foot infections. KOH and fungal culture is a gold standard to establish the diagnosis of superficial fungal foot infections. Both of the examination had a good sensitivity. A study in Thailand showed that the sensitivity of KOH examination and culture was quite high. The study stated that the sensitivity values for each KOH value and culture were 73.3% and 77.7%. This study reported a slightly lower KOH test sensitivity value than a study in Thailand. The sensitivity of the KOH examination in this study was 59.09%. The sensitivity value of culture examination in this study was found to be higher when compared to studies in Thailand, which was 83.6%. [2]

The diagnosis of superficial fungal foot infections was based on both from fungal culture and KOH 20% test. Among the sample, 66 students (68,0%) had superficial fungal foot infections, while the remaining 31 students were determined to have non-superficial fungal foot infections. The causes of non-superficial fungal foot infections could be caused by contact dermatitis or other skin diseases. This report was consistent with a study conducted in Thailand, which reported that 57 military students had superficial fungal foot infections based on KOH and mycological culture examination, with 1 student there having a secondary infection. In our study there were no students with secondary infection. This could be caused by all students already receive a treatment before in the health unit prior the day of sample were collected. [2]

Among 57 students who had positive culture findings, 39 had mold infection, which was the most common cause of fungal infections in this study (68.4%). The second common infections with the total of 17 students (29,8%) were infected by *Candida* spp. Surprisingly, we discovered that dermatophyte, only afflicted in 1 student (1,8%), and becoming the least common cause of superficial fungal foot infections in our study. A cohort study involving 788 navy military students in Thailand produced contradictory results. The most common causative fungal were dermatophytes consisting of *Tricophyton mentagrophytes* (52,8%), followed by *Epidermophyton floccosum* (13,9%), *Tricophyton rubrum* (11,1%), *Tricophyton tonsuranss* (2,8%),

while the case of non-dermatophyte fungal in this study were found *Neocystalidum dimidiatum* (11,1%), and *Candida* spp. (8,3%).[2]

Aspergillus spp. a common saprophytic mold that grows in soil, air, and plants was found to be the most common cause of superficial fungal foot infections in this study. A host is more likely to become infected if they have wounds, trauma, or broken nails. Walking barefoot, unhygienic surroundings, and perspiring skin are examples of predisposing factors that can significantly increase the chance of accidents and damage. Certain occupations can cause *Aspergillus* spp. as the cause for superficial fungal foot infections.[13] One case reported cutaneous aspergillosis in superficial fungal foot infections caused by *Aspergillus niger* in an immunocompetent adult in India. The clinically sign was reported as hyperpigmented, scaly, sharply marginated 3-4 lesions with slightly raised border over the right sole. KOH 10% revealed the presence of septate hyaline hyphae. The fungal cultured using SDA in this case found as white colonies initially and matures to velvety, jet-black center with characteristic white apron or brem and no reverse pigment after about 7 days. In one of our reports, the clinical sign of *Aspergillus* spp. was found as scaly erythematous lesion on the interdigital spaces and scaly hyperpigmented over both of the soles and onychodystrophy on the thumb. The 20% KOH examination showed a septate-hyphae. The fungal culture of *Aspergillus* spp. was found as cottony white colonies to the yellow. It is hard to differentiate the cause superficial fungal foot infections judging only by the clinical sign. Further examination such as fungal culture should be done to know the cause.[14]

Case report about *Penicillium* spp. as the cause of superficial fungal foot infections is rarely find. In our report, the clinical sign of superficial fungal foot infections caused by *Penicillium* spp. was founded no difference with other *mold* infections. 20% KOH revealed a hyphae. The fungal culture was found as white colonies. The microscopic culture in our case showed a typically long chain. *Penicillium* spp. typically showed a fast growing colonies in shades of green and sometimes white colonies and a dense felt of conidhiophores.[15] In few literatures, the microscopic of *Penicillium* spp. showed an insulated hyphae with ramifications at the end of the conidhiophores. Metulae, fialid, and conidia were attached like a long chain.[16]

Candida spp. as the second most common cause of non-dermatophyte infection in this case is a fungal infection caused by the yeast. The most common type of *Candida* as the cause of superficial fungal foot infections is *C. albicans*. *C. albicans* can grow in any conditions, this is because it has a different morphological forms (unicellular budding yeast, *pseudohyphae*, and true *hyphae*) which allow it to become virulent and attack the host. Environmental conditions, changes in the immune system, underlying diseases, and trauma can induces a normal flora to pathogens.[17]

Dermatophyte as the most common cause of superficial fungal foot infections were unexpectedly found less in this study, this could be happened because the transmission of dermatophyte occur through direct contact with infected skin or fomites. Other transmission method beside direct contact is human to human.[18] The transmission through soil to human (geophlyic) is rarely to be happened. The sample of this study was collected after the students underwent 3 weeks of training in the Purboyo forest, South Malang, so the risk of being exposed to dermatophyte was quite low. Apart from that, the students had brought their own toiletries and clothes, so the risk of the transmission of dermatophyte in this study was quite low.

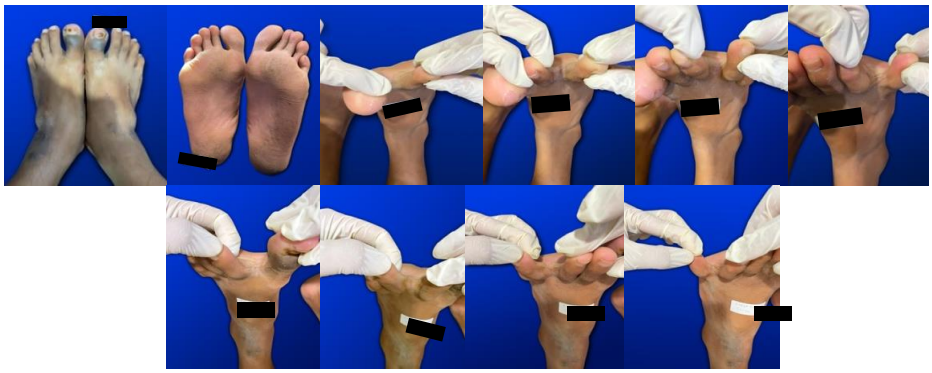

Figure 1. The clinical sign of superficial fungal foot infections caused by *Aspergillus* spp. in one of the navy students showed a multiple scale on *plantar pedis* and macule erythematous on *plantar pedis* and interdigital spaces. Multiple micro erosion were also seen.

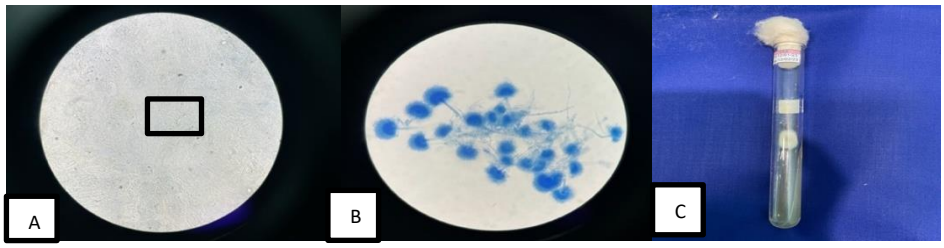

Figure 2. The result from 20% KOH showed a septate hyphae by 10x magnifier (A), the microscopic form of *Aspergillus* spp. showed conidhiophores (B), the macroscopic form of *Aspergillus* spp showed a cottony white colonies. **(**From A to C).

Figure 3. The clinical sign of superficial fungal foot infections caused by *Penicillium* spp. in one of the navy students showed a multiple scale on both *plantar pedis* and interdigital spaces. Multiple micro erosions were also seen.

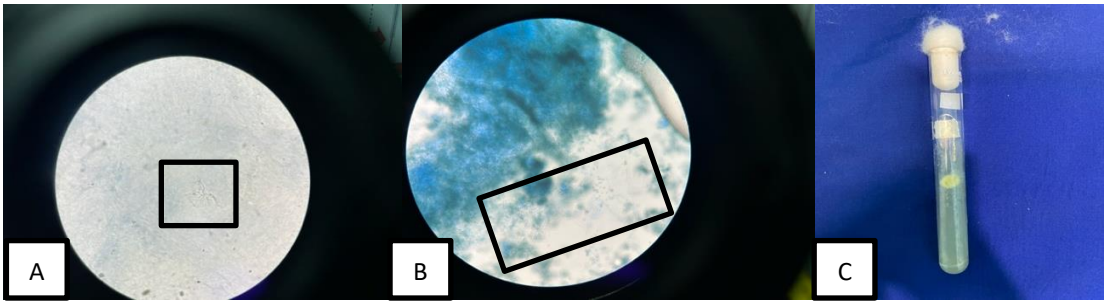

Figure 4. The result from 20% KOH showed a hyphae (A), the microscopic form of *Penicillium* spp. showed a long branch (B), the macroscopic form of *Penicillium* spp. showed a white colonies (C).

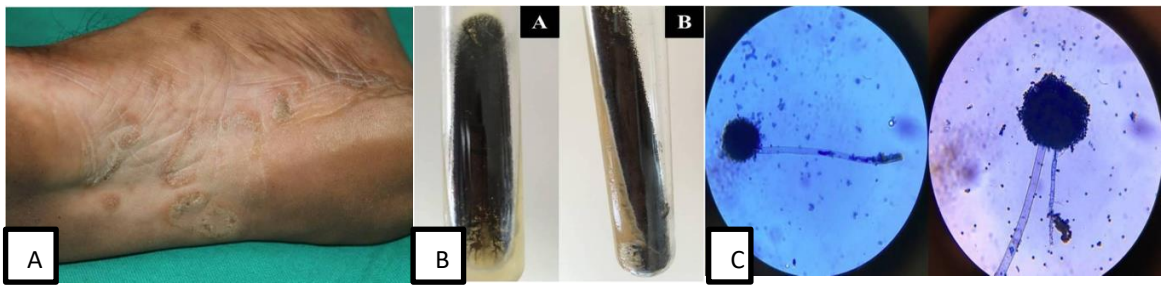

Figure 5. The clinical sign of *superficial fungal foot infections* caused by *Aspergillus niger* in India (A), the macroscopic form of *Aspergillus niger* (B), the microscopic form of *Aspergillus niger* (C).[14]

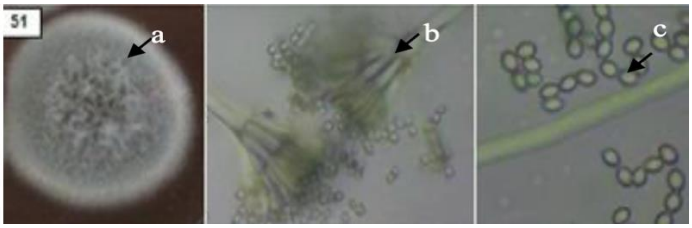

Figure 6. The macroscopic and microscopic of *Penicillium* spp. showed taken from fungi contaminated chicken feed in Tegal. (A to C) Macroscopic showed a white colony (A). Microscopic showed a conidhiophore and conidhia (B-C). [16]

Most of the navy military students have a good personal hygiene, they also use a close contact shoes > 8 hours frequently. The navy military students have a high physical activity every day. Mold is the most common cause of superficial fungal foot infections in this study.

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